PRECIPITATION PROCESSING SYSTEM

GLOBAL PRECIPITATION MEASUREMENT

File Specification for GPM Products

Version 7.16 TKIO 3.100

May 26, 2023

Contents

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1 Introduction

Global Precipitation Measurement (GPM) is an international satellite mission to provide observations of rain and snow worldwide. NASA and Japan Aerospace Exploration Agency (JAXA) launched the GPM Core satellite from Japan on February 27, 2014 UTC (February 28 Japan Standard Time). The data provided by the Core unifies precipitation measurements made by an international network of partner satellites to quantify when, where, and how much it rains or snows around the world.

1.1 Identification

This is the File Specification for GPM Products.

1.2 Scope

This document describes the data file formats for GPM products. Metadata is described in Metadata for GPM Products.

1.3 Purpose and Objectives

The purpose of this file specification document is to define the file content and format for the GPM data products.

1.4 Document Status and Schedule

The file specifications have been reviewed by the algorithm developers. Formats are expected to change for each processing cycle.

1.5 Document Organization

The organization is as follows:

Section 2 LOGICAL FORMAT - This section describes general aspects of the logical format.

Section 3 PHYSICAL FORMAT - This section describes general aspects of the physical format.

Section 4 FORMATTING CONVENTIONS - This section describes the general formatting conventions used in this document.

Section 5 STANDARD GPM PRODUCTS - This section describes the file specifications for the standard GPM products.

2 Logical Format

The logical format of a data product consists of the names, types, dimensions, and organization of the data. The physical format is the implementation of the logical format with an underlying format such as Hierarchical Data Format (HDF). The bulk of this document consists of the logical format of each GPM data product.

GPM data products contain metadata and data. Metadata are small text strings containing label information such as the name, date, and time of the data products. Metadata are often organized into metadata groups.

Data are arrays or scalers. Data are often organized into swath structures or grid structures. Some products have groups outside or inside swath structures or grid structures.

2.1 Swath Structure

The swath structure stores satellite data which are organized by scans. Swath structures are implemented in Levels 1A, 1B, 1C, 2A, and 2B. The swath structure is contained in a group. In this swath group is the metadata group SwathHeader, data group ScanTime, data arrays Latitude and Longitude and other data arrays. In some products there are additional data groups under the swath group. The contents of the metadata group SwathHeader are explained in Metadata for GPM Products.

2.2 Grid Structure

The grid structure stores earth located grids. Each grid is an array of grid boxes, rather than grid points. Grid structures are implemented in Level 3A and 3B products. The grid structure is contained in a grid group. In this group is the metadata group GridHeader and data arrays. In some products there are additional data groups under the grid group. The contents of the metadata group GridHeader are explained in Metadata for GPM Products.

3 Physical Format

The logical format of GPM data products is written in an underlying format such as HDF.

3.1 Heirarchical Data Format

HDF was developed by the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Champaign-Urbana and is the archive format for GPM data. HDF manuals and software may be obtained via anonymous ftp at ftp.ncsa.uiuc.edu

The logical group is implemented in HDF as a Vgroup. The logical array or scalar is implemented in HDF as a Scientific Data Set. Each SDS contains the data array and additional information as attributes: names of dimensions, units, scale, offset, and scale description.

Each metadata group is implemented in HDF as an attribute. Elements within a group are implemented as

ElementName=ElementValue;

If the element has a list of values, the values are separated with a comma:

ElementName=Value1,Value2,...,ValueN;

4 Formatting Conventions

4.1 File Structure Figure

Each data product section has a file structure figure and file contents. The file structure figure show the organization of the data within the file. The File is on the left. Under the file are circles showing swaths or grid structures or boxes showing metadata, groups, or arrays. Group boxes are shaded. Array boxes contain the size of one element with the dimensions to the right of the box. A group has an additional figure showing the contents of the group.

4.2 File Contents

Each array or scaler is described with name in bold, then parenthesis containing the data type and dimensions, and then a description.

4.3 Missing Data and Empty Granules

Missing data are denoted by values equal to -9999.9, -9999.9, -9999, -9999, -9999, -99, 65535, 4294967295, 255, and NULL for for 8-byte float, 4-byte float, 8-byte integer, 4-byte integer, 2-byte integer, 1-byte integer, 2-byte unsigned integer, 4-byte unsigned integer, 1-byte character, and variable length string. Any exceptions to the use of the above standard values are explicitly notes in the description.

If an entire granule is missing, an empty granule may be created. An empty granule is defined by the metadata element EmptyGranule in the metadata group FileHeader. Software reading a granule should check EmptyGranule first. Swath data or grid data may be empty.

4.4 Array Dimension Order

In the definition of array dimensions, e.g. npixel x nscan, the first dimension (npixel) is the most rapidly varying index and the last dimension (nscan) is the least rapidly varying index. To implement the format in FORTRAN, declare an array with the dimensions as they appear in this document. To implement the format in C, declare an array with the dimensions reversed from their appearance in this document.

4.5 Array Index

The meaning of each array index is explained at the beginning of each algorithm section in the list called "Dimension Definitions." Some array indeces denote a type rather than a number. For example, PIAalt has dimensions method x nray x nscan and there are 6 methods. If an index is enumerated the index value will start with 1 (rather than 0) unless otherwise indicated.

4.6 Granule definition

For orbital products, the beginning and ending time are defined as the time the sub-satellite track reaches its southernmost latitude. A scan is included in a granule when its ScanTime is greater than or equal to the Granule start time and less than the Granule end time.

For time-averaged products, the beginning time is the first millisecond of the period and the ending time is the last millisecond.

5 Standard GPM Products

5.1 1AGMI - GMI unpacked packet data

1AGMI contains unpacked packet data from GMI science data from the GMI passive microwave instrument flown on the GPM satellite. Swath S1 has 9 channels which are similar to TRMM TMI (10V 10H 19V 19H 23V 37V 37H 89V 89H). Swath S2 has 4 channels similar to AMSU-B (166V 166H 183+/-3V 183+/-8V). Data for both swaths is observed in the same revolution of the instrument. Swath S3 has ScienceDataHeader. Swath S4 has full rotation for low freq channels (S1). Swath S5 has full rotation for high freq channels (S2).

```
GMI sample counts.
                                        The S1 channels are:
10.7  GHz vertically-polarized
10.7  GHz horizontally-polarized
18.7  GHz vertically-polarized
18.7  GHz horizontally-polarized
23.8  GHz vertically-polarized
36.5  GHz vertically-polarized
36.5  GHz horizontally-polarized
        89.0  GHz vertically-polarized
        89.0  GHz horizontally-polarized


GMI sample counts.
                                        The S2 channels are:
166.0  GHz vertically-polarized
166.0  GHz horizontally-polarized
        183.31+/-3  GHz vertically-polarized
        183.31+/-8  GHz vertically-polarized
```

Earth observations are taken during a segment of the rotation when GMI is looking in the +x direction of the GPM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

32rpm * 1min/60s * 5538s/orbit = 2954 scans / orbit.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and the same number of pixels as Swath S1. Each S1 scan contains 9 channels sampled 221 times along the scan. Each S2 scan contains 4 channels sampled 221 times along the scan. Since the incidence angle of Swath S1 is different than Swath S2, the geolocations of the pixel centers are different.

Dimension definitions:

VH	2	Number of polarizations.
nscan1	var	Typical number of Swath S1 scans in the granule.
nchannel1	9	Number of Swath S1 channels (10V 10H 19V 19H 23V 37V 37H 89V 89H).
npixelev	221	Number of earth view pixels in one scan.
npixelht	221	Number of hot load pixels in one scan.
npixelcs	221	Number of cold sky pixels in one scan.
nscan2	var	Typical number of Swath S2 scans in the granule.
nchannel2	4	Number of Swath S2 channels (166V 166H 183+/-3V 183+/-8V).
npixel3	1	Number of "pixels" in one scan in S3.
npixelfr	500	Number of full rotation earth view pixels in one scan.
nchannel12	13	Number of Swath S1 and S2 channels.
dim2	2	Number.
dim3	3	Number.
dim4	4	Number.
dim5	5	Number.
dim6	6	Number.
dim7	7	Number.
dim8	8	Number.
dim9	9	Number.
dim10	10	Number.
dim11	11	Number.
dim12	12	Number.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.
SVBFd	3	SunVectorinBodyFrame dimension.

Figure 1 through Figure 47 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

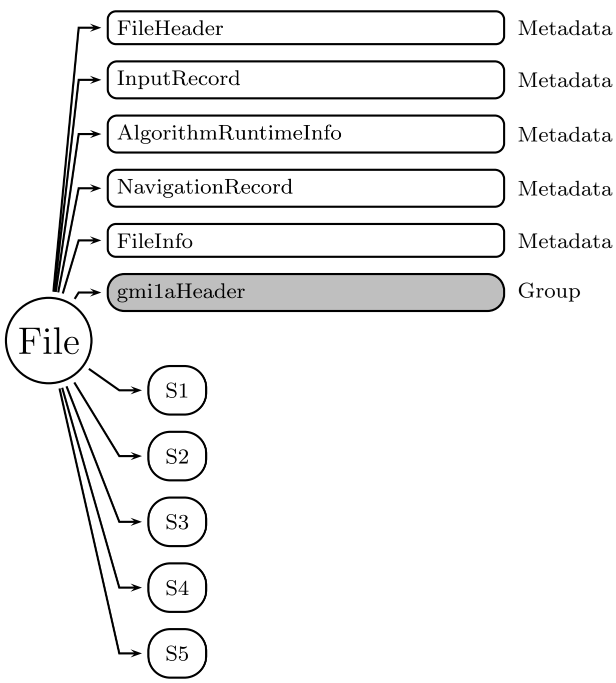

Figure 1: Data Format Structure for 1AGMI, GMI unpacked packet data

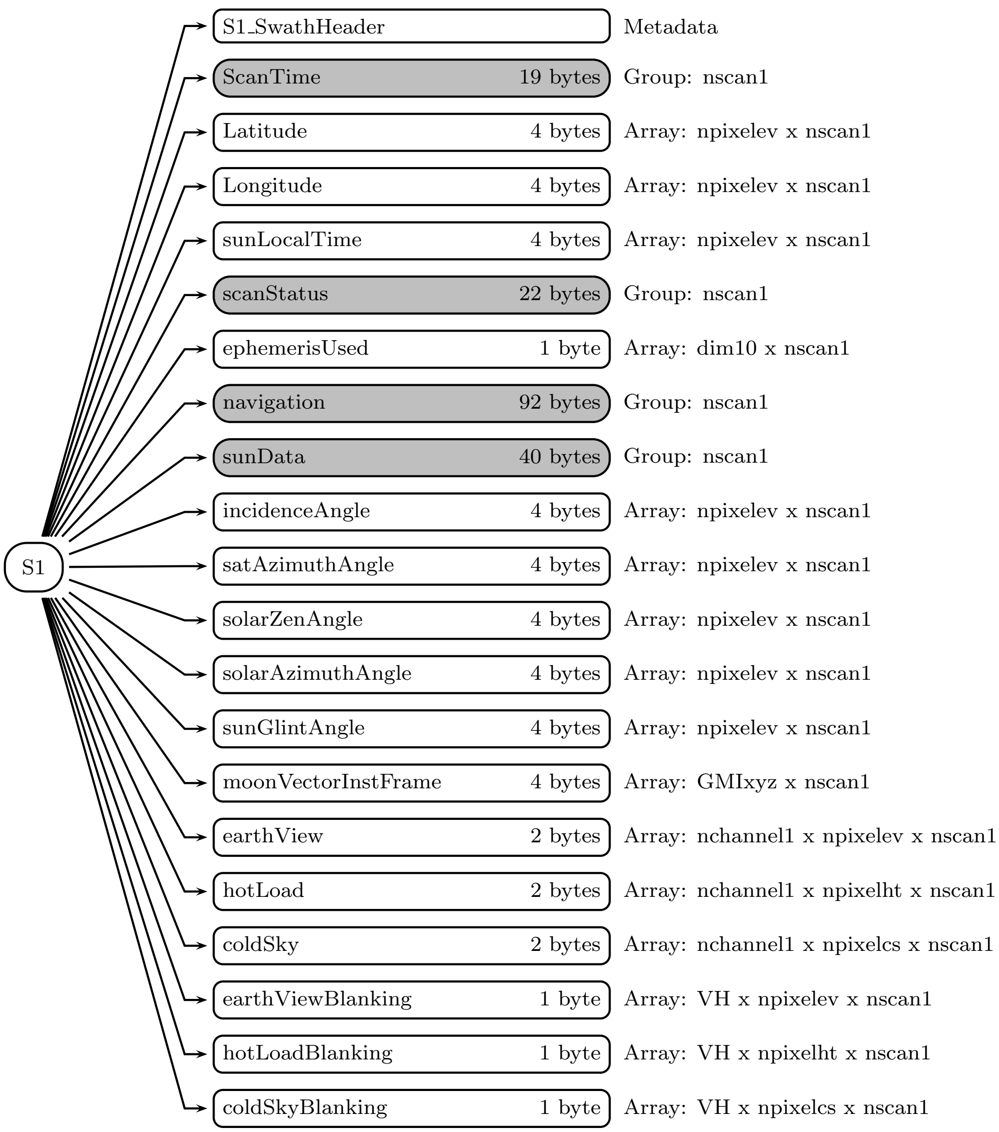

Figure 2: Data Format Structure for 1AGMI, S1

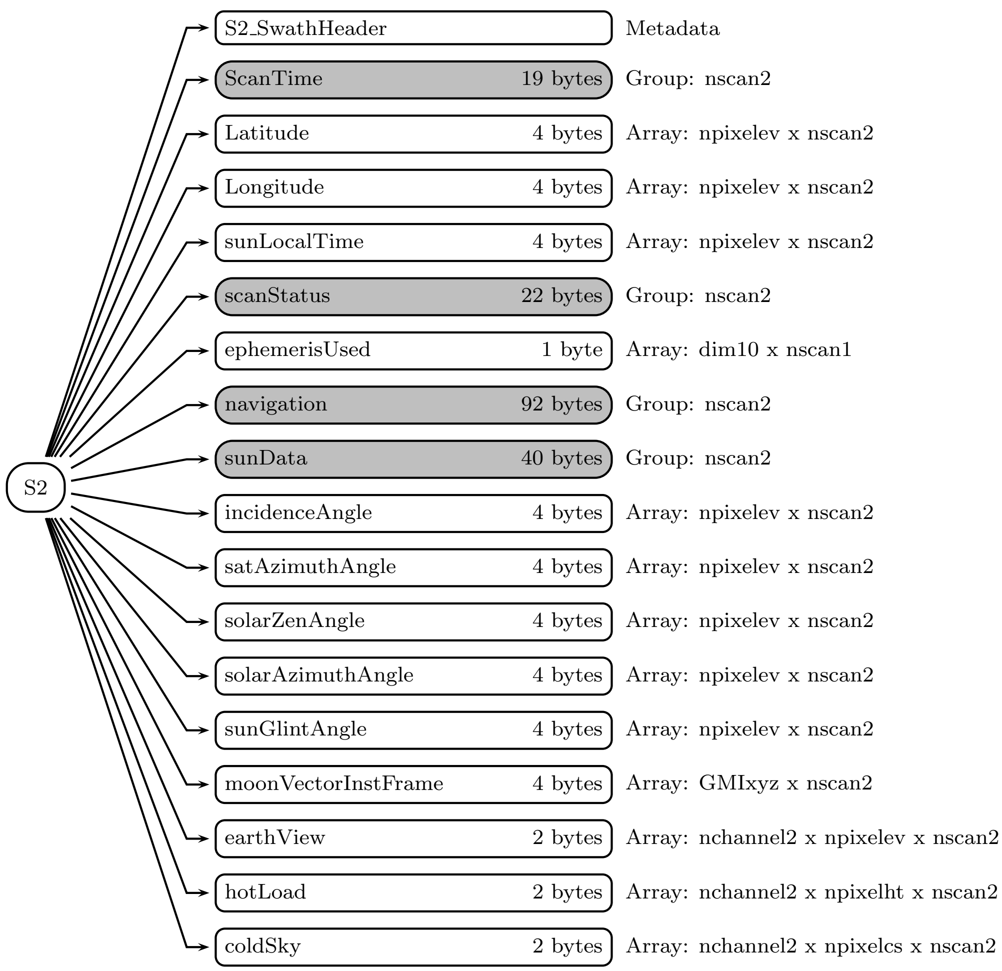

Figure 3: Data Format Structure for 1AGMI, S2

S3

- S3_SwathHeader — Metadata
- ScanTime 19 bytes — Group: nscan2
- ephemerisUsed 1 byte — Array: dim10 x nscan1
- Latitude 4 bytes — Array: nscan2
- Longitude 4 bytes — Array: nscan2
- TAM1 10 bytes — Group: nscan2
- TAM2 10 bytes — Group: nscan2
- TORQUE_BAR 10 bytes — Group: nscan2
- GMI_TEMPERATURES 16 bytes — Group: nscan2
- primaryHeader 10 bytes — Group: nscan2
- instrTimeSeconds 4 bytes — Array: nscan2
- instrTimeSubseconds 2 bytes — Array: nscan2
- numPacketSegments 1 byte — Array: nscan2
- spare 1 byte — Array: nscan2
- RDRversion 2 bytes — Array: nscan2
- GSDR_TIME 42 bytes — Group: nscan2
- SENSOR_INFO 74 bytes — Group: nscan2
- RS_INFO 90 bytes — Group: nscan2
- SYNCH_STAMPS 102 bytes — Group: nscan2
- SYNCH_STAMPS2 102 bytes — Group: nscan2
- RSHSK_STATUS 52 bytes — Group: nscan2
- RSHSK_SAMPL_INFO 28 bytes — Group: nscan2
- RSHSK_GAIN 28 bytes — Group: nscan2
- RSHSK_TEMP 56 bytes — Group: nscan2

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Figure 4: Data Format Structure for 1AGMI, S3,

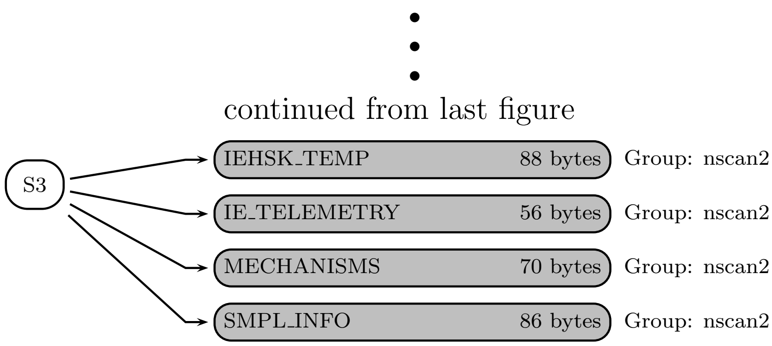

Figure 5: Data Format Structure for 1AGMI, S3

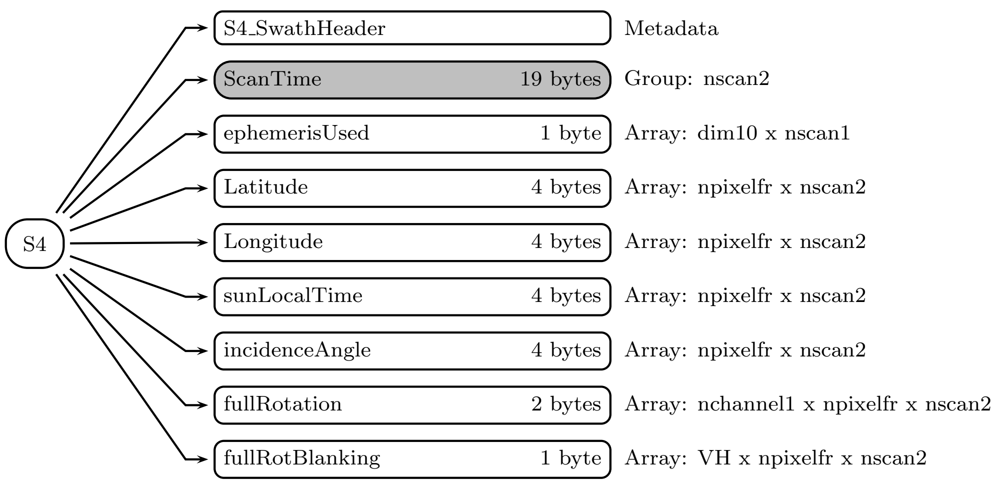

Figure 6: Data Format Structure for 1AGMI, S4

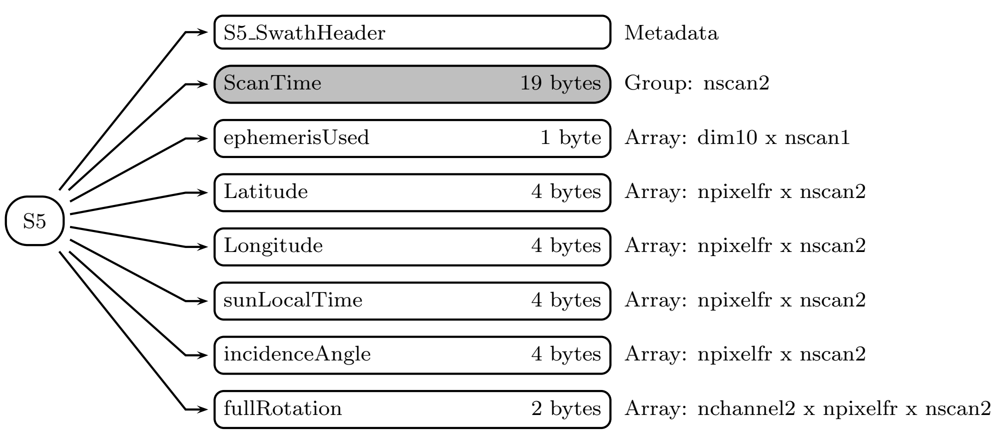

Figure 7: Data Format Structure for 1AGMI, S5

Figure 8: Data Format Structure for 1AGMI, gmi1aHeader

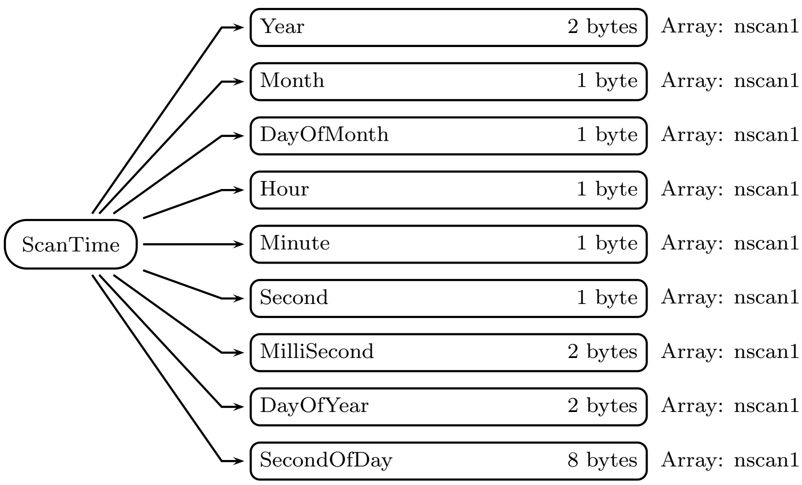

Figure 9: Data Format Structure for 1AGMI, S1, ScanTime

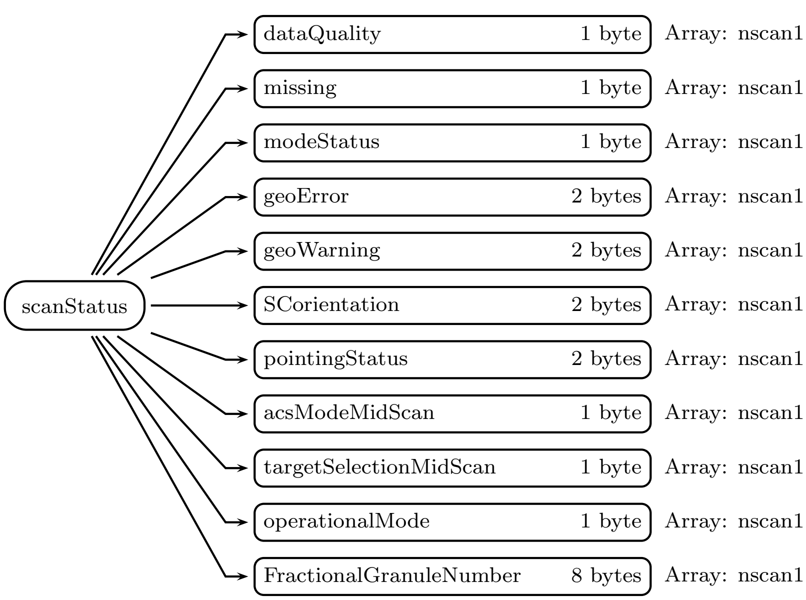

Figure 10: Data Format Structure for 1AGMI, S1, scanStatus

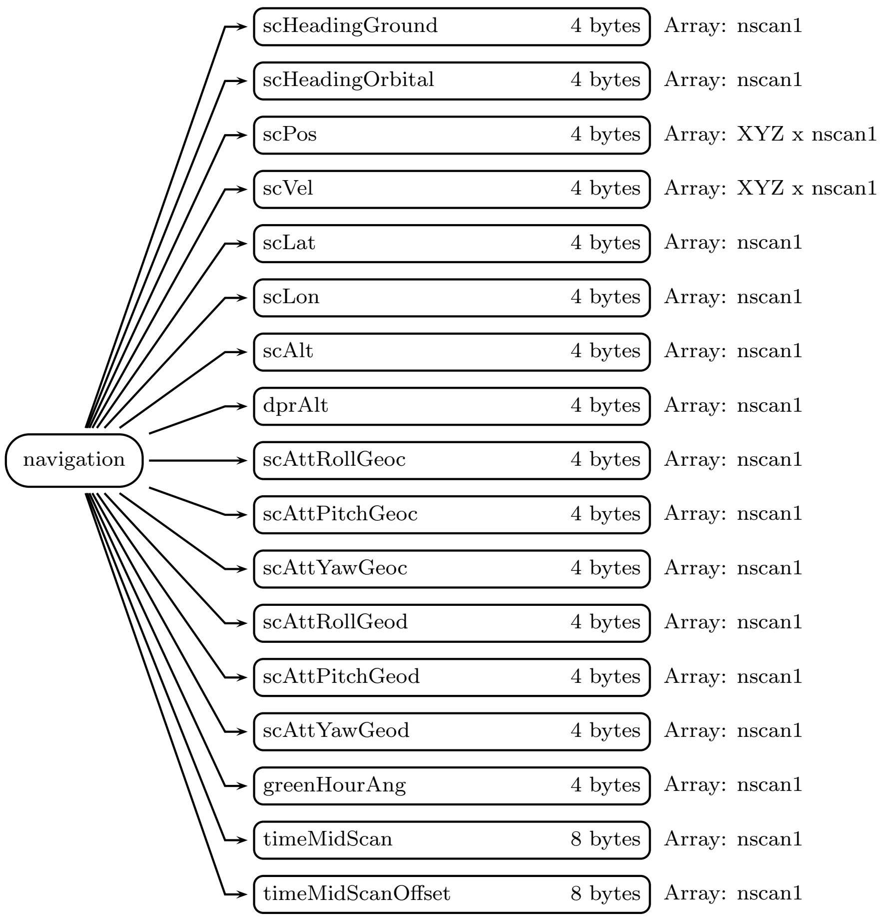

Figure 11: Data Format Structure for 1AGMI, S1, navigation

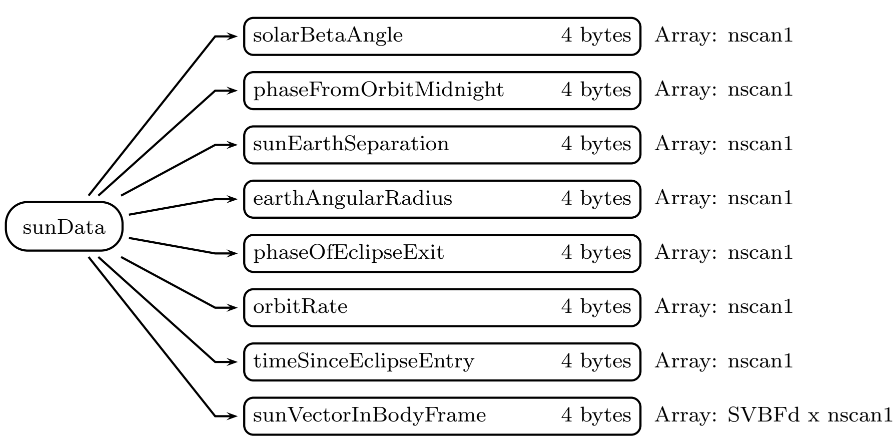

Figure 12: Data Format Structure for 1AGMI, S1, sunData

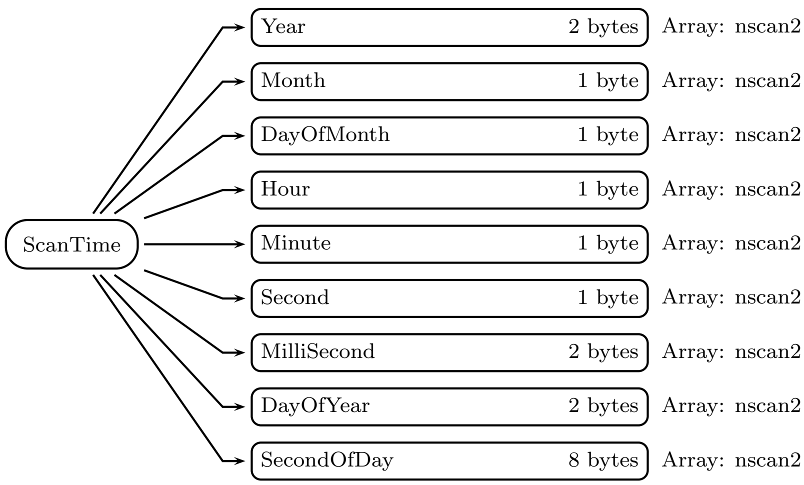

Figure 13: Data Format Structure for 1AGMI, S2, ScanTime

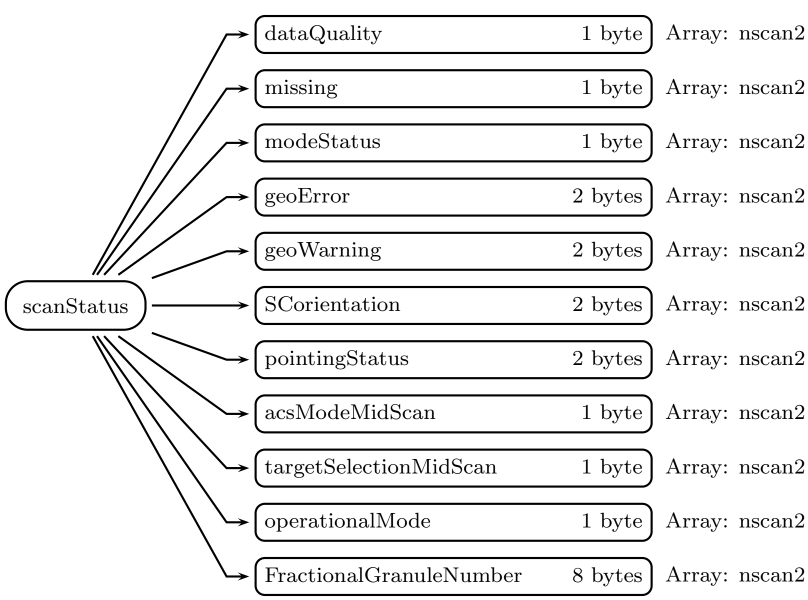

Figure 14: Data Format Structure for 1AGMI, S2, scanStatus

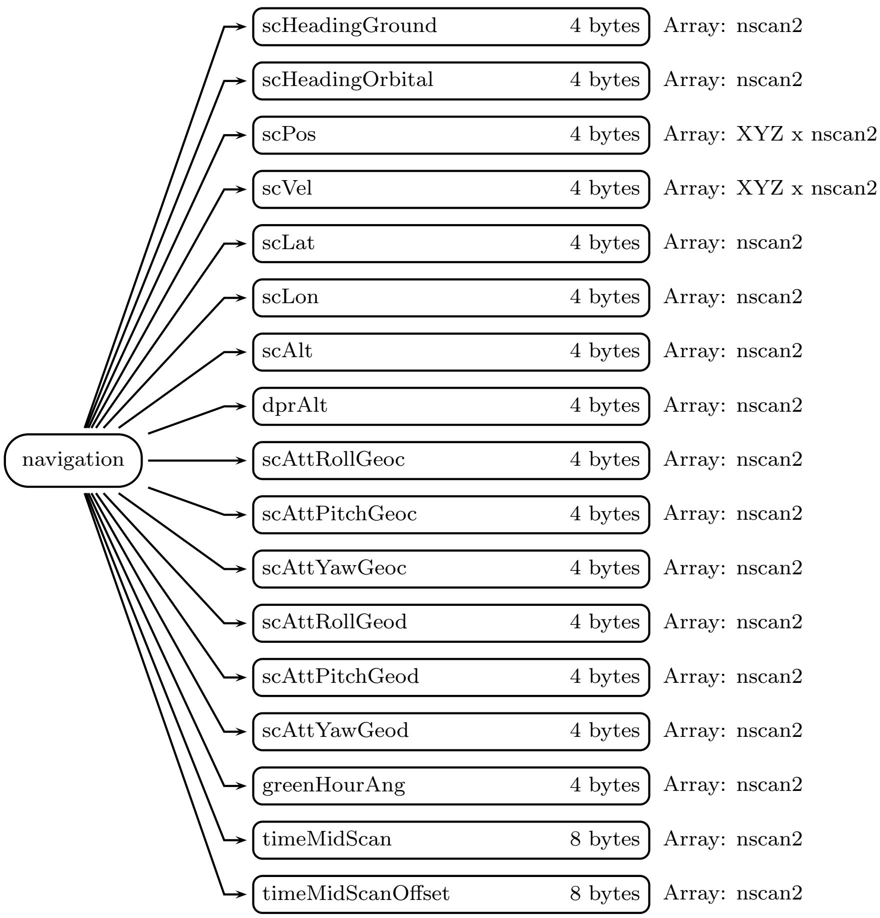

Figure 15: Data Format Structure for 1AGMI, S2, navigation

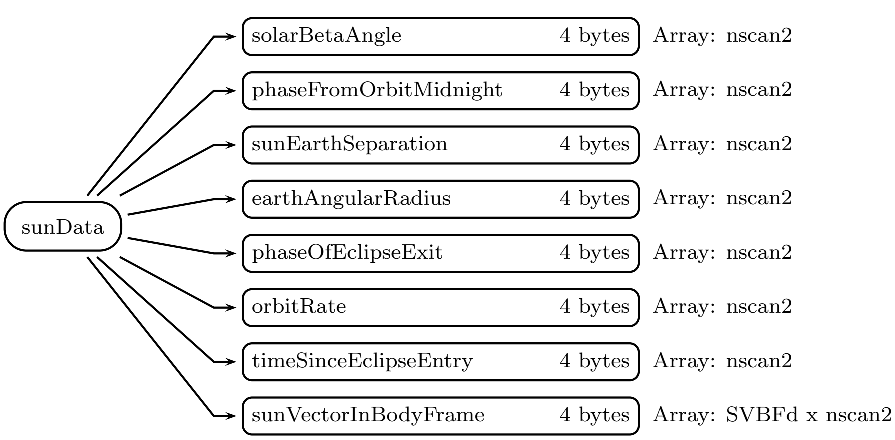

Figure 16: Data Format Structure for 1AGMI, S2, sunData

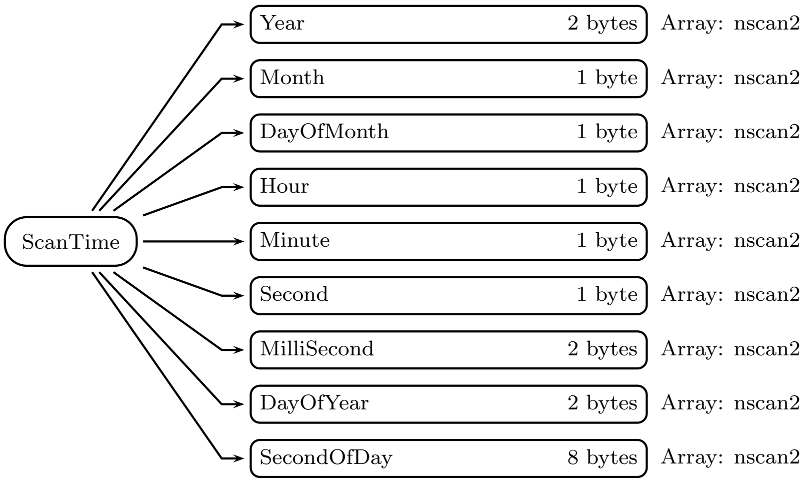

Figure 17: Data Format Structure for 1AGMI, S3, ScanTime

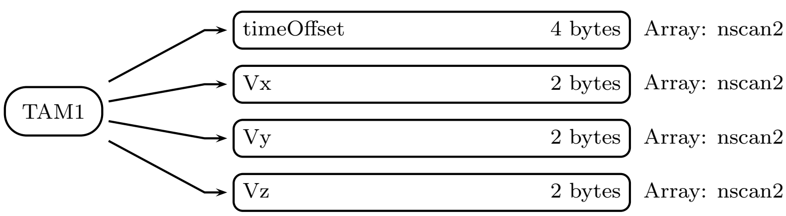

Figure 18: Data Format Structure for 1AGMI, S3, TAM1

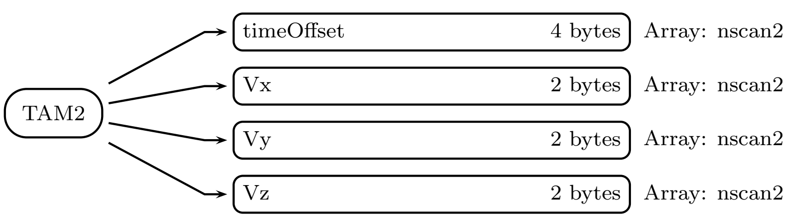

Figure 19: Data Format Structure for 1AGMI, S3, TAM2

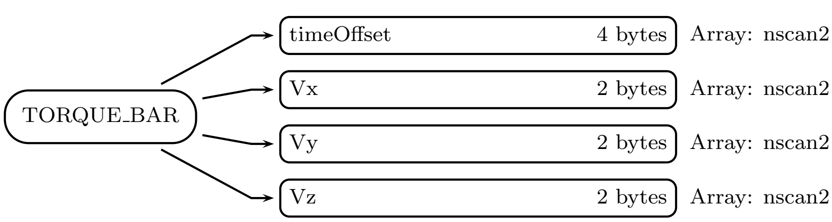

Figure 20: Data Format Structure for 1AGMI, S3, TORQUE_BAR

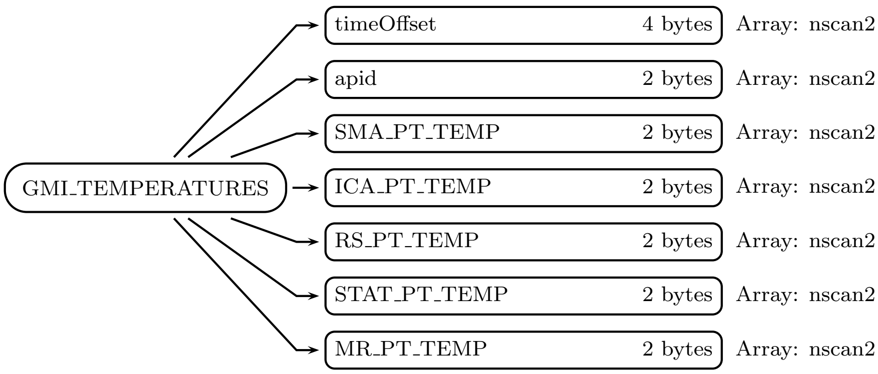

Figure 21: Data Format Structure for 1AGMI, S3, GMI_TEMPERATURES

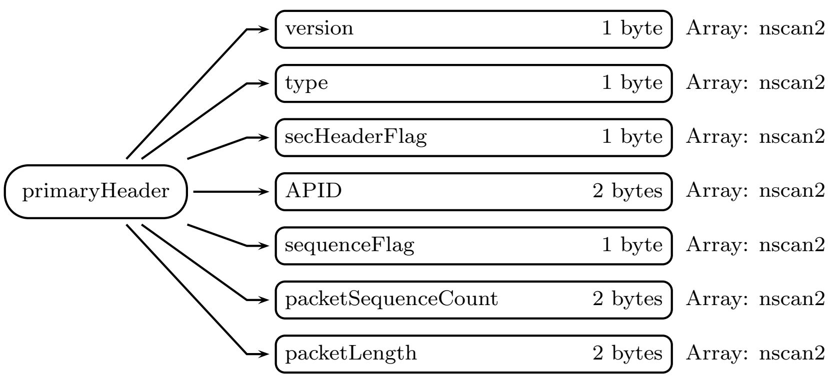

Figure 22: Data Format Structure for 1AGMI, S3, primaryHeader

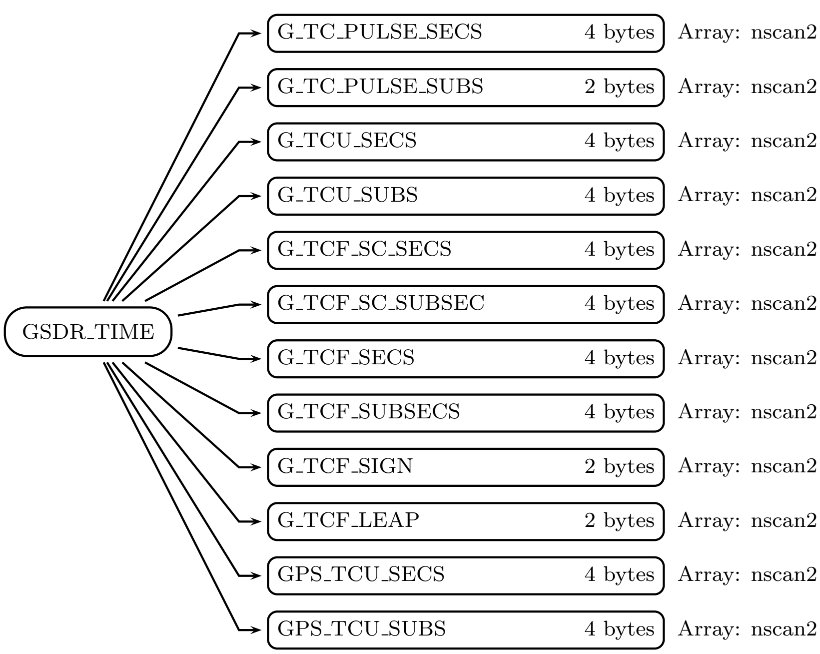

Figure 23: Data Format Structure for 1AGMI, S3, GSDR_TIME

SENSOR_INFO

KEEP_ALIVE_CNT	4 bytes	Array: nscan2
FPGA_RST_REASON	2 bytes	Array: nscan2
CRASH_REASON	2 bytes	Array: nscan2
VERSION_MIN	2 bytes	Array: nscan2
VERSION_MAJ	2 bytes	Array: nscan2
FPGA_MODE	2 bytes	Array: nscan2
ERR_HDL_FAILURE	2 bytes	Array: nscan2
RESET_REASON	2 bytes	Array: nscan2
BOOT_BANK	2 bytes	Array: nscan2
CURRENT_BANK	2 bytes	Array: nscan2
EDAC_ENABLE	2 bytes	Array: nscan2
WDOG_ENABLE	2 bytes	Array: nscan2
SC_1HZ_REF	2 bytes	Array: nscan2
SCE_FORCE_SEL	2 bytes	Array: nscan2
RS_1MHZ_REF	2 bytes	Array: nscan2
RS_SCAN_START	2 bytes	Array: nscan2
FPGA_IE_RX_EN	2 bytes	Array: nscan2
FPGA_RS_RX_EN	2 bytes	Array: nscan2
FPGA_SCE_RX_EN	2 bytes	Array: nscan2
EEPROM_BUSY	2 bytes	Array: nscan2
RS_TLM_PROG	2 bytes	Array: nscan2
SCE_A_ACTIVE	2 bytes	Array: nscan2
SCE_A_RLY	2 bytes	Array: nscan2
SCE_B_ACTIVE	2 bytes	Array: nscan2

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Figure 24: Data Format Structure for 1AGMI, S3, SENSOR_INFO,

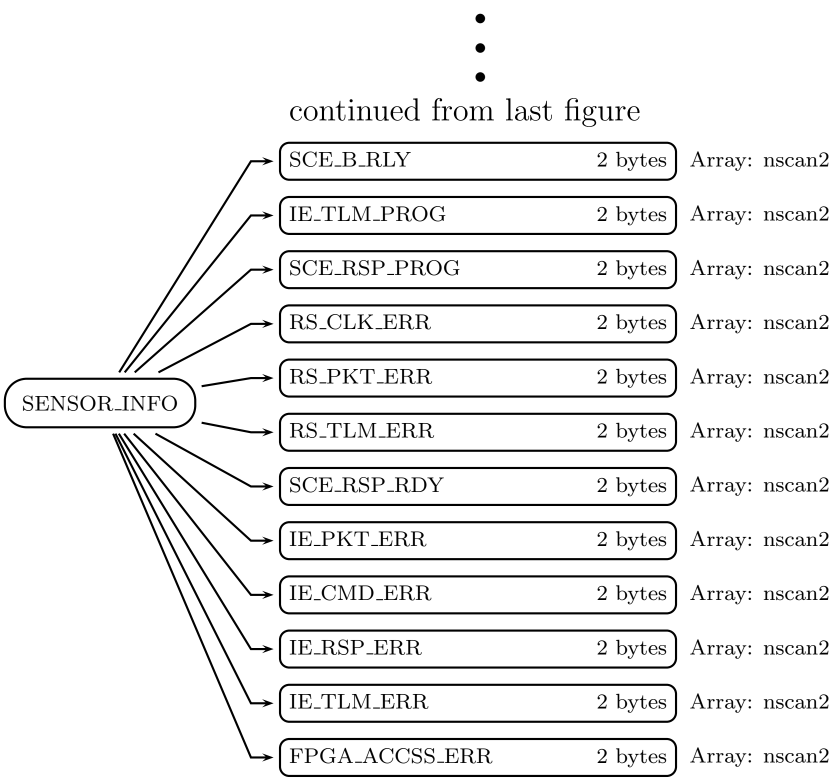

Figure 25: Data Format Structure for 1AGMI, S3, SENSOR_INFO

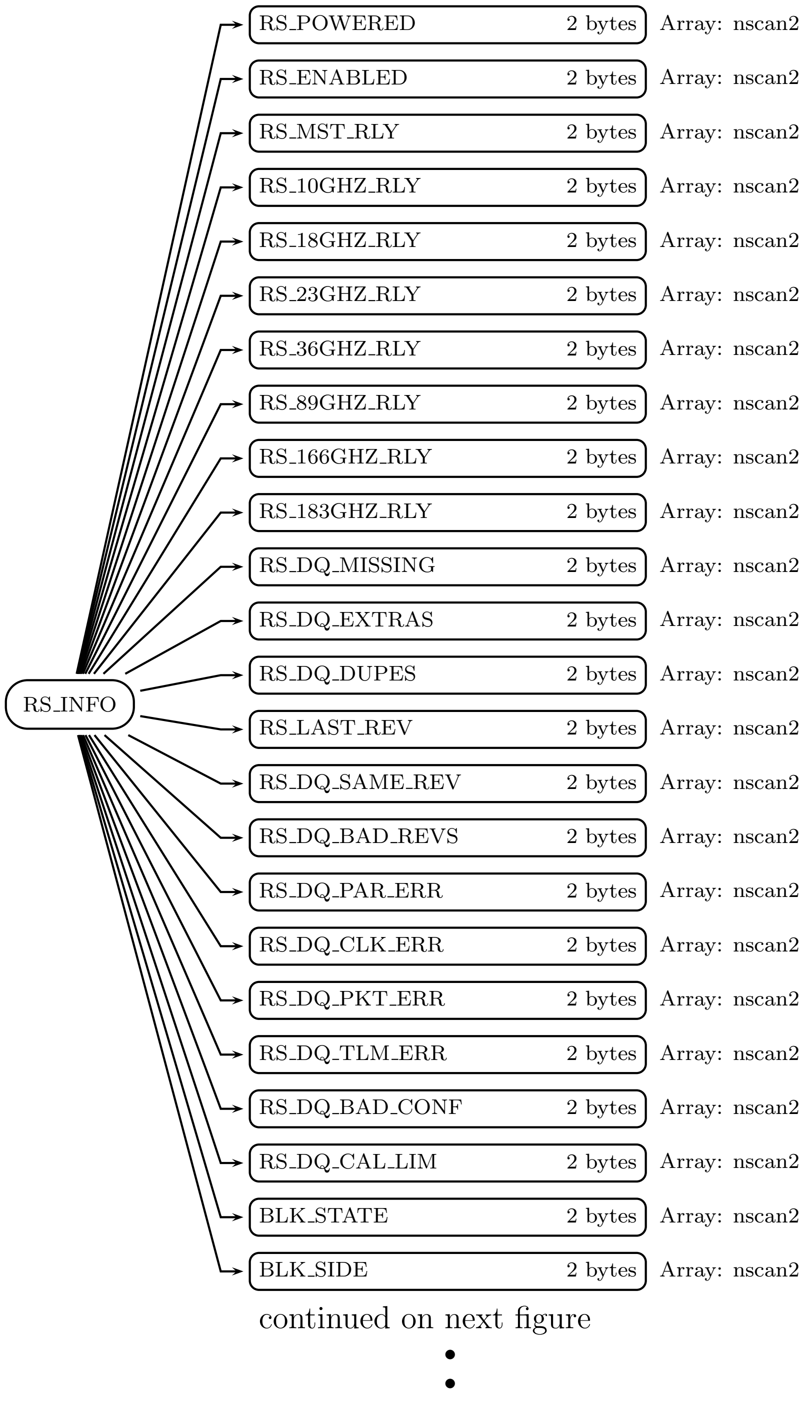

Figure 26: Data Format Structure for 1AGMI, S3, RS_INFO,

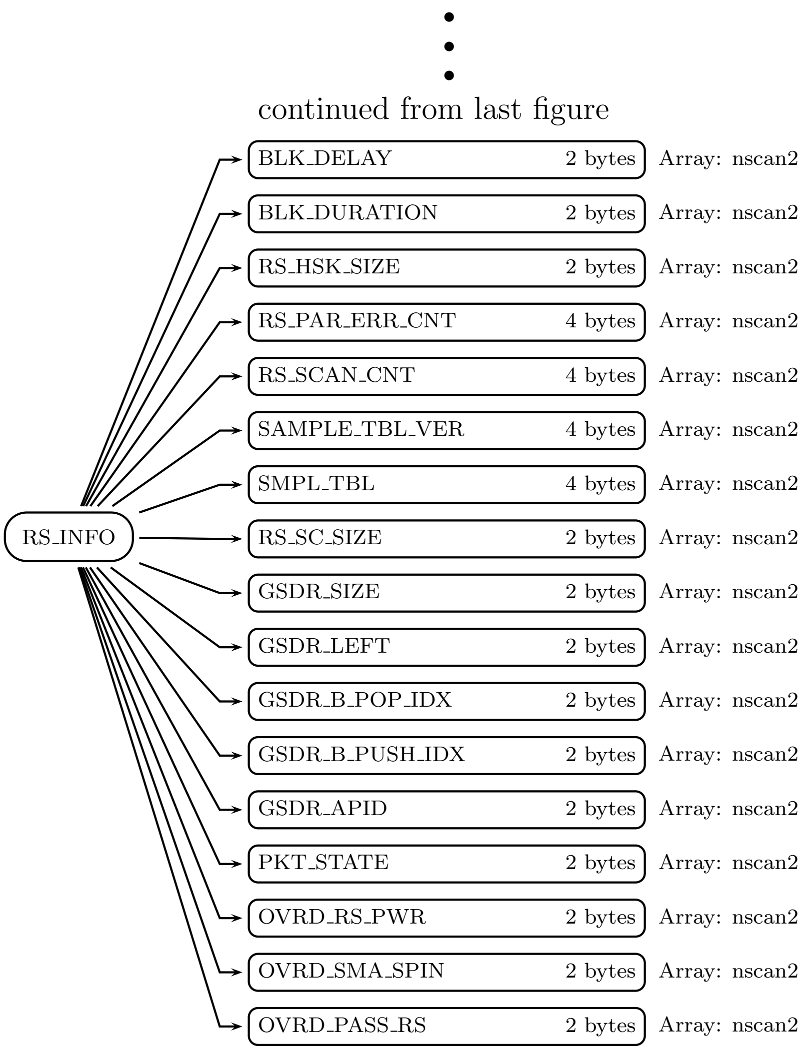

Figure 27: Data Format Structure for 1AGMI, S3, RS_INFO

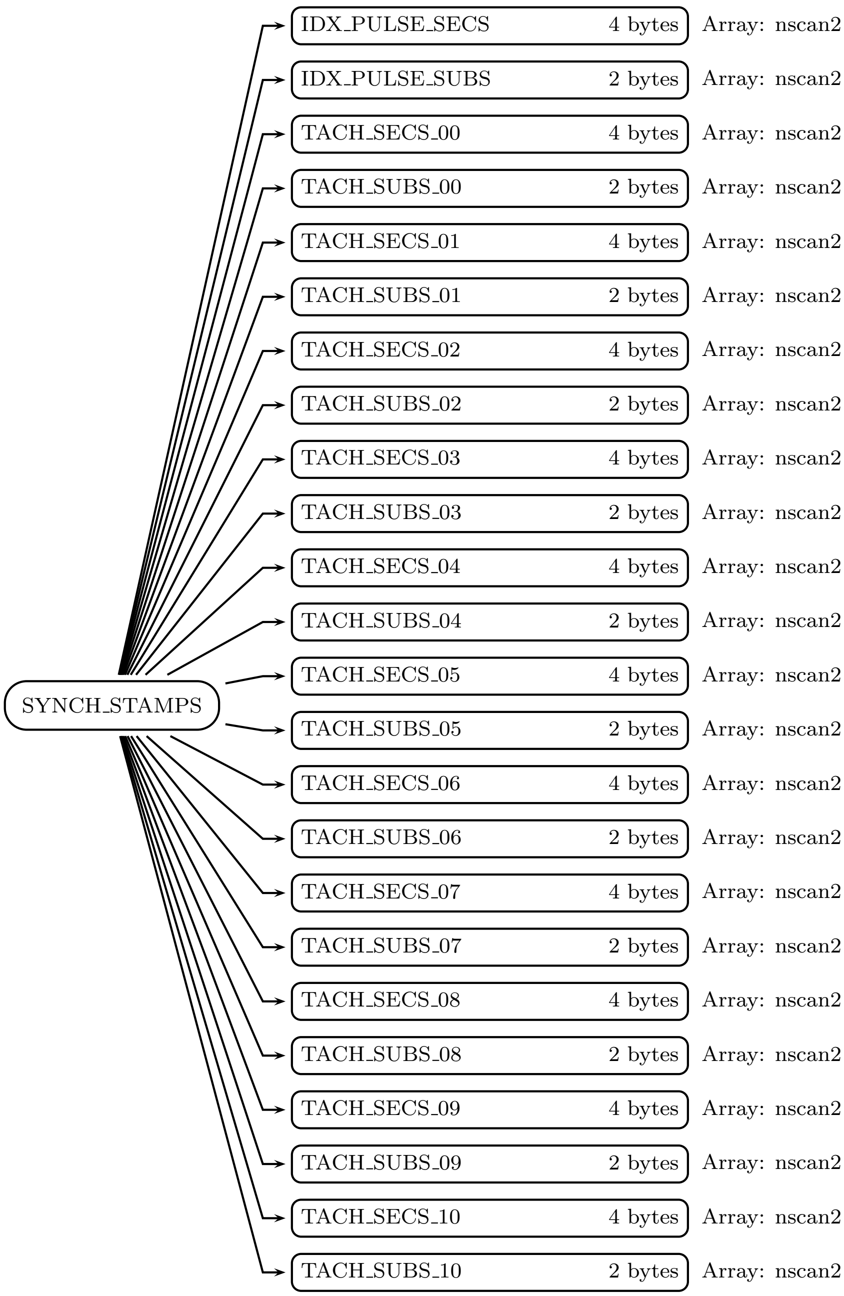

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Figure 28: Data Format Structure for 1AGMI, S3, SYNCH_STAMPS,

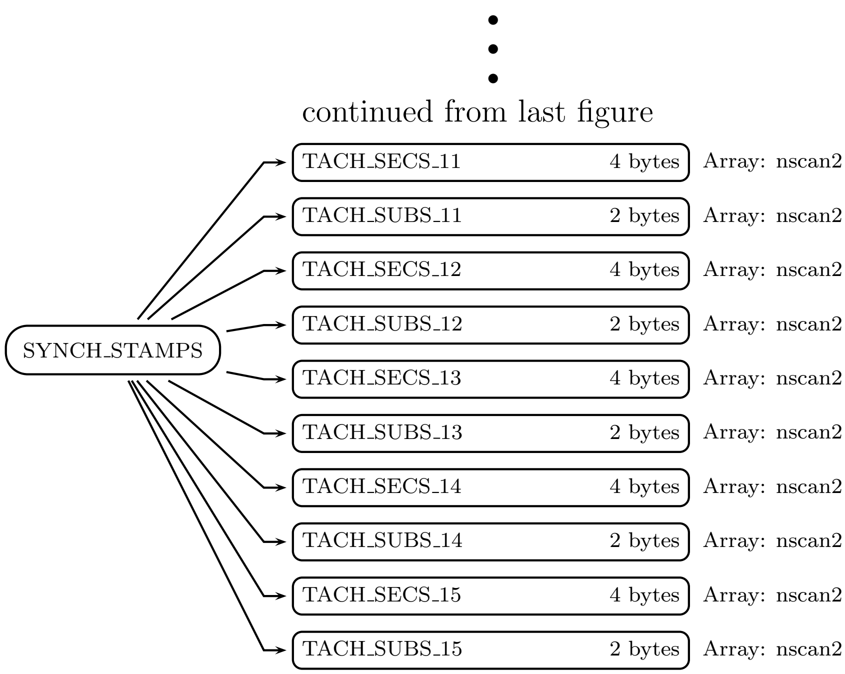

Figure 29: Data Format Structure for 1AGMI, S3, SYNCH_STAMPS

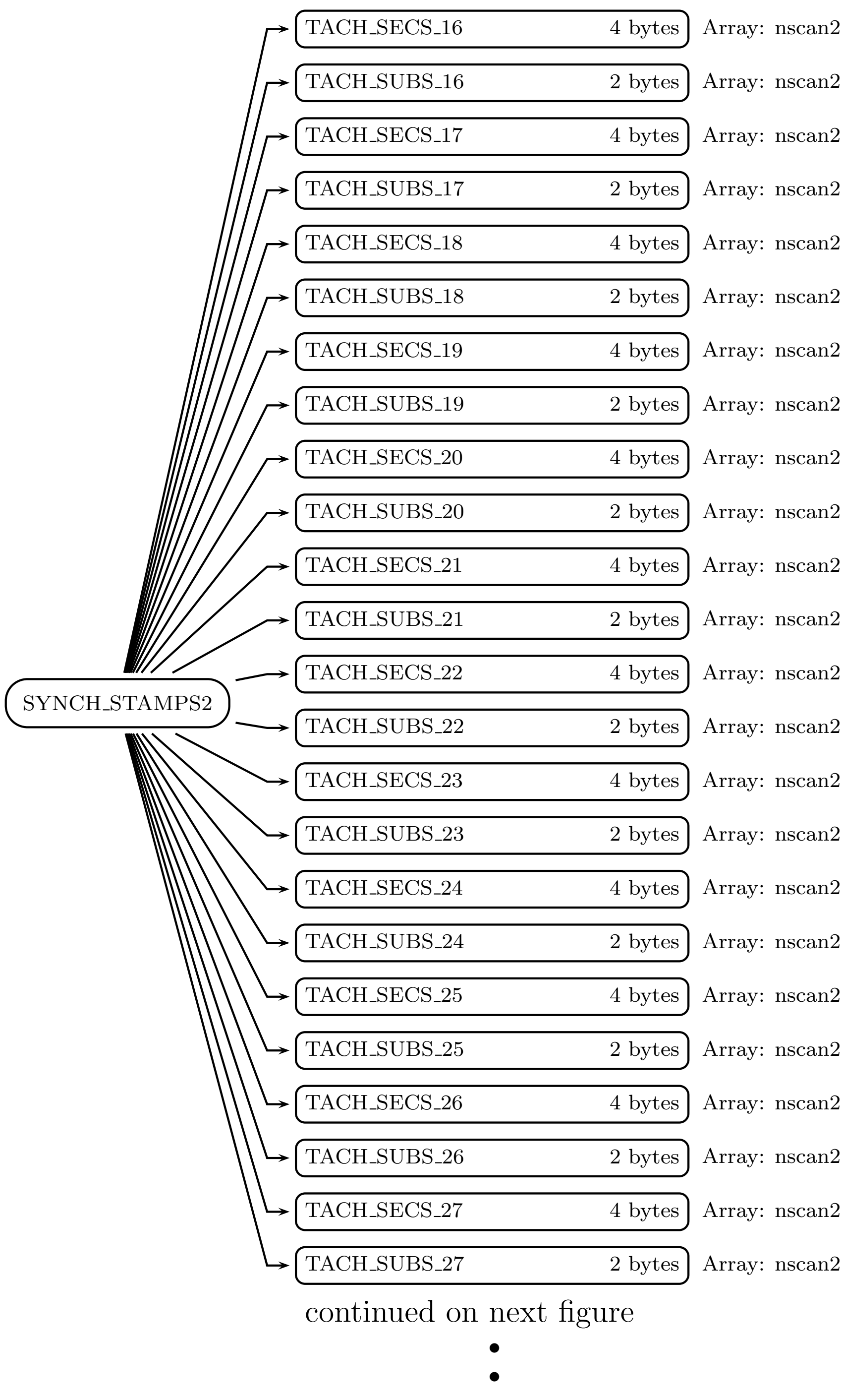

Figure 30: Data Format Structure for 1AGMI, S3, SYNCH_STAMPS2,

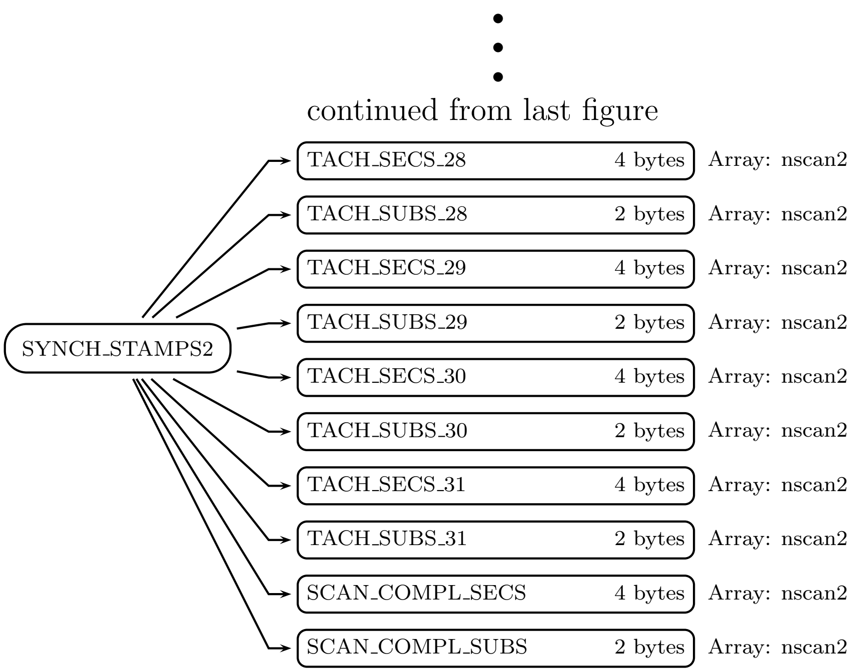

Figure 31: Data Format Structure for 1AGMI, S3, SYNCH_STAMPS2

RSHSK_STATUS

RSST_SCI_ADC_LP	2 bytes	Array: nscan2
RSST_HSK_ADC_LP	2 bytes	Array: nscan2
RSST_SAMP_OVLP	2 bytes	Array: nscan2
RSST_10GHZ_RLY	2 bytes	Array: nscan2
RSST_18GHZ_RLY	2 bytes	Array: nscan2
RSST_23GHZ_RLY	2 bytes	Array: nscan2
RSST_36GHZ_RLY	2 bytes	Array: nscan2
RSST_89GHZ_RLY	2 bytes	Array: nscan2
RSST_166GHZ_RLY	2 bytes	Array: nscan2
RSST_183GHZ_RLY	2 bytes	Array: nscan2
RSST_INVLD_CMD	2 bytes	Array: nscan2
RSST_CMD_AFTER	2 bytes	Array: nscan2
NDIODE_MODE	2 bytes	Array: nscan2
RSST_NDIODE_ST	2 bytes	Array: nscan2
NDIODE10GHZSNUM	2 bytes	Array: nscan2
RESERVED1	2 bytes	Array: nscan2
RS_CALRES_1	2 bytes	Array: nscan2
BATC_CALRES_1	2 bytes	Array: nscan2
RS_CALRES_2	2 bytes	Array: nscan2
BATC_CALRES_2	2 bytes	Array: nscan2
RS_EPC_ISENS	2 bytes	Array: nscan2
RS_EPC_5V	2 bytes	Array: nscan2
RS_EPC_7V	2 bytes	Array: nscan2
RS_EPC_POS12V	2 bytes	Array: nscan2

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Figure 32: Data Format Structure for 1AGMI, S3, RSHSK_STATUS,

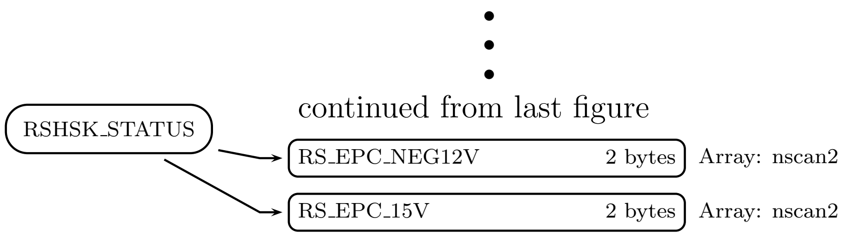

Figure 33: Data Format Structure for 1AGMI, S3, RSHSK_STATUS

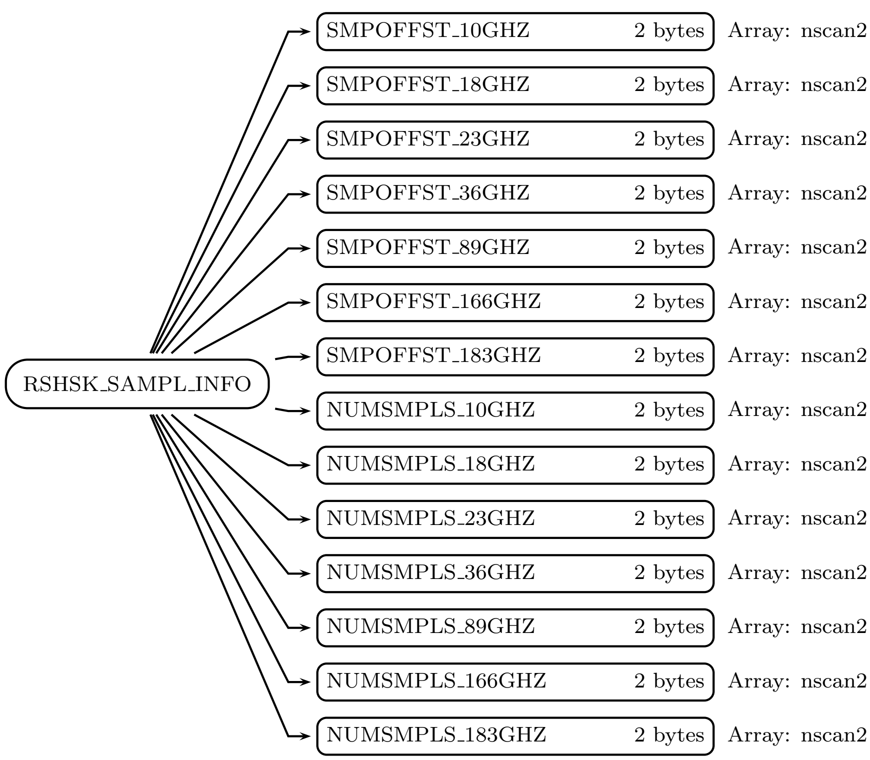

Figure 34: Data Format Structure for 1AGMI, S3, RSHSK_SAMPL_INFO

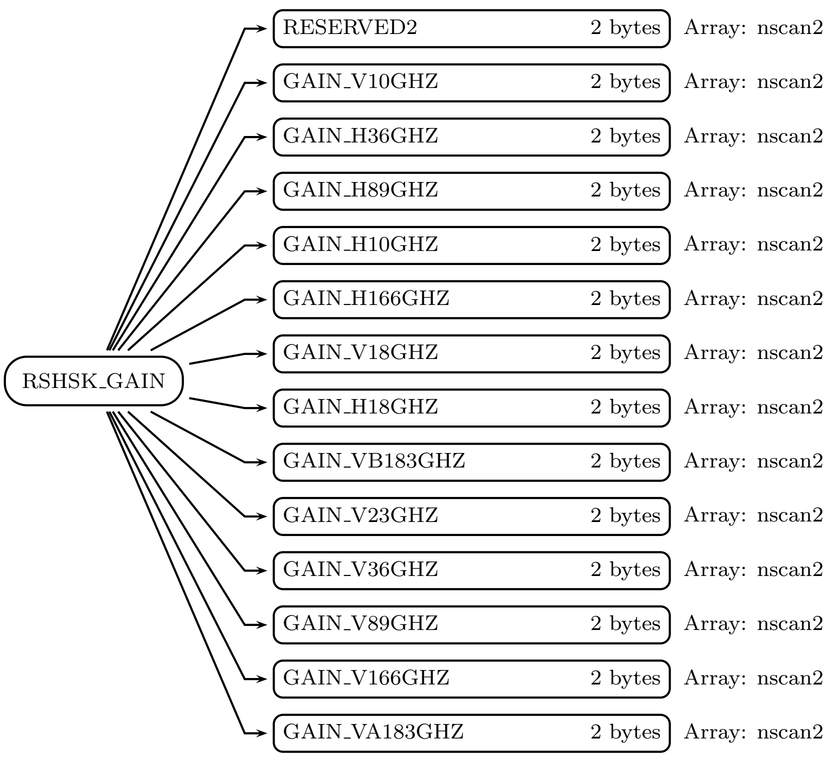

Figure 35: Data Format Structure for 1AGMI, S3, RSHSK_GAIN

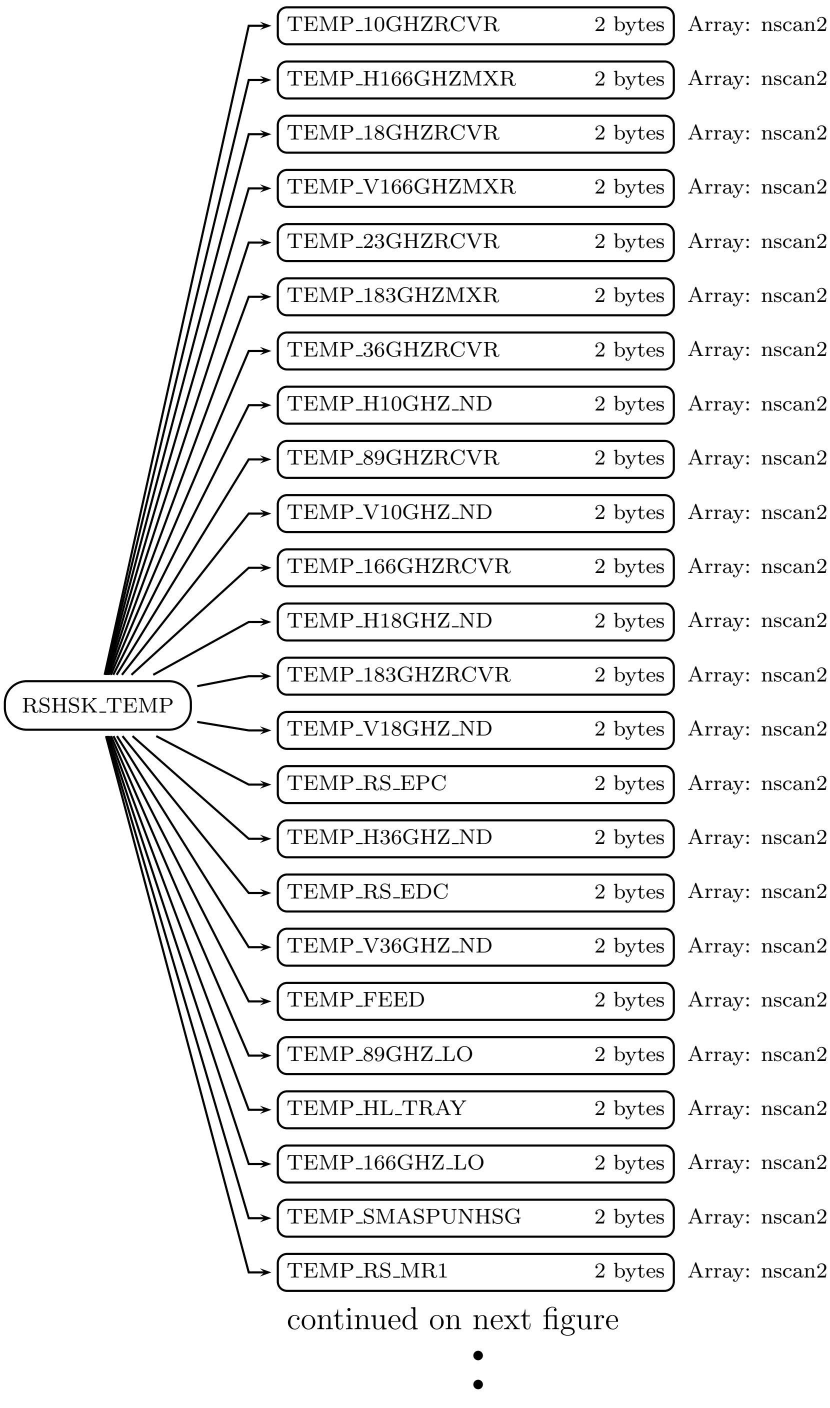

Figure 36: Data Format Structure for 1AGMI, S3, RSHSK_TEMP,

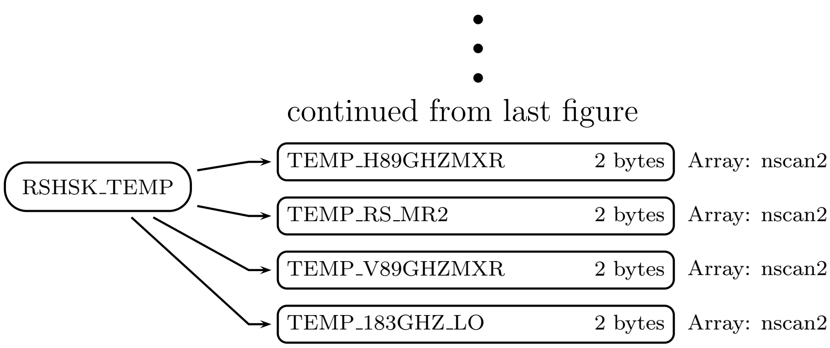

Figure 37: Data Format Structure for 1AGMI, S3, RSHSK_TEMP

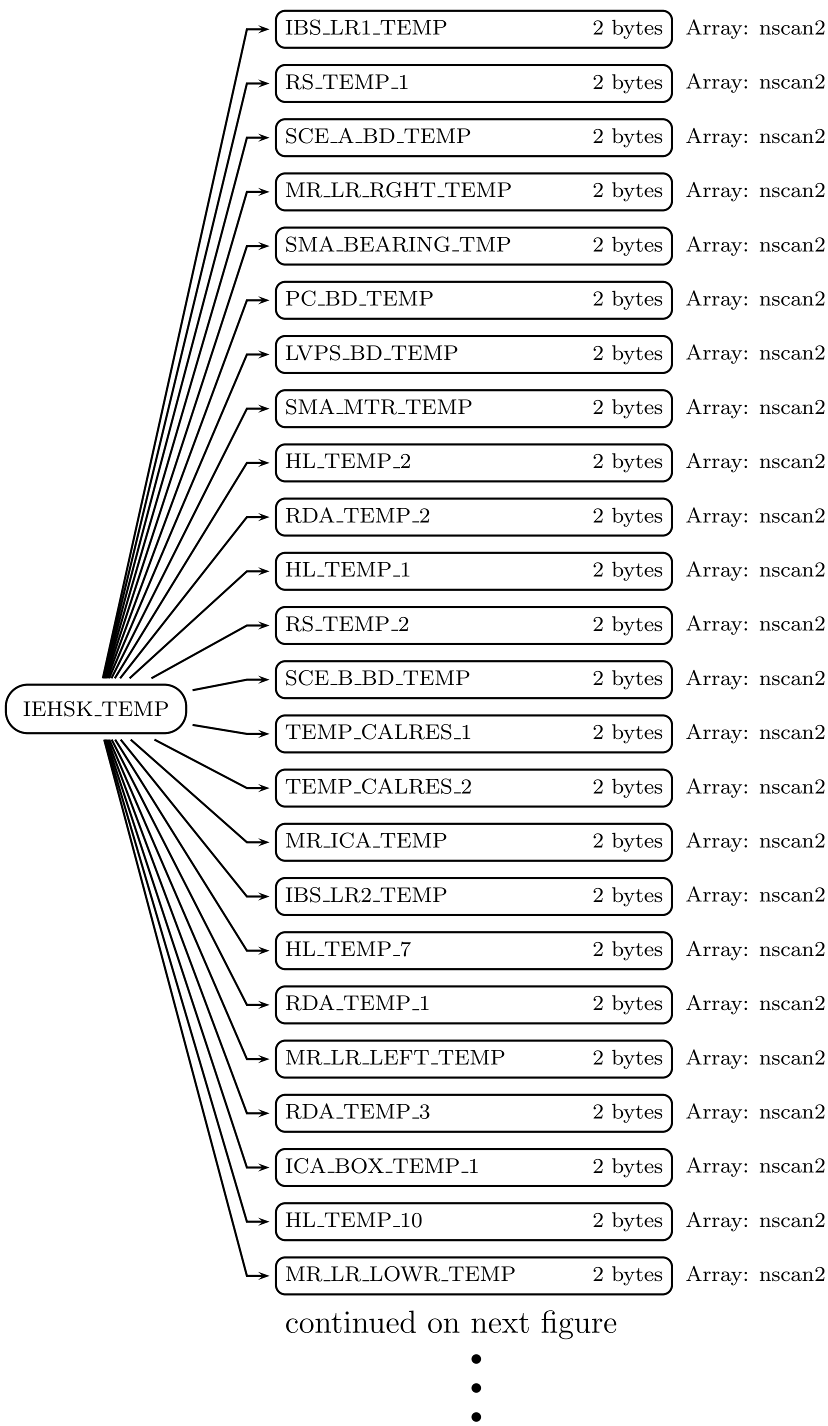

Figure 38: Data Format Structure for 1AGMI, S3, IEHSK_TEMP,

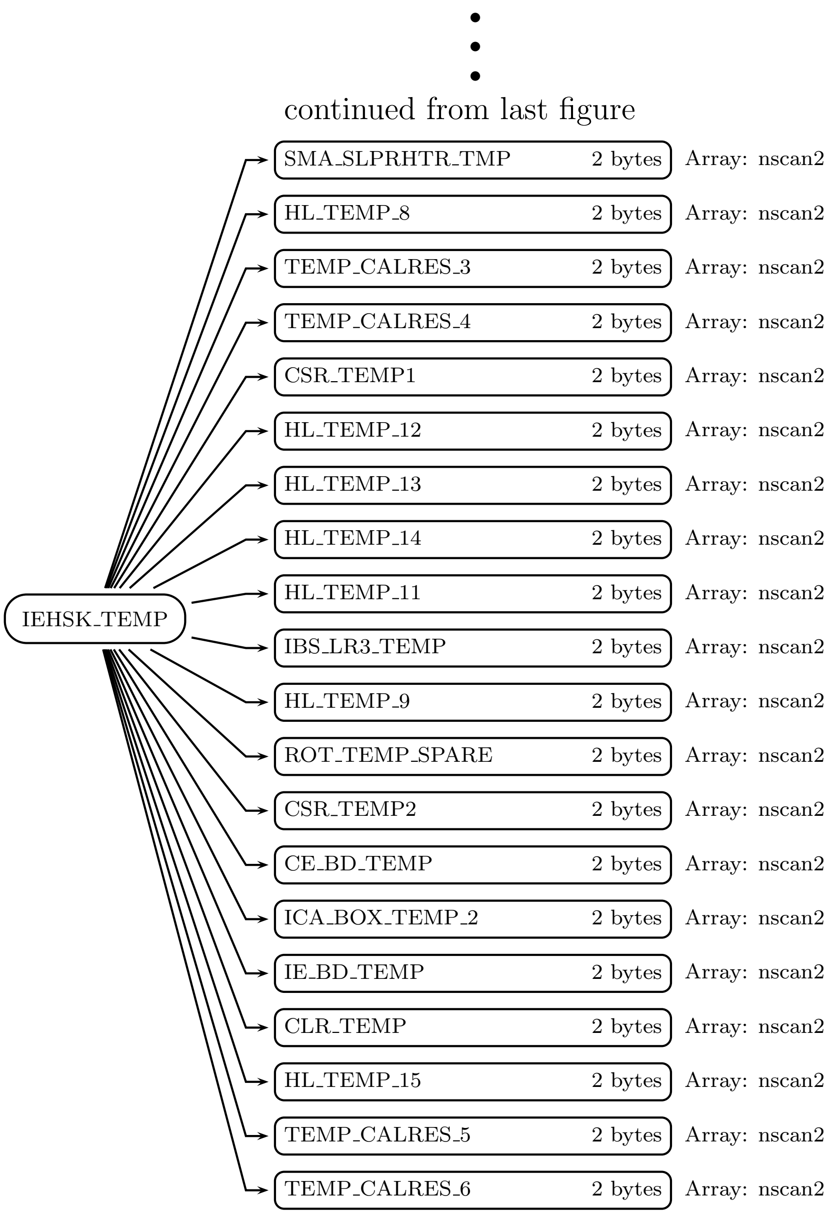

Figure 39: Data Format Structure for 1AGMI, S3, IEHSK_TEMP

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Figure 40: Data Format Structure for 1AGMI, S3, IE_TELEMETRY,

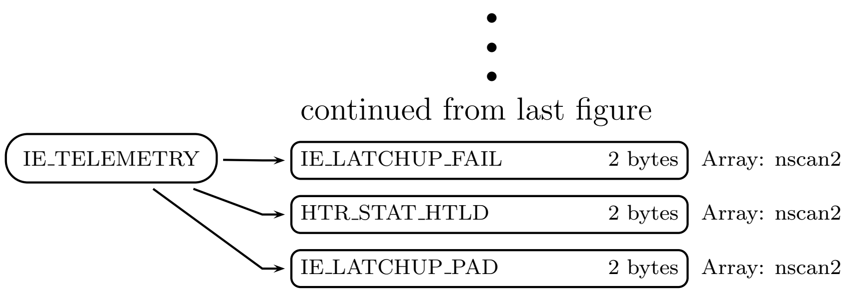

Figure 41: Data Format Structure for 1AGMI, S3, IE_TELEMETRY

MECHANISMS

SCE_LAST_CMD	4 bytes	Array: nscan2
SCE_LAST_RESPNS	4 bytes	Array: nscan2
SCE_CMD_CNT	4 bytes	Array: nscan2
SMA_RTPRB_SEC	2 bytes	Array: nscan2
SMA_RATE	2 bytes	Array: nscan2
SCE_RATE	2 bytes	Array: nscan2
SCE_CMD_RATE	2 bytes	Array: nscan2
SMA_CMD_RATE	2 bytes	Array: nscan2
RESOLVER_POS	2 bytes	Array: nscan2
MECH_CMD_CNT	2 bytes	Array: nscan2
SCE_INHIBIT	2 bytes	Array: nscan2
TACH_PULSE_CNT	2 bytes	Array: nscan2
LR_ABRT_CNT	2 bytes	Array: nscan2
RAMP_ABRT_CNT	2 bytes	Array: nscan2
OVRD_RDA_LR	2 bytes	Array: nscan2
OVRD_IBS_LR	2 bytes	Array: nscan2
SCE_PASSPROT	2 bytes	Array: nscan2
RAMP_INPROGRESS	2 bytes	Array: nscan2
SMA_SPINNING	2 bytes	Array: nscan2
LR_RLS_IN_PROG	2 bytes	Array: nscan2
SCE_A_POWER	2 bytes	Array: nscan2
SCE_B_POWER	2 bytes	Array: nscan2
SCE_SELECTION	2 bytes	Array: nscan2
SMA_RATE_PROB	2 bytes	Array: nscan2

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Figure 42: Data Format Structure for 1AGMI, S3, MECHANISMS,

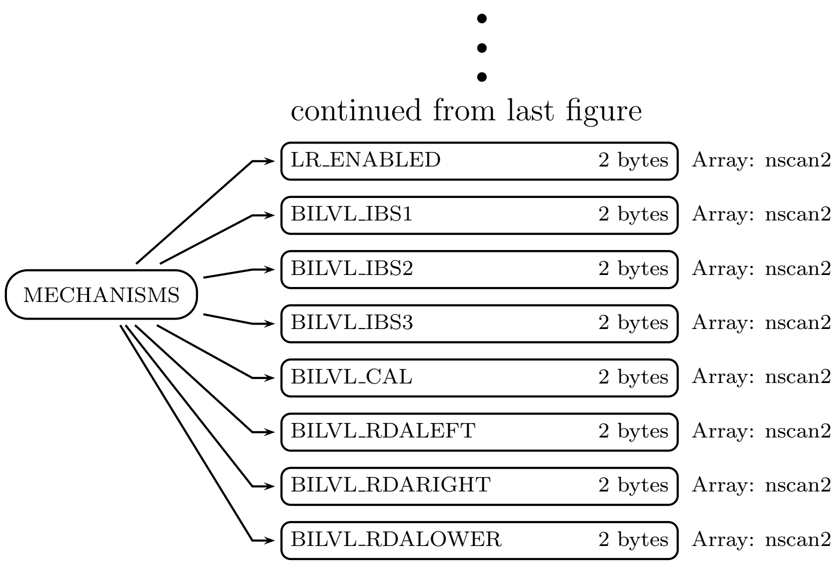

Figure 43: Data Format Structure for 1AGMI, S3, MECHANISMS

SMPL_INFO

SMPL_INFO_VALID	2 bytes	Array: nscan2
EARTH_10G_STRT	2 bytes	Array: nscan2
EARTH_10G_NUM	2 bytes	Array: nscan2
HLOAD_10G_STRT	2 bytes	Array: nscan2
HLOAD_10G_NUM	2 bytes	Array: nscan2
CSKY_10G_STRT	2 bytes	Array: nscan2
CSKY_10G_NUM	2 bytes	Array: nscan2
EARTH_18G_STRT	2 bytes	Array: nscan2
EARTH_18G_NUM	2 bytes	Array: nscan2
HLOAD_18G_STRT	2 bytes	Array: nscan2
HLOAD_18G_NUM	2 bytes	Array: nscan2
CSKY_18G_STRT	2 bytes	Array: nscan2
CSKY_18G_NUM	2 bytes	Array: nscan2
EARTH_23G_STRT	2 bytes	Array: nscan2
EARTH_23G_NUM	2 bytes	Array: nscan2
HLOAD_23G_STRT	2 bytes	Array: nscan2
HLOAD_23G_NUM	2 bytes	Array: nscan2
CSKY_23G_STRT	2 bytes	Array: nscan2
CSKY_23G_NUM	2 bytes	Array: nscan2
EARTH_36G_STRT	2 bytes	Array: nscan2
EARTH_36G_NUM	2 bytes	Array: nscan2
HLOAD_36G_STRT	2 bytes	Array: nscan2
HLOAD_36G_NUM	2 bytes	Array: nscan2
CSKY_36G_STRT	2 bytes	Array: nscan2

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Figure 44: Data Format Structure for 1AGMI, S3, SMPL_INFO,

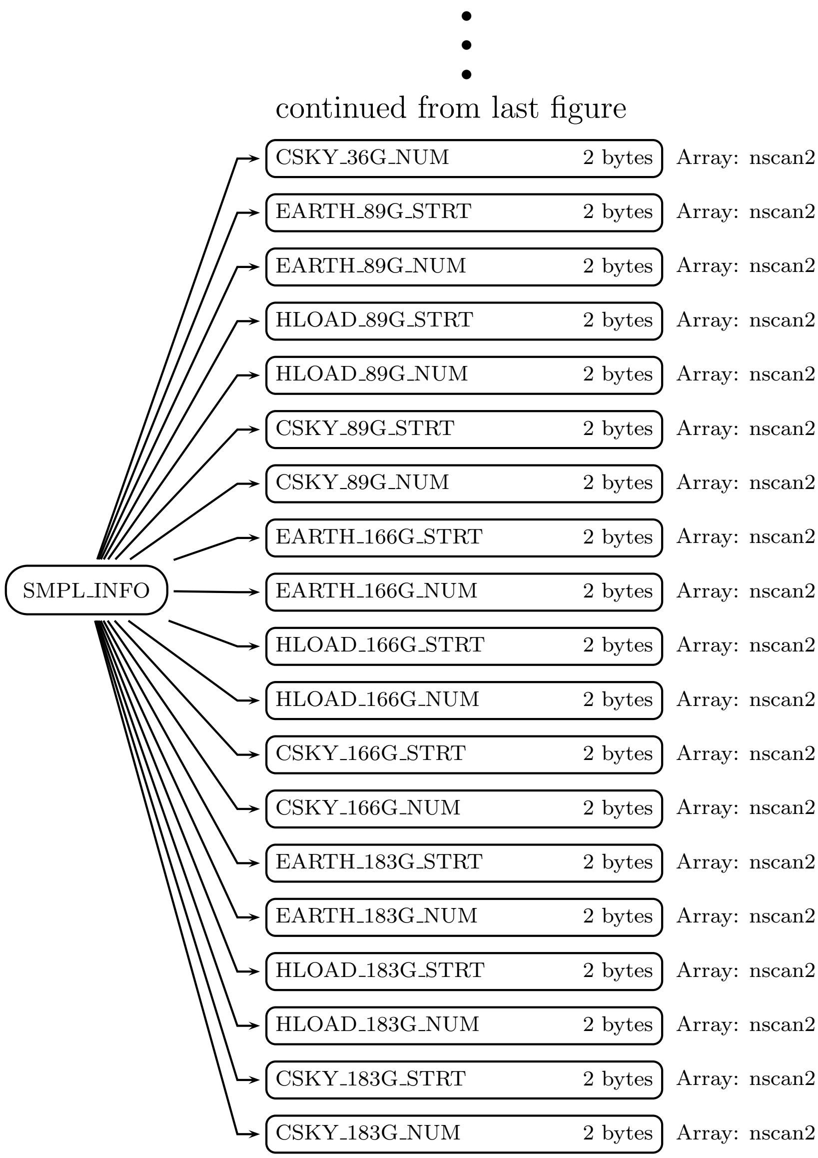


Figure 45: Data Format Structure for 1AGMI, S3, SMPL_INFO

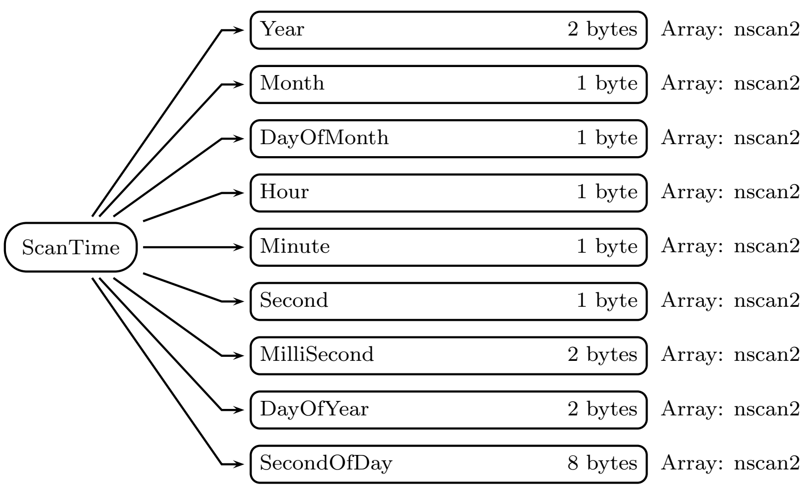


Figure 46: Data Format Structure for 1AGMI, S4, ScanTime

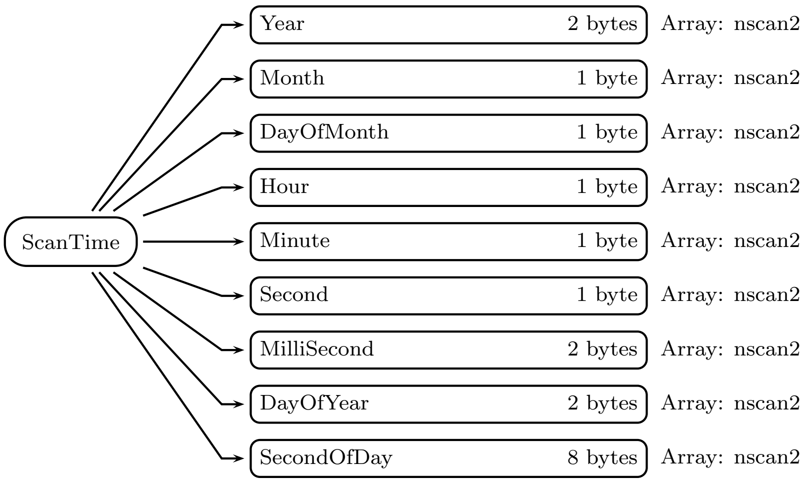


Figure 47: Data Format Structure for 1AGMI, S5, ScanTime

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

gmi1aHeader (Group)

sampleRangeFile (2-byte unsigned integer, array size: dim6 x dim7):
The sample range table that was used to subset S1 and S2.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude

is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan1):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan1):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan1):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan1):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
```

```
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan1):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan1):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan1):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is

good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan1):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan1):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan1):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

navigation (Group in S1)

scHeadingGround (4-byte float, array size: nscan1):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan1):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan1):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan1):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan1):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan1):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values

range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan1):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity

direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan1):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan1):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan1):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan1):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan1):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan1):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan1):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan1):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan1):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev x nscan1):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev x nscan1):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan1):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

earthView (2-byte unsigned integer, array size: nchannel1 x npixelev x nscan1):

```
Earth view counts.
```

Special values are defined as:
0 Missing value

hotLoad (2-byte unsigned integer, array size: nchannel1 x npixelht x nscan1):

```
Hot load counts.
```

Special values are defined as:
0 Missing value

coldSky (2-byte unsigned integer, array size: nchannel1 x npixelcs x nscan1):

```
Cold sky counts.
```

Special values are defined as:
0 Missing value

earthViewBlanking (1-byte char, array size: VH x npixelev x nscan1):

```
Earth view blanking counts.
```

Special values are defined as:
0 Missing value

hotLoadBlanking (1-byte char, array size: VH x npixelht x nscan1):

```
Hot load blanking counts.
```

Special values are defined as:
0 Missing value

coldSkyBlanking (1-byte char, array size: VH x npixelcs x nscan1):

```
Cold sky blanking counts.
```

Special values are defined as:
0 Missing value

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan2):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan2):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan2):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan2):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken

down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan2):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
```

```
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan2):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan2):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan2):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
```

```
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan2):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan2):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

navigation (Group in S2)

scHeadingGround (4-byte float, array size: nscan2):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan2):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan2):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan2):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan2):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan2):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that

pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan2):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan2):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan2):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range

from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan2):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan2):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan2):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan2):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan2):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan2):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan2):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan2):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan2):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev x nscan2):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev x nscan2):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan2):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

earthView (2-byte unsigned integer, array size: nchannel2 x npixelev x nscan2):

`Earth view counts.`

Special values are defined as:
0 Missing value

hotLoad (2-byte unsigned integer, array size: nchannel2 x npixelht x nscan2):

`Hot load counts.`

Special values are defined as:
0 Missing value

coldSky (2-byte unsigned integer, array size: nchannel2 x npixelcs x nscan2):

`Cold sky counts.`

Special values are defined as:
0 Missing value

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

Latitude (4-byte float, array size: nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

TAM1 (Group in S3)

timeOffset (4-byte float, array size: nscan2):
Time offset between magnetometer and scan time. Values range from -100 to 100 s. Special values are defined as:
-9999.9 Missing value

Vx (2-byte unsigned integer, array size: nscan2):
Magnetometer one vector, x component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vy (2-byte unsigned integer, array size: nscan2):
Magnetometer one vector, y component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vz (2-byte unsigned integer, array size: nscan2):
Magnetometer one vector, z component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

TAM2 (Group in S3)

timeOffset (4-byte float, array size: nscan2):
Time offset between magnetometer and scan time. Values range from -100 to 100 s. Special values are defined as:
-9999.9 Missing value

Vx (2-byte unsigned integer, array size: nscan2):
Magnetometer two vector, x component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vy (2-byte unsigned integer, array size: nscan2):
Magnetometer two vector, y component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vz (2-byte unsigned integer, array size: nscan2):
Magnetometer two vector, z component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

TORQUE_BAR (Group in S3)

timeOffset (4-byte float, array size: nscan2):
Time offset between torque bar and scan time. Values range from -100 to 100 s. Special values are defined as:
-9999.9 Missing value

Vx (2-byte unsigned integer, array size: nscan2):
Torque bar vector, x component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vy (2-byte unsigned integer, array size: nscan2):
Torque bar vector, y component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

Vz (2-byte unsigned integer, array size: nscan2):
Torque bar vector, z component. Values range from 0 to 65535 count. Special values are defined as:
65535 Missing value

GMI_TEMPERATURES (Group in S3)

timeOffset (4-byte float, array size: nscan2):
Time offset between thermisters and scan time. Values range from -100 to 100 s. Special values are defined as:
-9999.9 Missing value

apid (2-byte unsigned integer, array size: nscan2):
APID. 0 is the missing value.

SMA_PT_TEMP (2-byte unsigned integer, array size: nscan2):
SMA_PT_TEMP. 0 is the missing value.

ICA_PT_TEMP (2-byte unsigned integer, array size: nscan2):
ICA_PT_TEMP. 0 is the missing value.

RS_PT_TEMP (2-byte unsigned integer, array size: nscan2):
RS_PT_TEMP. 0 is the missing value.

STAT_PT_TEMP (2-byte unsigned integer, array size: nscan2):
STAT_PT_TEMP. 0 is the missing value.

MR_PT_TEMP (2-byte unsigned integer, array size: nscan2):
MR_PT_TEMP. 0 is the missing value.

primaryHeader (Group in S3)

version (1-byte integer, array size: nscan2):

type (1-byte integer, array size: nscan2):

secHeaderFlag (1-byte integer, array size: nscan2):

APID (2-byte integer, array size: nscan2):

sequenceFlag (1-byte integer, array size: nscan2):

packetSequenceCount (2-byte integer, array size: nscan2):

packetLength (2-byte unsigned integer, array size: nscan2):

instrTimeSeconds (4-byte unsigned integer, array size: nscan2):

instrTimeSubseconds (2-byte unsigned integer, array size: nscan2):

numPacketSegments (1-byte integer, array size: nscan2):

spare (1-byte integer, array size: nscan2):

RDRversion (2-byte integer, array size: nscan2):

GSDR_TIME (Group in S3)

G_TC_PULSE_SECS (4-byte unsigned integer, array size: nscan2):
GMI Instrument Time Code Pulse Timestamp (Seconds) */ Special values are defined as:

0 Missing value

G_TC_PULSE_SUBS (2-byte unsigned integer, array size: nscan2):
GMI Instrument Time Code Pulse Timestamp (Sub-Seconds) */ Special values are defined as:

0 Missing value

G_TCU_SECS (4-byte unsigned integer, array size: nscan2):
S/C Time Code Update (Seconds) */ Special values are defined as:
0 Missing value

G_TCU_SUBS (4-byte unsigned integer, array size: nscan2):
S/C Time Code Update (Sub-Seconds) */ Special values are defined as:
0 Missing value

G_TCF_SC_SECS (4-byte unsigned integer, array size: nscan2):
Time Correlation Factor spacecraft timestamp (Seconds) */ Special values are defined as:
0 Missing value

G_TCF_SC_SUBSEC (4-byte unsigned integer, array size: nscan2):
Time Correlation Factor spacecraft timestamp (Sub-seconds) */ Special values are defined as:
0 Missing value

G_TCF_SECS (4-byte unsigned integer, array size: nscan2):
Time Correlation Factor (Seconds) */ Special values are defined as:
0 Missing value

G_TCF_SUBSECS (4-byte unsigned integer, array size: nscan2):
Time Correlation Factor (Sub-seconds) */ Special values are defined as:
0 Missing value

G_TCF_SIGN (2-byte unsigned integer, array size: nscan2):
Time Correlation Factor (Sign) */ Special values are defined as:
0 Missing value

G_TCF_LEAP (2-byte unsigned integer, array size: nscan2):
Time Correlation Factor (Leap Seconds) */ Special values are defined as:
0 Missing value

GPS_TCU_SECS (4-byte unsigned integer, array size: nscan2):
S/C Time Code Update in GPS time (Seconds) */ Special values are defined as:
0 Missing value

GPS_TCU_SUBS (4-byte unsigned integer, array size: nscan2):
S/C Time Code Update in GPS time (Sub-Seconds) */ Special values are defined as:
0 Missing value

SENSOR_INFO (Group in S3)

KEEP_ALIVE_CNT (4-byte unsigned integer, array size: nscan2):
Keep Alive Counter */ Special values are defined as:
0 Missing value

FPGA_RST_REASON (2-byte unsigned integer, array size: nscan2):
Reason for last reset */ Special values are defined as:
0 Missing value

CRASH_REASON (2-byte unsigned integer, array size: nscan2):
Reason for last crash */ Special values are defined as:
0 Missing value

VERSION_MIN (2-byte unsigned integer, array size: nscan2):
GMI FSW minor version number */ Special values are defined as:
0 Missing value

VERSION_MAJ (2-byte unsigned integer, array size: nscan2):
GMI FSW major version number */ Special values are defined as:
0 Missing value

FPGA_MODE (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

ERR_HDL_FAILURE (2-byte unsigned integer, array size: nscan2):
Error Handler Failure Flag */ Special values are defined as:
0 Missing value

RESET_REASON (2-byte unsigned integer, array size: nscan2):
Reason for last reset */ Special values are defined as:
0 Missing value

BOOT_BANK (2-byte unsigned integer, array size: nscan2):
EEPROM Bank of last reboot */ Special values are defined as:
0 Missing value

CURRENT_BANK (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

EDAC_ENABLE (2-byte unsigned integer, array size: nscan2):
EDAC enable */ Special values are defined as:
0 Missing value

WDOG_ENABLE (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

SC_1HZ_REF (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

SCE_FORCE_SEL (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

RS_1MHZ_REF (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

RS_SCAN_START (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

FPGA_IE_RX_EN (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

FPGA_RS_RX_EN (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

FPGA_SCE_RX_EN (2-byte unsigned integer, array size: nscan2):
FPGA CNTL Special values are defined as:
0 Missing value

EEPROM_BUSY (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

RS_TLM_PROG (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_A_ACTIVE (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_A_RLY (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_B_ACTIVE (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_B_RLY (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_TLM_PROG (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_RSP_PROG (2-byte unsigned integer, array size: nscan2):
SCE response in progress. */ Special values are defined as:
0 Missing value

RS_CLK_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

RS_PKT_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

RS_TLM_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

SCE_RSP_RDY (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_PKT_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_CMD_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_RSP_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

IE_TLM_ERR (2-byte unsigned integer, array size: nscan2):
IE Tlm Error FPGA status bit */ Special values are defined as:
0 Missing value

FPGA_ACCSS_ERR (2-byte unsigned integer, array size: nscan2):
FPGA STAT Special values are defined as:
0 Missing value

RS_INFO (Group in S3)

RS_POWERED (2-byte unsigned integer, array size: nscan2):
RS Power */ Special values are defined as:
0 Missing value

RS_ENABLED (2-byte unsigned integer, array size: nscan2):
RS Science Enabled */ Special values are defined as:
0 Missing value

RS_MST_RLY (2-byte unsigned integer, array size: nscan2):
RS Master Relay */ Special values are defined as:
0 Missing value

RS_10GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 10GHz Relay */ Special values are defined as:
0 Missing value

RS_18GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 18GHz Relay */ Special values are defined as:
0 Missing value

RS_23GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 23GHz Relay */ Special values are defined as:
0 Missing value

RS_36GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 36GHz Relay */ Special values are defined as:
0 Missing value

RS_89GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 89GHz Relay */ Special values are defined as:
0 Missing value

RS_166GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 166GHz Relay */ Special values are defined as:
0 Missing value

RS_183GHZ_RLY (2-byte unsigned integer, array size: nscan2):
RS 183GHz Relay */ Special values are defined as:
0 Missing value

RS_DQ_MISSING (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Missing samples) */ Special values are defined as:
0 Missing value

RS_DQ_EXTRAS (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Extra samples) */ Special values are defined as:
0 Missing value

RS_DQ_DUPES (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Duplicate samples) */ Special values are defined as:
0 Missing value

RS_LAST_REV (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Latest Revolution) */ Special values are defined as:
0 Missing value

RS_DQ_SAME_REV (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Revolution bit not changing) */ Special values are defined as:
0 Missing value

RS_DQ_BAD_REVS (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Inconsistent Revolutions) */ Special values are defined as:
0 Missing value

RS_DQ_PAR_ERR (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Parity Error) */ Special values are defined as:
0 Missing value

RS_DQ_CLK_ERR (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Clock Error) */ Special values are defined as:
0 Missing value

RS_DQ_PKT_ERR (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Packet Error) */ Special values are defined as:
0 Missing value

RS_DQ_TLM_ERR (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Telemetry Error) */ Special values are defined as:
0 Missing value

RS_DQ_BAD_CONF (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Mismatched configuration) */ Special values are defined as:
0 Missing value

RS_DQ_CAL_LIM (2-byte unsigned integer, array size: nscan2):
RS Data Quality indicator (Calibration Limits) */ Special values are defined as:
0 Missing value

BLK_STATE (2-byte unsigned integer, array size: nscan2):
Blanking State */ Special values are defined as:
0 Missing value

BLK_SIDE (2-byte unsigned integer, array size: nscan2):
Blanking Side */ Special values are defined as:
0 Missing value

BLK_DELAY (2-byte unsigned integer, array size: nscan2):
Blanking Delay */ Special values are defined as:
0 Missing value

BLK_DURATION (2-byte unsigned integer, array size: nscan2):
Blanking Duration */ Special values are defined as:
0 Missing value

RS_HSK_SIZE (2-byte unsigned integer, array size: nscan2):
The number of RS Housekeeping samples */ Special values are defined as:
0 Missing value

RS_PAR_ERR_CNT (4-byte unsigned integer, array size: nscan2):
Number of RS parity errors */ Special values are defined as:
0 Missing value

RS_SCAN_CNT (4-byte unsigned integer, array size: nscan2):
Number of RS scans */ Special values are defined as:
0 Missing value

SAMPLE_TBL_VER (4-byte unsigned integer, array size: nscan2):
Sample table version */ Special values are defined as:
0 Missing value

SMPL_TBL (4-byte unsigned integer, array size: nscan2):
Sample Table Pointer */ Special values are defined as:
0 Missing value

RS_SC_SIZE (2-byte unsigned integer, array size: nscan2):
The number of science samples */ Special values are defined as:
0 Missing value

GSDR_SIZE (2-byte unsigned integer, array size: nscan2):
The size of the latest GSDR */ Special values are defined as:
0 Missing value

GSDR_LEFT (2-byte unsigned integer, array size: nscan2):
GSDR Remainder */ Special values are defined as:
0 Missing value

GSDR_B_POP_IDX (2-byte unsigned integer, array size: nscan2):
GSDR Buffer Pool Index (Pop) */ Special values are defined as:
0 Missing value

GSDR_B_PUSH_IDX (2-byte unsigned integer, array size: nscan2):
GSDR Buffer Pool Index (Push) */ Special values are defined as:
0 Missing value

GSDR_APID (2-byte unsigned integer, array size: nscan2):
GSDR Apid */ Special values are defined as:
0 Missing value

PKT_STATE (2-byte unsigned integer, array size: nscan2):
Packetizing State */ Special values are defined as:
0 Missing value

OVRD_RS_PWR (2-byte unsigned integer, array size: nscan2):
Override RS Power Check */ Special values are defined as:
0 Missing value

OVRD_SMA_SPIN (2-byte unsigned integer, array size: nscan2):
Override SMA Spinning Check */ Special values are defined as:
0 Missing value

OVRD_PASS_RS (2-byte unsigned integer, array size: nscan2):
Override RS Passthru protection indicator. */ Special values are defined as:
0 Missing value

SYNCH_STAMPS (Group in S3)

IDX_PULSE_SECS (4-byte unsigned integer, array size: nscan2):
Index Pulse (Seconds) */ Special values are defined as:
0 Missing value

IDX_PULSE_SUBS (2-byte unsigned integer, array size: nscan2):
Index Pulse (Sub-Seconds) */ Special values are defined as:
0 Missing value

TACH_SECS_00 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 0 */ Special values are defined as:
0 Missing value

TACH_SUBS_00 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 0 */ Special values are defined as:
0 Missing value

TACH_SECS_01 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 1 */ Special values are defined as:
0 Missing value

TACH_SUBS_01 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 1 */ Special values are defined as:
0 Missing value

TACH_SECS_02 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 2 */ Special values are defined as:
0 Missing value

TACH_SUBS_02 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 2 */ Special values are defined as:
0 Missing value

TACH_SECS_03 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 3 */ Special values are defined as:
0 Missing value

TACH_SUBS_03 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 3 */ Special values are defined as:
0 Missing value

TACH_SECS_04 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 4 */ Special values are defined as:
0 Missing value

TACH_SUBS_04 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 4 */ Special values are defined as:
0 Missing value

TACH_SECS_05 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 5 */ Special values are defined as:
0 Missing value

TACH_SUBS_05 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 5 */ Special values are defined as:
0 Missing value

TACH_SECS_06 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 6 */ Special values are defined as:
0 Missing value

TACH_SUBS_06 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 6 */ Special values are defined as:
0 Missing value

TACH_SECS_07 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 7 */ Special values are defined as:
0 Missing value

TACH_SUBS_07 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 7 */ Special values are defined as:
0 Missing value

TACH_SECS_08 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 8 */ Special values are defined as:
0 Missing value

TACH_SUBS_08 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 8 */ Special values are defined as:
0 Missing value

TACH_SECS_09 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 9 */ Special values are defined as:
0 Missing value

TACH_SUBS_09 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 9 */ Special values are defined as:
0 Missing value

TACH_SECS_10 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 10 */ Special values are defined as:
0 Missing value

TACH_SUBS_10 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 10 */ Special values are defined as:
0 Missing value

TACH_SECS_11 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 11 */ Special values are defined as:
0 Missing value

TACH_SUBS_11 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 11 */ Special values are defined as:
0 Missing value

TACH_SECS_12 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 12 */ Special values are defined as:
0 Missing value

TACH_SUBS_12 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 12 */ Special values are defined as:
0 Missing value

TACH_SECS_13 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 13 */ Special values are defined as:
0 Missing value

TACH_SUBS_13 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 13 */ Special values are defined as:
0 Missing value

TACH_SECS_14 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 14 */ Special values are defined as:
0 Missing value

TACH_SUBS_14 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 14 */ Special values are defined as:
0 Missing value

TACH_SECS_15 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 15 */ Special values are defined as:
0 Missing value

TACH_SUBS_15 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 15 */ Special values are defined as:
0 Missing value

SYNCH_STAMPS2 (Group in S3)

TACH_SECS_16 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 16 */ Special values are defined as:
0 Missing value

TACH_SUBS_16 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 16 */ Special values are defined as:
0 Missing value

TACH_SECS_17 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 17 */ Special values are defined as:
0 Missing value

TACH_SUBS_17 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 17 */ Special values are defined as:
0 Missing value

TACH_SECS_18 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 18 */ Special values are defined as:

0	Missing value

TACH_SUBS_18 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 18 */ Special values are defined as:

0	Missing value

TACH_SECS_19 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 19 */ Special values are defined as:

0	Missing value

TACH_SUBS_19 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 19 */ Special values are defined as:

0	Missing value

TACH_SECS_20 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 20 */ Special values are defined as:

0	Missing value

TACH_SUBS_20 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 20 */ Special values are defined as:

0	Missing value

TACH_SECS_21 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 21 */ Special values are defined as:

0	Missing value

TACH_SUBS_21 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 21 */ Special values are defined as:

0	Missing value

TACH_SECS_22 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 22 */ Special values are defined as:

0	Missing value

TACH_SUBS_22 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 22 */ Special values are defined as:

0	Missing value

TACH_SECS_23 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 23 */ Special values are defined as:

0	Missing value

TACH_SUBS_23 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 23 */ Special values are defined as:

0	Missing value

TACH_SECS_24 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 24 */ Special values are defined as:

0	Missing value

TACH_SUBS_24 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 24 */ Special values are defined as:
0 Missing value

TACH_SECS_25 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 25 */ Special values are defined as:
0 Missing value

TACH_SUBS_25 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 25 */ Special values are defined as:
0 Missing value

TACH_SECS_26 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 26 */ Special values are defined as:
0 Missing value

TACH_SUBS_26 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 26 */ Special values are defined as:
0 Missing value

TACH_SECS_27 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 27 */ Special values are defined as:
0 Missing value

TACH_SUBS_27 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 27 */ Special values are defined as:
0 Missing value

TACH_SECS_28 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 28 */ Special values are defined as:
0 Missing value

TACH_SUBS_28 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 28 */ Special values are defined as:
0 Missing value

TACH_SECS_29 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 29 */ Special values are defined as:
0 Missing value

TACH_SUBS_29 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 29 */ Special values are defined as:
0 Missing value

TACH_SECS_30 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 30 */ Special values are defined as:
0 Missing value

TACH_SUBS_30 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 30 */ Special values are defined as:
0 Missing value

TACH_SECS_31 (4-byte unsigned integer, array size: nscan2):
Tachometer Pulse Seconds 31 */ Special values are defined as:
0 Missing value

TACH_SUBS_31 (2-byte unsigned integer, array size: nscan2):
Tachometer Pulse Subseconds 31 */ Special values are defined as:
0 Missing value

SCAN_COMPL_SECS (4-byte unsigned integer, array size: nscan2):
Scan Complete Time Tag Seconds */ Special values are defined as:
0 Missing value

SCAN_COMPL_SUBS (2-byte unsigned integer, array size: nscan2):
Scan Complete Time Tag Subseconds */ Special values are defined as:
0 Missing value

RSHSK_STATUS (Group in S3)

RSST_SCI_ADC_LP (2-byte unsigned integer, array size: nscan2):
RS Science channel latchup */ Special values are defined as:
0 Missing value

RSST_HSK_ADC_LP (2-byte unsigned integer, array size: nscan2):
RS Housekeeping channel ADC latchup */ Special values are defined as:
0 Missing value

RSST_SAMP_OVLP (2-byte unsigned integer, array size: nscan2):
Sample offset overlap */ Special values are defined as:
0 Missing value

RSST_10GHZ_RLY (2-byte unsigned integer, array size: nscan2):
10 GHz relay status */ Special values are defined as:
0 Missing value

RSST_18GHZ_RLY (2-byte unsigned integer, array size: nscan2):
18 GHz relay status */ Special values are defined as:
0 Missing value

RSST_23GHZ_RLY (2-byte unsigned integer, array size: nscan2):
23 GHz relay status */ Special values are defined as:
0 Missing value

RSST_36GHZ_RLY (2-byte unsigned integer, array size: nscan2):
36 GHz relay status */ Special values are defined as:
0 Missing value

RSST_89GHZ_RLY (2-byte unsigned integer, array size: nscan2):
89 GHz relay status */ Special values are defined as:
0 Missing value

RSST_166GHZ_RLY (2-byte unsigned integer, array size: nscan2):
166 GHz relay status */ Special values are defined as:
0 Missing value

RSST_183GHZ_RLY (2-byte unsigned integer, array size: nscan2):
183 GHz relay status */ Special values are defined as:
0 Missing value

RSST_INVLD_CMD (2-byte unsigned integer, array size: nscan2):
Invalid command received */ Special values are defined as:
0 Missing value

RSST_CMD_AFTER (2-byte unsigned integer, array size: nscan2):
Command received after scan start */ Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan2):
RS Configuration of Noise Diode Mode */ Special values are defined as:
0 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan2):
Noise diode state during the scan */ Special values are defined as:
0 Missing value

NDIODE10GHZSNUM (2-byte unsigned integer, array size: nscan2):
RS Configuration of Noise Diode Start Sample Number */ Special values are defined as:
0 Missing value

RESERVED1 (2-byte unsigned integer, array size: nscan2):
Unused item */ Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan2):
RS Calibration Resistor for RS telemetry num 1 */ Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan2):
RS Calibration Resistor for BATC telemetry num 1 */ Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan2):
RS Calibration Resistor for BATC telemetry num 2 */ Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan2):
RS Calibration Resistor for BATC telemetry num 2 */ Special values are defined as:
0 Missing value

RS_EPC_ISENS (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem EPC Current Sense */ Special values are defined as:
0 Missing value

RS_EPC_5V (2-byte unsigned integer, array size: nscan2):
EPC 5V Telemetry */ Special values are defined as:
0 Missing value

RS_EPC_7V (2-byte unsigned integer, array size: nscan2):
EPC 7V Telemetry */ Special values are defined as:
0 Missing value

RS_EPC_POS12V (2-byte unsigned integer, array size: nscan2):
EPC +12V Telemetry */ Special values are defined as:
0 Missing value

RS_EPC_NEG12V (2-byte unsigned integer, array size: nscan2):
EPC -12V Telemetry */ Special values are defined as:
0 Missing value

RS_EPC_15V (2-byte unsigned integer, array size: nscan2):
EPC 15V Telemetry */ Special values are defined as:
0 Missing value

RSHSK_SAMPL_INFO (Group in S3)

SMPOFFST_10GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 10GHz Channels (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_18GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 18 GHz Channels (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_23GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 23 GHz Channel (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_36GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 36 GHz Channels (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_89GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 89 GHz Channels (4us) */ Special values are defined as:
0 Missing value

SMPOFFST_166GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 166 GHz Channels (4us) */ Special values are defined as:

0 Missing value

SMPOFFST_183GHZ (2-byte unsigned integer, array size: nscan2):
RS-Reported Sample Offset for the 183 GHz Channels (4us) */ Special values are defined as:

0 Missing value

NUMSMPLS_10GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:

0 Missing value

NUMSMPLS_18GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:

0 Missing value

NUMSMPLS_23GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:

0 Missing value

NUMSMPLS_36GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:

0 Missing value

NUMSMPLS_89GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 10 GHz channels */ Special values are defined as:

0 Missing value

NUMSMPLS_166GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 166 GHz channels */ Special values are defined as:

0 Missing value

NUMSMPLS_183GHZ (2-byte unsigned integer, array size: nscan2):
RS Configuration of Number of Samples for the 183 GHz channels */ Special values are defined as:

0 Missing value

RSHSK_GAIN (Group in S3)

RESERVED2 (2-byte unsigned integer, array size: nscan2):
Unused item */ Special values are defined as:
0 Missing value

GAIN_V10GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 10 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_H36GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 36 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_H89GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 89 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_H10GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 10 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_H166GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 166 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_V18GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 18 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_H18GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 18 GHz H-pol channel */ Special values are defined as:
0 Missing value

GAIN_VB183GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 183.31 +/ Special values are defined as:
0 Missing value

GAIN_V23GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 23 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_V36GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 36 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_V89GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 89 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_V166GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 166 GHz V-pol channel */ Special values are defined as:
0 Missing value

GAIN_VA183GHZ (2-byte unsigned integer, array size: nscan2):
RS-reported gain setting for the 183.31 +/ Special values are defined as:
0 Missing value

RSHSK_TEMP (Group in S3)

TEMP_10GHZRCVR (2-byte unsigned integer, array size: nscan2):
10 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_H166GHZMXR (2-byte unsigned integer, array size: nscan2):
166 H GHz Mixer Pre-Amp Temperature */ Special values are defined as:
0 Missing value

TEMP_18GHZRCVR (2-byte unsigned integer, array size: nscan2):
18 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_V166GHZMXR (2-byte unsigned integer, array size: nscan2):
166 V GHz Mixer Pre-amp Temperature */ Special values are defined as:
0 Missing value

TEMP_23GHZRCVR (2-byte unsigned integer, array size: nscan2):
23 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_183GHZMXR (2-byte unsigned integer, array size: nscan2):
183 GHz Mixer Pre-amp Temperature */ Special values are defined as:
0 Missing value

TEMP_36GHZRCVR (2-byte unsigned integer, array size: nscan2):
36 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_H10GHZ_ND (2-byte unsigned integer, array size: nscan2):
10 GHz H-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_89GHZRCVR (2-byte unsigned integer, array size: nscan2):
89 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_V10GHZ_ND (2-byte unsigned integer, array size: nscan2):
10 GHz V-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_166GHZRCVR (2-byte unsigned integer, array size: nscan2):
166 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_H18GHZ_ND (2-byte unsigned integer, array size: nscan2):
18 GHz H-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_183GHZRCVR (2-byte unsigned integer, array size: nscan2):
183 GHz Box Receiver Temperature */ Special values are defined as:
0 Missing value

TEMP_V18GHZ_ND (2-byte unsigned integer, array size: nscan2):
18 GHz V-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_RS_EPC (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem EPC Box Temperature */ Special values are defined as:
0 Missing value

TEMP_H36GHZ_ND (2-byte unsigned integer, array size: nscan2):
36 GHz H-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_RS_EDC (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem EDC Box Temperature */ Special values are defined as:
0 Missing value

TEMP_V36GHZ_ND (2-byte unsigned integer, array size: nscan2):
36 GHz V-pol Noise Diode Temperature */ Special values are defined as:
0 Missing value

TEMP_FEED (2-byte unsigned integer, array size: nscan2):
Feedhorn Assembly Temperature */ Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (2-byte unsigned integer, array size: nscan2):
89 GHz Local Oscillator Temperature */ Special values are defined as:
0 Missing value

TEMP_HL_TRAY (2-byte unsigned integer, array size: nscan2):
Hot Load tray temperature */ Special values are defined as:
0 Missing value

TEMP_166GHZ_LO (2-byte unsigned integer, array size: nscan2):
166 GHz Local Oscillator Temperature */ Special values are defined as:
0 Missing value

TEMP_SMASPUNHSG (2-byte unsigned integer, array size: nscan2):
Temp SMA spun HSG */ Special values are defined as:
0 Missing value

TEMP_RS_MR1 (2-byte unsigned integer, array size: nscan2):
Main Reflector Temperature read by RS num 1 */ Special values are defined as:
0 Missing value

TEMP_H89GHZMXR (2-byte unsigned integer, array size: nscan2):
Temp H89GHZMXR */ Special values are defined as:
0 Missing value

TEMP_RS_MR2 (2-byte unsigned integer, array size: nscan2):
Main Reflector Temperature read by RS num 2 */ Special values are defined as:
0 Missing value

TEMP_V89GHZMXR (2-byte unsigned integer, array size: nscan2):
Temp V89GHZMXR */ Special values are defined as:
0 Missing value

TEMP_183GHZ_LO (2-byte unsigned integer, array size: nscan2):
183 GHz Local Oscillator Temperature */ Special values are defined as:
0 Missing value

IEHSK_TEMP (Group in S3)

IBS_LR1_TEMP (2-byte unsigned integer, array size: nscan2):
IBS Launch Restraint 1 temperature */ Special values are defined as:
0 Missing value

RS_TEMP_1 (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem Temperature num 1 */ Special values are defined as:
0 Missing value

SCE_A_BD_TEMP (2-byte unsigned integer, array size: nscan2):
SCE A Board Temperature */ Special values are defined as:
0 Missing value

MR_LR_RGHT_TEMP (2-byte unsigned integer, array size: nscan2):
Main Reflector Right Launch Restraint Temperature */ Special values are defined as:
0 Missing value

SMA_BEARING_TMP (2-byte unsigned integer, array size: nscan2):
SMA Bearing Temperature */ Special values are defined as:
0 Missing value

PC_BD_TEMP (2-byte unsigned integer, array size: nscan2):
Power Controller Board Temperature */ Special values are defined as:
0 Missing value

LVPS_BD_TEMP (2-byte unsigned integer, array size: nscan2):
Low Voltage Power Supply Board Temperature */ Special values are defined as:
0 Missing value

SMA_MTR_TEMP (2-byte unsigned integer, array size: nscan2):
SMA Motor Temperature */ Special values are defined as:
0 Missing value

HL_TEMP_2 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 2 */ Special values are defined as:
0 Missing value

RDA_TEMP_2 (2-byte unsigned integer, array size: nscan2):
RDA Temperature num 2 */ Special values are defined as:
0 Missing value

HL_TEMP_1 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 1 */ Special values are defined as:
0 Missing value

RS_TEMP_2 (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem Temperature num 2 */ Special values are defined as:
0 Missing value

SCE_B_BD_TEMP (2-byte unsigned integer, array size: nscan2):
SCE B Board Temperature */ Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 1 */ Special values are defined as:
0 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 2 */ Special values are defined as:
0 Missing value

MR_ICA_TEMP (2-byte unsigned integer, array size: nscan2):
Main Reflector temperature read by the ICA */ Special values are defined as:
0 Missing value

IBS_LR2_TEMP (2-byte unsigned integer, array size: nscan2):
IBS Launch Restraint 2 temperature */ Special values are defined as:
0 Missing value

HL_TEMP_7 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 3 */ Special values are defined as:
0 Missing value

RDA_TEMP_1 (2-byte unsigned integer, array size: nscan2):
RDA Temperature num 1 */ Special values are defined as:
0 Missing value

MR_LR_LEFT_TEMP (2-byte unsigned integer, array size: nscan2):
Main Reflector Left Launch Restraint Temperature */ Special values are defined as:
0 Missing value

RDA_TEMP_3 (2-byte unsigned integer, array size: nscan2):
RDA Temperature num 3 */ Special values are defined as:
0 Missing value

ICA_BOX_TEMP_1 (2-byte unsigned integer, array size: nscan2):
ICA Box Temperature num 1 */ Special values are defined as:
0 Missing value

HL_TEMP_10 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 10 */ Special values are defined as:
0 Missing value

MR_LR_LOWR_TEMP (2-byte unsigned integer, array size: nscan2):
Main Reflector Lower Launch Restraint Temperature */ Special values are defined as:
0 Missing value

SMA_SLPRHTR_TMP (2-byte unsigned integer, array size: nscan2):
SMA Slip Ring Heater Temperature */ Special values are defined as:
0 Missing value

HL_TEMP_8 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 8 */ Special values are defined as:
0 Missing value

TEMP_CALRES_3 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 3 */ Special values are defined as:
0 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 4 */ Special values are defined as:
0 Missing value

CSR_TEMP1 (2-byte unsigned integer, array size: nscan2):
Cold Sky Reflector Temperature */ Special values are defined as:
0 Missing value

HL_TEMP_12 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 12 */ Special values are defined as:
0 Missing value

HL_TEMP_13 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 13 */ Special values are defined as:
0 Missing value

HL_TEMP_14 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 14 */ Special values are defined as:
0 Missing value

HL_TEMP_11 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 11 */ Special values are defined as:
0 Missing value

IBS_LR3_TEMP (2-byte unsigned integer, array size: nscan2):
IBS Launch Restraint 3 temperature */ Special values are defined as:
0 Missing value

HL_TEMP_9 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 9 */ Special values are defined as:
0 Missing value

ROT_TEMP_SPARE (2-byte unsigned integer, array size: nscan2):
Spare Temperature (Rotational Side) */ Special values are defined as:
0 Missing value

CSR_TEMP2 (2-byte unsigned integer, array size: nscan2):
Cold Sky Reflector temperature 2 */ Special values are defined as:
0 Missing value

CE_BD_TEMP (2-byte unsigned integer, array size: nscan2):
CE Board Temperature */ Special values are defined as:
0 Missing value

ICA_BOX_TEMP_2 (2-byte unsigned integer, array size: nscan2):
ICA Box Temperature num 2 */ Special values are defined as:
0 Missing value

IE_BD_TEMP (2-byte unsigned integer, array size: nscan2):
Interface Electronics Board Temperature */ Special values are defined as:
0 Missing value

CLR_TEMP (2-byte unsigned integer, array size: nscan2):
CLR Temperature */ Special values are defined as:
0 Missing value

HL_TEMP_15 (2-byte unsigned integer, array size: nscan2):
Hot Load Temperature num 15 */ Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 5 */ Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan2):
ICA IE Telemetry Calibration Resistor num 6 */ Special values are defined as:
0 Missing value

IE_TELEMETRY (Group in S3)

IE_PASSTHRU_RSP (4-byte unsigned integer, array size: nscan2):
The response to the last pass through command. */ Special values are defined as:
0 Missing value

IE_BLANKING_CNT (2-byte unsigned integer, array size: nscan2):
Number of blanking output pulses since last tlm cycle. */ Special values are defined as:
0 Missing value

PWR_STAT_LR_PR (2-byte unsigned integer, array size: nscan2):
Power Controller Special values are defined as:
0 Missing value

PWR_STAT_A (2-byte unsigned integer, array size: nscan2):
Operational Power A status */ Special values are defined as:
0 Missing value

HTR_STAT_SMA (2-byte unsigned integer, array size: nscan2):
Operational heater status for the SMA */ Special values are defined as:
0 Missing value

HTR_STAT_RDA (2-byte unsigned integer, array size: nscan2):
Operational heater status for the RDA */ Special values are defined as:
0 Missing value

HTR_STAT_RS (2-byte unsigned integer, array size: nscan2):
Receiver Subsystem operational heater */ Special values are defined as:
0 Missing value

PWR_STAT_LR_RED (2-byte unsigned integer, array size: nscan2):
Redundant Launch Restraint status */ Special values are defined as:
0 Missing value

RS_MST_RLY_STAT (2-byte unsigned integer, array size: nscan2):
Receiver Subsytem Master Relay status */ Special values are defined as:
0 Missing value

RDA_DEPL_STAT_4 (2-byte unsigned integer, array size: nscan2):
Reflector Deployment Assembly deployment status num 4 */ Special values are defined as:
0 Missing value

RDA_DEPL_STAT_3 (2-byte unsigned integer, array size: nscan2):
Reflector Deployment Assembly deployment status num 3 */ Special values are defined as:
0 Missing value

RDA_DEPL_STAT_2 (2-byte unsigned integer, array size: nscan2):
Reflector Deployment Assembly deployment status num 2 */ Special values are defined as:
0 Missing value

RDA_DEPL_STAT_1 (2-byte unsigned integer, array size: nscan2):
Reflector Deployment Assembly deployment status num 1 */ Special values are defined as:
0 Missing value

CLR_STAT_N (2-byte unsigned integer, array size: nscan2):
Calibration Launch Restraint Status */ Special values are defined as:
0 Missing value

IBS_LR3_STAT_N (2-byte unsigned integer, array size: nscan2):
Instrument Bay Structure Launch Restraint */ Special values are defined as:
0 Missing value

MR_LR_LOWR_STAT (2-byte unsigned integer, array size: nscan2):
Main Reflector Lower Launch Restraint */ Special values are defined as:
0 Missing value

IBS_LR2_STAT_N (2-byte unsigned integer, array size: nscan2):
Instrument Bay Structure Launch Restraint */ Special values are defined as:
0 Missing value

MR_LR_LEFT_STAT (2-byte unsigned integer, array size: nscan2):
Main Reflector Left Launch Restraint */ Special values are defined as:
0 Missing value

IBS_LR1_STAT_N (2-byte unsigned integer, array size: nscan2):
Instrument Bay Structure Launch Restraint */ Special values are defined as:
0 Missing value

MR_LR_RGHT_STAT (2-byte unsigned integer, array size: nscan2):
Main Reflector Right Launch Restraint */ Special values are defined as:
0 Missing value

IE_LATCHUP_CHAN (2-byte unsigned integer, array size: nscan2):
Indicates the telemetry sample which observed the last */ Special values are defined as:
0 Missing value

IE_LATCHUP_RETR (2-byte unsigned integer, array size: nscan2):
Number of Retries */ Special values are defined as:
0 Missing value

IE_LATCHUP_SMPS (2-byte unsigned integer, array size: nscan2):
Number of Samples with Latchup. */ Special values are defined as:
0 Missing value

IE_LATCHUP_NUM (2-byte unsigned integer, array size: nscan2):
Number of Latchups Detected */ Special values are defined as:
0 Missing value

IE_LATCHUP_FAIL (2-byte unsigned integer, array size: nscan2):
Latchup Failure. */ Special values are defined as:
0 Missing value

HTR_STAT_HTLD (2-byte unsigned integer, array size: nscan2):
Operational heater status for the Hot Load */ Special values are defined as:
0 Missing value

IE_LATCHUP_PAD (2-byte unsigned integer, array size: nscan2):
PADDING */ Special values are defined as:
0 Missing value

MECHANISMS (Group in S3)

SCE_LAST_CMD (4-byte unsigned integer, array size: nscan2):
Last command sent to the SCE. */ Special values are defined as:
0 Missing value

SCE_LAST_RESPNS (4-byte unsigned integer, array size: nscan2):
Response from the SCE of the last command sent */ Special values are defined as:
0 Missing value

SCE_CMD_CNT (4-byte unsigned integer, array size: nscan2):
Total number of cmds to the SCE. */ Special values are defined as:
0 Missing value

SMA_RTPRB_SEC (2-byte unsigned integer, array size: nscan2):
The time since the beginning of the rate problem. 20 seconds to */ Special values are defined as:
0 Missing value

SMA_RATE (2-byte unsigned integer, array size: nscan2):
The ICA calculated rotational rate of the SMA in integer scaled rpm */ Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan2):
The SMA rotational rate reported by the SCE */ Special values are defined as:
0 Missing value

SCE_CMD_RATE (2-byte unsigned integer, array size: nscan2):
Last rate value commanded to the SCE. Used for rate limits */ Special values are defined as:
0 Missing value

SMA_CMD_RATE (2-byte unsigned integer, array size: nscan2):
Last rate value commanded to the SCE, converted to integer */ Special values are defined as:
0 Missing value

RESOLVER_POS (2-byte unsigned integer, array size: nscan2):
The resolver position reported by the SCE */ Special values are defined as:
0 Missing value

MECH_CMD_CNT (2-byte unsigned integer, array size: nscan2):
Number of commands received by the Mechanisms CSC */ Special values are defined as:
0 Missing value

SCE_INHIBIT (2-byte unsigned integer, array size: nscan2):
Indicator that commanding to the SCE is inhibited */ Special values are defined as:
0 Missing value

TACH_PULSE_CNT (2-byte unsigned integer, array size: nscan2):
Array indexer for tach pulses */ Special values are defined as:
0 Missing value

LR_ABRT_CNT (2-byte unsigned integer, array size: nscan2):
The number of launch restraint release procedures that have been */ Special values are defined as:
0 Missing value

RAMP_ABRT_CNT (2-byte unsigned integer, array size: nscan2):
The number of ramp procedures that have been aborted. */ Special values are defined as:
0 Missing value

OVRD_RDA_LR (2-byte unsigned integer, array size: nscan2):
Flag indicating the RDA launch restraints order protection is */ Special values are defined as:
0 Missing value

OVRD_IBS_LR (2-byte unsigned integer, array size: nscan2):
Flag indicating the IBS launch restraints order protection is */ Special values are defined as:
0 Missing value

SCE_PASSPROT (2-byte unsigned integer, array size: nscan2):
Flag indicating the RDA launch restraints order protection is */ Special values are defined as:
0 Missing value

RAMP_INPROGRESS (2-byte unsigned integer, array size: nscan2):
A SMA speed modification procedure is in progress. */ Special values are defined as:
0 Missing value

SMA_SPINNING (2-byte unsigned integer, array size: nscan2):
Indicator of whether SMA is spinning, based on speed */ Special values are defined as:
0 Missing value

LR_RLS_IN_PROG (2-byte unsigned integer, array size: nscan2):
Reports state of launch release fire command */ Special values are defined as:
0 Missing value

SCE_A_POWER (2-byte unsigned integer, array size: nscan2):
FSW status of SCE A Card power */ Special values are defined as:
0 Missing value

SCE_B_POWER (2-byte unsigned integer, array size: nscan2):
FSW status of SCE B Card power */ Special values are defined as:
0 Missing value

SCE_SELECTION (2-byte unsigned integer, array size: nscan2):
The current SCE selection setting. */ Special values are defined as:
0 Missing value

SMA_RATE_PROB (2-byte unsigned integer, array size: nscan2):
This field indicates the SMA is out of rate tolerances. */ Special values are defined as:
0 Missing value

LR_ENABLED (2-byte unsigned integer, array size: nscan2):
This tlm point indicates that one of launch restraint power buses is */ Special values are defined as:
0 Missing value

BILVL_IBS1 (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_IBS2 (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_IBS3 (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_CAL (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_RDALEFT (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_RDARIGHT (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

BILVL_RDALOWER (2-byte unsigned integer, array size: nscan2):
A bilevel to control the Limits Monitor CSU. */ Special values are defined as:
0 Missing value

SMPL_INFO (Group in S3)

SMPL_INFO_VALID (2-byte unsigned integer, array size: nscan2):
Sample Table Valid */ Special values are defined as:
0 Missing value

EARTH_10G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (10GHz) */ Special values are defined as:
0 Missing value

EARTH_10G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (10GHz) */ Special values are defined as:
0 Missing value

HLOAD_10G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (10GHz) */ Special values are defined as:
0 Missing value

HLOAD_10G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (10GHz) */ Special values are defined as:
0 Missing value

CSKY_10G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (10GHz) */ Special values are defined as:
0 Missing value

CSKY_10G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (10GHz) */ Special values are defined as:
0 Missing value

EARTH_18G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (18GHz) */ Special values are defined as:
0 Missing value

EARTH_18G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (18GHz) */ Special values are defined as:
0 Missing value

HLOAD_18G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (18GHz) */ Special values are defined as:
0 Missing value

HLOAD_18G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (18GHz) */ Special values are defined as:
0 Missing value

CSKY_18G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (18GHz) */ Special values are defined as:
0 Missing value

CSKY_18G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (18GHz) */ Special values are defined as:
0 Missing value

EARTH_23G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (23GHz) */ Special values are defined as:
0 Missing value

EARTH_23G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (23GHz) */ Special values are defined as:
0 Missing value

HLOAD_23G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (23GHz) */ Special values are defined as:
0 Missing value

HLOAD_23G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (23GHz) */ Special values are defined as:
0 Missing value

CSKY_23G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (23GHz) */ Special values are defined as:
0 Missing value

CSKY_23G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (23GHz) */ Special values are defined as:
0 Missing value

EARTH_36G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (36GHz) */ Special values are defined as:
0 Missing value

EARTH_36G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (36GHz) */ Special values are defined as:
0 Missing value

HLOAD_36G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (36GHz) */ Special values are defined as:
0 Missing value

HLOAD_36G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (36GHz) */ Special values are defined as:
0 Missing value

CSKY_36G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (36GHz) */ Special values are defined as:
0 Missing value

CSKY_36G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (36GHz) */ Special values are defined as:
0 Missing value

EARTH_89G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (89GHz) */ Special values are defined as:
0 Missing value

EARTH_89G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (89GHz) */ Special values are defined as:
0 Missing value

HLOAD_89G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (89GHz) */ Special values are defined as:
0 Missing value

HLOAD_89G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (89GHz) */ Special values are defined as:
0 Missing value

CSKY_89G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (89GHz) */ Special values are defined as:
0 Missing value

CSKY_89G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (89GHz) */ Special values are defined as:
0 Missing value

EARTH_166G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (166GHz) */ Special values are defined as:
0 Missing value

EARTH_166G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (166GHz) */ Special values are defined as:
0 Missing value

HLOAD_166G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (166GHz) */ Special values are defined as:
0 Missing value

HLOAD_166G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (166GHz) */ Special values are defined as:
0 Missing value

CSKY_166G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (166GHz) */ Special values are defined as:
0 Missing value

CSKY_166G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (166GHz) */ Special values are defined as:
0 Missing value

EARTH_183G_STRT (2-byte unsigned integer, array size: nscan2):
Earth viewing start (183GHz) */ Special values are defined as:
0 Missing value

EARTH_183G_NUM (2-byte unsigned integer, array size: nscan2):
Earth viewing samples (183GHz) */ Special values are defined as:
0 Missing value

HLOAD_183G_STRT (2-byte unsigned integer, array size: nscan2):
Hot Load start (183GHz) */ Special values are defined as:
0 Missing value

HLOAD_183G_NUM (2-byte unsigned integer, array size: nscan2):
Hot Load samples (183GHz) */ Special values are defined as:
0 Missing value

CSKY_183G_STRT (2-byte unsigned integer, array size: nscan2):
Cold Sky start (183GHz) */ Special values are defined as:
0 Missing value

CSKY_183G_NUM (2-byte unsigned integer, array size: nscan2):
Cold Sky samples (183GHz) */ Special values are defined as:
0 Missing value

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

Latitude (4-byte float, array size: npixelfr x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelfr x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelfr x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelfr x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

fullRotation (2-byte unsigned integer, array size: nchannel1 x npixelfr x nscan2):

```
Full rotation counts.
```

Special values are defined as:
0 Missing value

fullRotBlanking (1-byte char, array size: VH x npixelfr x nscan2):

```
Full rotation blanking counts.
```

Special values are defined as:
0 Missing value

S5 (Swath)

S5_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S5)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

Latitude (4-byte float, array size: npixelfr x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelfr x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelfr x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelfr x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

fullRotation (2-byte unsigned integer, array size: nchannel2 x npixelfr x nscan2):

```
Full rotation counts.
```

Special values are defined as:
0 Missing value

C Structure Header file:

```
#ifndef _TK_1AGMI_H_
#define _TK_1AGMI_H_

#ifndef _L1AGMI_S5_
#define _L1AGMI_S5_

typedef struct {
    SCANTIME ScanTime;
    unsigned char ephemerisUsed[10];
    float Latitude[500];
    float Longitude[500];
    float sunLocalTime[500];
    float incidenceAngle[500];
    unsigned short fullRotation[500][4];
} L1AGMI_S5;

#endif

#ifndef _L1AGMI_S4_
#define _L1AGMI_S4_

typedef struct {
    SCANTIME ScanTime;
    unsigned char ephemerisUsed[10];
    float Latitude[500];
    float Longitude[500];
    float sunLocalTime[500];
    float incidenceAngle[500];
    unsigned short fullRotation[500][9];
    unsigned char fullRotBlanking[500][2];
} L1AGMI_S4;

#endif

#ifndef _L1AGMI_S3_SMPL_INFO_
#define _L1AGMI_S3_SMPL_INFO_
```

```
typedef struct {
    unsigned short SMPL_INFO_VALID;
    unsigned short EARTH_10G_STRT;
    unsigned short EARTH_10G_NUM;
    unsigned short HLOAD_10G_STRT;
    unsigned short HLOAD_10G_NUM;
    unsigned short CSKY_10G_STRT;
    unsigned short CSKY_10G_NUM;
    unsigned short EARTH_18G_STRT;
    unsigned short EARTH_18G_NUM;
    unsigned short HLOAD_18G_STRT;
    unsigned short HLOAD_18G_NUM;
    unsigned short CSKY_18G_STRT;
    unsigned short CSKY_18G_NUM;
    unsigned short EARTH_23G_STRT;
    unsigned short EARTH_23G_NUM;
    unsigned short HLOAD_23G_STRT;
    unsigned short HLOAD_23G_NUM;
    unsigned short CSKY_23G_STRT;
    unsigned short CSKY_23G_NUM;
    unsigned short EARTH_36G_STRT;
    unsigned short EARTH_36G_NUM;
    unsigned short HLOAD_36G_STRT;
    unsigned short HLOAD_36G_NUM;
    unsigned short CSKY_36G_STRT;
    unsigned short CSKY_36G_NUM;
    unsigned short EARTH_89G_STRT;
    unsigned short EARTH_89G_NUM;
    unsigned short HLOAD_89G_STRT;
    unsigned short HLOAD_89G_NUM;
    unsigned short CSKY_89G_STRT;
    unsigned short CSKY_89G_NUM;
    unsigned short EARTH_166G_STRT;
    unsigned short EARTH_166G_NUM;
    unsigned short HLOAD_166G_STRT;
    unsigned short HLOAD_166G_NUM;
    unsigned short CSKY_166G_STRT;
    unsigned short CSKY_166G_NUM;
    unsigned short EARTH_183G_STRT;
    unsigned short EARTH_183G_NUM;
    unsigned short HLOAD_183G_STRT;
    unsigned short HLOAD_183G_NUM;
    unsigned short CSKY_183G_STRT;
```

```
    unsigned short CSKY_183G_NUM;
} L1AGMI_S3_SMPL_INFO;

#endif

#ifndef _L1AGMI_S3_MECHANISMS_
#define _L1AGMI_S3_MECHANISMS_

typedef struct {
    unsigned int SCE_LAST_CMD;
    unsigned int SCE_LAST_RESPNS;
    unsigned int SCE_CMD_CNT;
    unsigned short SMA_RTPRB_SEC;
    unsigned short SMA_RATE;
    unsigned short SCE_RATE;
    unsigned short SCE_CMD_RATE;
    unsigned short SMA_CMD_RATE;
    unsigned short RESOLVER_POS;
    unsigned short MECH_CMD_CNT;
    unsigned short SCE_INHIBIT;
    unsigned short TACH_PULSE_CNT;
    unsigned short LR_ABRT_CNT;
    unsigned short RAMP_ABRT_CNT;
    unsigned short OVRD_RDA_LR;
    unsigned short OVRD_IBS_LR;
    unsigned short SCE_PASSPROT;
    unsigned short RAMP_INPROGRESS;
    unsigned short SMA_SPINNING;
    unsigned short LR_RLS_IN_PROG;
    unsigned short SCE_A_POWER;
    unsigned short SCE_B_POWER;
    unsigned short SCE_SELECTION;
    unsigned short SMA_RATE_PROB;
    unsigned short LR_ENABLED;
    unsigned short BILVL_IBS1;
    unsigned short BILVL_IBS2;
    unsigned short BILVL_IBS3;
    unsigned short BILVL_CAL;
    unsigned short BILVL_RDALEFT;
    unsigned short BILVL_RDARIGHT;
    unsigned short BILVL_RDALOWER;
} L1AGMI_S3_MECHANISMS;
```

```
#endif

#ifndef _L1AGMI_S3_IE_TELEMETRY_
#define _L1AGMI_S3_IE_TELEMETRY_

typedef struct {
    unsigned int IE_PASSTHRU_RSP;
    unsigned short IE_BLANKING_CNT;
    unsigned short PWR_STAT_LR_PR;
    unsigned short PWR_STAT_A;
    unsigned short HTR_STAT_SMA;
    unsigned short HTR_STAT_RDA;
    unsigned short HTR_STAT_RS;
    unsigned short PWR_STAT_LR_RED;
    unsigned short RS_MST_RLY_STAT;
    unsigned short RDA_DEPL_STAT_4;
    unsigned short RDA_DEPL_STAT_3;
    unsigned short RDA_DEPL_STAT_2;
    unsigned short RDA_DEPL_STAT_1;
    unsigned short CLR_STAT_N;
    unsigned short IBS_LR3_STAT_N;
    unsigned short MR_LR_LOWR_STAT;
    unsigned short IBS_LR2_STAT_N;
    unsigned short MR_LR_LEFT_STAT;
    unsigned short IBS_LR1_STAT_N;
    unsigned short MR_LR_RGHT_STAT;
    unsigned short IE_LATCHUP_CHAN;
    unsigned short IE_LATCHUP_RETR;
    unsigned short IE_LATCHUP_SMPS;
    unsigned short IE_LATCHUP_NUM;
    unsigned short IE_LATCHUP_FAIL;
    unsigned short HTR_STAT_HTLD;
    unsigned short IE_LATCHUP_PAD;
} L1AGMI_S3_IE_TELEMETRY;

#endif

#ifndef _L1AGMI_S3_IEHSK_TEMP_
#define _L1AGMI_S3_IEHSK_TEMP_

typedef struct {
    unsigned short IBS_LR1_TEMP;
    unsigned short RS_TEMP_1;
```

```
    unsigned short SCE_A_BD_TEMP;
    unsigned short MR_LR_RGHT_TEMP;
    unsigned short SMA_BEARING_TMP;
    unsigned short PC_BD_TEMP;
    unsigned short LVPS_BD_TEMP;
    unsigned short SMA_MTR_TEMP;
    unsigned short HL_TEMP_2;
    unsigned short RDA_TEMP_2;
    unsigned short HL_TEMP_1;
    unsigned short RS_TEMP_2;
    unsigned short SCE_B_BD_TEMP;
    unsigned short TEMP_CALRES_1;
    unsigned short TEMP_CALRES_2;
    unsigned short MR_ICA_TEMP;
    unsigned short IBS_LR2_TEMP;
    unsigned short HL_TEMP_7;
    unsigned short RDA_TEMP_1;
    unsigned short MR_LR_LEFT_TEMP;
    unsigned short RDA_TEMP_3;
    unsigned short ICA_BOX_TEMP_1;
    unsigned short HL_TEMP_10;
    unsigned short MR_LR_LOWR_TEMP;
    unsigned short SMA_SLPRHTR_TMP;
    unsigned short HL_TEMP_8;
    unsigned short TEMP_CALRES_3;
    unsigned short TEMP_CALRES_4;
    unsigned short CSR_TEMP1;
    unsigned short HL_TEMP_12;
    unsigned short HL_TEMP_13;
    unsigned short HL_TEMP_14;
    unsigned short HL_TEMP_11;
    unsigned short IBS_LR3_TEMP;
    unsigned short HL_TEMP_9;
    unsigned short ROT_TEMP_SPARE;
    unsigned short CSR_TEMP2;
    unsigned short CE_BD_TEMP;
    unsigned short ICA_BOX_TEMP_2;
    unsigned short IE_BD_TEMP;
    unsigned short CLR_TEMP;
    unsigned short HL_TEMP_15;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
} L1AGMI_S3_IEHSK_TEMP;
```

```
#endif

#ifndef _L1AGMI_S3_RSHSK_TEMP_
#define _L1AGMI_S3_RSHSK_TEMP_

typedef struct {
    unsigned short TEMP_10GHZRCVR;
    unsigned short TEMP_H166GHZMXR;
    unsigned short TEMP_18GHZRCVR;
    unsigned short TEMP_V166GHZMXR;
    unsigned short TEMP_23GHZRCVR;
    unsigned short TEMP_183GHZMXR;
    unsigned short TEMP_36GHZRCVR;
    unsigned short TEMP_H10GHZ_ND;
    unsigned short TEMP_89GHZRCVR;
    unsigned short TEMP_V10GHZ_ND;
    unsigned short TEMP_166GHZRCVR;
    unsigned short TEMP_H18GHZ_ND;
    unsigned short TEMP_183GHZRCVR;
    unsigned short TEMP_V18GHZ_ND;
    unsigned short TEMP_RS_EPC;
    unsigned short TEMP_H36GHZ_ND;
    unsigned short TEMP_RS_EDC;
    unsigned short TEMP_V36GHZ_ND;
    unsigned short TEMP_FEED;
    unsigned short TEMP_89GHZ_LO;
    unsigned short TEMP_HL_TRAY;
    unsigned short TEMP_166GHZ_LO;
    unsigned short TEMP_SMASPUNHSG;
    unsigned short TEMP_RS_MR1;
    unsigned short TEMP_H89GHZMXR;
    unsigned short TEMP_RS_MR2;
    unsigned short TEMP_V89GHZMXR;
    unsigned short TEMP_183GHZ_LO;
} L1AGMI_S3_RSHSK_TEMP;

#endif

#ifndef _L1AGMI_S3_RSHSK_GAIN_
#define _L1AGMI_S3_RSHSK_GAIN_

typedef struct {
```

```
    unsigned short RESERVED2;
    unsigned short GAIN_V10GHZ;
    unsigned short GAIN_H36GHZ;
    unsigned short GAIN_H89GHZ;
    unsigned short GAIN_H10GHZ;
    unsigned short GAIN_H166GHZ;
    unsigned short GAIN_V18GHZ;
    unsigned short GAIN_H18GHZ;
    unsigned short GAIN_VB183GHZ;
    unsigned short GAIN_V23GHZ;
    unsigned short GAIN_V36GHZ;
    unsigned short GAIN_V89GHZ;
    unsigned short GAIN_V166GHZ;
    unsigned short GAIN_VA183GHZ;
} L1AGMI_S3_RSHSK_GAIN;

#endif

#ifndef _L1AGMI_S3_RSHSK_SAMPL_INFO_
#define _L1AGMI_S3_RSHSK_SAMPL_INFO_

typedef struct {
    unsigned short SMPOFFST_10GHZ;
    unsigned short SMPOFFST_18GHZ;
    unsigned short SMPOFFST_23GHZ;
    unsigned short SMPOFFST_36GHZ;
    unsigned short SMPOFFST_89GHZ;
    unsigned short SMPOFFST_166GHZ;
    unsigned short SMPOFFST_183GHZ;
    unsigned short NUMSMPLS_10GHZ;
    unsigned short NUMSMPLS_18GHZ;
    unsigned short NUMSMPLS_23GHZ;
    unsigned short NUMSMPLS_36GHZ;
    unsigned short NUMSMPLS_89GHZ;
    unsigned short NUMSMPLS_166GHZ;
    unsigned short NUMSMPLS_183GHZ;
} L1AGMI_S3_RSHSK_SAMPL_INFO;

#endif

#ifndef _L1AGMI_S3_RSHSK_STATUS_
#define _L1AGMI_S3_RSHSK_STATUS_
```

```
typedef struct {
    unsigned short RSST_SCI_ADC_LP;
    unsigned short RSST_HSK_ADC_LP;
    unsigned short RSST_SAMP_OVLP;
    unsigned short RSST_10GHZ_RLY;
    unsigned short RSST_18GHZ_RLY;
    unsigned short RSST_23GHZ_RLY;
    unsigned short RSST_36GHZ_RLY;
    unsigned short RSST_89GHZ_RLY;
    unsigned short RSST_166GHZ_RLY;
    unsigned short RSST_183GHZ_RLY;
    unsigned short RSST_INVLD_CMD;
    unsigned short RSST_CMD_AFTER;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZSNUM;
    unsigned short RESERVED1;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short BATC_CALRES_2;
    unsigned short RS_EPC_ISENS;
    unsigned short RS_EPC_5V;
    unsigned short RS_EPC_7V;
    unsigned short RS_EPC_POS12V;
    unsigned short RS_EPC_NEG12V;
    unsigned short RS_EPC_15V;
} L1AGMI_S3_RSHSK_STATUS;

#endif

#ifndef _L1AGMI_S3_SYNCH_STAMPS2_
#define _L1AGMI_S3_SYNCH_STAMPS2_

typedef struct {
    unsigned int TACH_SECS_16;
    unsigned short TACH_SUBS_16;
    unsigned int TACH_SECS_17;
    unsigned short TACH_SUBS_17;
    unsigned int TACH_SECS_18;
    unsigned short TACH_SUBS_18;
    unsigned int TACH_SECS_19;
    unsigned short TACH_SUBS_19;
```

```
    unsigned int TACH_SECS_20;
    unsigned short TACH_SUBS_20;
    unsigned int TACH_SECS_21;
    unsigned short TACH_SUBS_21;
    unsigned int TACH_SECS_22;
    unsigned short TACH_SUBS_22;
    unsigned int TACH_SECS_23;
    unsigned short TACH_SUBS_23;
    unsigned int TACH_SECS_24;
    unsigned short TACH_SUBS_24;
    unsigned int TACH_SECS_25;
    unsigned short TACH_SUBS_25;
    unsigned int TACH_SECS_26;
    unsigned short TACH_SUBS_26;
    unsigned int TACH_SECS_27;
    unsigned short TACH_SUBS_27;
    unsigned int TACH_SECS_28;
    unsigned short TACH_SUBS_28;
    unsigned int TACH_SECS_29;
    unsigned short TACH_SUBS_29;
    unsigned int TACH_SECS_30;
    unsigned short TACH_SUBS_30;
    unsigned int TACH_SECS_31;
    unsigned short TACH_SUBS_31;
    unsigned int SCAN_COMPL_SECS;
    unsigned short SCAN_COMPL_SUBS;
} L1AGMI_S3_SYNCH_STAMPS2;

#endif

#ifndef _L1AGMI_S3_SYNCH_STAMPS_
#define _L1AGMI_S3_SYNCH_STAMPS_

typedef struct {
    unsigned int IDX_PULSE_SECS;
    unsigned short IDX_PULSE_SUBS;
    unsigned int TACH_SECS_00;
    unsigned short TACH_SUBS_00;
    unsigned int TACH_SECS_01;
    unsigned short TACH_SUBS_01;
    unsigned int TACH_SECS_02;
    unsigned short TACH_SUBS_02;
    unsigned int TACH_SECS_03;
```

```
    unsigned short TACH_SUBS_03;
    unsigned int TACH_SECS_04;
    unsigned short TACH_SUBS_04;
    unsigned int TACH_SECS_05;
    unsigned short TACH_SUBS_05;
    unsigned int TACH_SECS_06;
    unsigned short TACH_SUBS_06;
    unsigned int TACH_SECS_07;
    unsigned short TACH_SUBS_07;
    unsigned int TACH_SECS_08;
    unsigned short TACH_SUBS_08;
    unsigned int TACH_SECS_09;
    unsigned short TACH_SUBS_09;
    unsigned int TACH_SECS_10;
    unsigned short TACH_SUBS_10;
    unsigned int TACH_SECS_11;
    unsigned short TACH_SUBS_11;
    unsigned int TACH_SECS_12;
    unsigned short TACH_SUBS_12;
    unsigned int TACH_SECS_13;
    unsigned short TACH_SUBS_13;
    unsigned int TACH_SECS_14;
    unsigned short TACH_SUBS_14;
    unsigned int TACH_SECS_15;
    unsigned short TACH_SUBS_15;
} L1AGMI_S3_SYNCH_STAMPS;

#endif

#ifndef _L1AGMI_S3_RS_INFO_
#define _L1AGMI_S3_RS_INFO_

typedef struct {
    unsigned short RS_POWERED;
    unsigned short RS_ENABLED;
    unsigned short RS_MST_RLY;
    unsigned short RS_10GHZ_RLY;
    unsigned short RS_18GHZ_RLY;
    unsigned short RS_23GHZ_RLY;
    unsigned short RS_36GHZ_RLY;
    unsigned short RS_89GHZ_RLY;
    unsigned short RS_166GHZ_RLY;
    unsigned short RS_183GHZ_RLY;
```

```
    unsigned short RS_DQ_MISSING;
    unsigned short RS_DQ_EXTRAS;
    unsigned short RS_DQ_DUPES;
    unsigned short RS_LAST_REV;
    unsigned short RS_DQ_SAME_REV;
    unsigned short RS_DQ_BAD_REVS;
    unsigned short RS_DQ_PAR_ERR;
    unsigned short RS_DQ_CLK_ERR;
    unsigned short RS_DQ_PKT_ERR;
    unsigned short RS_DQ_TLM_ERR;
    unsigned short RS_DQ_BAD_CONF;
    unsigned short RS_DQ_CAL_LIM;
    unsigned short BLK_STATE;
    unsigned short BLK_SIDE;
    unsigned short BLK_DELAY;
    unsigned short BLK_DURATION;
    unsigned short RS_HSK_SIZE;
    unsigned int RS_PAR_ERR_CNT;
    unsigned int RS_SCAN_CNT;
    unsigned int SAMPLE_TBL_VER;
    unsigned int SMPL_TBL;
    unsigned short RS_SC_SIZE;
    unsigned short GSDR_SIZE;
    unsigned short GSDR_LEFT;
    unsigned short GSDR_B_POP_IDX;
    unsigned short GSDR_B_PUSH_IDX;
    unsigned short GSDR_APID;
    unsigned short PKT_STATE;
    unsigned short OVRD_RS_PWR;
    unsigned short OVRD_SMA_SPIN;
    unsigned short OVRD_PASS_RS;
} L1AGMI_S3_RS_INFO;

#endif

#ifndef _L1AGMI_S3_SENSOR_INFO_
#define _L1AGMI_S3_SENSOR_INFO_

typedef struct {
    unsigned int KEEP_ALIVE_CNT;
    unsigned short FPGA_RST_REASON;
    unsigned short CRASH_REASON;
    unsigned short VERSION_MIN;
```

```
    unsigned short VERSION_MAJ;
    unsigned short FPGA_MODE;
    unsigned short ERR_HDL_FAILURE;
    unsigned short RESET_REASON;
    unsigned short BOOT_BANK;
    unsigned short CURRENT_BANK;
    unsigned short EDAC_ENABLE;
    unsigned short WDOG_ENABLE;
    unsigned short SC_1HZ_REF;
    unsigned short SCE_FORCE_SEL;
    unsigned short RS_1MHZ_REF;
    unsigned short RS_SCAN_START;
    unsigned short FPGA_IE_RX_EN;
    unsigned short FPGA_RS_RX_EN;
    unsigned short FPGA_SCE_RX_EN;
    unsigned short EEPROM_BUSY;
    unsigned short RS_TLM_PROG;
    unsigned short SCE_A_ACTIVE;
    unsigned short SCE_A_RLY;
    unsigned short SCE_B_ACTIVE;
    unsigned short SCE_B_RLY;
    unsigned short IE_TLM_PROG;
    unsigned short SCE_RSP_PROG;
    unsigned short RS_CLK_ERR;
    unsigned short RS_PKT_ERR;
    unsigned short RS_TLM_ERR;
    unsigned short SCE_RSP_RDY;
    unsigned short IE_PKT_ERR;
    unsigned short IE_CMD_ERR;
    unsigned short IE_RSP_ERR;
    unsigned short IE_TLM_ERR;
    unsigned short FPGA_ACCSS_ERR;
} L1AGMI_S3_SENSOR_INFO;

#endif

#ifndef _L1AGMI_S3_GSDR_TIME_
#define _L1AGMI_S3_GSDR_TIME_

typedef struct {
    unsigned int G_TC_PULSE_SECS;
    unsigned short G_TC_PULSE_SUBS;
    unsigned int G_TCU_SECS;
```

```
    unsigned int G_TCU_SUBS;
    unsigned int G_TCF_SC_SECS;
    unsigned int G_TCF_SC_SUBSEC;
    unsigned int G_TCF_SECS;
    unsigned int G_TCF_SUBSECS;
    unsigned short G_TCF_SIGN;
    unsigned short G_TCF_LEAP;
    unsigned int GPS_TCU_SECS;
    unsigned int GPS_TCU_SUBS;
} L1AGMI_S3_GSDR_TIME;

#endif

#ifndef _PRIMARYHEADER_
#define _PRIMARYHEADER_

typedef struct {
    signed char version;
    signed char type;
    signed char secHeaderFlag;
    short APID;
    signed char sequenceFlag;
    short packetSequenceCount;
    unsigned short packetLength;
} PRIMARYHEADER;

#endif

#ifndef _L1AGMI_S3_GMI_TEMPERATURES_
#define _L1AGMI_S3_GMI_TEMPERATURES_

typedef struct {
    float timeOffset;
    unsigned short apid;
    unsigned short SMA_PT_TEMP;
    unsigned short ICA_PT_TEMP;
    unsigned short RS_PT_TEMP;
    unsigned short STAT_PT_TEMP;
    unsigned short MR_PT_TEMP;
} L1AGMI_S3_GMI_TEMPERATURES;

#endif
```

```
#ifndef _L1AGMI_S3_TORQUE_BAR_
#define _L1AGMI_S3_TORQUE_BAR_

typedef struct {
    float timeOffset;
    unsigned short Vx;
    unsigned short Vy;
    unsigned short Vz;
} L1AGMI_S3_TORQUE_BAR;

#endif

#ifndef _L1AGMI_S3_TAM2_
#define _L1AGMI_S3_TAM2_

typedef struct {
    float timeOffset;
    unsigned short Vx;
    unsigned short Vy;
    unsigned short Vz;
} L1AGMI_S3_TAM2;

#endif

#ifndef _L1AGMI_S3_TAM1_
#define _L1AGMI_S3_TAM1_

typedef struct {
    float timeOffset;
    unsigned short Vx;
    unsigned short Vy;
    unsigned short Vz;
} L1AGMI_S3_TAM1;

#endif

#ifndef _L1AGMI_S3_
#define _L1AGMI_S3_

typedef struct {
    SCANTIME ScanTime;
    unsigned char ephemerisUsed[10];
    float Latitude;
```

```
    float Longitude;
    L1AGMI_S3_TAM1 TAM1;
    L1AGMI_S3_TAM2 TAM2;
    L1AGMI_S3_TORQUE_BAR TORQUE_BAR;
    L1AGMI_S3_GMI_TEMPERATURES GMI_TEMPERATURES;
    PRIMARYHEADER primaryHeader;
    unsigned int instrTimeSeconds;
    unsigned short instrTimeSubseconds;
    signed char numPacketSegments;
    signed char spare;
    short RDRversion;
    L1AGMI_S3_GSDR_TIME GSDR_TIME;
    L1AGMI_S3_SENSOR_INFO SENSOR_INFO;
    L1AGMI_S3_RS_INFO RS_INFO;
    L1AGMI_S3_SYNCH_STAMPS SYNCH_STAMPS;
    L1AGMI_S3_SYNCH_STAMPS2 SYNCH_STAMPS2;
    L1AGMI_S3_RSHSK_STATUS RSHSK_STATUS;
    L1AGMI_S3_RSHSK_SAMPL_INFO RSHSK_SAMPL_INFO;
    L1AGMI_S3_RSHSK_GAIN RSHSK_GAIN;
    L1AGMI_S3_RSHSK_TEMP RSHSK_TEMP;
    L1AGMI_S3_IEHSK_TEMP IEHSK_TEMP;
    L1AGMI_S3_IE_TELEMETRY IE_TELEMETRY;
    L1AGMI_S3_MECHANISMS MECHANISMS;
    L1AGMI_S3_SMPL_INFO SMPL_INFO;
} L1AGMI_S3;

#endif

#ifndef _L1AGMI_S2_SUNDATA_
#define _L1AGMI_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1AGMI_S2_SUNDATA;

#endif
```

```
#ifndef _L1AGMI_S2_SCANSTATUS_
#define _L1AGMI_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1AGMI_S2_SCANSTATUS;

#endif

#ifndef _L1AGMI_S2_
#define _L1AGMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    L1AGMI_S2_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    NAVIGATION navigation;
    L1AGMI_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float moonVectorInstFrame[3];
    unsigned short earthView[221][4];
    unsigned short hotLoad[221][4];
    unsigned short coldSky[221][4];
} L1AGMI_S2;
```

```
#endif

#ifndef _L1AGMI_S1_SUNDATA_
#define _L1AGMI_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1AGMI_S1_SUNDATA;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif
```

```
#ifndef _L1AGMI_S1_SCANSTATUS_
#define _L1AGMI_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1AGMI_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1AGMI_S1_
#define _L1AGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
```

```
    float sunLocalTime[221];
    L1AGMI_S1_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    NAVIGATION navigation;
    L1AGMI_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float moonVectorInstFrame[3];
    unsigned short earthView[221][9];
    unsigned short hotLoad[221][9];
    unsigned short coldSky[221][9];
    unsigned char earthViewBlanking[221][2];
    unsigned char hotLoadBlanking[221][2];
    unsigned char coldSkyBlanking[221][2];
} L1AGMI_S1;

#endif

#ifndef _L1AGMI_SWATHS_
#define _L1AGMI_SWATHS_

typedef struct {
    L1AGMI_S1 S1;
    L1AGMI_S2 S2;
    L1AGMI_S3 S3;
    L1AGMI_S4 S4;
    L1AGMI_S5 S5;
} L1AGMI_SWATHS;

#endif

#ifndef _L1AGMI_GMI1AHEADER_
#define _L1AGMI_GMI1AHEADER_

typedef struct {
    unsigned short sampleRangeFile[7][6];
} L1AGMI_GMI1AHEADER;

#endif
```

```
#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1AGMI_S5/
    RECORD /SCANTIME/ ScanTime
    CHARACTER ephemerisUsed(10)
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 sunLocalTime(500)
    REAL*4 incidenceAngle(500)
    INTEGER*2 fullRotation(4,500)
END STRUCTURE

STRUCTURE /L1AGMI_S4/
    RECORD /SCANTIME/ ScanTime
    CHARACTER ephemerisUsed(10)
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 sunLocalTime(500)
    REAL*4 incidenceAngle(500)
    INTEGER*2 fullRotation(9,500)
    CHARACTER fullRotBlanking(2,500)
END STRUCTURE

STRUCTURE /L1AGMI_S3_SMPL_INFO/
    INTEGER*2 SMPL_INFO_VALID
    INTEGER*2 EARTH_10G_STRT
    INTEGER*2 EARTH_10G_NUM
    INTEGER*2 HLOAD_10G_STRT
    INTEGER*2 HLOAD_10G_NUM
    INTEGER*2 CSKY_10G_STRT
    INTEGER*2 CSKY_10G_NUM
    INTEGER*2 EARTH_18G_STRT
    INTEGER*2 EARTH_18G_NUM
    INTEGER*2 HLOAD_18G_STRT
    INTEGER*2 HLOAD_18G_NUM
    INTEGER*2 CSKY_18G_STRT
    INTEGER*2 CSKY_18G_NUM
    INTEGER*2 EARTH_23G_STRT
    INTEGER*2 EARTH_23G_NUM
    INTEGER*2 HLOAD_23G_STRT
    INTEGER*2 HLOAD_23G_NUM
```

```
    INTEGER*2 CSKY_23G_STRT
    INTEGER*2 CSKY_23G_NUM
    INTEGER*2 EARTH_36G_STRT
    INTEGER*2 EARTH_36G_NUM
    INTEGER*2 HLOAD_36G_STRT
    INTEGER*2 HLOAD_36G_NUM
    INTEGER*2 CSKY_36G_STRT
    INTEGER*2 CSKY_36G_NUM
    INTEGER*2 EARTH_89G_STRT
    INTEGER*2 EARTH_89G_NUM
    INTEGER*2 HLOAD_89G_STRT
    INTEGER*2 HLOAD_89G_NUM
    INTEGER*2 CSKY_89G_STRT
    INTEGER*2 CSKY_89G_NUM
    INTEGER*2 EARTH_166G_STRT
    INTEGER*2 EARTH_166G_NUM
    INTEGER*2 HLOAD_166G_STRT
    INTEGER*2 HLOAD_166G_NUM
    INTEGER*2 CSKY_166G_STRT
    INTEGER*2 CSKY_166G_NUM
    INTEGER*2 EARTH_183G_STRT
    INTEGER*2 EARTH_183G_NUM
    INTEGER*2 HLOAD_183G_STRT
    INTEGER*2 HLOAD_183G_NUM
    INTEGER*2 CSKY_183G_STRT
    INTEGER*2 CSKY_183G_NUM
END STRUCTURE

STRUCTURE /L1AGMI_S3_MECHANISMS/
    INTEGER*4 SCE_LAST_CMD
    INTEGER*4 SCE_LAST_RESPNS
    INTEGER*4 SCE_CMD_CNT
    INTEGER*2 SMA_RTPRB_SEC
    INTEGER*2 SMA_RATE
    INTEGER*2 SCE_RATE
    INTEGER*2 SCE_CMD_RATE
    INTEGER*2 SMA_CMD_RATE
    INTEGER*2 RESOLVER_POS
    INTEGER*2 MECH_CMD_CNT
    INTEGER*2 SCE_INHIBIT
    INTEGER*2 TACH_PULSE_CNT
    INTEGER*2 LR_ABRT_CNT
    INTEGER*2 RAMP_ABRT_CNT
```

```
    INTEGER*2 OVRD_RDA_LR
    INTEGER*2 OVRD_IBS_LR
    INTEGER*2 SCE_PASSPROT
    INTEGER*2 RAMP_INPROGRESS
    INTEGER*2 SMA_SPINNING
    INTEGER*2 LR_RLS_IN_PROG
    INTEGER*2 SCE_A_POWER
    INTEGER*2 SCE_B_POWER
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SMA_RATE_PROB
    INTEGER*2 LR_ENABLED
    INTEGER*2 BILVL_IBS1
    INTEGER*2 BILVL_IBS2
    INTEGER*2 BILVL_IBS3
    INTEGER*2 BILVL_CAL
    INTEGER*2 BILVL_RDALEFT
    INTEGER*2 BILVL_RDARIGHT
    INTEGER*2 BILVL_RDALOWER
END STRUCTURE

STRUCTURE /L1AGMI_S3_IE_TELEMETRY/
    INTEGER*4 IE_PASSTHRU_RSP
    INTEGER*2 IE_BLANKING_CNT
    INTEGER*2 PWR_STAT_LR_PR
    INTEGER*2 PWR_STAT_A
    INTEGER*2 HTR_STAT_SMA
    INTEGER*2 HTR_STAT_RDA
    INTEGER*2 HTR_STAT_RS
    INTEGER*2 PWR_STAT_LR_RED
    INTEGER*2 RS_MST_RLY_STAT
    INTEGER*2 RDA_DEPL_STAT_4
    INTEGER*2 RDA_DEPL_STAT_3
    INTEGER*2 RDA_DEPL_STAT_2
    INTEGER*2 RDA_DEPL_STAT_1
    INTEGER*2 CLR_STAT_N
    INTEGER*2 IBS_LR3_STAT_N
    INTEGER*2 MR_LR_LOWR_STAT
    INTEGER*2 IBS_LR2_STAT_N
    INTEGER*2 MR_LR_LEFT_STAT
    INTEGER*2 IBS_LR1_STAT_N
    INTEGER*2 MR_LR_RGHT_STAT
    INTEGER*2 IE_LATCHUP_CHAN
    INTEGER*2 IE_LATCHUP_RETR
```

```
    INTEGER*2 IE_LATCHUP_SMPS
    INTEGER*2 IE_LATCHUP_NUM
    INTEGER*2 IE_LATCHUP_FAIL
    INTEGER*2 HTR_STAT_HTLD
    INTEGER*2 IE_LATCHUP_PAD
END STRUCTURE

STRUCTURE /L1AGMI_S3_IEHSK_TEMP/
    INTEGER*2 IBS_LR1_TEMP
    INTEGER*2 RS_TEMP_1
    INTEGER*2 SCE_A_BD_TEMP
    INTEGER*2 MR_LR_RGHT_TEMP
    INTEGER*2 SMA_BEARING_TMP
    INTEGER*2 PC_BD_TEMP
    INTEGER*2 LVPS_BD_TEMP
    INTEGER*2 SMA_MTR_TEMP
    INTEGER*2 HL_TEMP_2
    INTEGER*2 RDA_TEMP_2
    INTEGER*2 HL_TEMP_1
    INTEGER*2 RS_TEMP_2
    INTEGER*2 SCE_B_BD_TEMP
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 MR_ICA_TEMP
    INTEGER*2 IBS_LR2_TEMP
    INTEGER*2 HL_TEMP_7
    INTEGER*2 RDA_TEMP_1
    INTEGER*2 MR_LR_LEFT_TEMP
    INTEGER*2 RDA_TEMP_3
    INTEGER*2 ICA_BOX_TEMP_1
    INTEGER*2 HL_TEMP_10
    INTEGER*2 MR_LR_LOWR_TEMP
    INTEGER*2 SMA_SLPRHTR_TMP
    INTEGER*2 HL_TEMP_8
    INTEGER*2 TEMP_CALRES_3
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 CSR_TEMP1
    INTEGER*2 HL_TEMP_12
    INTEGER*2 HL_TEMP_13
    INTEGER*2 HL_TEMP_14
    INTEGER*2 HL_TEMP_11
    INTEGER*2 IBS_LR3_TEMP
    INTEGER*2 HL_TEMP_9
```

```
    INTEGER*2 ROT_TEMP_SPARE
    INTEGER*2 CSR_TEMP2
    INTEGER*2 CE_BD_TEMP
    INTEGER*2 ICA_BOX_TEMP_2
    INTEGER*2 IE_BD_TEMP
    INTEGER*2 CLR_TEMP
    INTEGER*2 HL_TEMP_15
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
END STRUCTURE

STRUCTURE /L1AGMI_S3_RSHSK_TEMP/
    INTEGER*2 TEMP_10GHZRCVR
    INTEGER*2 TEMP_H166GHZMXR
    INTEGER*2 TEMP_18GHZRCVR
    INTEGER*2 TEMP_V166GHZMXR
    INTEGER*2 TEMP_23GHZRCVR
    INTEGER*2 TEMP_183GHZMXR
    INTEGER*2 TEMP_36GHZRCVR
    INTEGER*2 TEMP_H10GHZ_ND
    INTEGER*2 TEMP_89GHZRCVR
    INTEGER*2 TEMP_V10GHZ_ND
    INTEGER*2 TEMP_166GHZRCVR
    INTEGER*2 TEMP_H18GHZ_ND
    INTEGER*2 TEMP_183GHZRCVR
    INTEGER*2 TEMP_V18GHZ_ND
    INTEGER*2 TEMP_RS_EPC
    INTEGER*2 TEMP_H36GHZ_ND
    INTEGER*2 TEMP_RS_EDC
    INTEGER*2 TEMP_V36GHZ_ND
    INTEGER*2 TEMP_FEED
    INTEGER*2 TEMP_89GHZ_LO
    INTEGER*2 TEMP_HL_TRAY
    INTEGER*2 TEMP_166GHZ_LO
    INTEGER*2 TEMP_SMASPUNHSG
    INTEGER*2 TEMP_RS_MR1
    INTEGER*2 TEMP_H89GHZMXR
    INTEGER*2 TEMP_RS_MR2
    INTEGER*2 TEMP_V89GHZMXR
    INTEGER*2 TEMP_183GHZ_LO
END STRUCTURE

STRUCTURE /L1AGMI_S3_RSHSK_GAIN/
```

```
    INTEGER*2 RESERVED2
    INTEGER*2 GAIN_V10GHZ
    INTEGER*2 GAIN_H36GHZ
    INTEGER*2 GAIN_H89GHZ
    INTEGER*2 GAIN_H10GHZ
    INTEGER*2 GAIN_H166GHZ
    INTEGER*2 GAIN_V18GHZ
    INTEGER*2 GAIN_H18GHZ
    INTEGER*2 GAIN_VB183GHZ
    INTEGER*2 GAIN_V23GHZ
    INTEGER*2 GAIN_V36GHZ
    INTEGER*2 GAIN_V89GHZ
    INTEGER*2 GAIN_V166GHZ
    INTEGER*2 GAIN_VA183GHZ
END STRUCTURE

STRUCTURE /L1AGMI_S3_RSHSK_SAMPL_INFO/
    INTEGER*2 SMPOFFST_10GHZ
    INTEGER*2 SMPOFFST_18GHZ
    INTEGER*2 SMPOFFST_23GHZ
    INTEGER*2 SMPOFFST_36GHZ
    INTEGER*2 SMPOFFST_89GHZ
    INTEGER*2 SMPOFFST_166GHZ
    INTEGER*2 SMPOFFST_183GHZ
    INTEGER*2 NUMSMPLS_10GHZ
    INTEGER*2 NUMSMPLS_18GHZ
    INTEGER*2 NUMSMPLS_23GHZ
    INTEGER*2 NUMSMPLS_36GHZ
    INTEGER*2 NUMSMPLS_89GHZ
    INTEGER*2 NUMSMPLS_166GHZ
    INTEGER*2 NUMSMPLS_183GHZ
END STRUCTURE

STRUCTURE /L1AGMI_S3_RSHSK_STATUS/
    INTEGER*2 RSST_SCI_ADC_LP
    INTEGER*2 RSST_HSK_ADC_LP
    INTEGER*2 RSST_SAMP_OVLP
    INTEGER*2 RSST_10GHZ_RLY
    INTEGER*2 RSST_18GHZ_RLY
    INTEGER*2 RSST_23GHZ_RLY
    INTEGER*2 RSST_36GHZ_RLY
    INTEGER*2 RSST_89GHZ_RLY
    INTEGER*2 RSST_166GHZ_RLY
```

```
    INTEGER*2 RSST_183GHZ_RLY
    INTEGER*2 RSST_INVLD_CMD
    INTEGER*2 RSST_CMD_AFTER
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZSNUM
    INTEGER*2 RESERVED1
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 RS_EPC_ISENS
    INTEGER*2 RS_EPC_5V
    INTEGER*2 RS_EPC_7V
    INTEGER*2 RS_EPC_POS12V
    INTEGER*2 RS_EPC_NEG12V
    INTEGER*2 RS_EPC_15V
END STRUCTURE

STRUCTURE /L1AGMI_S3_SYNCH_STAMPS2/
    INTEGER*4 TACH_SECS_16
    INTEGER*2 TACH_SUBS_16
    INTEGER*4 TACH_SECS_17
    INTEGER*2 TACH_SUBS_17
    INTEGER*4 TACH_SECS_18
    INTEGER*2 TACH_SUBS_18
    INTEGER*4 TACH_SECS_19
    INTEGER*2 TACH_SUBS_19
    INTEGER*4 TACH_SECS_20
    INTEGER*2 TACH_SUBS_20
    INTEGER*4 TACH_SECS_21
    INTEGER*2 TACH_SUBS_21
    INTEGER*4 TACH_SECS_22
    INTEGER*2 TACH_SUBS_22
    INTEGER*4 TACH_SECS_23
    INTEGER*2 TACH_SUBS_23
    INTEGER*4 TACH_SECS_24
    INTEGER*2 TACH_SUBS_24
    INTEGER*4 TACH_SECS_25
    INTEGER*2 TACH_SUBS_25
    INTEGER*4 TACH_SECS_26
    INTEGER*2 TACH_SUBS_26
    INTEGER*4 TACH_SECS_27
```

```
    INTEGER*2 TACH_SUBS_27
    INTEGER*4 TACH_SECS_28
    INTEGER*2 TACH_SUBS_28
    INTEGER*4 TACH_SECS_29
    INTEGER*2 TACH_SUBS_29
    INTEGER*4 TACH_SECS_30
    INTEGER*2 TACH_SUBS_30
    INTEGER*4 TACH_SECS_31
    INTEGER*2 TACH_SUBS_31
    INTEGER*4 SCAN_COMPL_SECS
    INTEGER*2 SCAN_COMPL_SUBS
END STRUCTURE

STRUCTURE /L1AGMI_S3_SYNCH_STAMPS/
    INTEGER*4 IDX_PULSE_SECS
    INTEGER*2 IDX_PULSE_SUBS
    INTEGER*4 TACH_SECS_00
    INTEGER*2 TACH_SUBS_00
    INTEGER*4 TACH_SECS_01
    INTEGER*2 TACH_SUBS_01
    INTEGER*4 TACH_SECS_02
    INTEGER*2 TACH_SUBS_02
    INTEGER*4 TACH_SECS_03
    INTEGER*2 TACH_SUBS_03
    INTEGER*4 TACH_SECS_04
    INTEGER*2 TACH_SUBS_04
    INTEGER*4 TACH_SECS_05
    INTEGER*2 TACH_SUBS_05
    INTEGER*4 TACH_SECS_06
    INTEGER*2 TACH_SUBS_06
    INTEGER*4 TACH_SECS_07
    INTEGER*2 TACH_SUBS_07
    INTEGER*4 TACH_SECS_08
    INTEGER*2 TACH_SUBS_08
    INTEGER*4 TACH_SECS_09
    INTEGER*2 TACH_SUBS_09
    INTEGER*4 TACH_SECS_10
    INTEGER*2 TACH_SUBS_10
    INTEGER*4 TACH_SECS_11
    INTEGER*2 TACH_SUBS_11
    INTEGER*4 TACH_SECS_12
    INTEGER*2 TACH_SUBS_12
    INTEGER*4 TACH_SECS_13
```

```
    INTEGER*2 TACH_SUBS_13
    INTEGER*4 TACH_SECS_14
    INTEGER*2 TACH_SUBS_14
    INTEGER*4 TACH_SECS_15
    INTEGER*2 TACH_SUBS_15
END STRUCTURE

STRUCTURE /L1AGMI_S3_RS_INFO/
    INTEGER*2 RS_POWERED
    INTEGER*2 RS_ENABLED
    INTEGER*2 RS_MST_RLY
    INTEGER*2 RS_10GHZ_RLY
    INTEGER*2 RS_18GHZ_RLY
    INTEGER*2 RS_23GHZ_RLY
    INTEGER*2 RS_36GHZ_RLY
    INTEGER*2 RS_89GHZ_RLY
    INTEGER*2 RS_166GHZ_RLY
    INTEGER*2 RS_183GHZ_RLY
    INTEGER*2 RS_DQ_MISSING
    INTEGER*2 RS_DQ_EXTRAS
    INTEGER*2 RS_DQ_DUPES
    INTEGER*2 RS_LAST_REV
    INTEGER*2 RS_DQ_SAME_REV
    INTEGER*2 RS_DQ_BAD_REVS
    INTEGER*2 RS_DQ_PAR_ERR
    INTEGER*2 RS_DQ_CLK_ERR
    INTEGER*2 RS_DQ_PKT_ERR
    INTEGER*2 RS_DQ_TLM_ERR
    INTEGER*2 RS_DQ_BAD_CONF
    INTEGER*2 RS_DQ_CAL_LIM
    INTEGER*2 BLK_STATE
    INTEGER*2 BLK_SIDE
    INTEGER*2 BLK_DELAY
    INTEGER*2 BLK_DURATION
    INTEGER*2 RS_HSK_SIZE
    INTEGER*4 RS_PAR_ERR_CNT
    INTEGER*4 RS_SCAN_CNT
    INTEGER*4 SAMPLE_TBL_VER
    INTEGER*4 SMPL_TBL
    INTEGER*2 RS_SC_SIZE
    INTEGER*2 GSDR_SIZE
    INTEGER*2 GSDR_LEFT
    INTEGER*2 GSDR_B_POP_IDX
```

```
    INTEGER*2 GSDR_B_PUSH_IDX
    INTEGER*2 GSDR_APID
    INTEGER*2 PKT_STATE
    INTEGER*2 OVRD_RS_PWR
    INTEGER*2 OVRD_SMA_SPIN
    INTEGER*2 OVRD_PASS_RS
END STRUCTURE

STRUCTURE /L1AGMI_S3_SENSOR_INFO/
    INTEGER*4 KEEP_ALIVE_CNT
    INTEGER*2 FPGA_RST_REASON
    INTEGER*2 CRASH_REASON
    INTEGER*2 VERSION_MIN
    INTEGER*2 VERSION_MAJ
    INTEGER*2 FPGA_MODE
    INTEGER*2 ERR_HDL_FAILURE
    INTEGER*2 RESET_REASON
    INTEGER*2 BOOT_BANK
    INTEGER*2 CURRENT_BANK
    INTEGER*2 EDAC_ENABLE
    INTEGER*2 WDOG_ENABLE
    INTEGER*2 SC_1HZ_REF
    INTEGER*2 SCE_FORCE_SEL
    INTEGER*2 RS_1MHZ_REF
    INTEGER*2 RS_SCAN_START
    INTEGER*2 FPGA_IE_RX_EN
    INTEGER*2 FPGA_RS_RX_EN
    INTEGER*2 FPGA_SCE_RX_EN
    INTEGER*2 EEPROM_BUSY
    INTEGER*2 RS_TLM_PROG
    INTEGER*2 SCE_A_ACTIVE
    INTEGER*2 SCE_A_RLY
    INTEGER*2 SCE_B_ACTIVE
    INTEGER*2 SCE_B_RLY
    INTEGER*2 IE_TLM_PROG
    INTEGER*2 SCE_RSP_PROG
    INTEGER*2 RS_CLK_ERR
    INTEGER*2 RS_PKT_ERR
    INTEGER*2 RS_TLM_ERR
    INTEGER*2 SCE_RSP_RDY
    INTEGER*2 IE_PKT_ERR
    INTEGER*2 IE_CMD_ERR
    INTEGER*2 IE_RSP_ERR
```

```
    INTEGER*2 IE_TLM_ERR
    INTEGER*2 FPGA_ACCSS_ERR
END STRUCTURE

STRUCTURE /L1AGMI_S3_GSDR_TIME/
    INTEGER*4 G_TC_PULSE_SECS
    INTEGER*2 G_TC_PULSE_SUBS
    INTEGER*4 G_TCU_SECS
    INTEGER*4 G_TCU_SUBS
    INTEGER*4 G_TCF_SC_SECS
    INTEGER*4 G_TCF_SC_SUBSEC
    INTEGER*4 G_TCF_SECS
    INTEGER*4 G_TCF_SUBSECS
    INTEGER*2 G_TCF_SIGN
    INTEGER*2 G_TCF_LEAP
    INTEGER*4 GPS_TCU_SECS
    INTEGER*4 GPS_TCU_SUBS
END STRUCTURE

STRUCTURE /PRIMARYHEADER/
    BYTE version
    BYTE type
    BYTE secHeaderFlag
    INTEGER*2 APID
    BYTE sequenceFlag
    INTEGER*2 packetSequenceCount
    INTEGER*2 packetLength
END STRUCTURE

STRUCTURE /L1AGMI_S3_GMI_TEMPERATURES/
    REAL*4 timeOffset
    INTEGER*2 apid
    INTEGER*2 SMA_PT_TEMP
    INTEGER*2 ICA_PT_TEMP
    INTEGER*2 RS_PT_TEMP
    INTEGER*2 STAT_PT_TEMP
    INTEGER*2 MR_PT_TEMP
END STRUCTURE

STRUCTURE /L1AGMI_S3_TORQUE_BAR/
    REAL*4 timeOffset
    INTEGER*2 Vx
    INTEGER*2 Vy
```

```
    INTEGER*2 Vz
END STRUCTURE

STRUCTURE /L1AGMI_S3_TAM2/
    REAL*4 timeOffset
    INTEGER*2 Vx
    INTEGER*2 Vy
    INTEGER*2 Vz
END STRUCTURE

STRUCTURE /L1AGMI_S3_TAM1/
    REAL*4 timeOffset
    INTEGER*2 Vx
    INTEGER*2 Vy
    INTEGER*2 Vz
END STRUCTURE

STRUCTURE /L1AGMI_S3/
    RECORD /SCANTIME/ ScanTime
    CHARACTER ephemerisUsed(10)
    REAL*4 Latitude
    REAL*4 Longitude
    RECORD /L1AGMI_S3_TAM1/ TAM1
    RECORD /L1AGMI_S3_TAM2/ TAM2
    RECORD /L1AGMI_S3_TORQUE_BAR/ TORQUE_BAR
    RECORD /L1AGMI_S3_GMI_TEMPERATURES/ GMI_TEMPERATURES
    RECORD /PRIMARYHEADER/ primaryHeader
    INTEGER*4 instrTimeSeconds
    INTEGER*2 instrTimeSubseconds
    BYTE numPacketSegments
    BYTE spare
    INTEGER*2 RDRversion
    RECORD /L1AGMI_S3_GSDR_TIME/ GSDR_TIME
    RECORD /L1AGMI_S3_SENSOR_INFO/ SENSOR_INFO
    RECORD /L1AGMI_S3_RS_INFO/ RS_INFO
    RECORD /L1AGMI_S3_SYNCH_STAMPS/ SYNCH_STAMPS
    RECORD /L1AGMI_S3_SYNCH_STAMPS2/ SYNCH_STAMPS2
    RECORD /L1AGMI_S3_RSHSK_STATUS/ RSHSK_STATUS
    RECORD /L1AGMI_S3_RSHSK_SAMPL_INFO/ RSHSK_SAMPL_INFO
    RECORD /L1AGMI_S3_RSHSK_GAIN/ RSHSK_GAIN
    RECORD /L1AGMI_S3_RSHSK_TEMP/ RSHSK_TEMP
    RECORD /L1AGMI_S3_IEHSK_TEMP/ IEHSK_TEMP
    RECORD /L1AGMI_S3_IE_TELEMETRY/ IE_TELEMETRY
```

```
    RECORD /L1AGMI_S3_MECHANISMS/ MECHANISMS
    RECORD /L1AGMI_S3_SMPL_INFO/ SMPL_INFO
END STRUCTURE

STRUCTURE /L1AGMI_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1AGMI_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1AGMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /L1AGMI_S2_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /NAVIGATION/ navigation
    RECORD /L1AGMI_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
```

```
    REAL*4 moonVectorInstFrame(3)
    INTEGER*2 earthView(4,221)
    INTEGER*2 hotLoad(4,221)
    INTEGER*2 coldSky(4,221)
END STRUCTURE

STRUCTURE /L1AGMI_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1AGMI_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
```

```
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1AGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /L1AGMI_S1_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /NAVIGATION/ navigation
    RECORD /L1AGMI_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 moonVectorInstFrame(3)
    INTEGER*2 earthView(9,221)
    INTEGER*2 hotLoad(9,221)
    INTEGER*2 coldSky(9,221)
    CHARACTER earthViewBlanking(2,221)
    CHARACTER hotLoadBlanking(2,221)
    CHARACTER coldSkyBlanking(2,221)
END STRUCTURE
```

```
STRUCTURE /L1AGMI_SWATHS/
    RECORD /L1AGMI_S1/ S1;
    RECORD /L1AGMI_S2/ S2;
    RECORD /L1AGMI_S3/ S3;
    RECORD /L1AGMI_S4/ S4;
    RECORD /L1AGMI_S5/ S5;
END STRUCTURE

STRUCTURE /L1AGMI_GMI1AHEADER/
    INTEGER*2 sampleRangeFile(6,7)
END STRUCTURE
```

5.2 1ATMI - TMI unpacked packet data

1ATMI contains unpacked packet data from TMI science data from the TMI passive microwave instrument flown on the TRMM satellite. There are 4 swaths. Swath S1 has 10V 10H; Swath S2 has 19V, 19H, 21V, 37V, 37H; Swath S3 has 85V, 85H; Swath S4 has Housekeeping.

```
        The S1 channels are:
10.7  GHz vertically-polarized
10.7  GHz horizontally-polarized


        The S2 channels are:
18.7  GHz vertically-polarized
18.7  GHz horizontally-polarized
23.8  GHz vertically-polarized
36.5  GHz vertically-polarized
36.5  GHz horizontally-polarized


        The S3 channels are:
85.0  GHz vertically-polarized
85.0  GHz horizontally-polarized


S4 has TMI housekeeping.
```

Earth observations are taken during a segment of the rotation when TMI is looking in the +x direction of the TRMM satellite. Since the spacecraft turns around every few weeks,

+x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

Before Aug 7, 2001 31.6rpm * 1min/60s * 5490s/orbit = 2891 scans / orbit.

After Aug 24, 2001 31.6rpm * 1min/60s * 5550s/orbit = 2923 scans / orbit.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and the same number of pixels as Swath S1. Swath S3 has the same number of scans and twice as many pixels as Swath S1. Each S1 scan contains 2 channels sampled 104 times along the scan. Each S2 scan contains 5 channels sampled 104 times along the scan. Each S3 scan contains 2 channels sampled 208 times along the scan.

Dimension definitions:

nsoparm	3	Number of swath offset parameters: cone angle, start angle, first pixel time.
nswath	3	Number of swaths, not counting housekeeping swath.
VH	2	Number of polarizations.
nscan1	var	Typical number of Swath S1 scans in the granule.
nchannel1	2	Number of Swath S1 channels (10V).
npixelev1	104	Number of earth view pixels in one scan.
npixelht1	8	Number of hot load pixels in one scan.
npixelcs1	8	Number of cold sky pixels in one scan.
nscan2	var	Typical number of Swath S2 scans in the granule.
nchannel2	5	Number of Swath S2 channels (19V 19H 21V 37V 37H).
npixelev2	104	Number of earth view pixels in one scan.
npixelht2	8	Number of hot load pixels in one scan.
npixelcs2	8	Number of cold sky pixels in one scan.
nscan3	var	Typical number of Swath S3 scans in the granule.
nchannel3	2	Number of Swath S3 channels (85V 85H).
npixelev3	208	Number of earth view pixels in one scan.
npixelht3	16	Number of hot load pixels in one scan.
npixelcs3	16	Number of cold sky pixels in one scan.
nscan4	var	Typical number of Swath S4 scans in the granule.
nchannelall	9	Number of all channels.
dim1	1	Number.
dim2	2	Number.
dim3	3	Number.
dim4	4	Number.
dim5	5	Number.
dim6	6	Number.
dim7	7	Number.
dim8	8	Number.
dim9	9	Number.
dim10	10	Number.
dim11	11	Number.
dim12	12	Number.
TMIxyz	3	x, y, z components in TMI instrument coordinate system.
SVBFd	3	SunVectorinBodyFrame dimension.

Figure 48 through Figure 72 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

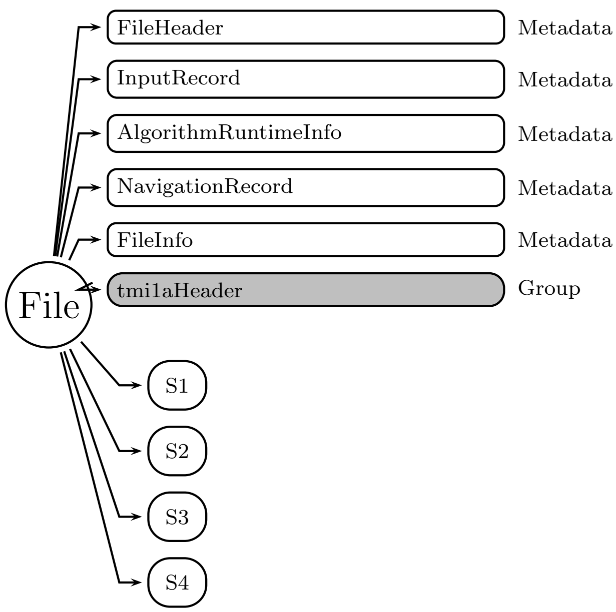


Figure 48: Data Format Structure for 1ATMI, TMI unpacked packet data

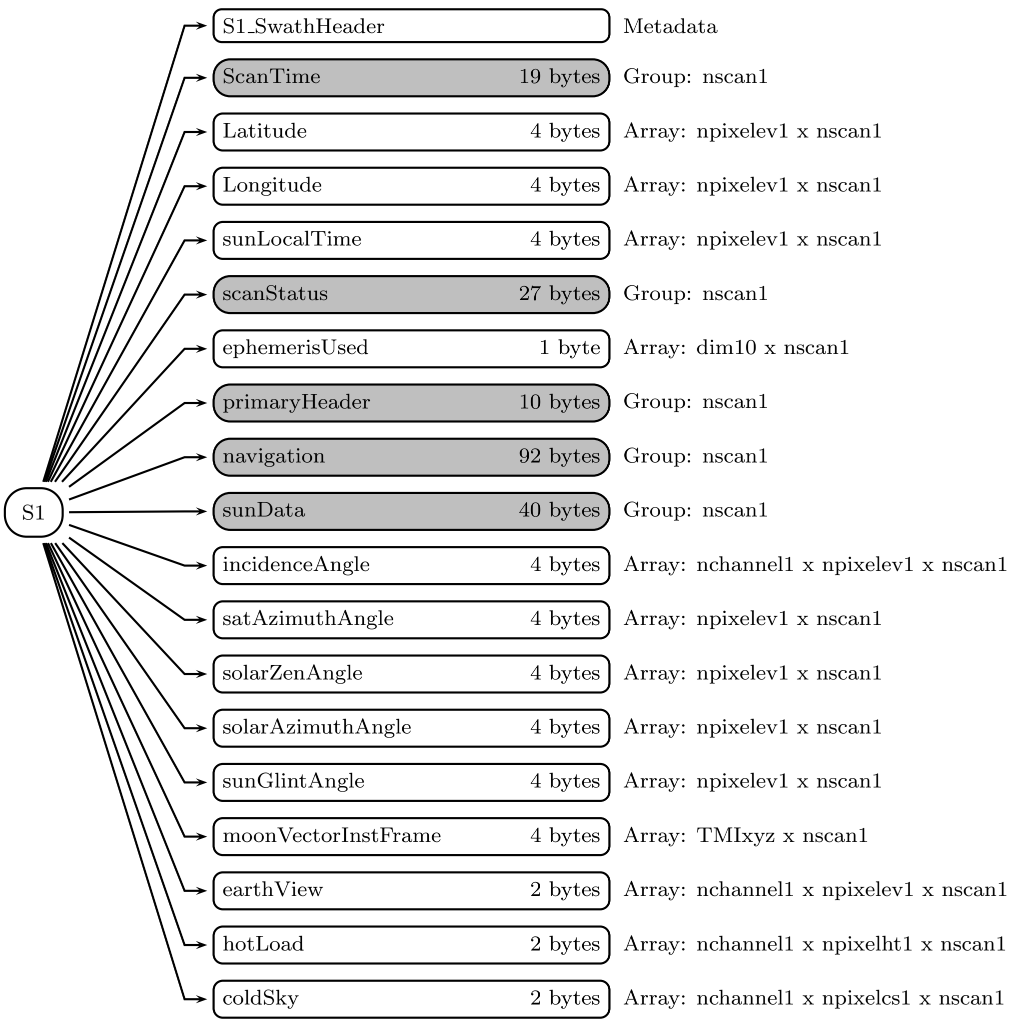


Figure 49: Data Format Structure for 1ATMI, S1

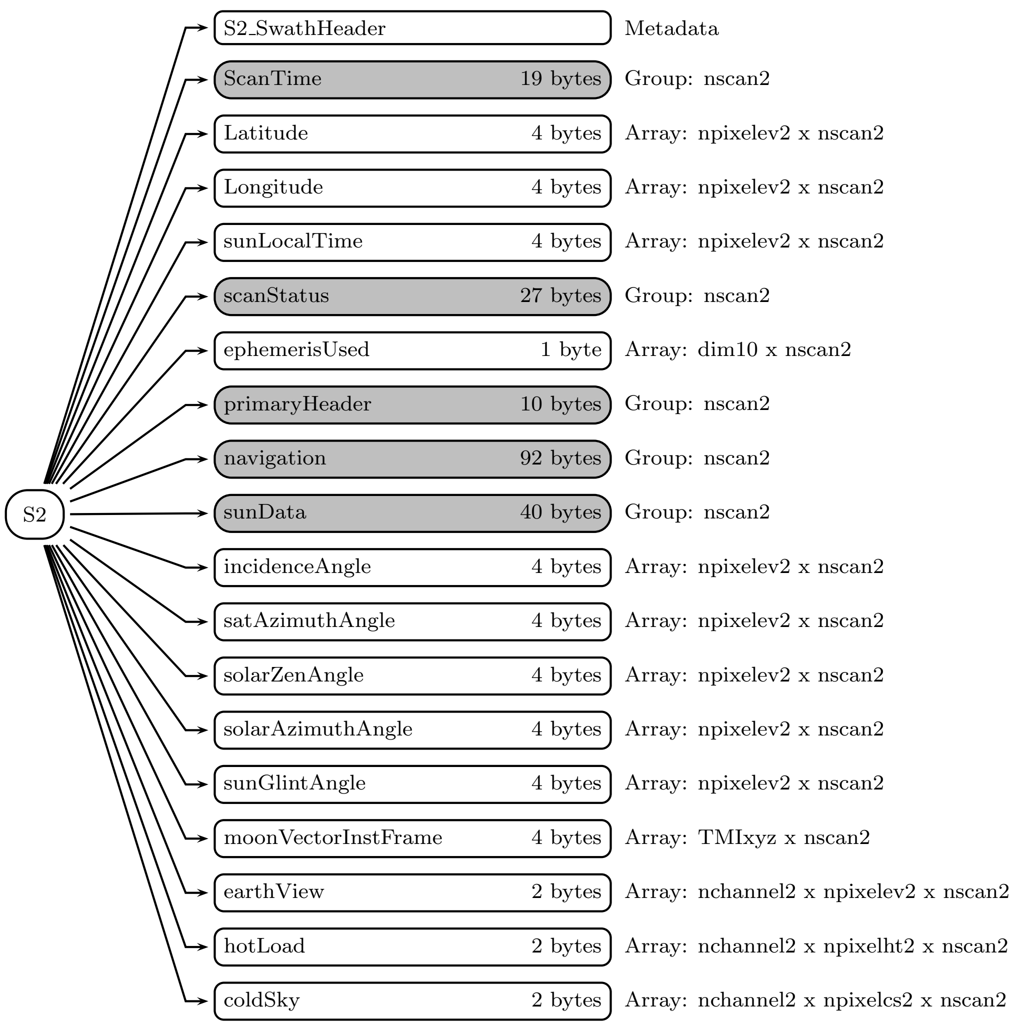


Figure 50: Data Format Structure for 1ATMI, S2

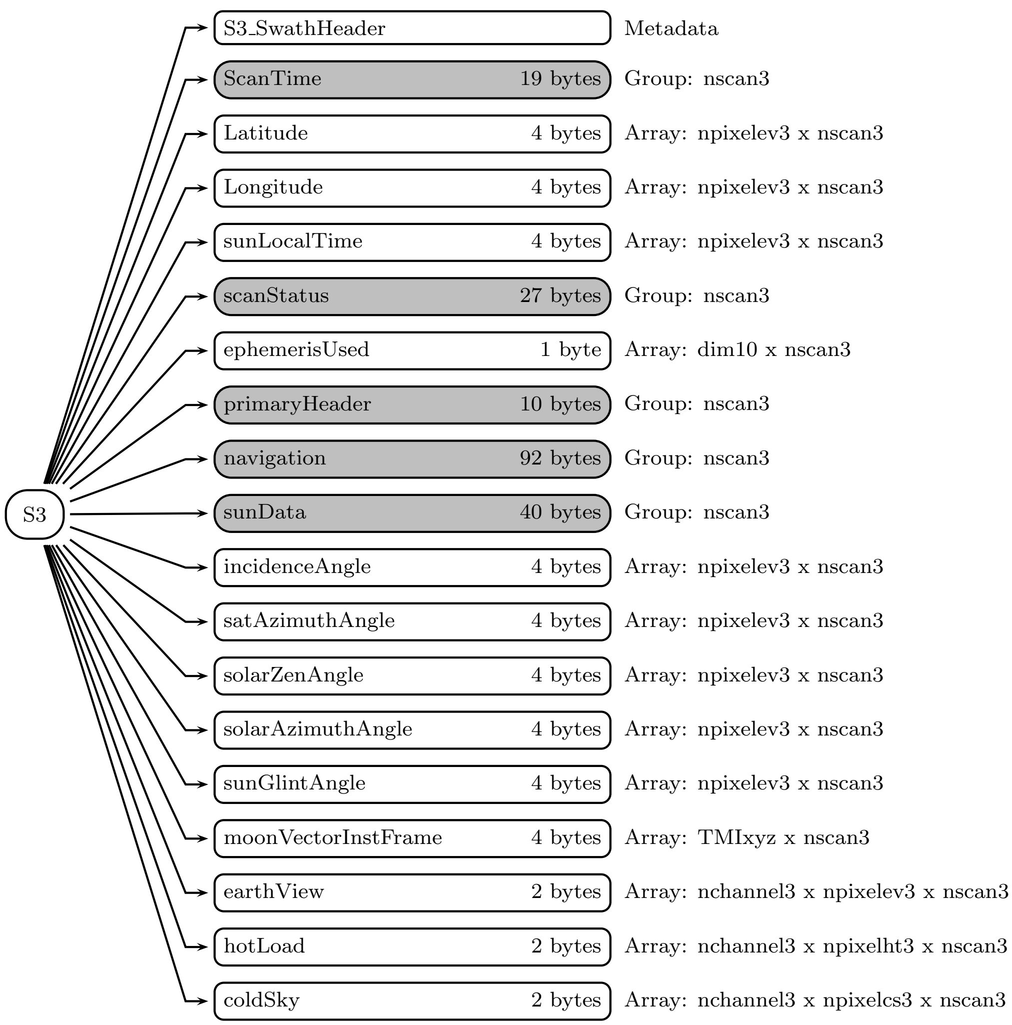


Figure 51: Data Format Structure for 1ATMI, S3

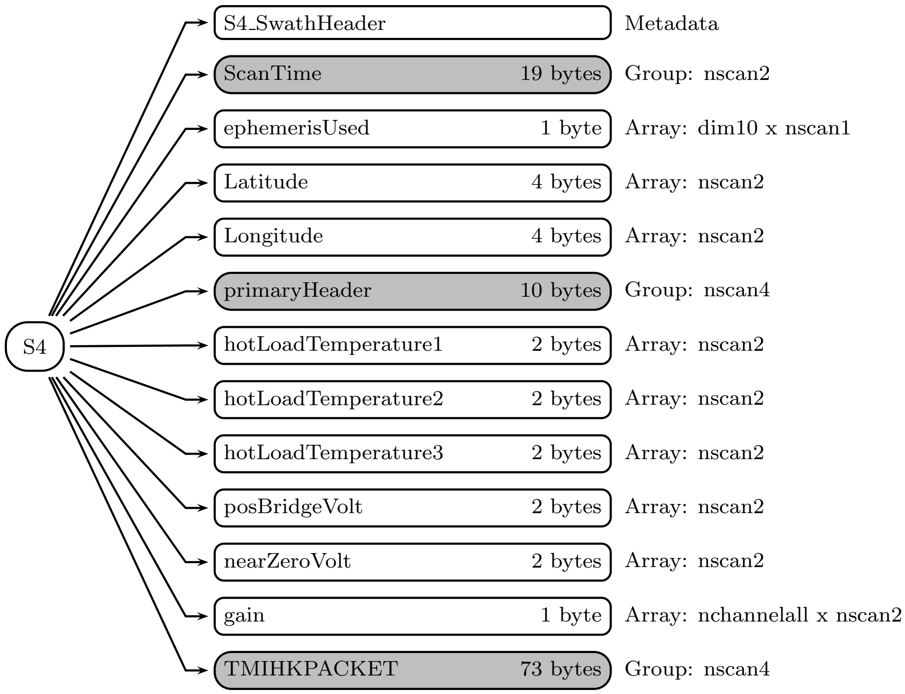


Figure 52: Data Format Structure for 1ATMI, S4

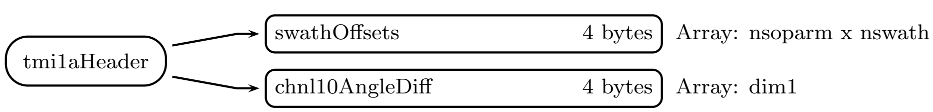


Figure 53: Data Format Structure for 1ATMI, tmi1aHeader

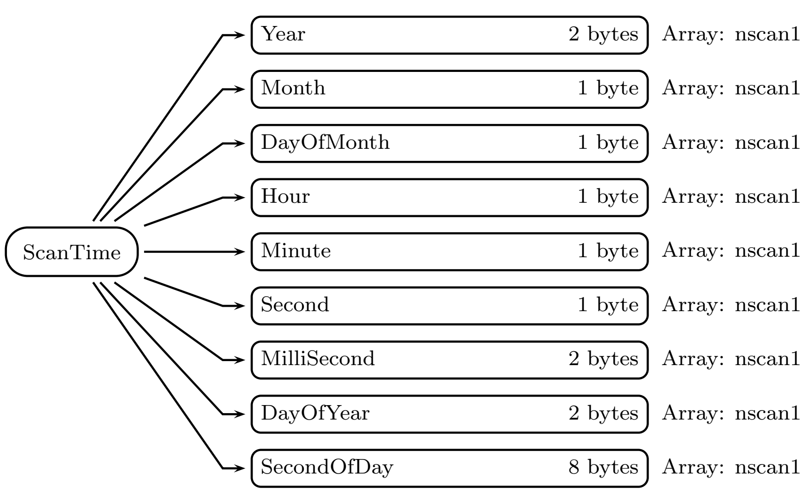


Figure 54: Data Format Structure for 1ATMI, S1, ScanTime

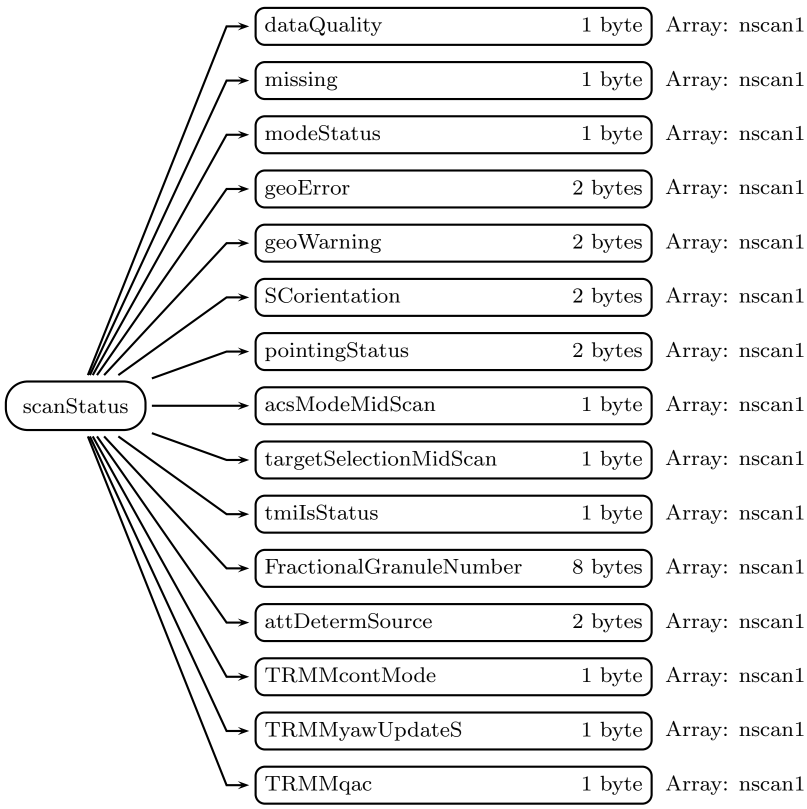


Figure 55: Data Format Structure for 1ATMI, S1, scanStatus

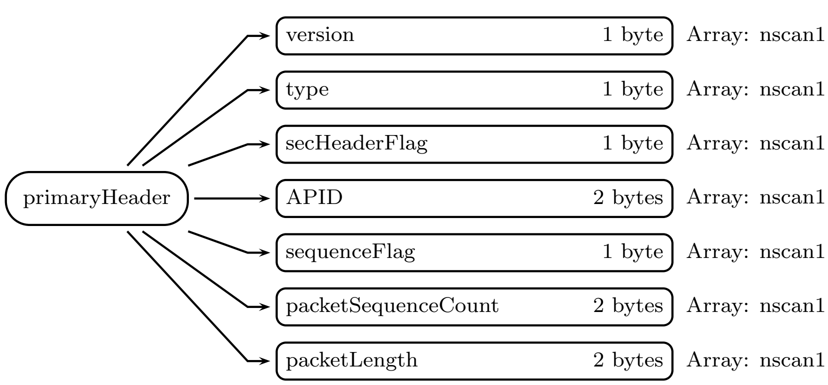


Figure 56: Data Format Structure for 1ATMI, S1, primaryHeader

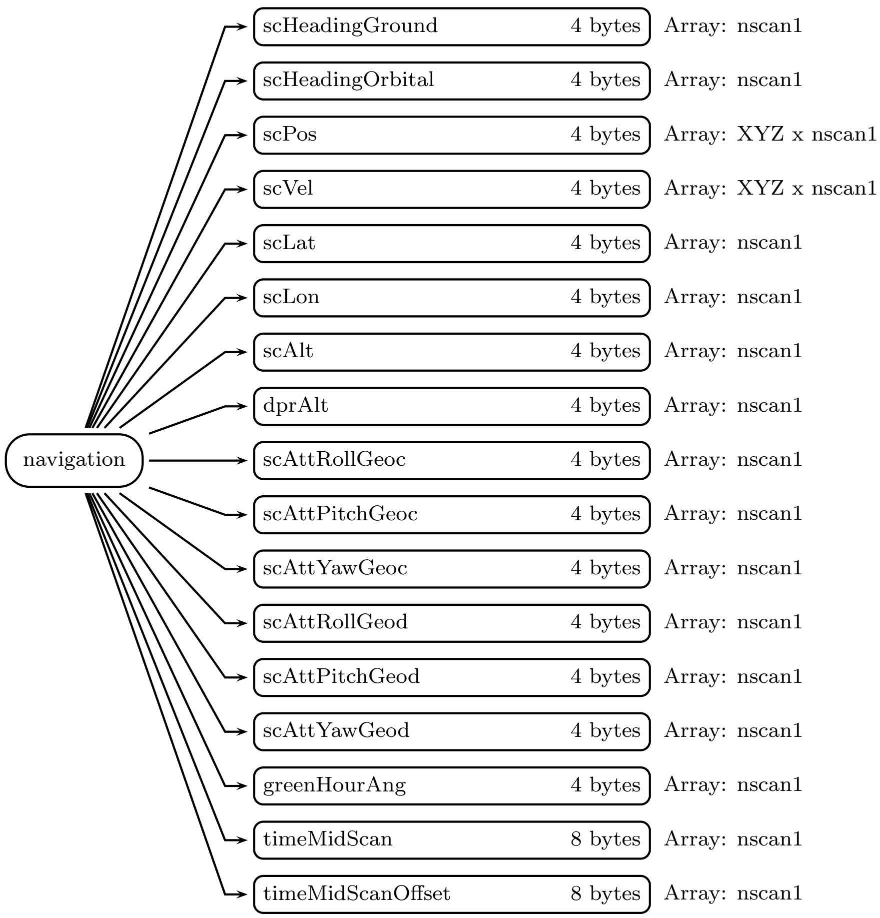


Figure 57: Data Format Structure for 1ATMI, S1, navigation

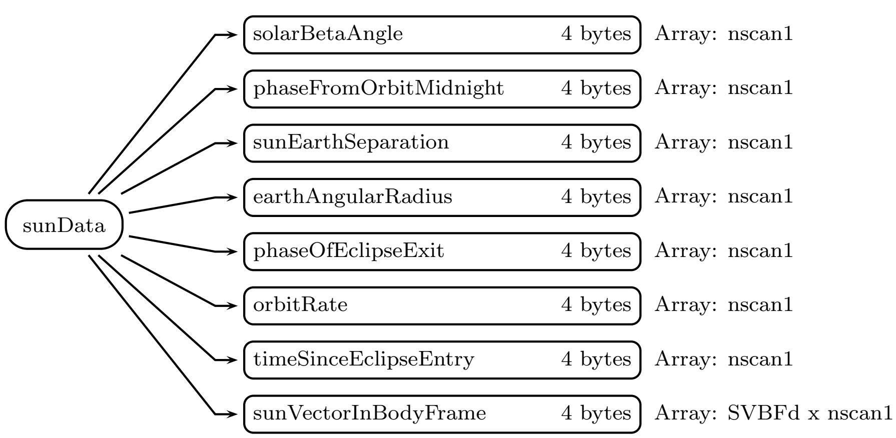


Figure 58: Data Format Structure for 1ATMI, S1, sunData

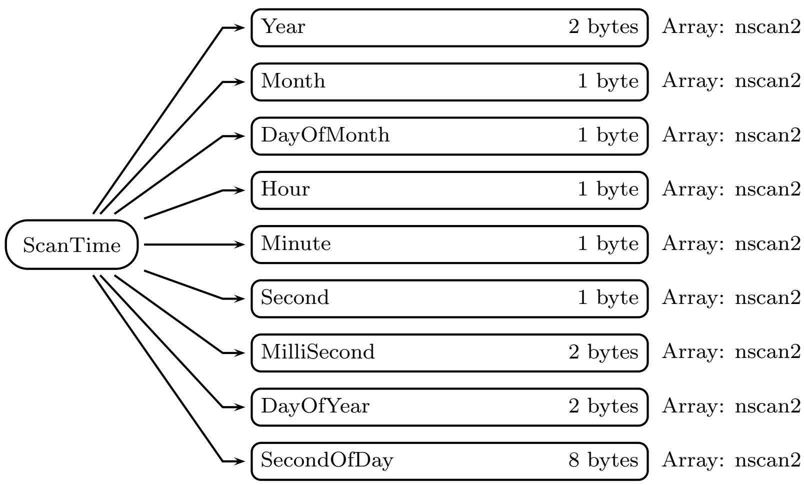


Figure 59: Data Format Structure for 1ATMI, S2, ScanTime

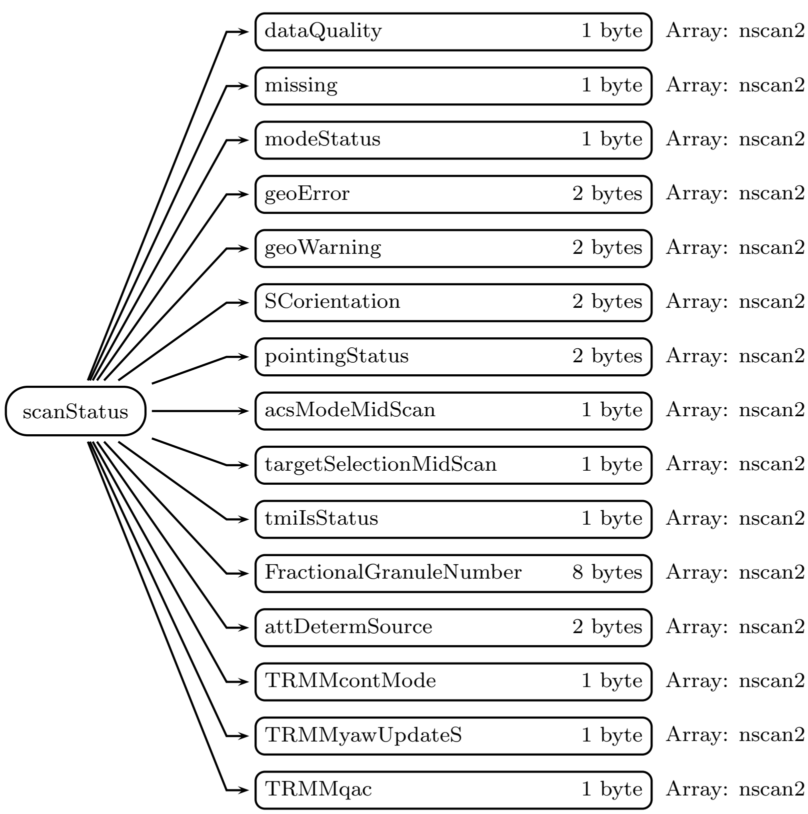


Figure 60: Data Format Structure for 1ATMI, S2, scanStatus

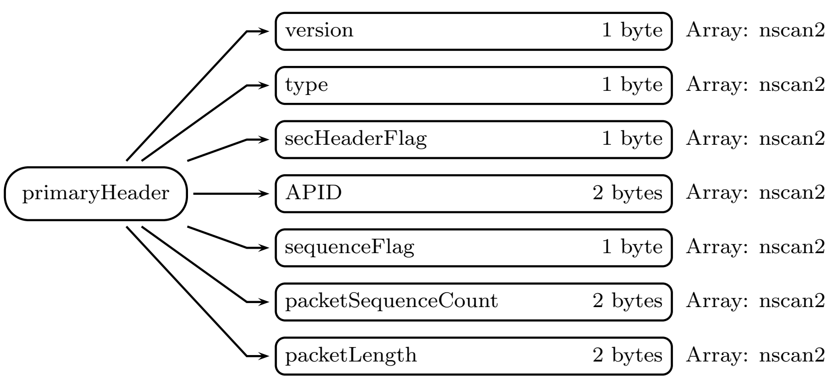


Figure 61: Data Format Structure for 1ATMI, S2, primaryHeader

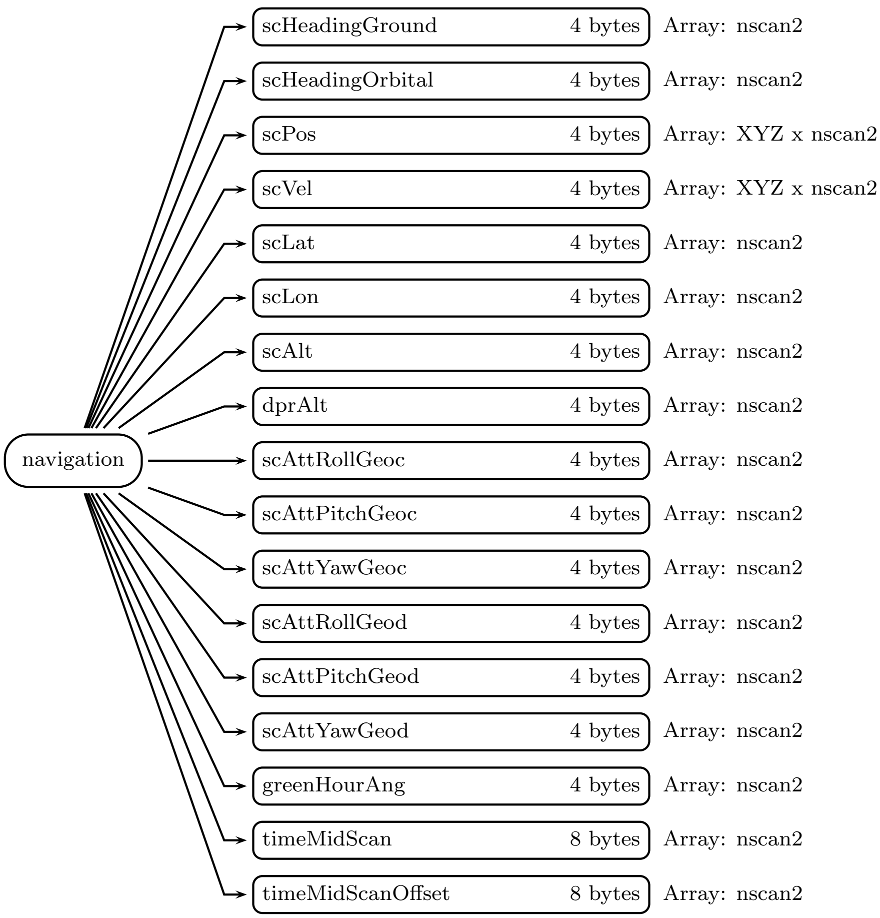


Figure 62: Data Format Structure for 1ATMI, S2, navigation

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

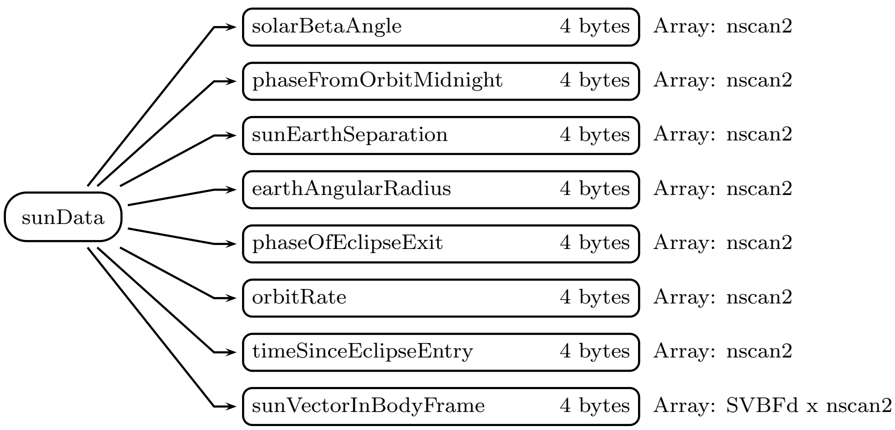


Figure 63: Data Format Structure for 1ATMI, S2, sunData

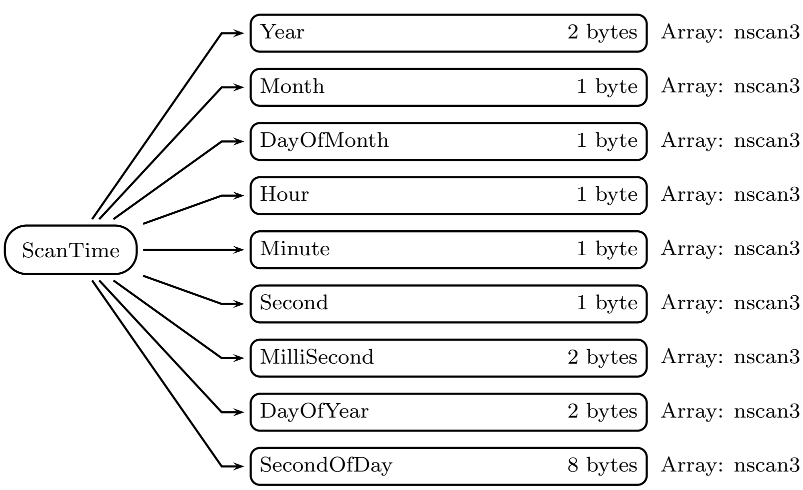


Figure 64: Data Format Structure for 1ATMI, S3, ScanTime

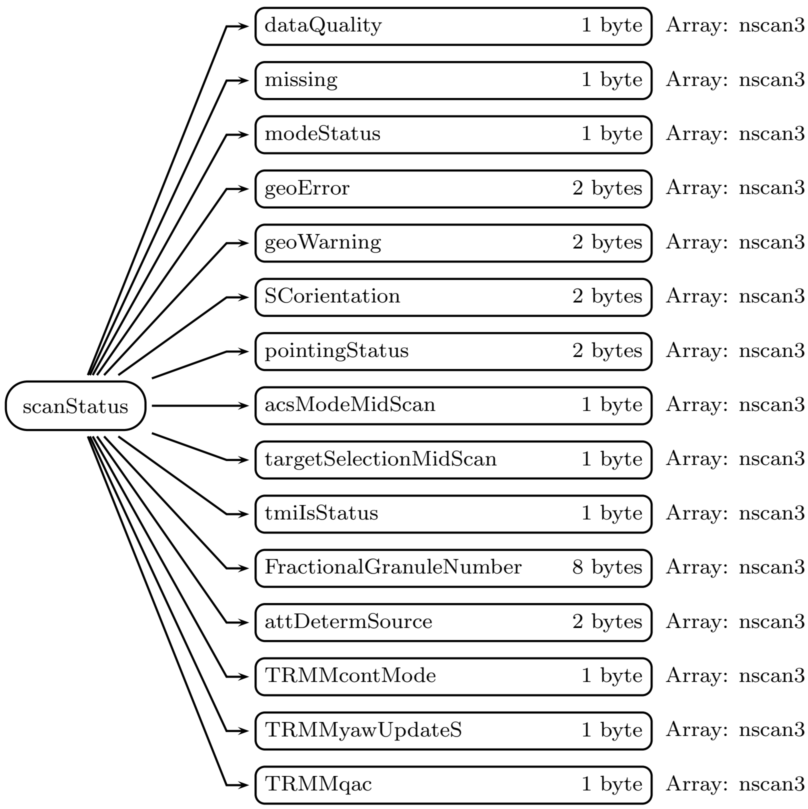


Figure 65: Data Format Structure for 1ATMI, S3, scanStatus

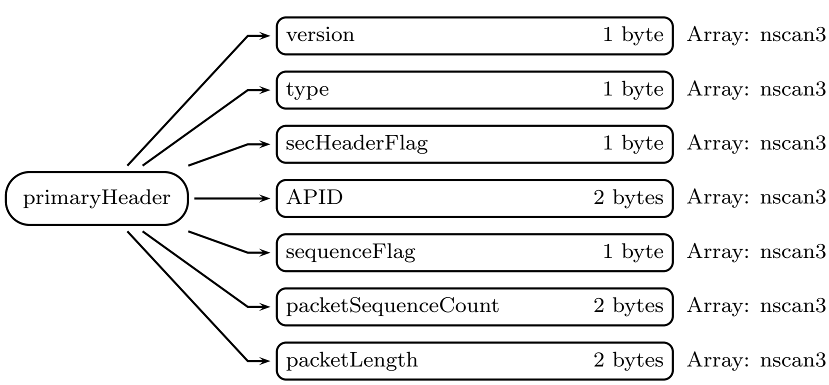


Figure 66: Data Format Structure for 1ATMI, S3, primaryHeader

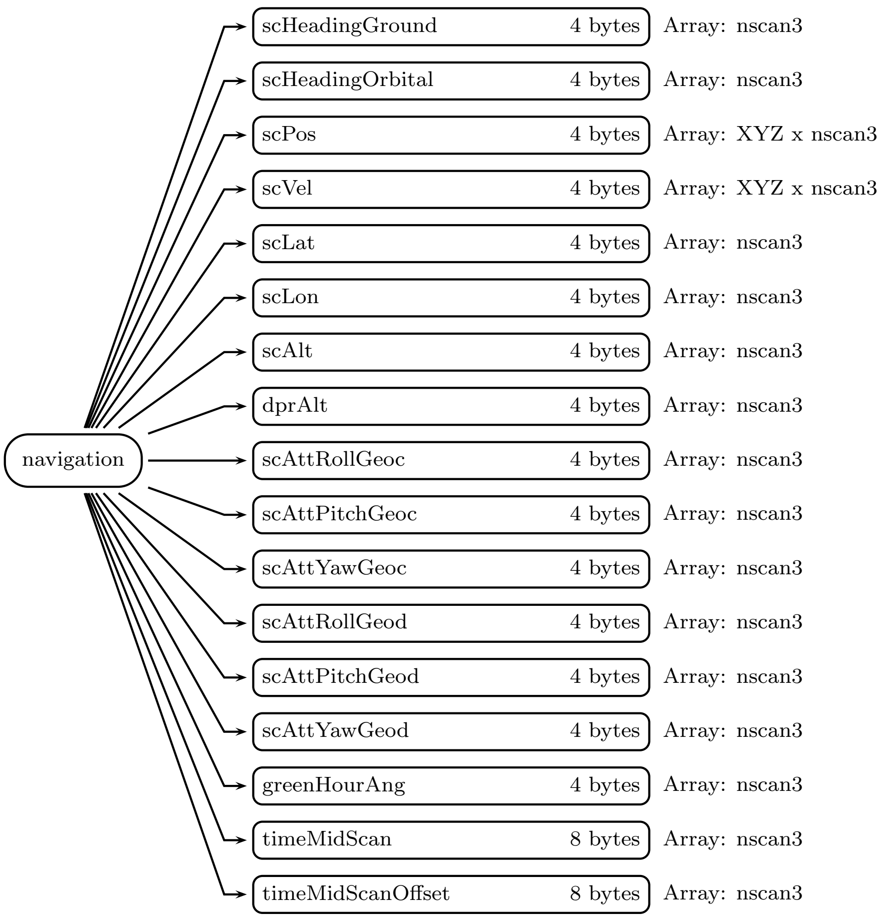


Figure 67: Data Format Structure for 1ATMI, S3, navigation

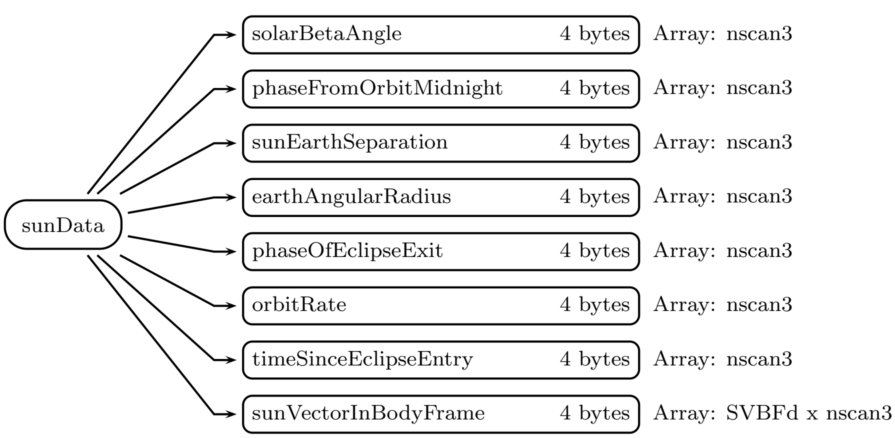


Figure 68: Data Format Structure for 1ATMI, S3, sunData

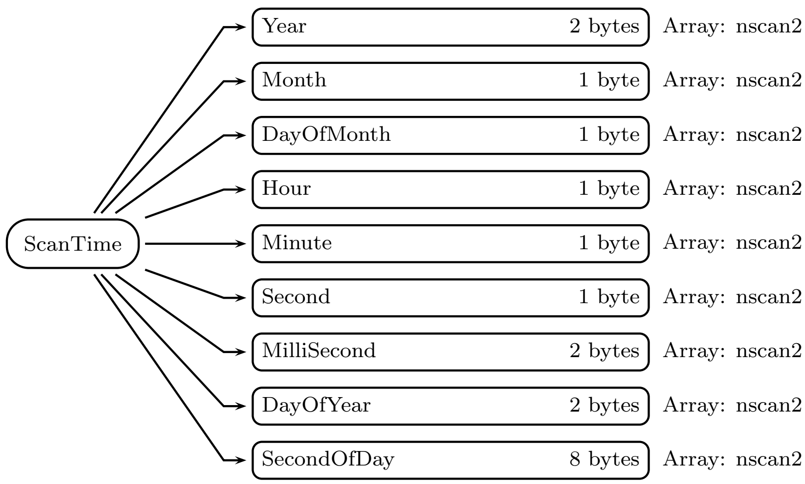


Figure 69: Data Format Structure for 1ATMI, S4, ScanTime

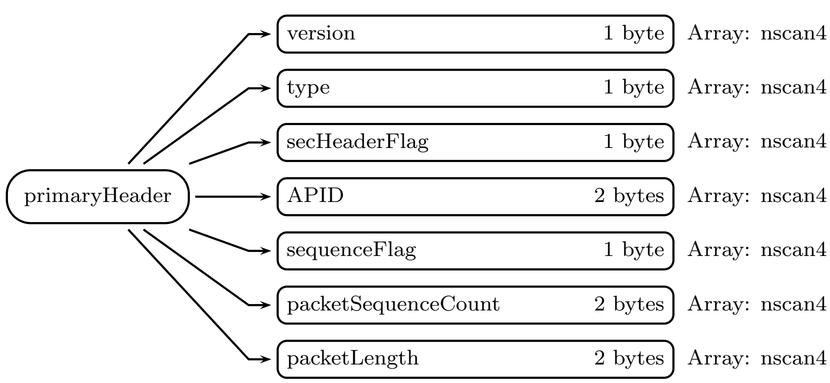


Figure 70: Data Format Structure for 1ATMI, S4, primaryHeader

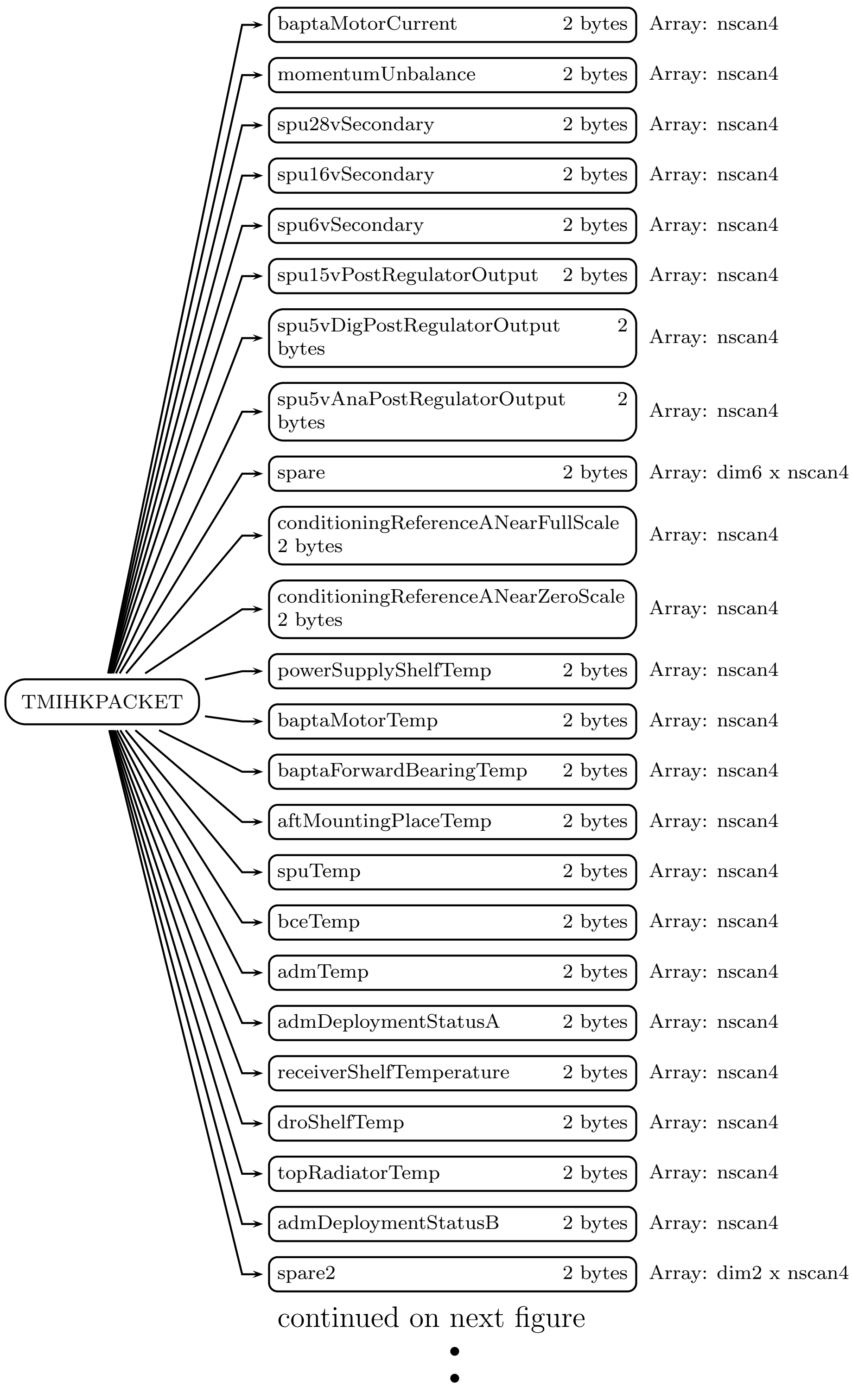


Figure 71: Data Format Structure for 1ATMI, S4, TMIHKPACKET,

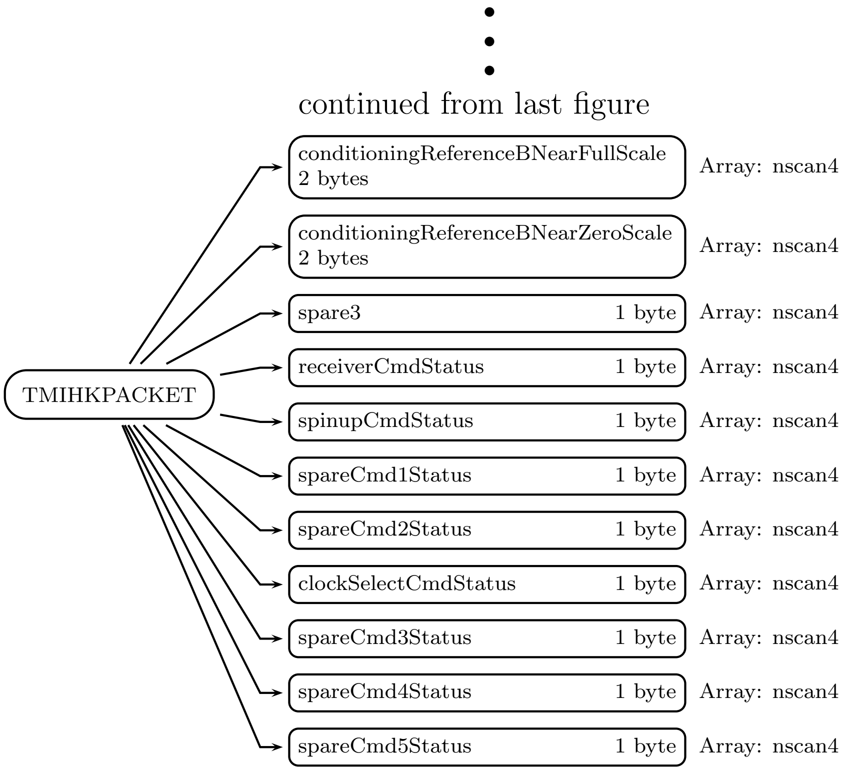


Figure 72: Data Format Structure for 1ATMI, S4, TMIHKPACKET

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

tmi1aHeader (Group)

swathOffsets (4-byte float, array size: nsoparm x nswath):
Angle and timing offsets for each swath. Swath index (4) is 10V 10H 37 85 GHz. Parameter index (3) is cone angle (degrees), start angle (degrees), first pixel time (seconds).

chnl10AngleDiff (4-byte float, array size: dim1):
Cone angle offsets for 10V/H channels used for calculation of incidence angles. Negative offset for 10V channel, positive offset for 10H channel. Values range from 0.0 to 1.0 degrees. Special values are defined as:

-9999.9 Missing value

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte char, array size: nscan1):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan1):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan1):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine tmiIsStatus
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan1):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
```

```
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan1):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan1):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan1):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan1):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan1):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

tmiIsStatus (1-byte char, array size: nscan1):
Status of the instrument from Housekeeping packets. Bit 0 is the most significant bit (I.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00   Receiver status (0=ON, 1=OFF)
```

```
    01   Spinup Status (0=ON, 1=OFF)
    02   Spare command 1 Status
    03   Spare command 2 Status
    04   1 Hz Clock Select (1=A, 0=B)
    05   Spare
    06   Spare Command 4 Status
    07   Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan1):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value             Meaning
    430 and higher    Best accuracy, good data for this orbit
    421               Reduced accuracy, PR roll data not available
                      (affecting roll/yaw estimates)
    413               Reduced accuracy, sun data not available (affecting pitch)
    411               Reduced accuracy, PR roll and sun sensor not available
    300-399           Reduced accuracy due to various special conditions
    200-299           Fallback to using the onboard attitude estimates
                      with TRMM V7 corrections
    -91               Spacecraft in safehold mode, no science data
    -99               No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan1):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
```

```
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan1):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan1):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

primaryHeader (Group in S1)

version (1-byte integer, array size: nscan1):

type (1-byte integer, array size: nscan1):

secHeaderFlag (1-byte integer, array size: nscan1):

APID (2-byte integer, array size: nscan1):

sequenceFlag (1-byte integer, array size: nscan1):

packetSequenceCount (2-byte integer, array size: nscan1):

packetLength (2-byte unsigned integer, array size: nscan1):

navigation (Group in S1)

scHeadingGround (4-byte float, array size: nscan1):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan1):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan1):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan1):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan1):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan1):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan1):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan1):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan1):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan1):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan1):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan1):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan1):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan1):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan1):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan1):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such

that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: nchannel1 x npixelev1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev1 x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev1 x nscan1):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev1 x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev1 x nscan1):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: TMIxyz x nscan1):
The x, y, z components of the moon vector in the TMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

earthView (2-byte unsigned integer, array size: nchannel1 x npixelev1 x nscan1):

```
Earth view counts.
```

Special values are defined as:
0 Missing value

hotLoad (2-byte unsigned integer, array size: nchannel1 x npixelht1 x nscan1):

```
Hot load counts.
```

Special values are defined as:
0 Missing value

coldSky (2-byte unsigned integer, array size: nchannel1 x npixelcs1 x nscan1):

```
Cold sky counts.
```

Special values are defined as:
0 Missing value

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte char, array size: nscan2):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan2):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan2):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine tmiIsStatus
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan2):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan2):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
```

```
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan2):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan2):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan2):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
```

```
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan2):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

tmiIsStatus (1-byte char, array size: nscan2):
Status of the instrument from Housekeeping packets. Bit 0 is the most significant bit (I.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00  Receiver status (0=ON, 1=OFF)
01  Spinup Status (0=ON, 1=OFF)
02  Spare command 1 Status
03  Spare command 2 Status
04  1 Hz Clock Select (1=A, 0=B)
05  Spare
06  Spare Command 4 Status
07  Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan2):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
```

```
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value             Meaning
    430 and higher    Best accuracy, good data for this orbit
    421               Reduced accuracy, PR roll data not available
                      (affecting roll/yaw estimates)
    413               Reduced accuracy, sun data not available (affecting pitch)
    411               Reduced accuracy, PR roll and sun sensor not available
    300-399           Reduced accuracy due to various special conditions
    200-299           Fallback to using the onboard attitude estimates
                      with TRMM V7 corrections
    -91               Spacecraft in safehold mode, no science data
    -99               No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan2):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan2):

```
The Yaw Update Status flag in telemetry gives the status
```

```
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan2):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

ephemerisUsed (1-byte char, array size: dim10 x nscan2):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

primaryHeader (Group in S2)

version (1-byte integer, array size: nscan2):

type (1-byte integer, array size: nscan2):

secHeaderFlag (1-byte integer, array size: nscan2):

APID (2-byte integer, array size: nscan2):

sequenceFlag (1-byte integer, array size: nscan2):

packetSequenceCount (2-byte integer, array size: nscan2):

packetLength (2-byte unsigned integer, array size: nscan2):

navigation (Group in S2)

scHeadingGround (4-byte float, array size: nscan2):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan2):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan2):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan2):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan2):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan2):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000

to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan2):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values

range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan2):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan2):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan2):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan2):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan2):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan2):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan2):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan2):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan2):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan2):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan2):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev2 x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev2 x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev2 x nscan2):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev2 x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev2 x nscan2):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle

is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: TMIxyz x nscan2):
The x, y, z components of the moon vector in the TMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

earthView (2-byte unsigned integer, array size: nchannel2 x npixelev2 x nscan2):

```
Earth view counts.
```

Special values are defined as:
0 Missing value

hotLoad (2-byte unsigned integer, array size: nchannel2 x npixelht2 x nscan2):

```
Hot load counts.
```

Special values are defined as:
0 Missing value

coldSky (2-byte unsigned integer, array size: nchannel2 x npixelcs2 x nscan2):

```
Cold sky counts.
```

Special values are defined as:
0 Missing value

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev3 x nscan3):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev3 x nscan3):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev3 x nscan3):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S3)

dataQuality (1-byte char, array size: nscan3):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan3):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan3):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit =

1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine tmiIsStatus
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan3):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan3):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan3):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan3):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan3):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan3):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

tmiIsStatus (1-byte char, array size: nscan3):
Status of the instrument from Housekeeping packets. Bit 0 is the most significant bit (I.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00   Receiver status (0=ON, 1=OFF)
01   Spinup Status (0=ON, 1=OFF)
02   Spare command 1 Status
03   Spare command 2 Status
04   1 Hz Clock Select (1=A, 0=B)
05   Spare
```

```
    06   Spare Command 4 Status
    07   Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan3):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value            Meaning
    430 and higher   Best accuracy, good data for this orbit
    421              Reduced accuracy, PR roll data not available
                     (affecting roll/yaw estimates)
    413              Reduced accuracy, sun data not available (affecting pitch)
    411              Reduced accuracy, PR roll and sun sensor not available
    300-399          Reduced accuracy due to various special conditions
    200-299          Fallback to using the onboard attitude estimates
                     with TRMM V7 corrections
    -91              Spacecraft in safehold mode, no science data
    -99              No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan3):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
```

```
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan3):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan3):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

ephemerisUsed (1-byte char, array size: dim10 x nscan3):
The ephemeris source used to geolocate the swath. Special values are defined as:

255 Missing value

primaryHeader (Group in S3)

version (1-byte integer, array size: nscan3):

type (1-byte integer, array size: nscan3):

secHeaderFlag (1-byte integer, array size: nscan3):

APID (2-byte integer, array size: nscan3):

sequenceFlag (1-byte integer, array size: nscan3):

packetSequenceCount (2-byte integer, array size: nscan3):

packetLength (2-byte unsigned integer, array size: nscan3):

navigation (Group in S3)

scHeadingGround (4-byte float, array size: nscan3):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan3):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan3):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan3):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time.

Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan3):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan3):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan3):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan3):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan3):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan3):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan3):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values

range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan3):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan3):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan3):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan3):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan3):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan3):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group in S3)

solarBetaAngle (4-byte float, array size: nscan3):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from

-89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan3):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan3):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan3):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan3):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan3):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan3):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan3):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev3 x nscan3):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel

location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev3 x nscan3):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev3 x nscan3):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev3 x nscan3):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev3 x nscan3):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: TMIxyz x nscan3):
The x, y, z components of the moon vector in the TMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

earthView (2-byte unsigned integer, array size: nchannel3 x npixelev3 x nscan3):

```
Earth view counts.
```

Special values are defined as:
0 Missing value

hotLoad (2-byte unsigned integer, array size: nchannel3 x npixelht3 x nscan3):

```
Hot load counts.
```

Special values are defined as:
0 Missing value

coldSky (2-byte unsigned integer, array size: nchannel3 x npixelcs3 x nscan3):

```
Cold sky counts.
```

Special values are defined as:
0 Missing value

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

Latitude (4-byte float, array size: nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

primaryHeader (Group in S4)

version (1-byte integer, array size: nscan4):

type (1-byte integer, array size: nscan4):

secHeaderFlag (1-byte integer, array size: nscan4):

APID (2-byte integer, array size: nscan4):

sequenceFlag (1-byte integer, array size: nscan4):

packetSequenceCount (2-byte integer, array size: nscan4):

packetLength (2-byte unsigned integer, array size: nscan4):

hotLoadTemperature1 (2-byte unsigned integer, array size: nscan2):
Hot Load Thermister Count Values are in count. Special values are defined as:
65535 Missing value

hotLoadTemperature2 (2-byte unsigned integer, array size: nscan2):
Hot Load Thermister Count Values are in count. Special values are defined as:
65535 Missing value

hotLoadTemperature3 (2-byte unsigned integer, array size: nscan2):
Hot Load Thermister Count Values are in count. Special values are defined as:
65535 Missing value

posBridgeVolt (2-byte unsigned integer, array size: nscan2):
Positive Bridge Voltage Count. Values are in count. Special values are defined as:
65535 Missing value

nearZeroVolt (2-byte unsigned integer, array size: nscan2):
Near zero voltage of hot load bridge reference. Values are in count. Special values are defined as:
65535 Missing value

gain (1-byte char, array size: nchannelall x nscan2):
Gain for each channel. Special values are defined as:
255 Missing value

TMIHKPACKET (Group in S4)

baptaMotorCurrent (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

momentumUnbalance (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu28vSecondary (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu16vSecondary (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu6vSecondary (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu15vPostRegulatorOutput (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu5vDigPostRegulatorOutput (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu5vAnaPostRegulatorOutput (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spare (2-byte unsigned integer, array size: dim6 x nscan4):
Special values are defined as:
0 Missing value

conditioningReferenceANearFullScale (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

conditioningReferenceANearZeroScale (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

powerSupplyShelfTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

baptaMotorTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

baptaForwardBearingTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

aftMountingPlaceTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spuTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

bceTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

admTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

admDeploymentStatusA (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

receiverShelfTemperature (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

droShelfTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

topRadiatorTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

admDeploymentStatusB (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spare2 (2-byte unsigned integer, array size: dim2 x nscan4):
Special values are defined as:
0 Missing value

conditioningReferenceBNearFullScale (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

conditioningReferenceBNearZeroScale (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spare3 (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

receiverCmdStatus (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spinupCmdStatus (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd1Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd2Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

clockSelectCmdStatus (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd3Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd4Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd5Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

C Structure Header file:

```
#ifndef _TK_1ATMI_H_
#define _TK_1ATMI_H_

#ifndef _L1ATMI_S4_TMIHKPACKET_
#define _L1ATMI_S4_TMIHKPACKET_

typedef struct {
    unsigned short baptaMotorCurrent;
    unsigned short momentumUnbalance;
    unsigned short spu28vSecondary;
    unsigned short spu16vSecondary;
    unsigned short spu6vSecondary;
    unsigned short spu15vPostRegulatorOutput;
    unsigned short spu5vDigPostRegulatorOutput;
    unsigned short spu5vAnaPostRegulatorOutput;
    unsigned short spare[6];
    unsigned short conditioningReferenceANearFullScale;
    unsigned short conditioningReferenceANearZeroScale;
    unsigned short powerSupplyShelfTemp;
    unsigned short baptaMotorTemp;
    unsigned short baptaForwardBearingTemp;
    unsigned short aftMountingPlaceTemp;
    unsigned short spuTemp;
    unsigned short bceTemp;
    unsigned short admTemp;
    unsigned short admDeploymentStatusA;
    unsigned short receiverShelfTemperature;
    unsigned short droShelfTemp;
```

```
    unsigned short topRadiatorTemp;
    unsigned short admDeploymentStatusB;
    unsigned short spare2[2];
    unsigned short conditioningReferenceBNearFullScale;
    unsigned short conditioningReferenceBNearZeroScale;
    unsigned char spare3;
    unsigned char receiverCmdStatus;
    unsigned char spinupCmdStatus;
    unsigned char spareCmd1Status;
    unsigned char spareCmd2Status;
    unsigned char clockSelectCmdStatus;
    unsigned char spareCmd3Status;
    unsigned char spareCmd4Status;
    unsigned char spareCmd5Status;
} L1ATMI_S4_TMIHKPACKET;

#endif

#ifndef _L1ATMI_S4_
#define _L1ATMI_S4_

typedef struct {
    SCANTIME ScanTime;
    unsigned char ephemerisUsed[10];
    float Latitude;
    float Longitude;
    PRIMARYHEADER primaryHeader;
    unsigned short hotLoadTemperature1;
    unsigned short hotLoadTemperature2;
    unsigned short hotLoadTemperature3;
    unsigned short posBridgeVolt;
    unsigned short nearZeroVolt;
    unsigned char gain[9];
    L1ATMI_S4_TMIHKPACKET TMIHKPACKET;
} L1ATMI_S4;

#endif

#ifndef _L1ATMI_S3_SUNDATA_
#define _L1ATMI_S3_SUNDATA_

typedef struct {
    float solarBetaAngle;
```

```
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1ATMI_S3_SUNDATA;

#endif

#ifndef _L1ATMI_S3_SCANSTATUS_
#define _L1ATMI_S3_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    unsigned char tmiIsStatus;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1ATMI_S3_SCANSTATUS;

#endif

#ifndef _L1ATMI_S3_
#define _L1ATMI_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    float sunLocalTime[208];
    L1ATMI_S3_SCANSTATUS scanStatus;
```

```
    unsigned char ephemerisUsed[10];
    PRIMARYHEADER primaryHeader;
    NAVIGATION navigation;
    L1ATMI_S3_SUNDATA sunData;
    float incidenceAngle[208];
    float satAzimuthAngle[208];
    float solarZenAngle[208];
    float solarAzimuthAngle[208];
    float sunGlintAngle[208];
    float moonVectorInstFrame[3];
    unsigned short earthView[208][2];
    unsigned short hotLoad[16][2];
    unsigned short coldSky[16][2];
} L1ATMI_S3;

#endif

#ifndef _L1ATMI_S2_SUNDATA_
#define _L1ATMI_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1ATMI_S2_SUNDATA;

#endif

#ifndef _L1ATMI_S2_SCANSTATUS_
#define _L1ATMI_S2_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
```

```
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    unsigned char tmiIsStatus;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1ATMI_S2_SCANSTATUS;

#endif

#ifndef _L1ATMI_S2_
#define _L1ATMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[104];
    float Longitude[104];
    float sunLocalTime[104];
    L1ATMI_S2_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    PRIMARYHEADER primaryHeader;
    NAVIGATION navigation;
    L1ATMI_S2_SUNDATA sunData;
    float incidenceAngle[104];
    float satAzimuthAngle[104];
    float solarZenAngle[104];
    float solarAzimuthAngle[104];
    float sunGlintAngle[104];
    float moonVectorInstFrame[3];
    unsigned short earthView[104][5];
    unsigned short hotLoad[8][5];
    unsigned short coldSky[8][5];
} L1ATMI_S2;

#endif

#ifndef _L1ATMI_S1_SUNDATA_
#define _L1ATMI_S1_SUNDATA_

typedef struct {
```

```
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1ATMI_S1_SUNDATA;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _PRIMARYHEADER_
#define _PRIMARYHEADER_

typedef struct {
    signed char version;
    signed char type;
```

```
    signed char secHeaderFlag;
    short APID;
    signed char sequenceFlag;
    short packetSequenceCount;
    unsigned short packetLength;
} PRIMARYHEADER;

#endif

#ifndef _L1ATMI_S1_SCANSTATUS_
#define _L1ATMI_S1_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    unsigned char tmiIsStatus;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1ATMI_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
```

```
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1ATMI_S1_
#define _L1ATMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[104];
    float Longitude[104];
    float sunLocalTime[104];
    L1ATMI_S1_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    PRIMARYHEADER primaryHeader;
    NAVIGATION navigation;
    L1ATMI_S1_SUNDATA sunData;
    float incidenceAngle[104][2];
    float satAzimuthAngle[104];
    float solarZenAngle[104];
    float solarAzimuthAngle[104];
    float sunGlintAngle[104];
    float moonVectorInstFrame[3];
    unsigned short earthView[104][2];
    unsigned short hotLoad[8][2];
    unsigned short coldSky[8][2];
} L1ATMI_S1;

#endif

#ifndef _L1ATMI_SWATHS_
#define _L1ATMI_SWATHS_

typedef struct {
    L1ATMI_S1 S1;
    L1ATMI_S2 S2;
    L1ATMI_S3 S3;
    L1ATMI_S4 S4;
} L1ATMI_SWATHS;

#endif
```

```
#ifndef _L1ATMI_TMI1AHEADER_
#define _L1ATMI_TMI1AHEADER_

typedef struct {
    float swathOffsets[3][3];
    float chnl10AngleDiff[1];
} L1ATMI_TMI1AHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1ATMI_S4_TMIHKPACKET/
    INTEGER*2 baptaMotorCurrent
    INTEGER*2 momentumUnbalance
    INTEGER*2 spu28vSecondary
    INTEGER*2 spu16vSecondary
    INTEGER*2 spu6vSecondary
    INTEGER*2 spu15vPostRegulatorOutput
    INTEGER*2 spu5vDigPostRegulatorOutput
    INTEGER*2 spu5vAnaPostRegulatorOutput
    INTEGER*2 spare(6)
    INTEGER*2 conditioningReferenceANearFullScale
    INTEGER*2 conditioningReferenceANearZeroScale
    INTEGER*2 powerSupplyShelfTemp
    INTEGER*2 baptaMotorTemp
    INTEGER*2 baptaForwardBearingTemp
    INTEGER*2 aftMountingPlaceTemp
    INTEGER*2 spuTemp
    INTEGER*2 bceTemp
    INTEGER*2 admTemp
    INTEGER*2 admDeploymentStatusA
    INTEGER*2 receiverShelfTemperature
    INTEGER*2 droShelfTemp
    INTEGER*2 topRadiatorTemp
    INTEGER*2 admDeploymentStatusB
    INTEGER*2 spare2(2)
    INTEGER*2 conditioningReferenceBNearFullScale
    INTEGER*2 conditioningReferenceBNearZeroScale
    CHARACTER spare3
```

```
    CHARACTER receiverCmdStatus
    CHARACTER spinupCmdStatus
    CHARACTER spareCmd1Status
    CHARACTER spareCmd2Status
    CHARACTER clockSelectCmdStatus
    CHARACTER spareCmd3Status
    CHARACTER spareCmd4Status
    CHARACTER spareCmd5Status
END STRUCTURE

STRUCTURE /L1ATMI_S4/
    RECORD /SCANTIME/ ScanTime
    CHARACTER ephemerisUsed(10)
    REAL*4 Latitude
    REAL*4 Longitude
    RECORD /PRIMARYHEADER/ primaryHeader
    INTEGER*2 hotLoadTemperature1
    INTEGER*2 hotLoadTemperature2
    INTEGER*2 hotLoadTemperature3
    INTEGER*2 posBridgeVolt
    INTEGER*2 nearZeroVolt
    CHARACTER gain(9)
    RECORD /L1ATMI_S4_TMIHKPACKET/ TMIHKPACKET
END STRUCTURE

STRUCTURE /L1ATMI_S3_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1ATMI_S3_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
```

```
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    CHARACTER tmiIsStatus
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE

STRUCTURE /L1ATMI_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    REAL*4 sunLocalTime(208)
    RECORD /L1ATMI_S3_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /PRIMARYHEADER/ primaryHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1ATMI_S3_SUNDATA/ sunData
    REAL*4 incidenceAngle(208)
    REAL*4 satAzimuthAngle(208)
    REAL*4 solarZenAngle(208)
    REAL*4 solarAzimuthAngle(208)
    REAL*4 sunGlintAngle(208)
    REAL*4 moonVectorInstFrame(3)
    INTEGER*2 earthView(2,208)
    INTEGER*2 hotLoad(2,16)
    INTEGER*2 coldSky(2,16)
END STRUCTURE

STRUCTURE /L1ATMI_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE
```

```
STRUCTURE /L1ATMI_S2_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    CHARACTER tmiIsStatus
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE

STRUCTURE /L1ATMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(104)
    REAL*4 Longitude(104)
    REAL*4 sunLocalTime(104)
    RECORD /L1ATMI_S2_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /PRIMARYHEADER/ primaryHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1ATMI_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(104)
    REAL*4 satAzimuthAngle(104)
    REAL*4 solarZenAngle(104)
    REAL*4 solarAzimuthAngle(104)
    REAL*4 sunGlintAngle(104)
    REAL*4 moonVectorInstFrame(3)
    INTEGER*2 earthView(5,104)
    INTEGER*2 hotLoad(5,8)
    INTEGER*2 coldSky(5,8)
END STRUCTURE

STRUCTURE /L1ATMI_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
```

```
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /PRIMARYHEADER/
    BYTE version
    BYTE type
    BYTE secHeaderFlag
    INTEGER*2 APID
    BYTE sequenceFlag
    INTEGER*2 packetSequenceCount
    INTEGER*2 packetLength
END STRUCTURE

STRUCTURE /L1ATMI_S1_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
```

```
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    CHARACTER tmiIsStatus
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1ATMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(104)
    REAL*4 Longitude(104)
    REAL*4 sunLocalTime(104)
    RECORD /L1ATMI_S1_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /PRIMARYHEADER/ primaryHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1ATMI_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(2,104)
    REAL*4 satAzimuthAngle(104)
    REAL*4 solarZenAngle(104)
    REAL*4 solarAzimuthAngle(104)
    REAL*4 sunGlintAngle(104)
    REAL*4 moonVectorInstFrame(3)
    INTEGER*2 earthView(2,104)
    INTEGER*2 hotLoad(2,8)
    INTEGER*2 coldSky(2,8)
```

```
END STRUCTURE

STRUCTURE /L1ATMI_SWATHS/
    RECORD /L1ATMI_S1/ S1;
    RECORD /L1ATMI_S2/ S2;
    RECORD /L1ATMI_S3/ S3;
    RECORD /L1ATMI_S4/ S4;
END STRUCTURE

STRUCTURE /L1ATMI_TMI1AHEADER/
    REAL*4 swathOffsets(3,3)
    REAL*4 chnl10AngleDiff(1)
END STRUCTURE
```

5.3 1AVIRS - VIRS unpacked packet data

1AVIRS contains unpacked packet data from VIRS science data from the VIRS instrument flown on the TRMM satellite. There are 2 swaths. Swath S1 has 5 science channels; Swath S2 has Housekeeping.

```
        The S1 channels are:
0.63   micrometers
 1.6   micrometers
3.75   micrometers
10.8   micrometers
12.0   micrometers
```

```
S2 has VIRS housekeeping.
```

We define the spacecraft axis v, used in the definition of the variable SCorientation...

RELATION BETWEEN THE SWATHS: Only Swath S1 has science data.

Dimension definitions:

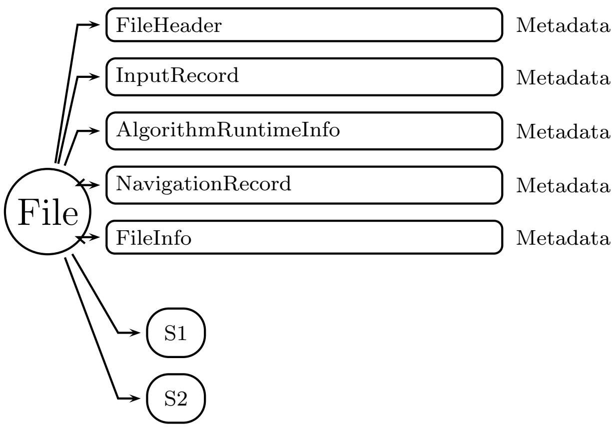


Figure 73: Data Format Structure for 1AVIRS, VIRS unpacked packet data

nsoparm	3	Number of swath offset parameters: cone angle, start angle, first pixel time.
np2	2	TBD.
nswath	1	Number of swaths.
VH	2	Number of polarizations.
nscan1	var	Typical number of Swath S1 scans in the granule.
nchannel1	5	Number of Swath S1 channels.
npixelev1	261	Number of earth view pixels in one scan.
npixelht1	8	Number of hot load pixels in one scan.
npixelcs1	8	Number of cold sky pixels in one scan.
nscan2	var	Typical number of Swath S2 scans in the granule.
nchannelall	5	Number of all channels.
dim2	2	Number.
dim3	3	Number.
dim4	4	Number.
dim5	5	Number.
dim6	6	Number.
dim7	7	Number.
dim8	8	Number.
dim9	9	Number.
dim10	10	Number.
dim11	11	Number.
dim12	12	Number.
VIRSxyz	3	x, y, z components in VIRS instrument coordinate system.
SVBFd	3	SunVectorinBodyFrame dimension.
nsample	2	Number of samples in blackbody, spaceview, solarDiffuser.

Figure 73 through Figure 89 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

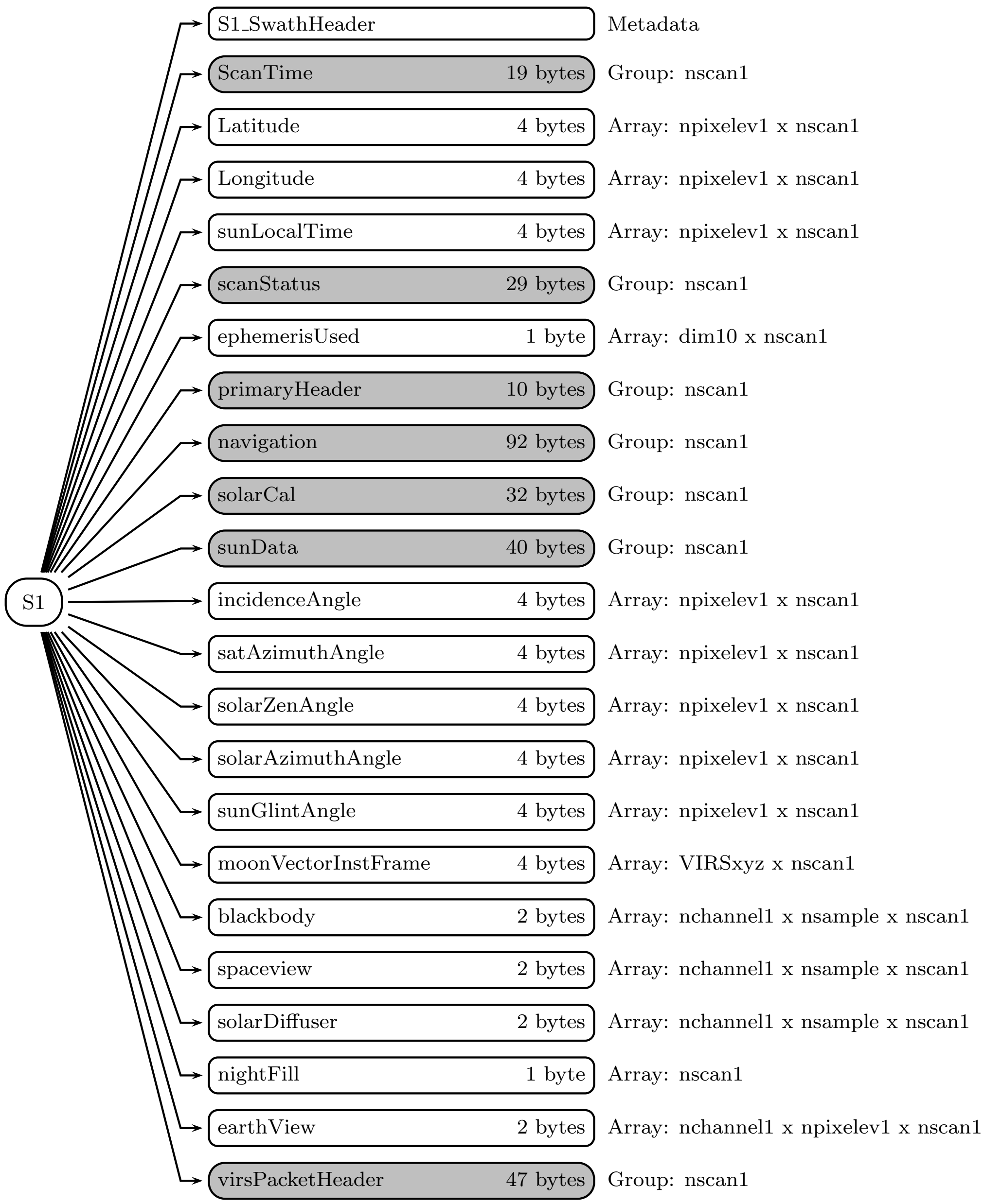


Figure 74: Data Format Structure for 1AVIRS, S1

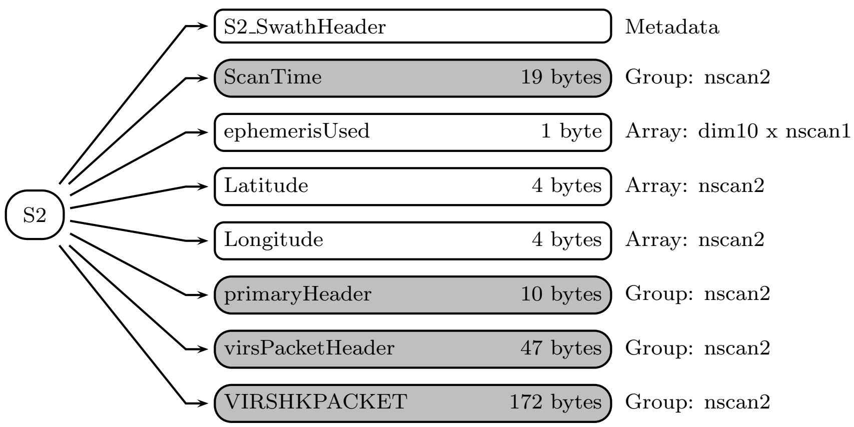


Figure 75: Data Format Structure for 1AVIRS, S2

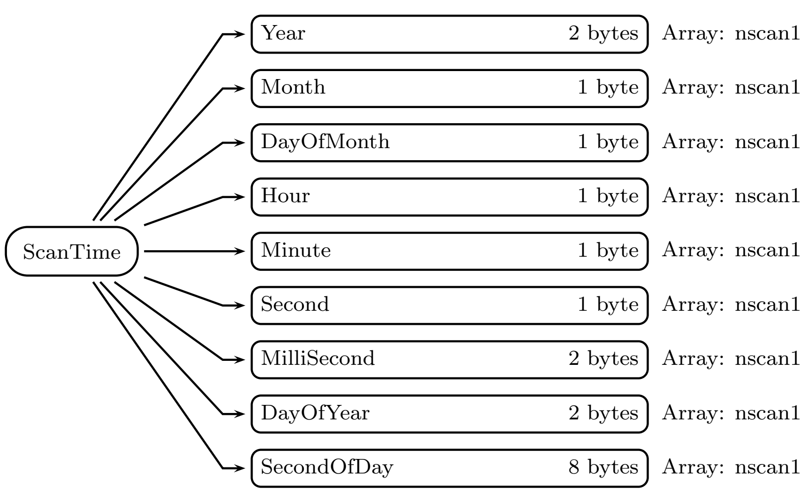


Figure 76: Data Format Structure for 1AVIRS, S1, ScanTime

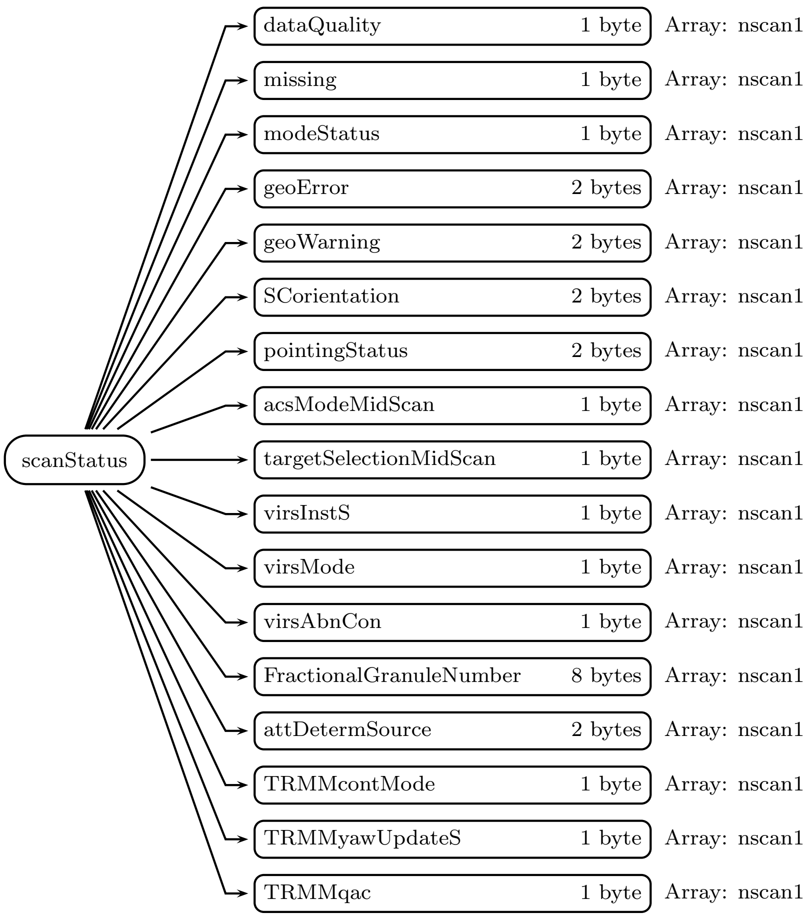


Figure 77: Data Format Structure for 1AVIRS, S1, scanStatus

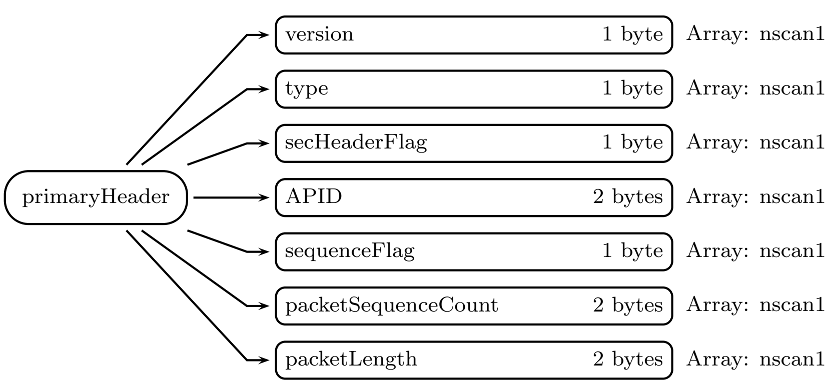


Figure 78: Data Format Structure for 1AVIRS, S1, primaryHeader

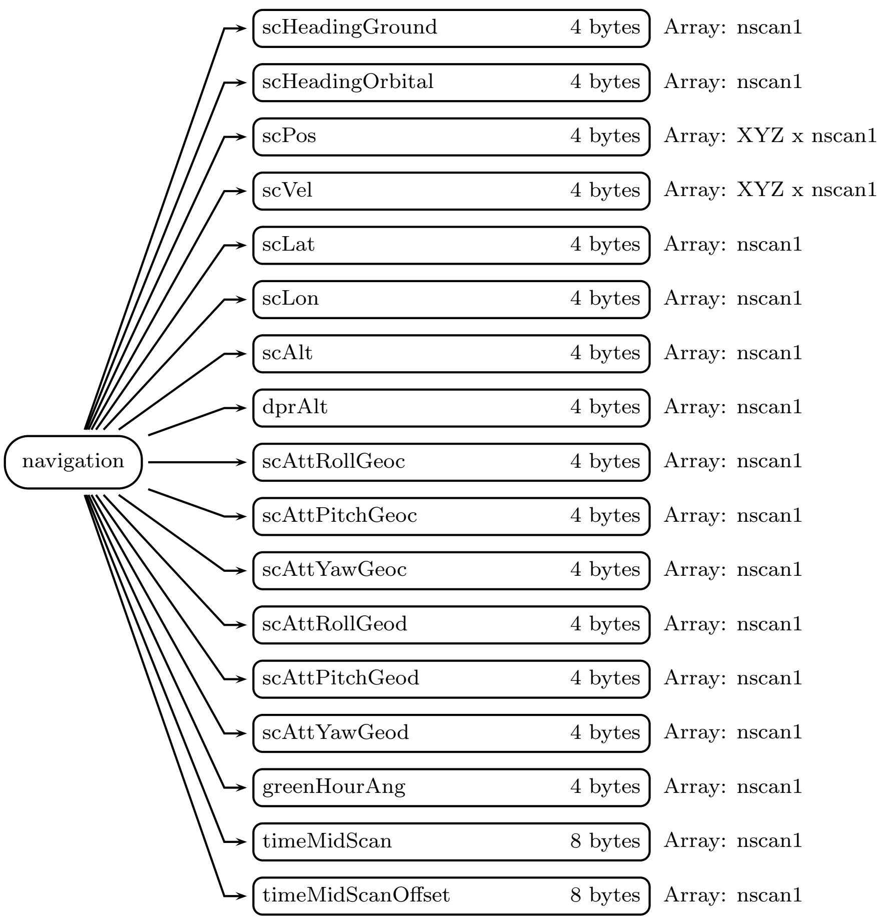


Figure 79: Data Format Structure for 1AVIRS, S1, navigation

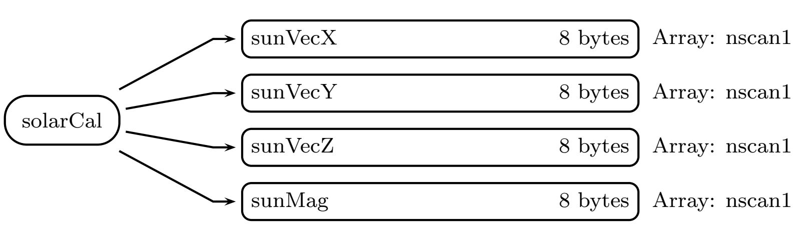


Figure 80: Data Format Structure for 1AVIRS, S1, solarCal

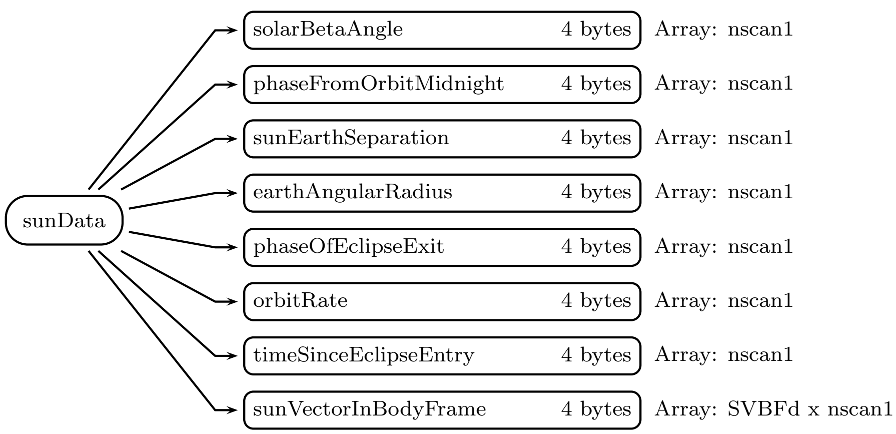
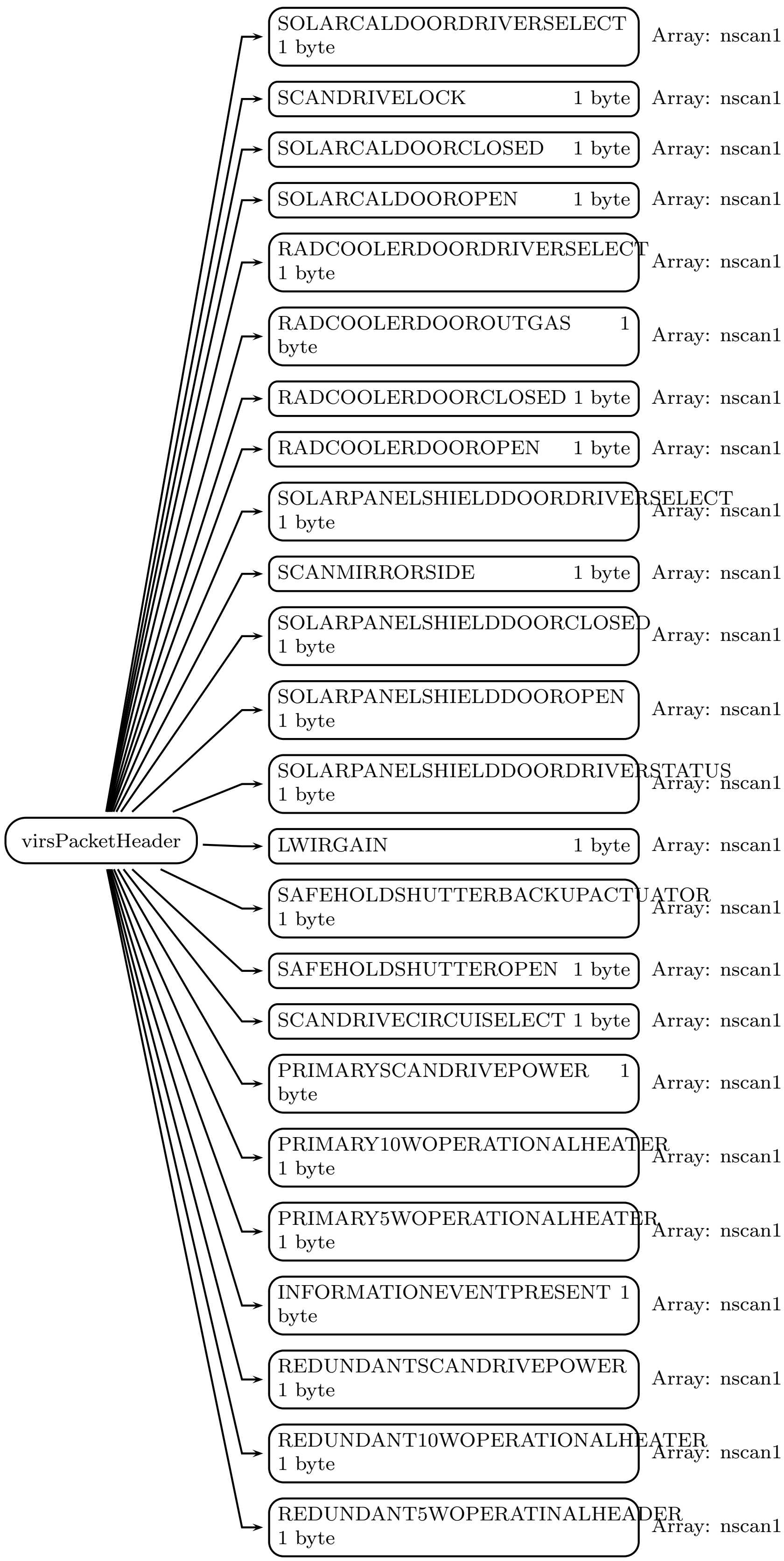


Figure 81: Data Format Structure for 1AVIRS, S1, sunData



continued on next figure

•
•

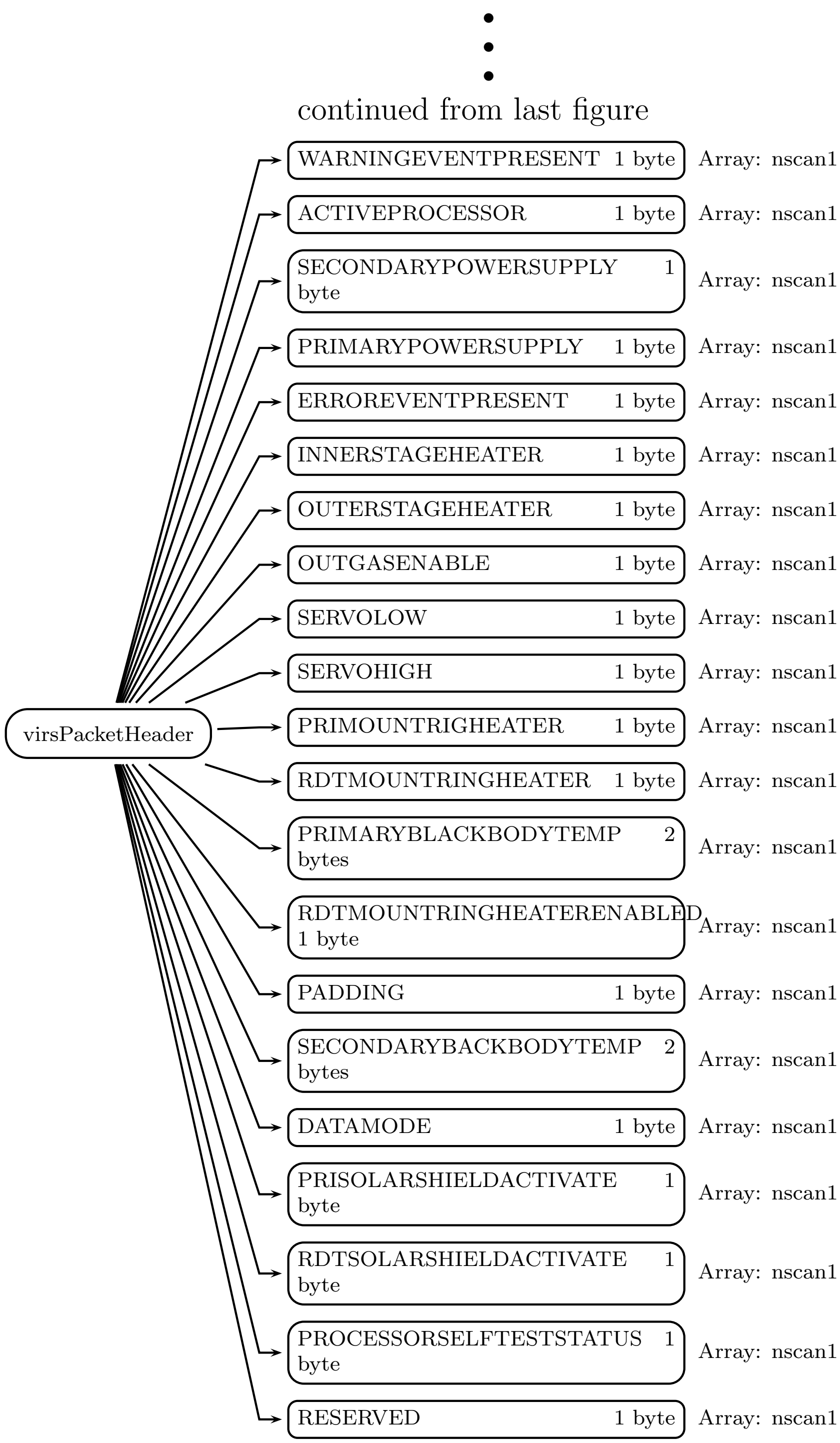


Figure 83: Data Format Structure for 1AVIRS, S1, virsPacketHeader

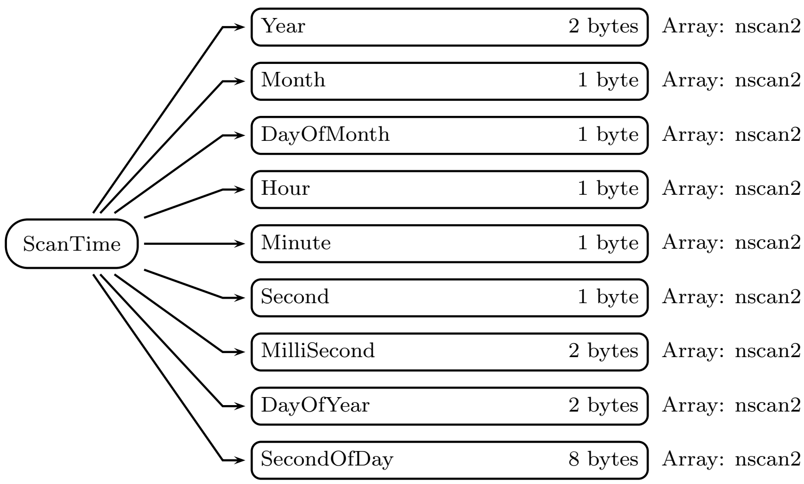


Figure 84: Data Format Structure for 1AVIRS, S2, ScanTime

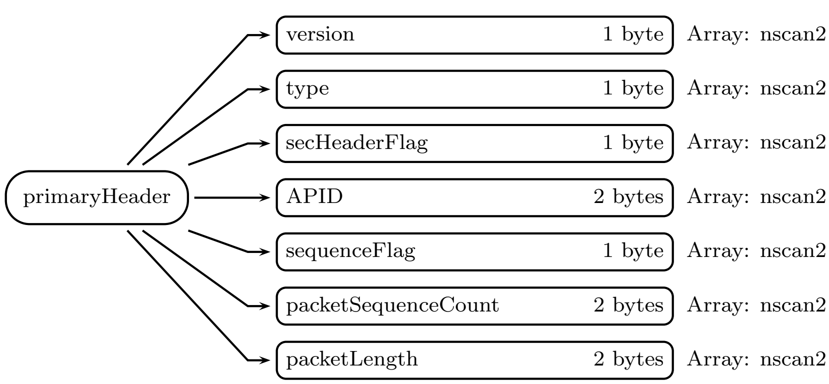


Figure 85: Data Format Structure for 1AVIRS, S2, primaryHeader

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

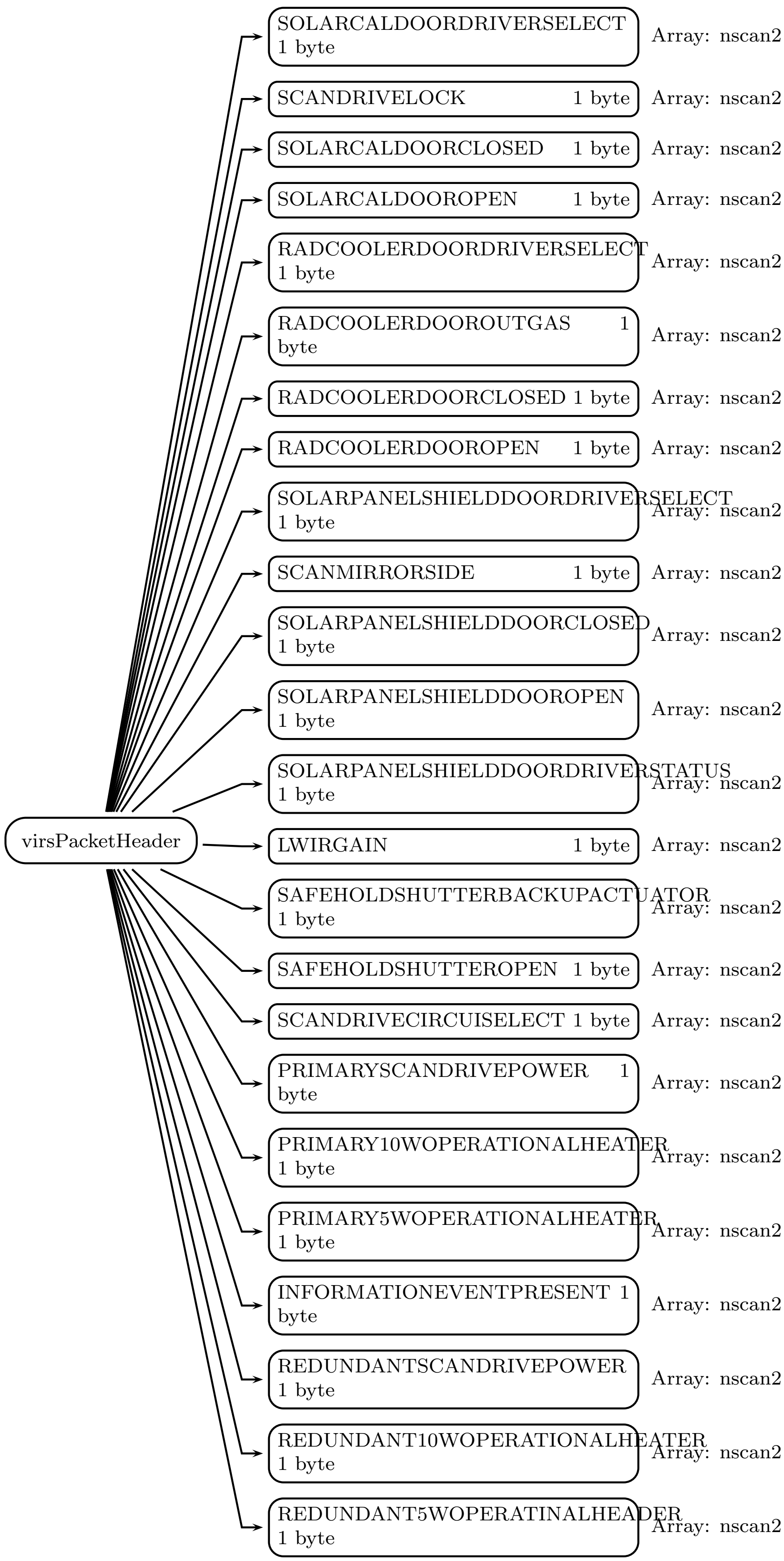
ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value



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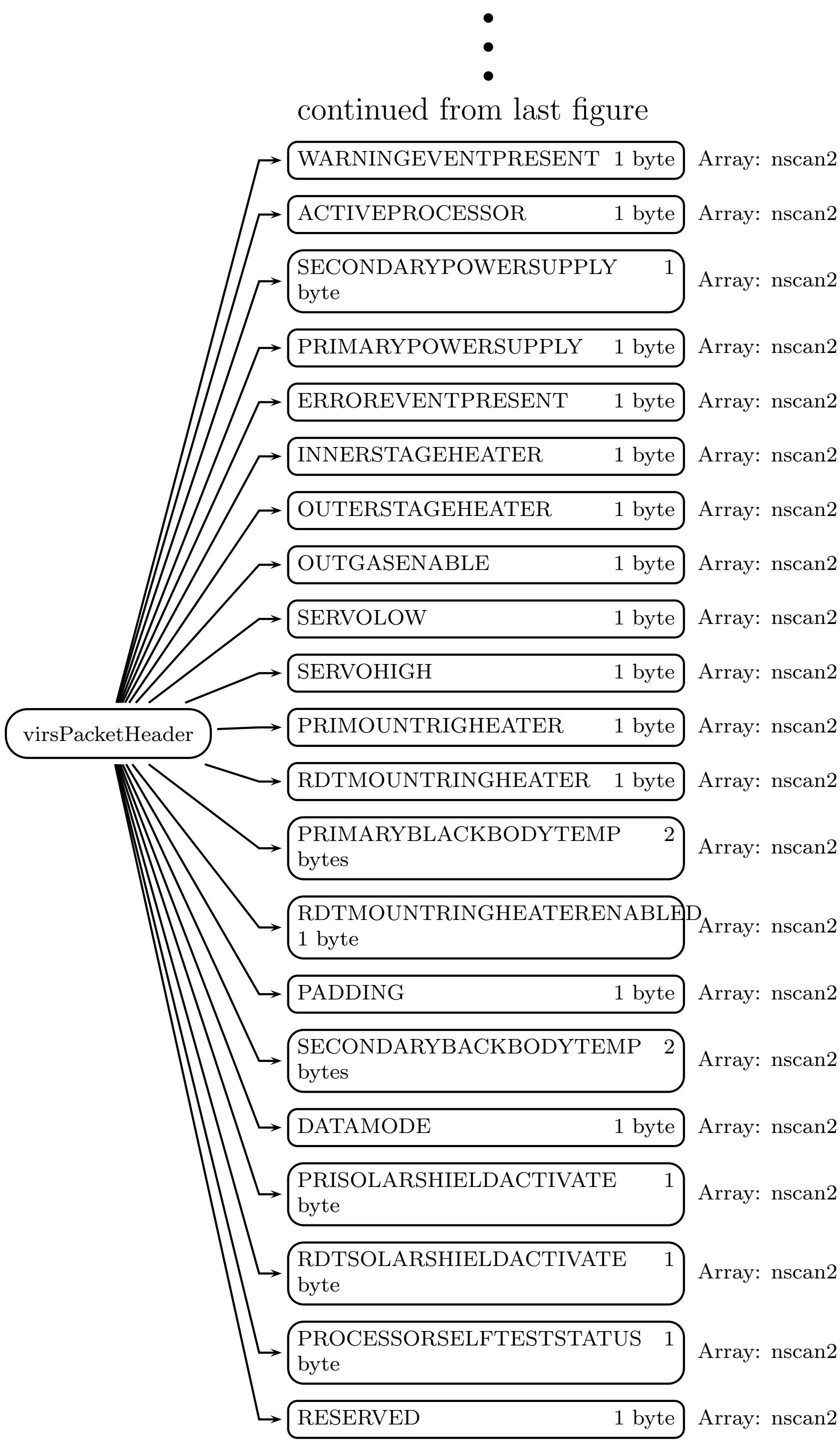


Figure 87: Data Format Structure for 1AVIRS, S2, virsPacketHeader

- VIRSHKPACKET
  - PRIMARYSCANDRIVESERVOPHASEERROR 4 bytes — Array: nscan2
  - TELEMETRYBOARDTEMP 4 bytes — Array: nscan2
  - PRIMARYSCANDRIVEMOTORCURRENT 4 bytes — Array: nscan2
  - REDUNDANTSCANDRIVEMOTORCURRENT 4 bytes — Array: nscan2
  - COOLERINTERMEDIATESTAGETEMP 4 bytes — Array: nscan2
  - COOLERCOLDSTAGETEMP 4 bytes — Array: nscan2
  - FPATEMPCONTROLPOWER 4 bytes — Array: nscan2
  - PRIMARYAPOWERSUPPYTEMP 4 bytes — Array: nscan2
  - REDUNDANTBPOWERSUPPYTEMP 4 bytes — Array: nscan2
  - MOTORENCODERTEMP 4 bytes — Array: nscan2
  - COOLERMOUNTINGRINGTEMP 4 bytes — Array: nscan2
  - PRIMARYBLACKBODYTEMP 4 bytes — Array: nscan2
  - REDUNDANTBLACKBODYTEMP 4 bytes — Array: nscan2
  - PRIMARYPSSECONDARYVOLTAGEPOS28 4 bytes — Array: nscan2
  - PRIMARYPSVOLTAGEPOS16_5 4 bytes — Array: nscan2
  - PRIMARYPSVOLTAGENEG16_5 4 bytes — Array: nscan2
  - REDUNDANTSCANDRIVESERVOPHASEERROR 4 bytes — Array: nscan2
  - PRIMARYPSVOLTAGENEG12 4 bytes — Array: nscan2
  - PRIMARYPSVOLTAGEPOS8_5 4 bytes — Array: nscan2
  - PRIMARYPSVOLTAGEPOS8_0 4 bytes — Array: nscan2
  - PRIMARYPSVOLTAGENEG8_0 4 bytes — Array: nscan2
  - REDUNDANTPSSECONDARYVOLTAGEPOS28 4 bytes — Array: nscan2
  - REDUNDANTPSVOLTAGEPOS16_5 4 bytes — Array: nscan2

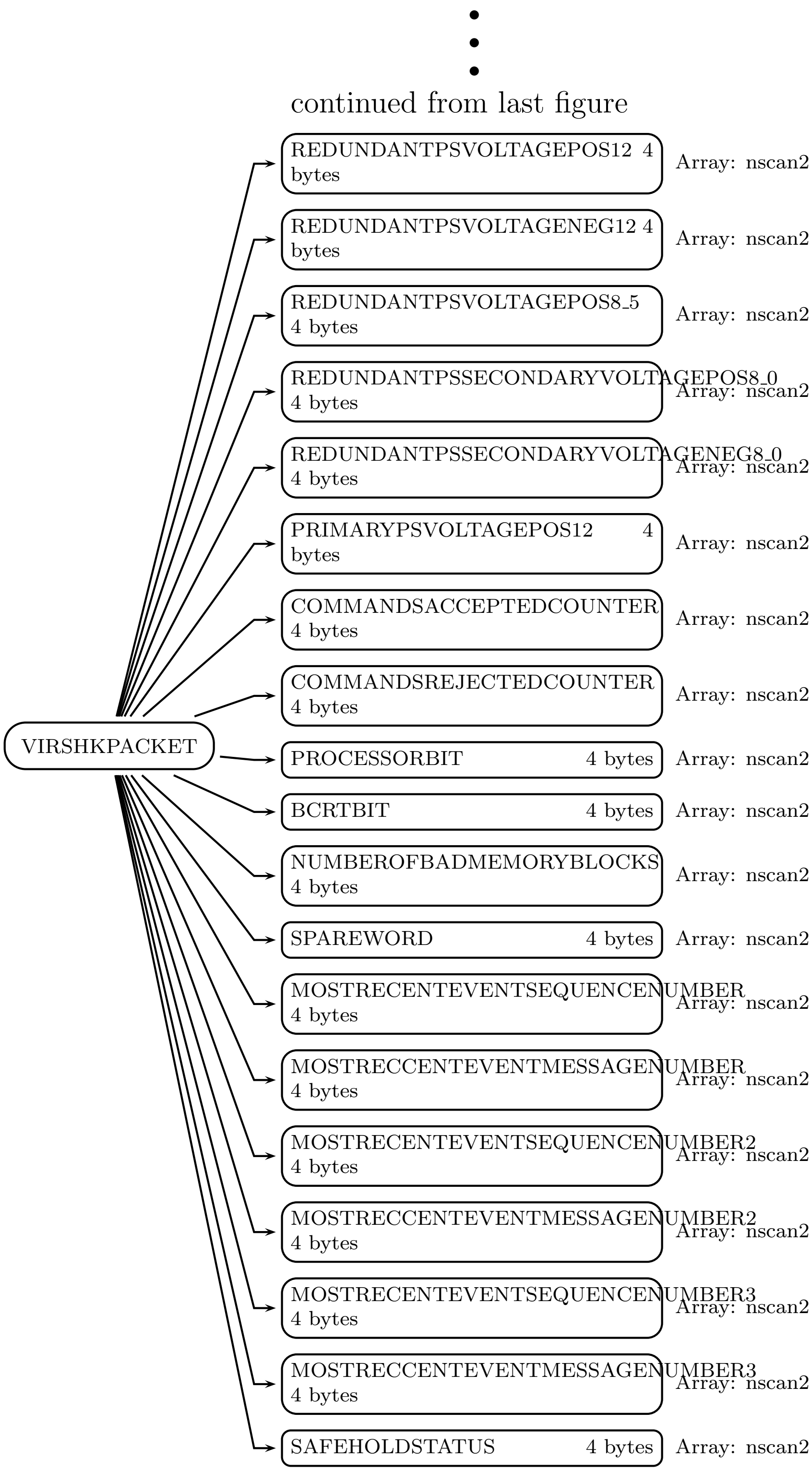


Figure 89: Data Format Structure for 1AVIRS, S2, VIRSHKPACKET

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte char, array size: nscan1):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan1):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan1):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine instrument status
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan1):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan1):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
```

```
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan1):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan1):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan1):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan1):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

virsInstS (1-byte integer, array size: nscan1):

```
Value Meaning
0     Day (no calibration occurring)
1     Night
2     Monitor Scan Stability
3     Day with Calibration
```

virsMode (1-byte integer, array size: nscan1):

```
Value Meaning
0     mission mode
1     safehold mode
2     outgas mode
3     activation mode
```

virsAbnCon (1-byte char, array size: nscan1):
Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Value Meaning
0   0     normal
    1     scan phase error
1   0     normal
    1     selftest error
2   0     normal
    1     thermal data missing
3   0     normal
    1     moon in space view
4   0     normal
    1     H/K data drop-out suspected
5   0     normal
    1     SV counts for channel 4 or 5 greater than
          L1B01\_MIN\_DNSV
6   0     not used
7   0     not used
```

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan1):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value            Meaning
    430 and higher   Best accuracy, good data for this orbit
    421              Reduced accuracy, PR roll data not available
                     (affecting roll/yaw estimates)
    413              Reduced accuracy, sun data not available (affecting pitch)
    411              Reduced accuracy, PR roll and sun sensor not available
    300-399          Reduced accuracy due to various special conditions
    200-299          Fallback to using the onboard attitude estimates
                     with TRMM V7 corrections
```

```
    -91              Spacecraft in safehold mode, no science data
    -99              No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan1):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan1):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
```

```
0     Inaccurate
1     Indeterminate
2     Accurate
-99   Missing
```

TRMMqac (1-byte integer, array size: nscan1):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:

255	Missing value

primaryHeader (Group in S1)

version (1-byte integer, array size: nscan1):

type (1-byte integer, array size: nscan1):

secHeaderFlag (1-byte integer, array size: nscan1):

APID (2-byte integer, array size: nscan1):

sequenceFlag (1-byte integer, array size: nscan1):

packetSequenceCount (2-byte integer, array size: nscan1):

packetLength (2-byte unsigned integer, array size: nscan1):

navigation (Group in S1)

scHeadingGround (4-byte float, array size: nscan1):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9	Missing value

scHeadingOrbital (4-byte float, array size: nscan1):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9	Missing value

scPos (4-byte float, array size: XYZ x nscan1):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:

-9999.9	Missing value

scVel (4-byte float, array size: XYZ x nscan1):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:

-9999.9	Missing value

scLat (4-byte float, array size: nscan1):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:

-9999.9	Missing value

scLon (4-byte float, array size: nscan1):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9	Missing value

scAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:

-9999.9	Missing value

dprAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:

-9999.9	Missing value

scAttRollGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that

pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan1):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan1):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan1):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range

from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan1):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

solarCal (Group in S1)

sunVecX (8-byte float, array size: nscan1):
Solar Position (X-component) (Geocentric Inertial Coord).

sunVecY (8-byte float, array size: nscan1):
Solar Position (Y-component) (Geocentric Inertial Coord).

sunVecZ (8-byte float, array size: nscan1):
Solar Position (Z-component) (Geocentric Inertial Coord).

sunMag (8-byte float, array size: nscan1):
Sun-Earth Distance (m).

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan1):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan1):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan1):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan1):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan1):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan1):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev1 x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev1 x nscan1):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev1 x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev1 x nscan1):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:

-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: VIRSxyz x nscan1):
The x, y, z components of the moon vector in the VIRS instrument coordinate system. Values are in counts. Special values are defined as:

-9999.9 Missing value

blackbody (2-byte unsigned integer, array size: nchannel1 x nsample x nscan1):

```
Radiance measured
from VIRS onboard blackbody calibration target.
```

spaceview (2-byte unsigned integer, array size: nchannel1 x nsample x nscan1):

```
radiance measured from deep space.
```

solarDiffuser (2-byte unsigned integer, array size: nchannel1 x nsample x nscan1):

```
Reflectance measured
from VIRS onboard solar diffuser calibration target.
```

nightFill (1-byte char, array size: nscan1):

```
TBD.
```

earthView (2-byte unsigned integer, array size: nchannel1 x npixelev1 x nscan1):

```
Radiance measured from earth view.
```

virsPacketHeader (Group in S1)

SOLARCALDOORDRIVERSELECT (1-byte char, array size: nscan1):

SCANDRIVELOCK (1-byte char, array size: nscan1):

SOLARCALDOORCLOSED (1-byte char, array size: nscan1):

SOLARCALDOOROPEN (1-byte char, array size: nscan1):

RADCOOLERDOORDRIVERSELECT (1-byte char, array size: nscan1):

RADCOOLERDOOROUTGAS (1-byte char, array size: nscan1):

RADCOOLERDOORCLOSED (1-byte char, array size: nscan1):

RADCOOLERDOOROPEN (1-byte char, array size: nscan1):

SOLARPANELSHIELDDOORDRIVERSELECT (1-byte char, array size: nscan1):

SCANMIRRORSIDE (1-byte char, array size: nscan1):

SOLARPANELSHIELDDOORCLOSED (1-byte char, array size: nscan1):

SOLARPANELSHIELDDOOROPEN (1-byte char, array size: nscan1):

SOLARPANELSHIELDDOORDRIVERSTATUS (1-byte char, array size: nscan1):

LWIRGAIN (1-byte char, array size: nscan1):

SAFEHOLDSHUTTERBACKUPACTUATOR (1-byte char, array size: nscan1):

SAFEHOLDSHUTTEROPEN (1-byte char, array size: nscan1):

SCANDRIVECIRCUISELECT (1-byte char, array size: nscan1):

PRIMARYSCANDRIVEPOWER (1-byte char, array size: nscan1):

PRIMARY10WOPERATIONALHEATER (1-byte char, array size: nscan1):

PRIMARY5WOPERATIONALHEATER (1-byte char, array size: nscan1):

INFORMATIONEVENTPRESENT (1-byte char, array size: nscan1):

REDUNDANTSCANDRIVEPOWER (1-byte char, array size: nscan1):

REDUNDANT10WOPERATIONALHEATER (1-byte char, array size: nscan1):

REDUNDANT5WOPERATINALHEADER (1-byte char, array size: nscan1):

WARNINGEVENTPRESENT (1-byte char, array size: nscan1):

ACTIVEPROCESSOR (1-byte char, array size: nscan1):

SECONDARYPOWERSUPPLY (1-byte char, array size: nscan1):

PRIMARYPOWERSUPPLY (1-byte char, array size: nscan1):

ERROREVENTPRESENT (1-byte char, array size: nscan1):

INNERSTAGEHEATER (1-byte char, array size: nscan1):

OUTERSTAGEHEATER (1-byte char, array size: nscan1):

OUTGASENABLE (1-byte char, array size: nscan1):

SERVOLOW (1-byte char, array size: nscan1):

SERVOHIGH (1-byte char, array size: nscan1):

PRIMOUNTRIGHEATER (1-byte char, array size: nscan1):

RDTMOUNTRINGHEATER (1-byte char, array size: nscan1):

PRIMARYBLACKBODYTEMP (2-byte unsigned integer, array size: nscan1):

RDTMOUNTRINGHEATERENABLED (1-byte char, array size: nscan1):

PADDING (1-byte char, array size: nscan1):

SECONDARYBACKBODYTEMP (2-byte unsigned integer, array size: nscan1):

DATAMODE (1-byte char, array size: nscan1):

PRISOLARSHIELDACTIVATE (1-byte char, array size: nscan1):

RDTSOLARSHIELDACTIVATE (1-byte char, array size: nscan1):

PROCESSORSELFTESTSTATUS (1-byte char, array size: nscan1):

RESERVED (1-byte char, array size: nscan1):

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

Latitude (4-byte float, array size: nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

primaryHeader (Group in S2)

version (1-byte integer, array size: nscan2):

type (1-byte integer, array size: nscan2):

secHeaderFlag (1-byte integer, array size: nscan2):

APID (2-byte integer, array size: nscan2):

sequenceFlag (1-byte integer, array size: nscan2):

packetSequenceCount (2-byte integer, array size: nscan2):

packetLength (2-byte unsigned integer, array size: nscan2):

virsPacketHeader (Group in S2)

SOLARCALDOORDRIVERSELECT (1-byte char, array size: nscan2):

SCANDRIVELOCK (1-byte char, array size: nscan2):

SOLARCALDOORCLOSED (1-byte char, array size: nscan2):

SOLARCALDOOROPEN (1-byte char, array size: nscan2):

RADCOOLERDOORDRIVERSELECT (1-byte char, array size: nscan2):

RADCOOLERDOOROUTGAS (1-byte char, array size: nscan2):

RADCOOLERDOORCLOSED (1-byte char, array size: nscan2):

RADCOOLERDOOROPEN (1-byte char, array size: nscan2):

SOLARPANELSHIELDDOORDRIVERSELECT (1-byte char, array size: nscan2):

SCANMIRRORSIDE (1-byte char, array size: nscan2):

SOLARPANELSHIELDDOORCLOSED (1-byte char, array size: nscan2):

SOLARPANELSHIELDDOOROPEN (1-byte char, array size: nscan2):

SOLARPANELSHIELDDOORDRIVERSTATUS (1-byte char, array size: nscan2):

LWIRGAIN (1-byte char, array size: nscan2):

SAFEHOLDSHUTTERBACKUPACTUATOR (1-byte char, array size: nscan2):

SAFEHOLDSHUTTEROPEN (1-byte char, array size: nscan2):

SCANDRIVECIRCUISELECT (1-byte char, array size: nscan2):

PRIMARYSCANDRIVEPOWER (1-byte char, array size: nscan2):

PRIMARY10WOPERATIONALHEATER (1-byte char, array size: nscan2):

PRIMARY5WOPERATIONALHEATER (1-byte char, array size: nscan2):

INFORMATIONEVENTPRESENT (1-byte char, array size: nscan2):

REDUNDANTSCANDRIVEPOWER (1-byte char, array size: nscan2):

REDUNDANT10WOPERATIONALHEATER (1-byte char, array size: nscan2):

REDUNDANT5WOPERATINALHEADER (1-byte char, array size: nscan2):

WARNINGEVENTPRESENT (1-byte char, array size: nscan2):

ACTIVEPROCESSOR (1-byte char, array size: nscan2):

SECONDARYPOWERSUPPLY (1-byte char, array size: nscan2):

PRIMARYPOWERSUPPLY (1-byte char, array size: nscan2):

ERROREVENTPRESENT (1-byte char, array size: nscan2):

INNERSTAGEHEATER (1-byte char, array size: nscan2):

OUTERSTAGEHEATER (1-byte char, array size: nscan2):

OUTGASENABLE (1-byte char, array size: nscan2):

SERVOLOW (1-byte char, array size: nscan2):

SERVOHIGH (1-byte char, array size: nscan2):

PRIMOUNTRIGHEATER (1-byte char, array size: nscan2):

RDTMOUNTRINGHEATER (1-byte char, array size: nscan2):

PRIMARYBLACKBODYTEMP (2-byte unsigned integer, array size: nscan2):

RDTMOUNTRINGHEATERENABLED (1-byte char, array size: nscan2):

PADDING (1-byte char, array size: nscan2):

SECONDARYBACKBODYTEMP (2-byte unsigned integer, array size: nscan2):

DATAMODE (1-byte char, array size: nscan2):

PRISOLARSHIELDACTIVATE (1-byte char, array size: nscan2):

RDTSOLARSHIELDACTIVATE (1-byte char, array size: nscan2):

PROCESSORSELFTESTSTATUS (1-byte char, array size: nscan2):

RESERVED (1-byte char, array size: nscan2):

VIRSHKPACKET (Group in S2)

PRIMARYSCANDRIVESERVOPHASEERROR (4-byte unsigned integer, array size: nscan2):

TELEMETRYBOARDTEMP (4-byte unsigned integer, array size: nscan2):

PRIMARYSCANDRIVEMOTORCURRENT (4-byte unsigned integer, array size: nscan2):

REDUNDANTSCANDRIVEMOTORCURRENT (4-byte unsigned integer, array size: nscan2):

COOLERINTERMEDIATESTAGETEMP (4-byte unsigned integer, array size: nscan2):

COOLERCOLDSTAGETEMP (4-byte unsigned integer, array size: nscan2):

FPATEMPCONTROLPOWER (4-byte unsigned integer, array size: nscan2):

PRIMARYAPOWERSUPPYTEMP (4-byte unsigned integer, array size: nscan2):

REDUNDANTBPOWERSUPPYTEMP (4-byte unsigned integer, array size: nscan2):

MOTORENCODERTEMP (4-byte unsigned integer, array size: nscan2):

COOLERMOUNTINGRINGTEMP (4-byte unsigned integer, array size: nscan2):

PRIMARYBLACKBODYTEMP (4-byte unsigned integer, array size: nscan2):

REDUNDANTBLACKBODYTEMP (4-byte unsigned integer, array size: nscan2):

PRIMARYPSSECONDARYVOLTAGEPOS28 (4-byte unsigned integer, array size: nscan2):

PRIMARYPSVOLTAGEPOS16_5 (4-byte unsigned integer, array size: nscan2):

PRIMARYPSVOLTAGENEG16_5 (4-byte unsigned integer, array size: nscan2):

REDUNDANTSCANDRIVESERVOPHASEERROR (4-byte unsigned integer, array size: nscan2):

PRIMARYPSVOLTAGENEG12 (4-byte unsigned integer, array size: nscan2):

PRIMARYPSVOLTAGEPOS8_5 (4-byte unsigned integer, array size: nscan2):

PRIMARYPSVOLTAGEPOS8_0 (4-byte unsigned integer, array size: nscan2):

PRIMARYPSVOLTAGENEG8_0 (4-byte unsigned integer, array size: nscan2):

REDUNDANTPSSECONDARYVOLTAGEPOS28 (4-byte unsigned integer, array size: nscan2):

REDUNDANTPSVOLTAGEPOS16_5 (4-byte unsigned integer, array size: nscan2):

REDUNDANTPSVOLTAGENEG16_5 (4-byte unsigned integer, array size: nscan2):

REDUNDANTPSVOLTAGEPOS12 (4-byte unsigned integer, array size: nscan2):

REDUNDANTPSVOLTAGENEG12 (4-byte unsigned integer, array size: nscan2):

REDUNDANTPSVOLTAGEPOS8_5 (4-byte unsigned integer, array size: nscan2):

REDUNDANTPSSECONDARYVOLTAGEPOS8_0 (4-byte unsigned integer, array size: nscan2):

REDUNDANTPSSECONDARYVOLTAGENEG8_0 (4-byte unsigned integer, array size: nscan2):

PRIMARYPSVOLTAGEPOS12 (4-byte unsigned integer, array size: nscan2):

COMMANDSACCEPTEDCOUNTER (4-byte unsigned integer, array size: nscan2):

COMMANDSREJECTEDCOUNTER (4-byte unsigned integer, array size: nscan2):

PROCESSORBIT (4-byte unsigned integer, array size: nscan2):

BCRTBIT (4-byte unsigned integer, array size: nscan2):

NUMBEROFBADMEMORYBLOCKS (4-byte unsigned integer, array size: nscan2):

SPAREWORD (4-byte unsigned integer, array size: nscan2):

MOSTRECENTEVENTSEQUENCENUMBER (4-byte unsigned integer, array size: nscan2):

MOSTRECCENTEVENTMESSAGENUMBER (4-byte unsigned integer, array size: nscan2):

MOSTRECENTEVENTSEQUENCENUMBER2 (4-byte unsigned integer, array size: nscan2):

MOSTRECCENTEVENTMESSAGENUMBER2 (4-byte unsigned integer, array size: nscan2):

MOSTRECENTEVENTSEQUENCENUMBER3 (4-byte unsigned integer, array size: nscan2):

MOSTRECCENTEVENTMESSAGENUMBER3 (4-byte unsigned integer, array size: nscan2):

SAFEHOLDSTATUS (4-byte unsigned integer, array size: nscan2):

C Structure Header file:

```
#ifndef _TK_1AVIRS_H_
#define _TK_1AVIRS_H_

#ifndef _L1AVIRS_S2_VIRSHKPACKET_
#define _L1AVIRS_S2_VIRSHKPACKET_

typedef struct {
    unsigned int PRIMARYSCANDRIVESERVOPHASEERROR;
    unsigned int TELEMETRYBOARDTEMP;
    unsigned int PRIMARYSCANDRIVEMOTORCURRENT;
    unsigned int REDUNDANTSCANDRIVEMOTORCURRENT;
    unsigned int COOLERINTERMEDIATESTAGETEMP;
    unsigned int COOLERCOLDSTAGETEMP;
    unsigned int FPATEMPCONTROLPOWER;
    unsigned int PRIMARYAPOWERSUPPYTEMP;
    unsigned int REDUNDANTBPOWERSUPPYTEMP;
    unsigned int MOTORENCODERTEMP;
```

```
    unsigned int COOLERMOUNTINGRINGTEMP;
    unsigned int PRIMARYBLACKBODYTEMP;
    unsigned int REDUNDANTBLACKBODYTEMP;
    unsigned int PRIMARYPSSECONDARYVOLTAGEPOS28;
    unsigned int PRIMARYPSVOLTAGEPOS16_5;
    unsigned int PRIMARYPSVOLTAGENEG16_5;
    unsigned int REDUNDANTSCANDRIVESERVOPHASEERROR;
    unsigned int PRIMARYPSVOLTAGENEG12;
    unsigned int PRIMARYPSVOLTAGEPOS8_5;
    unsigned int PRIMARYPSVOLTAGEPOS8_0;
    unsigned int PRIMARYPSVOLTAGENEG8_0;
    unsigned int REDUNDANTPSSECONDARYVOLTAGEPOS28;
    unsigned int REDUNDANTPSVOLTAGEPOS16_5;
    unsigned int REDUNDANTPSVOLTAGENEG16_5;
    unsigned int REDUNDANTPSVOLTAGEPOS12;
    unsigned int REDUNDANTPSVOLTAGENEG12;
    unsigned int REDUNDANTPSVOLTAGEPOS8_5;
    unsigned int REDUNDANTPSSECONDARYVOLTAGEPOS8_0;
    unsigned int REDUNDANTPSSECONDARYVOLTAGENEG8_0;
    unsigned int PRIMARYPSVOLTAGEPOS12;
    unsigned int COMMANDSACCEPTEDCOUNTER;
    unsigned int COMMANDSREJECTEDCOUNTER;
    unsigned int PROCESSORBIT;
    unsigned int BCRTBIT;
    unsigned int NUMBEROFBADMEMORYBLOCKS;
    unsigned int SPAREWORD;
    unsigned int MOSTRECENTEVENTSEQUENCENUMBER;
    unsigned int MOSTRECCENTEVENTMESSAGENUMBER;
    unsigned int MOSTRECENTEVENTSEQUENCENUMBER2;
    unsigned int MOSTRECCENTEVENTMESSAGENUMBER2;
    unsigned int MOSTRECENTEVENTSEQUENCENUMBER3;
    unsigned int MOSTRECCENTEVENTMESSAGENUMBER3;
    unsigned int SAFEHOLDSTATUS;
} L1AVIRS_S2_VIRSHKPACKET;

#endif

#ifndef _L1AVIRS_S2_
#define _L1AVIRS_S2_

typedef struct {
    SCANTIME ScanTime;
    unsigned char ephemerisUsed[10];
```

```
    float Latitude;
    float Longitude;
    PRIMARYHEADER primaryHeader;
    VIRSPACKETHEADER virsPacketHeader;
    L1AVIRS_S2_VIRSHKPACKET VIRSHKPACKET;
} L1AVIRS_S2;

#endif

#ifndef _VIRSPACKETHEADER_
#define _VIRSPACKETHEADER_

typedef struct {
    unsigned char SOLARCALDOORDRIVERSELECT;
    unsigned char SCANDRIVELOCK;
    unsigned char SOLARCALDOORCLOSED;
    unsigned char SOLARCALDOOROPEN;
    unsigned char RADCOOLERDOORDRIVERSELECT;
    unsigned char RADCOOLERDOOROUTGAS;
    unsigned char RADCOOLERDOORCLOSED;
    unsigned char RADCOOLERDOOROPEN;
    unsigned char SOLARPANELSHIELDDOORDRIVERSELECT;
    unsigned char SCANMIRRORSIDE;
    unsigned char SOLARPANELSHIELDDOORCLOSED;
    unsigned char SOLARPANELSHIELDDOOROPEN;
    unsigned char SOLARPANELSHIELDDOORDRIVERSTATUS;
    unsigned char LWIRGAIN;
    unsigned char SAFEHOLDSHUTTERBACKUPACTUATOR;
    unsigned char SAFEHOLDSHUTTEROPEN;
    unsigned char SCANDRIVECIRCUISELECT;
    unsigned char PRIMARYSCANDRIVEPOWER;
    unsigned char PRIMARY10WOPERATIONALHEATER;
    unsigned char PRIMARY5WOPERATIONALHEATER;
    unsigned char INFORMATIONEVENTPRESENT;
    unsigned char REDUNDANTSCANDRIVEPOWER;
    unsigned char REDUNDANT10WOPERATIONALHEATER;
    unsigned char REDUNDANT5WOPERATINALHEADER;
    unsigned char WARNINGEVENTPRESENT;
    unsigned char ACTIVEPROCESSOR;
    unsigned char SECONDARYPOWERSUPPLY;
    unsigned char PRIMARYPOWERSUPPLY;
    unsigned char ERROREVENTPRESENT;
    unsigned char INNERSTAGEHEATER;
```

```
    unsigned char OUTERSTAGEHEATER;
    unsigned char OUTGASENABLE;
    unsigned char SERVOLOW;
    unsigned char SERVOHIGH;
    unsigned char PRIMOUNTRIGHEATER;
    unsigned char RDTMOUNTRINGHEATER;
    unsigned short PRIMARYBLACKBODYTEMP;
    unsigned char RDTMOUNTRINGHEATERENABLED;
    unsigned char PADDING;
    unsigned short SECONDARYBACKBODYTEMP;
    unsigned char DATAMODE;
    unsigned char PRISOLARSHIELDACTIVATE;
    unsigned char RDTSOLARSHIELDACTIVATE;
    unsigned char PROCESSORSELFTESTSTATUS;
    unsigned char RESERVED;
} VIRSPACKETHEADER;

#endif

#ifndef _L1AVIRS_S1_SUNDATA_
#define _L1AVIRS_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1AVIRS_S1_SUNDATA;

#endif

#ifndef _L1AVIRS_S1_SOLARCAL_
#define _L1AVIRS_S1_SOLARCAL_

typedef struct {
    double sunVecX;
    double sunVecY;
    double sunVecZ;
    double sunMag;
```

```
} L1AVIRS_S1_SOLARCAL;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _PRIMARYHEADER_
#define _PRIMARYHEADER_

typedef struct {
    signed char version;
    signed char type;
    signed char secHeaderFlag;
    short APID;
    signed char sequenceFlag;
    short packetSequenceCount;
    unsigned short packetLength;
} PRIMARYHEADER;

#endif
```

```
#ifndef _L1AVIRS_S1_SCANSTATUS_
#define _L1AVIRS_S1_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char virsInstS;
    signed char virsMode;
    unsigned char virsAbnCon;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1AVIRS_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif
```

```
#ifndef _L1AVIRS_S1_
#define _L1AVIRS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[261];
    float Longitude[261];
    float sunLocalTime[261];
    L1AVIRS_S1_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    PRIMARYHEADER primaryHeader;
    NAVIGATION navigation;
    L1AVIRS_S1_SOLARCAL solarCal;
    L1AVIRS_S1_SUNDATA sunData;
    float incidenceAngle[261];
    float satAzimuthAngle[261];
    float solarZenAngle[261];
    float solarAzimuthAngle[261];
    float sunGlintAngle[261];
    float moonVectorInstFrame[3];
    unsigned short blackbody[2][5];
    unsigned short spaceview[2][5];
    unsigned short solarDiffuser[2][5];
    unsigned char nightFill;
    unsigned short earthView[261][5];
    VIRSPACKETHEADER virsPacketHeader;
} L1AVIRS_S1;

#endif

#ifndef _L1AVIRS_SWATHS_
#define _L1AVIRS_SWATHS_

typedef struct {
    L1AVIRS_S1 S1;
    L1AVIRS_S2 S2;
} L1AVIRS_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1AVIRS_S2_VIRSHKPACKET/
    INTEGER*4 PRIMARYSCANDRIVESERVOPHASEERROR
    INTEGER*4 TELEMETRYBOARDTEMP
    INTEGER*4 PRIMARYSCANDRIVEMOTORCURRENT
    INTEGER*4 REDUNDANTSCANDRIVEMOTORCURRENT
    INTEGER*4 COOLERINTERMEDIATESTAGETEMP
    INTEGER*4 COOLERCOLDSTAGETEMP
    INTEGER*4 FPATEMPCONTROLPOWER
    INTEGER*4 PRIMARYAPOWERSUPPYTEMP
    INTEGER*4 REDUNDANTBPOWERSUPPYTEMP
    INTEGER*4 MOTORENCODERTEMP
    INTEGER*4 COOLERMOUNTINGRINGTEMP
    INTEGER*4 PRIMARYBLACKBODYTEMP
    INTEGER*4 REDUNDANTBLACKBODYTEMP
    INTEGER*4 PRIMARYPSSECONDARYVOLTAGEPOS28
    INTEGER*4 PRIMARYPSVOLTAGEPOS16_5
    INTEGER*4 PRIMARYPSVOLTAGENEG16_5
    INTEGER*4 REDUNDANTSCANDRIVESERVOPHASEERROR
    INTEGER*4 PRIMARYPSVOLTAGENEG12
    INTEGER*4 PRIMARYPSVOLTAGEPOS8_5
    INTEGER*4 PRIMARYPSVOLTAGEPOS8_0
    INTEGER*4 PRIMARYPSVOLTAGENEG8_0
    INTEGER*4 REDUNDANTPSSECONDARYVOLTAGEPOS28
    INTEGER*4 REDUNDANTPSVOLTAGEPOS16_5
    INTEGER*4 REDUNDANTPSVOLTAGENEG16_5
    INTEGER*4 REDUNDANTPSVOLTAGEPOS12
    INTEGER*4 REDUNDANTPSVOLTAGENEG12
    INTEGER*4 REDUNDANTPSVOLTAGEPOS8_5
    INTEGER*4 REDUNDANTPSSECONDARYVOLTAGEPOS8_0
    INTEGER*4 REDUNDANTPSSECONDARYVOLTAGENEG8_0
    INTEGER*4 PRIMARYPSVOLTAGEPOS12
    INTEGER*4 COMMANDSACCEPTEDCOUNTER
    INTEGER*4 COMMANDSREJECTEDCOUNTER
    INTEGER*4 PROCESSORBIT
    INTEGER*4 BCRTBIT
    INTEGER*4 NUMBEROFBADMEMORYBLOCKS
    INTEGER*4 SPAREWORD
    INTEGER*4 MOSTRECENTEVENTSEQUENCENUMBER
    INTEGER*4 MOSTRECCENTEVENTMESSAGENUMBER
    INTEGER*4 MOSTRECENTEVENTSEQUENCENUMBER2
    INTEGER*4 MOSTRECCENTEVENTMESSAGENUMBER2
    INTEGER*4 MOSTRECENTEVENTSEQUENCENUMBER3
```

```
    INTEGER*4 MOSTRECCENTEVENTMESSAGENUMBER3
    INTEGER*4 SAFEHOLDSTATUS
END STRUCTURE

STRUCTURE /L1AVIRS_S2/
    RECORD /SCANTIME/ ScanTime
    CHARACTER ephemerisUsed(10)
    REAL*4 Latitude
    REAL*4 Longitude
    RECORD /PRIMARYHEADER/ primaryHeader
    RECORD /VIRSPACKETHEADER/ virsPacketHeader
    RECORD /L1AVIRS_S2_VIRSHKPACKET/ VIRSHKPACKET
END STRUCTURE

STRUCTURE /VIRSPACKETHEADER/
    CHARACTER SOLARCALDOORDRIVERSELECT
    CHARACTER SCANDRIVELOCK
    CHARACTER SOLARCALDOORCLOSED
    CHARACTER SOLARCALDOOROPEN
    CHARACTER RADCOOLERDOORDRIVERSELECT
    CHARACTER RADCOOLERDOOROUTGAS
    CHARACTER RADCOOLERDOORCLOSED
    CHARACTER RADCOOLERDOOROPEN
    CHARACTER SOLARPANELSHIELDDOORDRIVERSELECT
    CHARACTER SCANMIRRORSIDE
    CHARACTER SOLARPANELSHIELDDOORCLOSED
    CHARACTER SOLARPANELSHIELDDOOROPEN
    CHARACTER SOLARPANELSHIELDDOORDRIVERSTATUS
    CHARACTER LWIRGAIN
    CHARACTER SAFEHOLDSHUTTERBACKUPACTUATOR
    CHARACTER SAFEHOLDSHUTTEROPEN
    CHARACTER SCANDRIVECIRCUISELECT
    CHARACTER PRIMARYSCANDRIVEPOWER
    CHARACTER PRIMARY10WOPERATIONALHEATER
    CHARACTER PRIMARY5WOPERATIONALHEATER
    CHARACTER INFORMATIONEVENTPRESENT
    CHARACTER REDUNDANTSCANDRIVEPOWER
    CHARACTER REDUNDANT10WOPERATIONALHEATER
    CHARACTER REDUNDANT5WOPERATINALHEADER
    CHARACTER WARNINGEVENTPRESENT
    CHARACTER ACTIVEPROCESSOR
    CHARACTER SECONDARYPOWERSUPPLY
    CHARACTER PRIMARYPOWERSUPPLY
```

```
    CHARACTER ERROREVENTPRESENT
    CHARACTER INNERSTAGEHEATER
    CHARACTER OUTERSTAGEHEATER
    CHARACTER OUTGASENABLE
    CHARACTER SERVOLOW
    CHARACTER SERVOHIGH
    CHARACTER PRIMOUNTRIGHEATER
    CHARACTER RDTMOUNTRINGHEATER
    INTEGER*2 PRIMARYBLACKBODYTEMP
    CHARACTER RDTMOUNTRINGHEATERENABLED
    CHARACTER PADDING
    INTEGER*2 SECONDARYBACKBODYTEMP
    CHARACTER DATAMODE
    CHARACTER PRISOLARSHIELDACTIVATE
    CHARACTER RDTSOLARSHIELDACTIVATE
    CHARACTER PROCESSORSELFTESTSTATUS
    CHARACTER RESERVED
END STRUCTURE

STRUCTURE /L1AVIRS_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1AVIRS_S1_SOLARCAL/
    REAL*8 sunVecX
    REAL*8 sunVecY
    REAL*8 sunVecZ
    REAL*8 sunMag
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
```

```
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /PRIMARYHEADER/
    BYTE version
    BYTE type
    BYTE secHeaderFlag
    INTEGER*2 APID
    BYTE sequenceFlag
    INTEGER*2 packetSequenceCount
    INTEGER*2 packetLength
END STRUCTURE

STRUCTURE /L1AVIRS_S1_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE virsInstS
    BYTE virsMode
    CHARACTER virsAbnCon
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE
```

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1AVIRS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(261)
    REAL*4 Longitude(261)
    REAL*4 sunLocalTime(261)
    RECORD /L1AVIRS_S1_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /PRIMARYHEADER/ primaryHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1AVIRS_S1_SOLARCAL/ solarCal
    RECORD /L1AVIRS_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(261)
    REAL*4 satAzimuthAngle(261)
    REAL*4 solarZenAngle(261)
    REAL*4 solarAzimuthAngle(261)
    REAL*4 sunGlintAngle(261)
    REAL*4 moonVectorInstFrame(3)
    INTEGER*2 blackbody(5,2)
    INTEGER*2 spaceview(5,2)
    INTEGER*2 solarDiffuser(5,2)
    CHARACTER nightFill
    INTEGER*2 earthView(5,261)
    RECORD /VIRSPACKETHEADER/ virsPacketHeader
END STRUCTURE

STRUCTURE /L1AVIRS_SWATHS/
    RECORD /L1AVIRS_S1/ S1;
    RECORD /L1AVIRS_S2/ S2;
END STRUCTURE
```

5.4 1BASETMI - TMI Brightness Temperatures

1BASETMI contains TMI science data from the TMI passive microwave instrument flown on the TRMM satellite. There are 4 swaths. Swath S1 has 10V 10H; Swath S2 has 19V, 19H, 21V, 37V, 37H; Swath S3 has 85V, 85H; Swath S4 has Housekeeping.

```
        The S1 channels are:
10.7  GHz vertically-polarized
10.7  GHz horizontally-polarized
```

```
        The S2 channels are:
18.7  GHz vertically-polarized
18.7  GHz horizontally-polarized
23.8  GHz vertically-polarized
36.5  GHz vertically-polarized
36.5  GHz horizontally-polarized
```

```
        The S3 channels are:
85.0  GHz vertically-polarized
85.0  GHz horizontally-polarized
```

```
S4 has TMI housekeeping.
```

Earth observations are taken during a segment of the rotation when TMI is looking in the +x direction of the TRMM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

Before Aug 7, 2001 31.6rpm * 1min/60s * 5490s/orbit = 2891 scans / orbit.

After Aug 24, 2001 31.6rpm * 1min/60s * 5550s/orbit = 2923 scans / orbit.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and the same number of pixels as Swath S1. Swath S3 has the same number of scans and twice as many pixels as Swath S1. Each S1 scan contains 2 channels sampled 104 times along the scan. Each S2 scan contains 5 channels sampled 104 times along the scan. Each S3 scan contains 2 channels sampled 208 times along the scan.

Dimension definitions:

VH	2	Number of polarizations.
nscan1	var	Typical number of Swath S1 scans in the granule.
nchannel1	2	Number of Swath S1 channels (10V).
nfreq1	1	Number of frequencies in Swath 1.
npixelev1	104	Number of earth view pixels in one scan.
npixelht1	8	Number of hot load pixels in one scan.
npixelcs1	8	Number of cold sky pixels in one scan.
nscan2	var	Typical number of Swath S2 scans in the granule.
nchannel2	5	Number of Swath S2 channels (19V 19H 21V 37V 37H).
nfreq2	3	Number of frequencies in Swath 1.
npixelev2	104	Number of earth view pixels in one scan.
npixelht2	8	Number of hot load pixels in one scan.
npixelcs2	8	Number of cold sky pixels in one scan.
nscan3	var	Typical number of Swath S3 scans in the granule.
nchannel3	2	Number of Swath S3 channels (85V 85H).
nfreq3	1	Number of frequencies in Swath 1.
npixelev3	208	Number of earth view pixels in one scan.
npixelht3	16	Number of hot load pixels in one scan.
npixelcs3	16	Number of cold sky pixels in one scan.
nscan4	var	Typical number of Swath S5 scans in the granule.
nchannelall	9	Number of all channels.
ntherm	3	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nndiode	6	Number of noise diodes.
dim2	2	Number.
dim3	3	Number.
dim4	4	Number.
dim5	5	Number.
dim6	6	Number.
dim7	7	Number.
dim8	8	Number.
dim9	9	Number.
dim10	10	Number.
dim11	11	Number.
dim12	12	Number.
TMIxyz	3	x, y, z components in TMI instrument coordinate system.
SVBFd	3	SunVectorinBodyFrame dimension.

Figure 90 through Figure 119 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

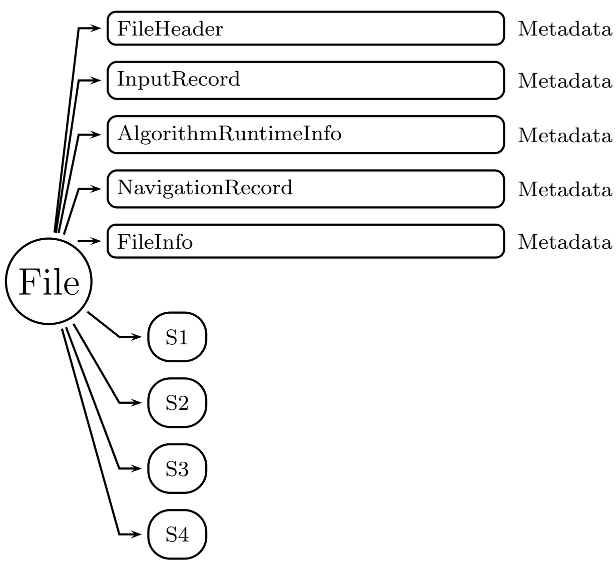


Figure 90: Data Format Structure for 1BASETMI, TMI Brightness Temperatures

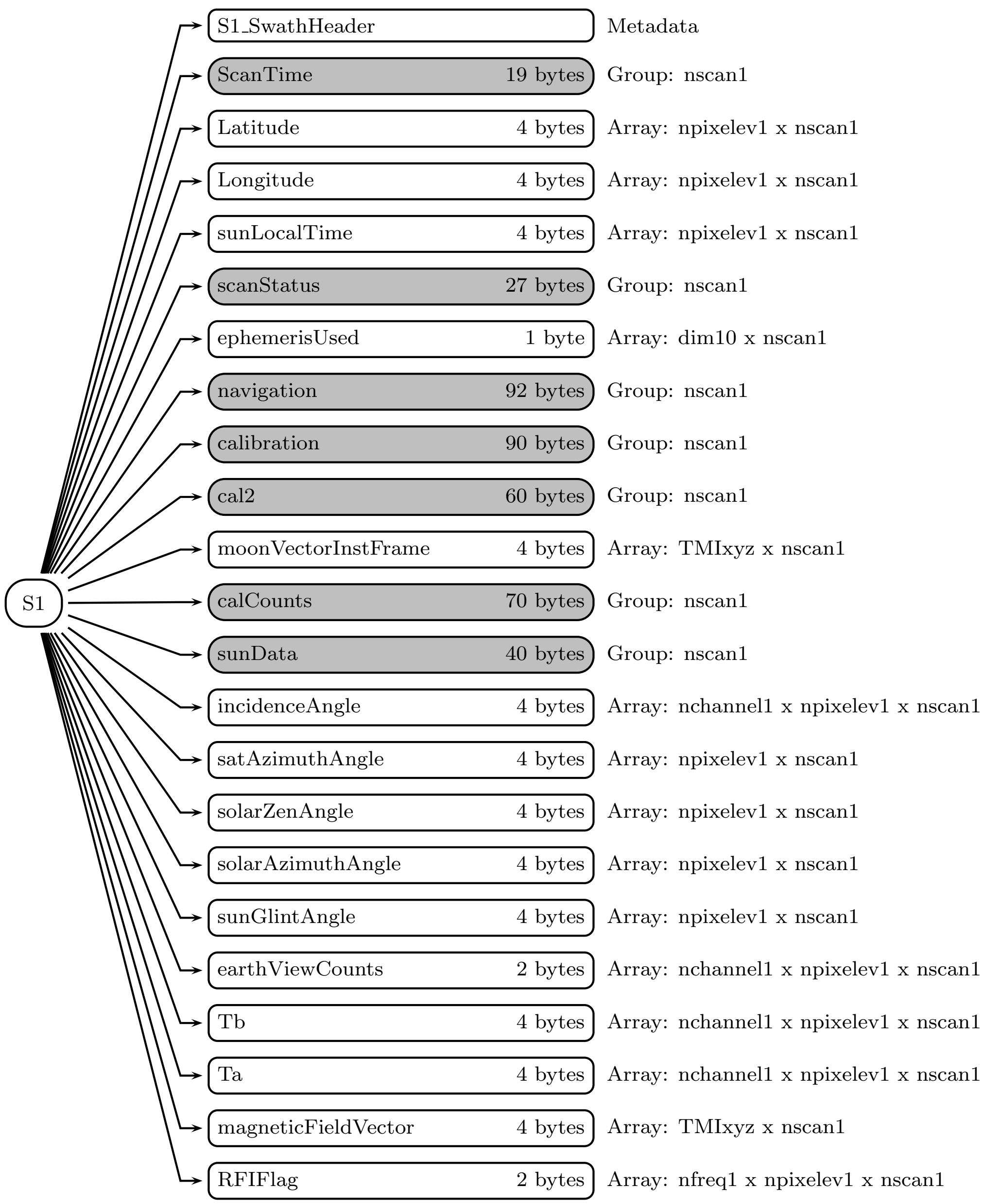


Figure 91: Data Format Structure for 1BASETMI, S1

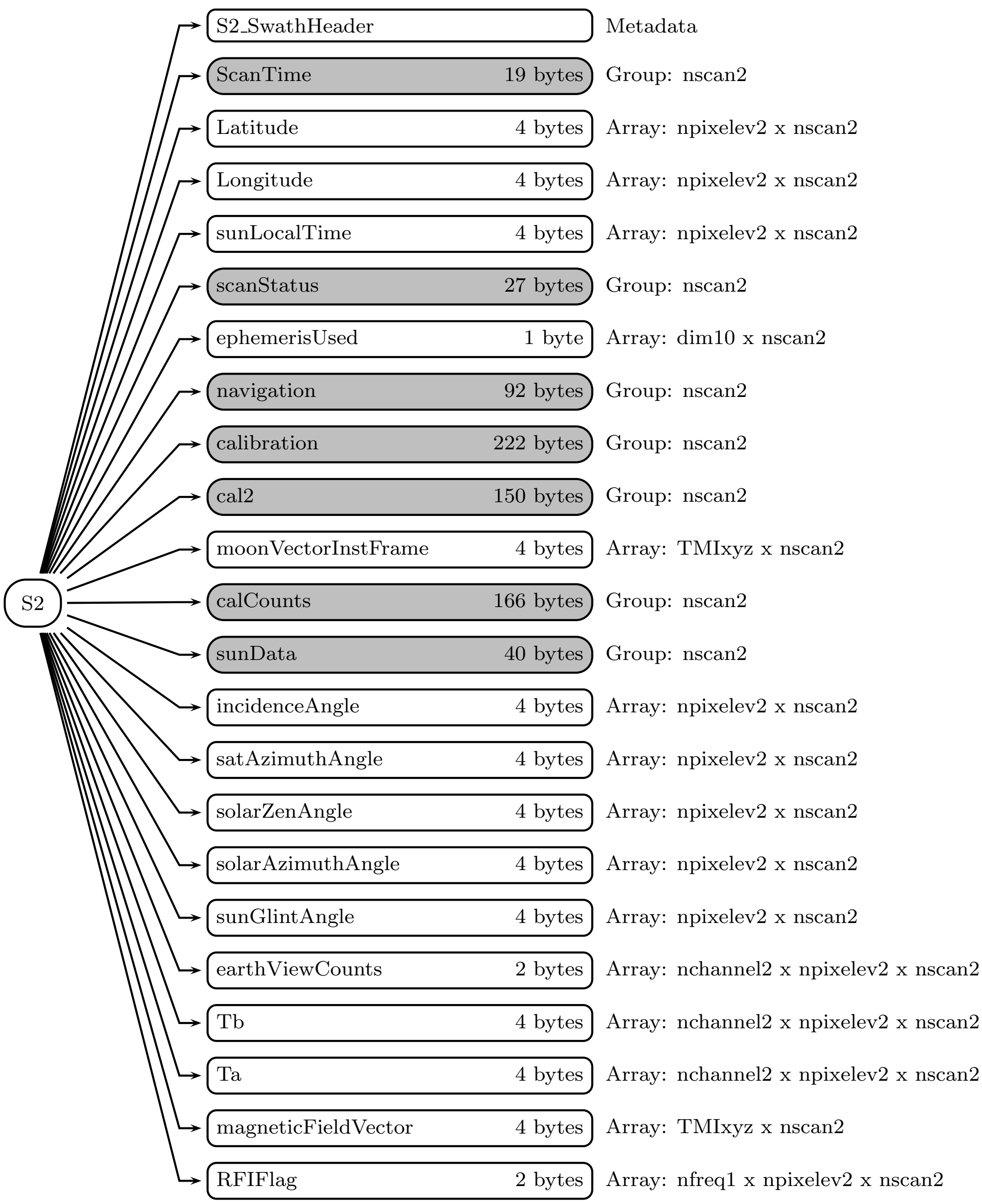


Figure 92: Data Format Structure for 1BASETMI, S2

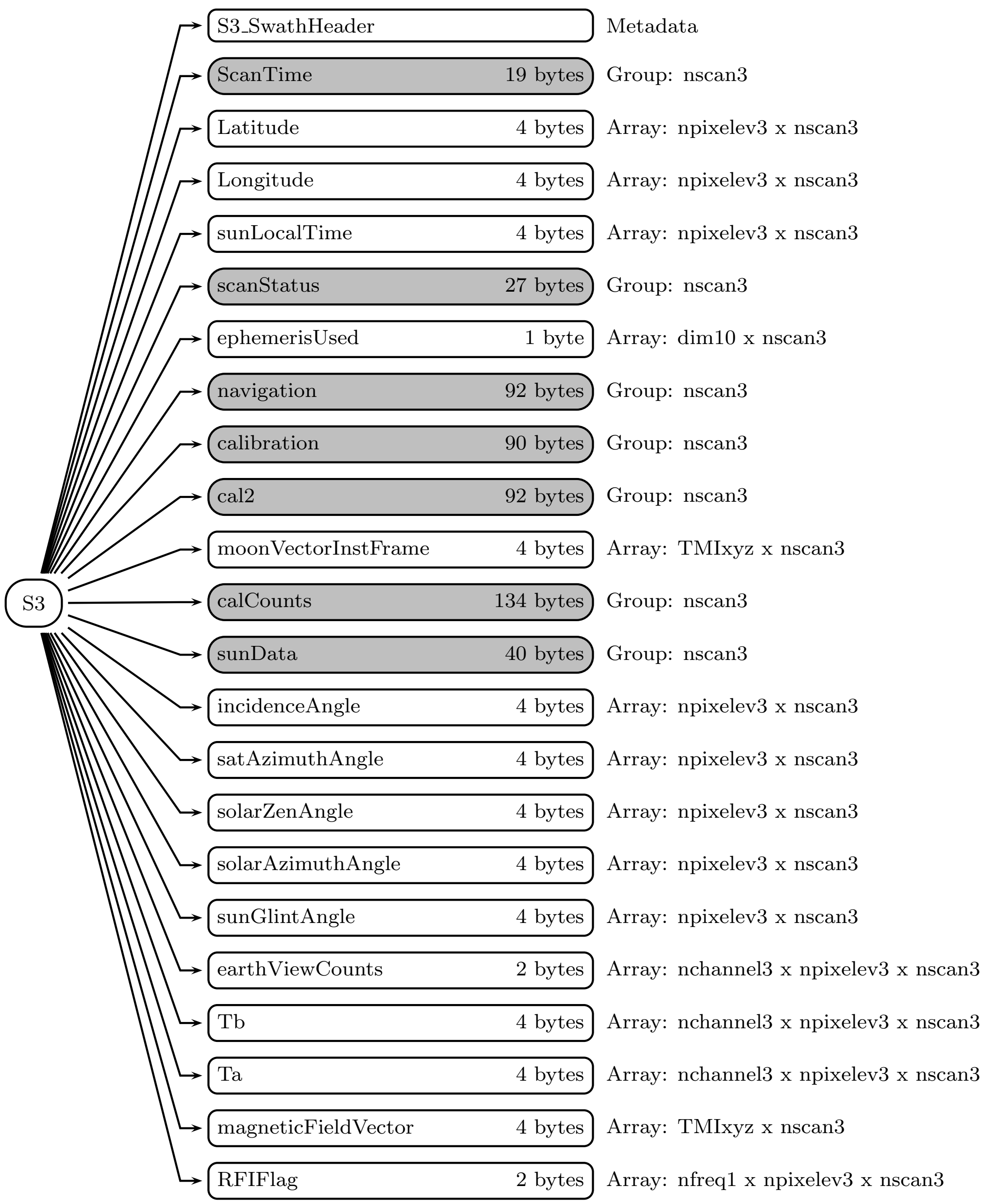


Figure 93: Data Format Structure for 1BASETMI, S3

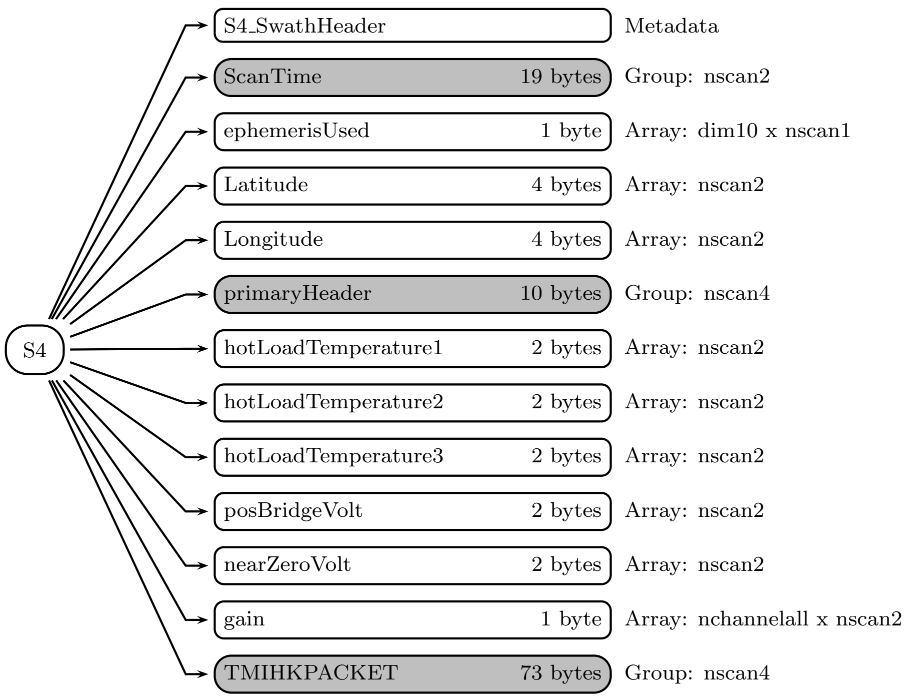


Figure 94: Data Format Structure for 1BASETMI, S4

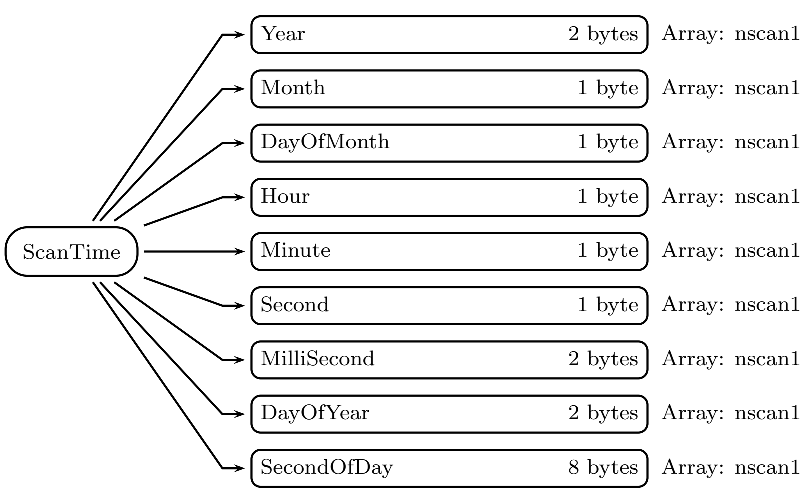


Figure 95: Data Format Structure for 1BASETMI, S1, ScanTime

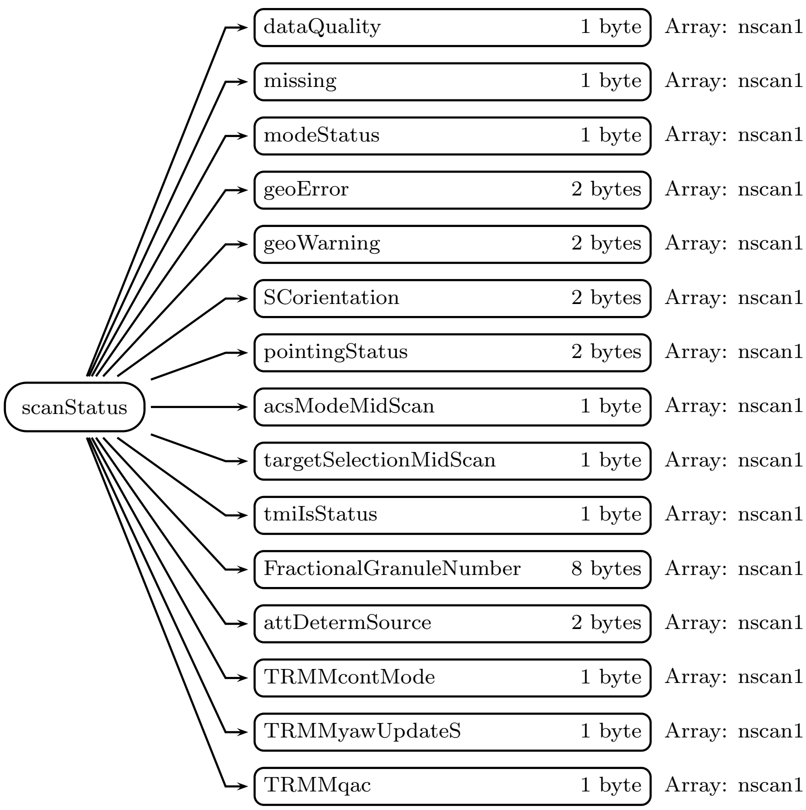


Figure 96: Data Format Structure for 1BASETMI, S1, scanStatus

navigation

scHeadingGround	4 bytes	Array: nscan1
scHeadingOrbital	4 bytes	Array: nscan1
scPos	4 bytes	Array: XYZ x nscan1
scVel	4 bytes	Array: XYZ x nscan1
scLat	4 bytes	Array: nscan1
scLon	4 bytes	Array: nscan1
scAlt	4 bytes	Array: nscan1
dprAlt	4 bytes	Array: nscan1
scAttRollGeoc	4 bytes	Array: nscan1
scAttPitchGeoc	4 bytes	Array: nscan1
scAttYawGeoc	4 bytes	Array: nscan1
scAttRollGeod	4 bytes	Array: nscan1
scAttPitchGeod	4 bytes	Array: nscan1
scAttYawGeod	4 bytes	Array: nscan1
greenHourAng	4 bytes	Array: nscan1
timeMidScan	8 bytes	Array: nscan1
timeMidScanOffset	8 bytes	Array: nscan1

Figure 97: Data Format Structure for 1BASETMI, S1, navigation

calibration

hotLoadTemp	4 bytes	Array: nchannel1 x nscan1
coldSkyTemp	4 bytes	Array: nchannel1 x nscan1
onOrbitNonLinearity	4 bytes	Array: nchannel1 x nscan1
meanHotLoadCount	2 bytes	Array: nchannel1 x nscan1
meanColdSkyCount	2 bytes	Array: nchannel1 x nscan1
gain	4 bytes	Array: LNL x nchannel1 x nscan1
offset	4 bytes	Array: LNL x nchannel1 x nscan1
nonLinearGain	4 bytes	Array: nchannel1 x nscan1
calibrationQCflag	2 bytes	Array: nscan1
receiverTemp	4 bytes	Array: nchannel1 x nscan1
receiverGain	4 bytes	Array: nchannel1 x nscan1

Figure 98: Data Format Structure for 1BASETMI, S1, calibration

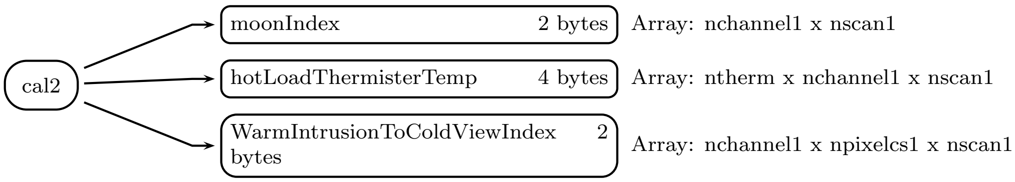


Figure 99: Data Format Structure for 1BASETMI, S1, cal2

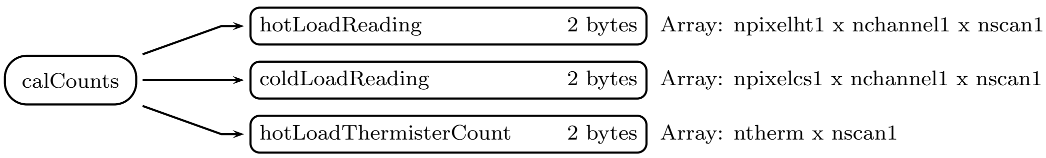


Figure 100: Data Format Structure for 1BASETMI, S1, calCounts

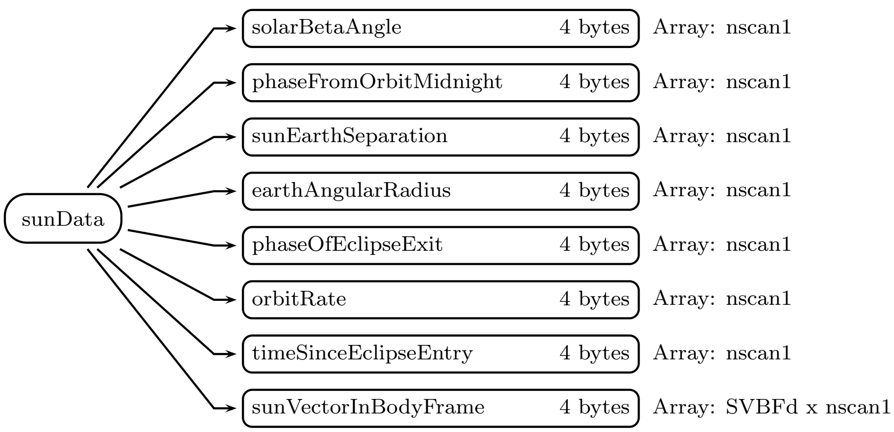


Figure 101: Data Format Structure for 1BASETMI, S1, sunData

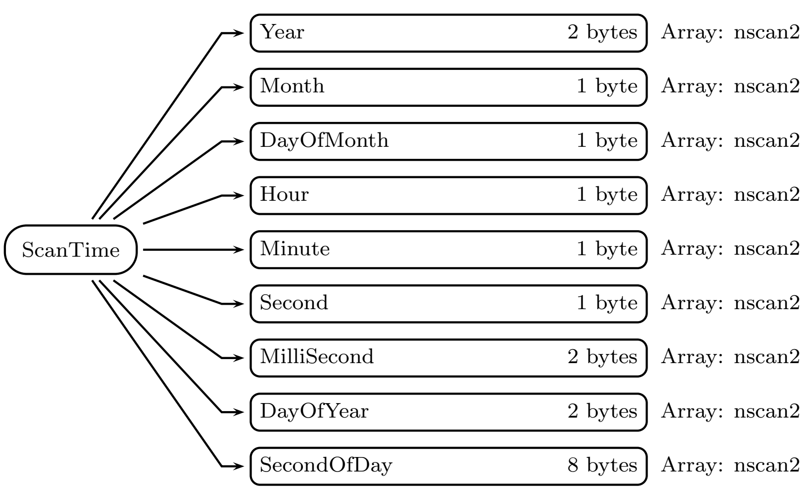


Figure 102: Data Format Structure for 1BASETMI, S2, ScanTime

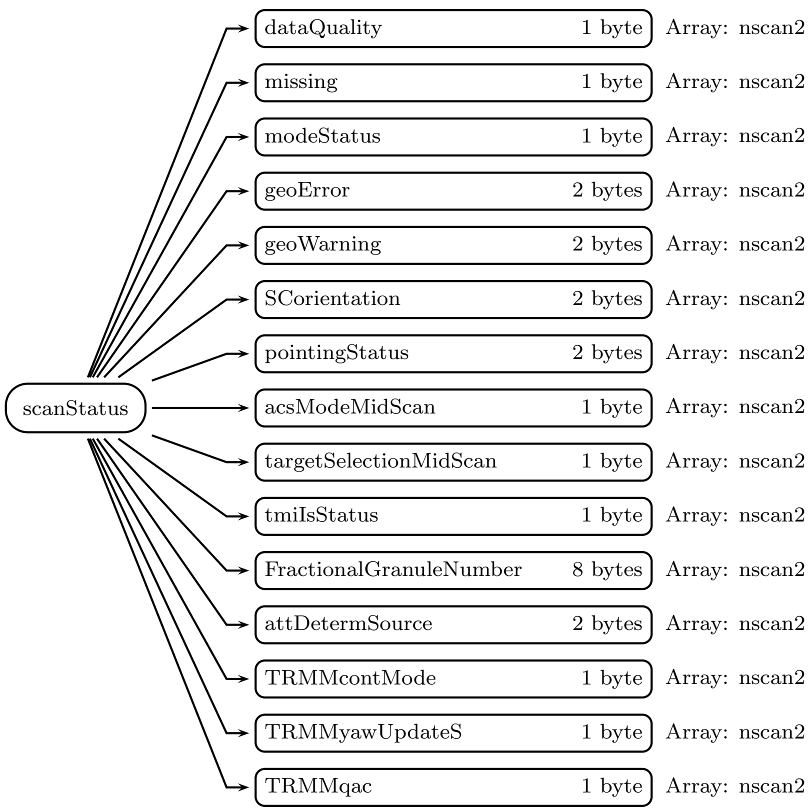


Figure 103: Data Format Structure for 1BASETMI, S2, scanStatus

navigation	scHeadingGround	4 bytes	Array: nscan2
navigation	scHeadingOrbital	4 bytes	Array: nscan2
navigation	scPos	4 bytes	Array: XYZ x nscan2
navigation	scVel	4 bytes	Array: XYZ x nscan2
navigation	scLat	4 bytes	Array: nscan2
navigation	scLon	4 bytes	Array: nscan2
navigation	scAlt	4 bytes	Array: nscan2
navigation	dprAlt	4 bytes	Array: nscan2
navigation	scAttRollGeoc	4 bytes	Array: nscan2
navigation	scAttPitchGeoc	4 bytes	Array: nscan2
navigation	scAttYawGeoc	4 bytes	Array: nscan2
navigation	scAttRollGeod	4 bytes	Array: nscan2
navigation	scAttPitchGeod	4 bytes	Array: nscan2
navigation	scAttYawGeod	4 bytes	Array: nscan2
navigation	greenHourAng	4 bytes	Array: nscan2
navigation	timeMidScan	8 bytes	Array: nscan2
navigation	timeMidScanOffset	8 bytes	Array: nscan2

Figure 104: Data Format Structure for 1BASETMI, S2, navigation

calibration	hotLoadTemp	4 bytes	Array: nchannel2 x nscan2
calibration	coldSkyTemp	4 bytes	Array: nchannel2 x nscan2
calibration	onOrbitNonLinearity	4 bytes	Array: nchannel2 x nscan2
calibration	meanHotLoadCount	2 bytes	Array: nchannel2 x nscan2
calibration	meanColdSkyCount	2 bytes	Array: nchannel2 x nscan2
calibration	gain	4 bytes	Array: LNL x nchannel2 x nscan2
calibration	offset	4 bytes	Array: LNL x nchannel2 x nscan2
calibration	nonLinearGain	4 bytes	Array: nchannel2 x nscan2
calibration	calibrationQCflag	2 bytes	Array: nscan2
calibration	receiverTemp	4 bytes	Array: nchannel2 x nscan2
calibration	receiverGain	4 bytes	Array: nchannel2 x nscan2

Figure 105: Data Format Structure for 1BASETMI, S2, calibration

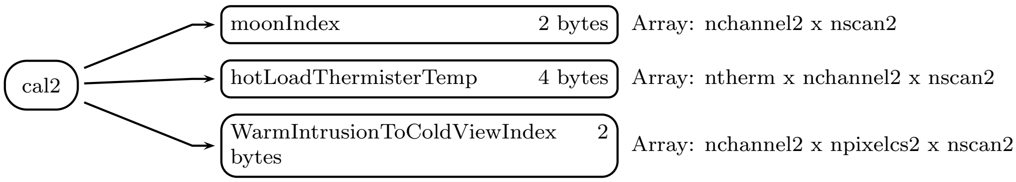


Figure 106: Data Format Structure for 1BASETMI, S2, cal2

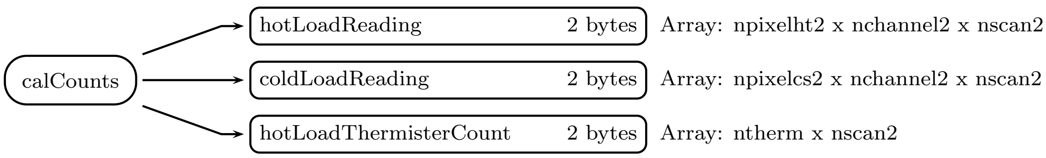


Figure 107: Data Format Structure for 1BASETMI, S2, calCounts

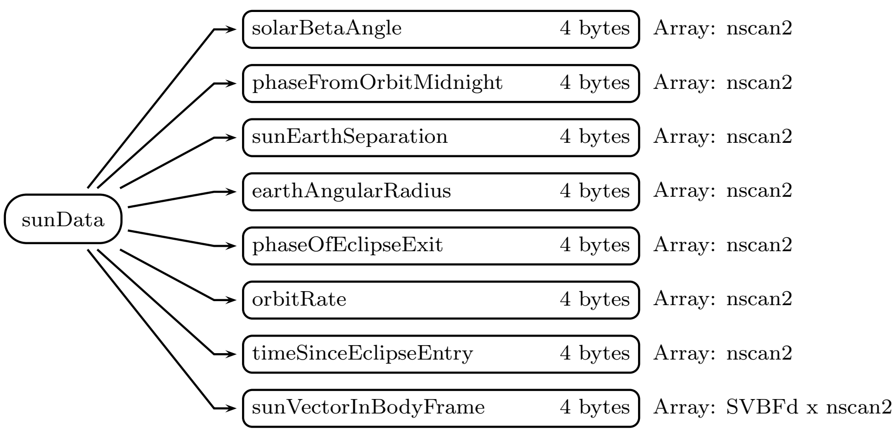


Figure 108: Data Format Structure for 1BASETMI, S2, sunData

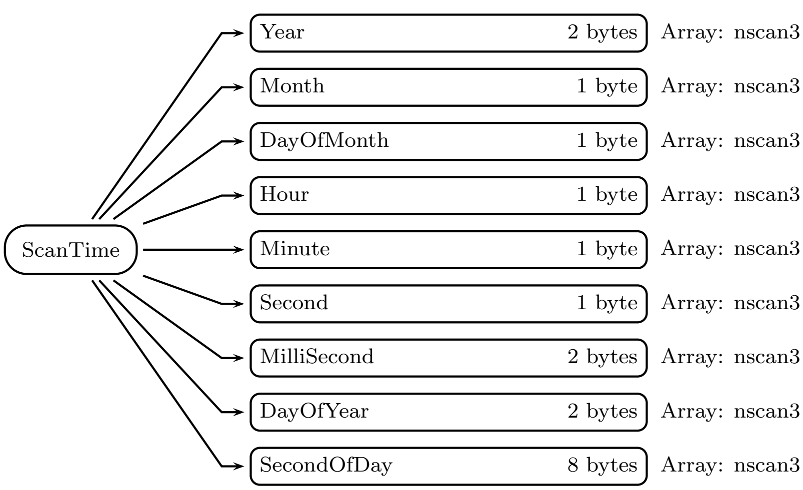


Figure 109: Data Format Structure for 1BASETMI, S3, ScanTime

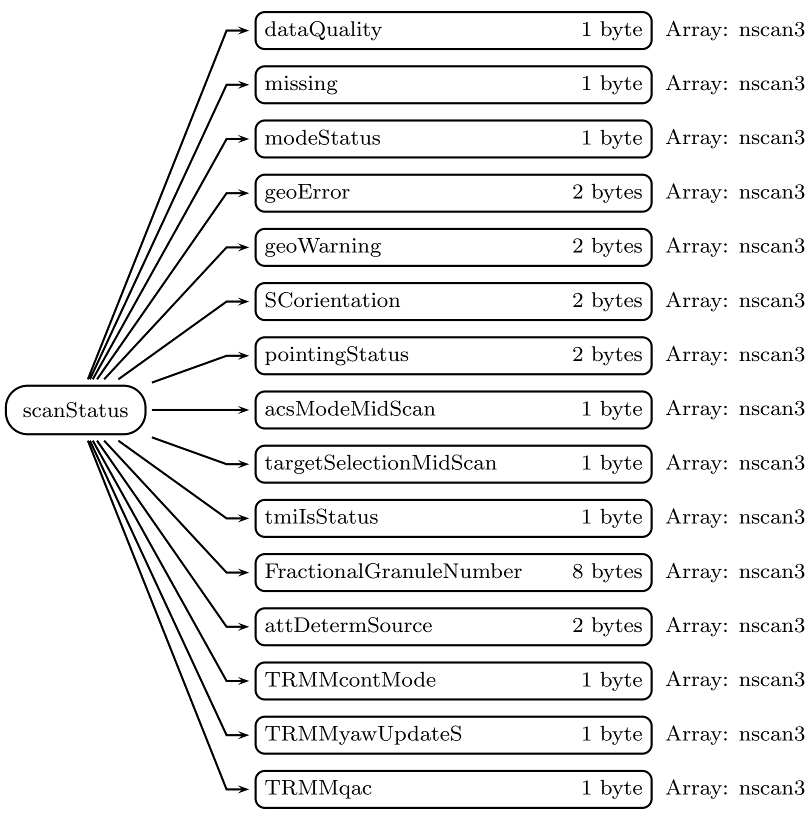


Figure 110: Data Format Structure for 1BASETMI, S3, scanStatus

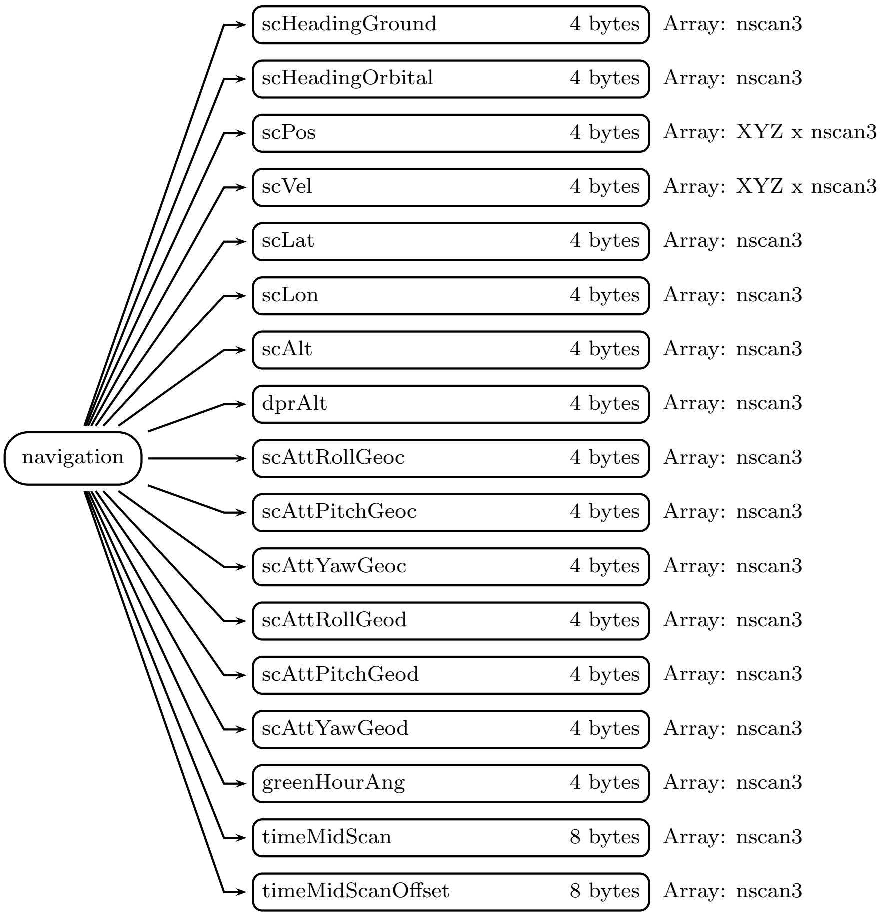


Figure 111: Data Format Structure for 1BASETMI, S3, navigation

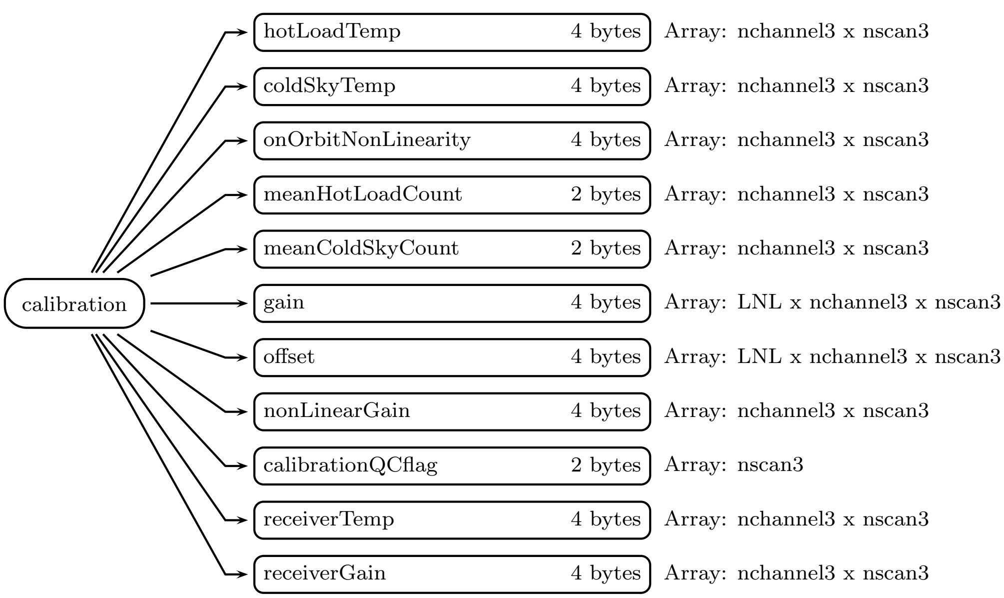


Figure 112: Data Format Structure for 1BASETMI, S3, calibration

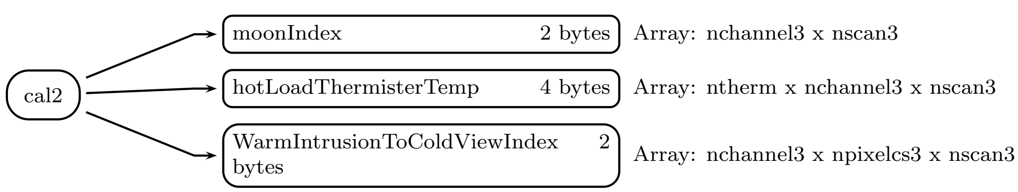


Figure 113: Data Format Structure for 1BASETMI, S3, cal2

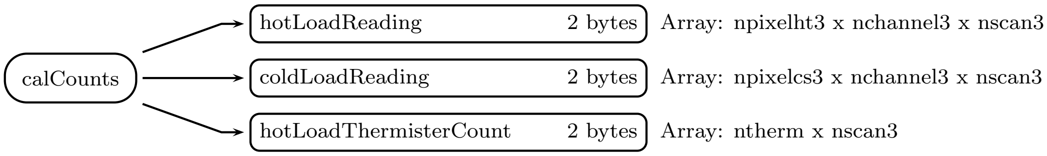


Figure 114: Data Format Structure for 1BASETMI, S3, calCounts

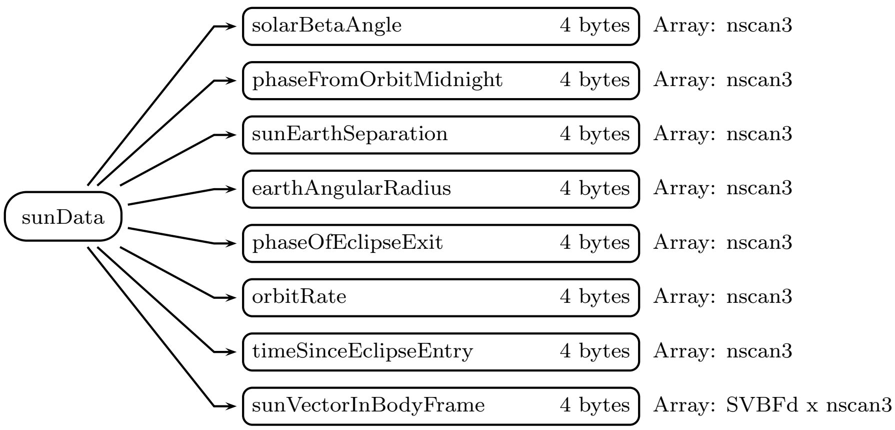


Figure 115: Data Format Structure for 1BASETMI, S3, sunData

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

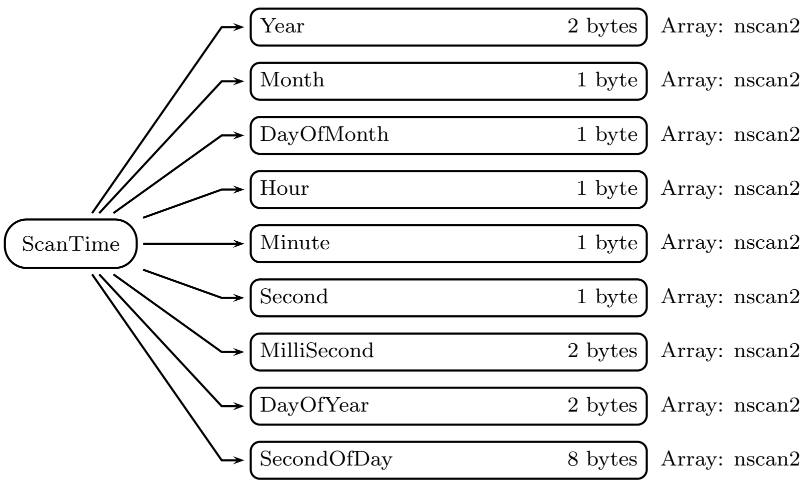


Figure 116: Data Format Structure for 1BASETMI, S4, ScanTime

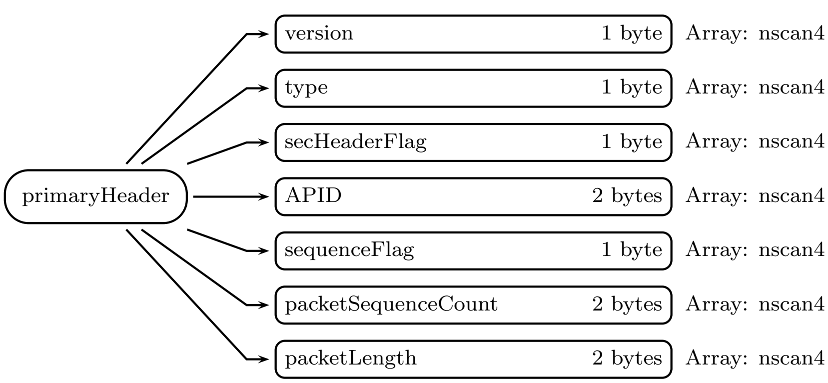
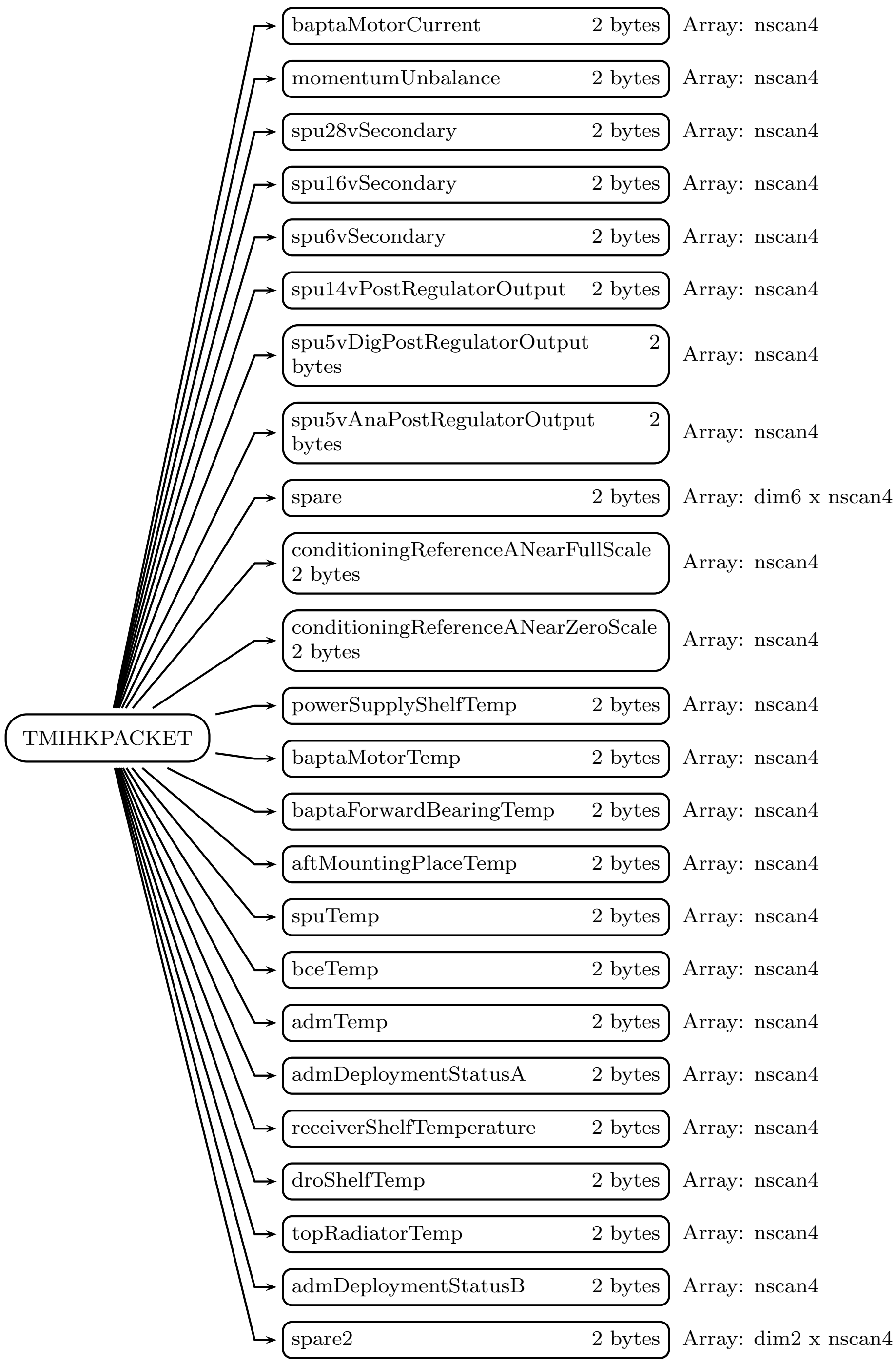


Figure 117: Data Format Structure for 1BASETMI, S4, primaryHeader



continued on next figure

Figure 118: Data Format Structure for 1BASETMI, S4, TMIHKPACKET,

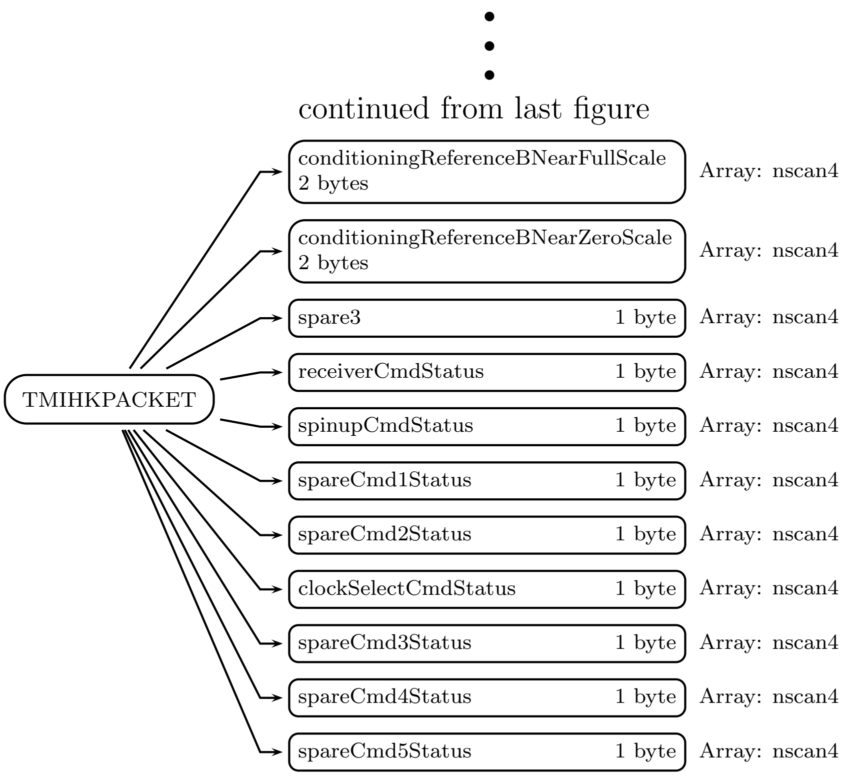


Figure 119: Data Format Structure for 1BASETMI, S4, TMIHKPACKET

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte char, array size: nscan1):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is

meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan1):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan1):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine tmiIsStatus
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan1):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality.

A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan1):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
```

```
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan1):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan1):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan1):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
```

```
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan1):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

tmiIsStatus (1-byte char, array size: nscan1):
Status of the instrument from Housekeeping packets. Bit 0 is the most significant bit (I.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00   Receiver status (0=ON, 1=OFF)
01   Spinup Status (0=ON, 1=OFF)
02   Spare command 1 Status
03   Spare command 2 Status
04   1 Hz Clock Select (1=A, 0=B)
05   Spare
06   Spare Command 4 Status
07   Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan1):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
```

```
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value           Meaning
    430 and higher  Best accuracy, good data for this orbit
    421             Reduced accuracy, PR roll data not available
                    (affecting roll/yaw estimates)
    413             Reduced accuracy, sun data not available (affecting pitch)
    411             Reduced accuracy, PR roll and sun sensor not available
    300-399         Reduced accuracy due to various special conditions
    200-299         Fallback to using the onboard attitude estimates
                    with TRMM V7 corrections
    -91             Spacecraft in safehold mode, no science data
    -99             No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan1):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan1):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan1):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

navigation (Group in S1)

scHeadingGround (4-byte float, array size: nscan1):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan1):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan1):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan1):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan1):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan1):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan1):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan1):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan1):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan1):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchannel1 x nscan1):
The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchannel1 x nscan1):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchannel1 x nscan1):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchannel1 x nscan1):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchannel1 x nscan1):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

gain (4-byte float, array size: LNL x nchannel1 x nscan1):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchannel1 x nscan1):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchannel1 x nscan1):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan1):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchannel1 x nscan1):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchannel1 x nscan1):
The receiver gain. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S1)

moonIndex (2-byte unsigned integer, array size: nchannel1 x nscan1):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchannel1 x nscan1):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchannel1 x npixelcs1 x nscan1):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: TMIxyz x nscan1):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadReading (2-byte unsigned integer, array size: npixelht1 x nchannel1 x nscan1):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: npixelcs1 x nchannel1 x nscan1):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan1):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan1):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan1):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan1):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan1):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan1):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow. Values

range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan1):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: nchannel1 x npixelev1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev1 x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev1 x nscan1):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev1 x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev1 x nscan1):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchannel1 x npixelev1 x nscan1):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Tb (4-byte float, array size: nchannel1 x npixelev1 x nscan1):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

Ta (4-byte float, array size: nchannel1 x npixelev1 x nscan1):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: TMIxyz x nscan1):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npixelev1 x nscan1):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0: No RFI on earth view samples and all Tb values of this swath are lower
than or equal to 320 K.
1: Earth view Tb values from one or more channels of this swath are greater
than 320 K.
2: RFI on earth view samples is detected by spectral differential method (10
GHz and 19 GHz channels only).
3: (combination of 1 and 2). Earth view Tb values from one or more channels
of this swath are greater than 320 K and RFI is detected by spectral
differential method (10 GHz and 19 GHz channels only)
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined

as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any

location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte char, array size: nscan2):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan2):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan2):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
```

```
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine tmiIsStatus
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan2):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan2):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down

into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan2):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan2):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan2):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan2):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

tmiIsStatus (1-byte char, array size: nscan2):
Status of the instrument from Housekeeping packets. Bit 0 is the most significant bit (I.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00  Receiver status (0=ON, 1=OFF)
01  Spinup Status (0=ON, 1=OFF)
02  Spare command 1 Status
03  Spare command 2 Status
04  1 Hz Clock Select (1=A, 0=B)
05  Spare
06  Spare Command 4 Status
07  Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan2):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value            Meaning
    430 and higher   Best accuracy, good data for this orbit
    421              Reduced accuracy, PR roll data not available
                     (affecting roll/yaw estimates)
    413              Reduced accuracy, sun data not available (affecting pitch)
    411              Reduced accuracy, PR roll and sun sensor not available
    300-399          Reduced accuracy due to various special conditions
    200-299          Fallback to using the onboard attitude estimates
                     with TRMM V7 corrections
    -91              Spacecraft in safehold mode, no science data
    -99              No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan2):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
```

```
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan2):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan2):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

ephemerisUsed (1-byte char, array size: dim10 x nscan2):
The ephemeris source used to geolocate the swath. Special values are defined as:

255	Missing value

navigation (Group in S2)

scHeadingGround (4-byte float, array size: nscan2):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan2):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan2):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan2):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan2):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan2):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed

using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan2):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan2):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coor-

dinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan2):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan2):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchannel2 x nscan2):
The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchannel2 x nscan2):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchannel2 x nscan2):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchannel2 x nscan2):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchannel2 x nscan2):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

gain (4-byte float, array size: LNL x nchannel2 x nscan2):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchannel2 x nscan2):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchannel2 x nscan2):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan2):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchannel2 x nscan2):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchannel2 x nscan2):
The receiver gain. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S2)

moonIndex (2-byte unsigned integer, array size: nchannel2 x nscan2):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchannel2 x nscan2):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchannel2 x npixelcs2 x nscan2):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: TMIxyz x nscan2):
The x, y, z components of the moon vector in the GMI instrument coordinate system.

Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadReading (2-byte unsigned integer, array size: npixelht2 x nchannel2 x nscan2):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: npixelcs2 x nchannel2 x nscan2):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan2):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan2):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan2):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan2):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan2):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius.

Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan2):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan2):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan2):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan2):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev2 x nscan2):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev2 x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev2 x nscan2):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev2 x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev2 x nscan2):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location

on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchannel2 x npixelev2 x nscan2): Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Tb (4-byte float, array size: nchannel2 x npixelev2 x nscan2):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

Ta (4-byte float, array size: nchannel2 x npixelev2 x nscan2):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: TMIxyz x nscan2):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npixelev2 x nscan2):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0: No RFI on earth view samples and all Tb values of this swath are lower
than or equal to 320 K.
1: Earth view Tb values from one or more channels of this swath are greater
than 320 K.
2: RFI on earth view samples is detected by spectral differential method (10
GHz and 19 GHz channels only).
3: (combination of 1 and 2). Earth view Tb values from one or more channels
of this swath are greater than 320 K and RFI is detected by spectral
differential method (10 GHz and 19 GHz channels only)
-9999: Missing
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev3 x nscan3):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev3 x nscan3):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev3 x nscan3):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S3)

dataQuality (1-byte char, array size: nscan3):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan3):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan3):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine tmiIsStatus
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan3):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
```

```
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan3):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan3):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
```

```
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan3):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan3):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan3):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

tmiIsStatus (1-byte char, array size: nscan3):
Status of the instrument from Housekeeping packets. Bit 0 is the most significant bit (I.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00   Receiver status (0=ON, 1=OFF)
01   Spinup Status (0=ON, 1=OFF)
02   Spare command 1 Status
03   Spare command 2 Status
04   1 Hz Clock Select (1=A, 0=B)
05   Spare
06   Spare Command 4 Status
07   Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan3):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value             Meaning
    430 and higher    Best accuracy, good data for this orbit
    421               Reduced accuracy, PR roll data not available
                      (affecting roll/yaw estimates)
    413               Reduced accuracy, sun data not available (affecting pitch)
    411               Reduced accuracy, PR roll and sun sensor not available
    300-399           Reduced accuracy due to various special conditions
    200-299           Fallback to using the onboard attitude estimates
                      with TRMM V7 corrections
    -91               Spacecraft in safehold mode, no science data
    -99               No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan3):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan3):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan3):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

ephemerisUsed (1-byte char, array size: dim10 x nscan3):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

navigation (Group in S3)

scHeadingGround (4-byte float, array size: nscan3):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan3):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan3):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan3):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan3):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan3):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan3):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan3):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan3):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan3):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan3):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan3):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values

are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan3):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan3):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan3):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan3):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan3):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S3)

hotLoadTemp (4-byte float, array size: nchannel3 x nscan3):
The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchannel3 x nscan3):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchannel3 x nscan3):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchannel3 x nscan3):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchannel3 x nscan3):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

gain (4-byte float, array size: LNL x nchannel3 x nscan3):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchannel3 x nscan3):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchannel3 x nscan3):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan3):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchannel3 x nscan3):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchannel3 x nscan3):
The receiver gain. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S3)

moonIndex (2-byte unsigned integer, array size: nchannel3 x nscan3):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchannel3 x nscan3):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchannel3 x npixelcs3 x nscan3):

Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: TMIxyz x nscan3):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S3)

hotLoadReading (2-byte unsigned integer, array size: npixelht3 x nchannel3 x nscan3):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: npixelcs3 x nchannel3 x nscan3):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan3):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S3)

solarBetaAngle (4-byte float, array size: nscan3):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan3):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees

occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan3):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan3):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan3):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan3):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan3):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan3):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev3 x nscan3):
The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsiod. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev3 x nscan3):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev3 x nscan3):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:

-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev3 x nscan3):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev3 x nscan3):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:

-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchannel3 x npixelev3 x nscan3):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:

0 Missing value

Tb (4-byte float, array size: nchannel3 x npixelev3 x nscan3):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

Ta (4-byte float, array size: nchannel3 x npixelev3 x nscan3):
Earth view antenna temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

magneticFieldVector (4-byte float, array size: TMIxyz x nscan3):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:

-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npixelev3 x nscan3):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:
```

```
0: No RFI on earth view samples and all Tb values of this swath are lower
than or equal to 320 K.
1: Earth view Tb values from one or more channels of this swath are greater
than 320 K.
-9999: Missing
```

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

ephemerisUsed (1-byte char, array size: dim10 x nscan1):
The ephemeris source used to geolocate the swath. Special values are defined as:
255 Missing value

Latitude (4-byte float, array size: nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

primaryHeader (Group in S4)

version (1-byte integer, array size: nscan4):

type (1-byte integer, array size: nscan4):

secHeaderFlag (1-byte integer, array size: nscan4):

APID (2-byte integer, array size: nscan4):

sequenceFlag (1-byte integer, array size: nscan4):

packetSequenceCount (2-byte integer, array size: nscan4):

packetLength (2-byte unsigned integer, array size: nscan4):

hotLoadTemperature1 (2-byte unsigned integer, array size: nscan2):
Hot Load Thermister Count Values are in count. Special values are defined as:
65535 Missing value

hotLoadTemperature2 (2-byte unsigned integer, array size: nscan2):
Hot Load Thermister Count Values are in count. Special values are defined as:
65535 Missing value

hotLoadTemperature3 (2-byte unsigned integer, array size: nscan2):
Hot Load Thermister Count Values are in count. Special values are defined as:
65535 Missing value

posBridgeVolt (2-byte unsigned integer, array size: nscan2):
Positive Bridge Voltage Count. Values are in count. Special values are defined as:
65535 Missing value

nearZeroVolt (2-byte unsigned integer, array size: nscan2):
Near zero voltage of hot load bridge reference. Values are in count. Special values are defined as:
65535 Missing value

gain (1-byte char, array size: nchannelall x nscan2):
Gain for each channel. Special values are defined as:
255 Missing value

TMIHKPACKET (Group in S4)

baptaMotorCurrent (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

momentumUnbalance (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu28vSecondary (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu16vSecondary (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu6vSecondary (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu14vPostRegulatorOutput (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu5vDigPostRegulatorOutput (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spu5vAnaPostRegulatorOutput (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spare (2-byte unsigned integer, array size: dim6 x nscan4):
Special values are defined as:
0 Missing value

conditioningReferenceANearFullScale (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

conditioningReferenceANearZeroScale (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

powerSupplyShelfTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

baptaMotorTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

baptaForwardBearingTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

aftMountingPlaceTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spuTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

bceTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

admTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

admDeploymentStatusA (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

receiverShelfTemperature (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

droShelfTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

topRadiatorTemp (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

admDeploymentStatusB (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spare2 (2-byte unsigned integer, array size: dim2 x nscan4):
Special values are defined as:
0 Missing value

conditioningReferenceBNearFullScale (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

conditioningReferenceBNearZeroScale (2-byte unsigned integer, array size: nscan4):
Special values are defined as:
0 Missing value

spare3 (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

receiverCmdStatus (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spinupCmdStatus (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd1Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd2Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

clockSelectCmdStatus (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd3Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd4Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

spareCmd5Status (1-byte char, array size: nscan4):
Special values are defined as:
0 Missing value

C Structure Header file:

```
#ifndef _TK_1BASETMI_H_
#define _TK_1BASETMI_H_

#ifndef _L1BASETMI_S4_TMIHKPACKET_
#define _L1BASETMI_S4_TMIHKPACKET_

typedef struct {
    unsigned short baptaMotorCurrent;
    unsigned short momentumUnbalance;
    unsigned short spu28vSecondary;
    unsigned short spu16vSecondary;
    unsigned short spu6vSecondary;
    unsigned short spu14vPostRegulatorOutput;
    unsigned short spu5vDigPostRegulatorOutput;
    unsigned short spu5vAnaPostRegulatorOutput;
    unsigned short spare[6];
    unsigned short conditioningReferenceANearFullScale;
    unsigned short conditioningReferenceANearZeroScale;
    unsigned short powerSupplyShelfTemp;
    unsigned short baptaMotorTemp;
    unsigned short baptaForwardBearingTemp;
    unsigned short aftMountingPlaceTemp;
    unsigned short spuTemp;
    unsigned short bceTemp;
    unsigned short admTemp;
    unsigned short admDeploymentStatusA;
    unsigned short receiverShelfTemperature;
    unsigned short droShelfTemp;
```

```
    unsigned short topRadiatorTemp;
    unsigned short admDeploymentStatusB;
    unsigned short spare2[2];
    unsigned short conditioningReferenceBNearFullScale;
    unsigned short conditioningReferenceBNearZeroScale;
    unsigned char spare3;
    unsigned char receiverCmdStatus;
    unsigned char spinupCmdStatus;
    unsigned char spareCmd1Status;
    unsigned char spareCmd2Status;
    unsigned char clockSelectCmdStatus;
    unsigned char spareCmd3Status;
    unsigned char spareCmd4Status;
    unsigned char spareCmd5Status;
} L1BASETMI_S4_TMIHKPACKET;

#endif

#ifndef _PRIMARYHEADER_
#define _PRIMARYHEADER_

typedef struct {
    signed char version;
    signed char type;
    signed char secHeaderFlag;
    short APID;
    signed char sequenceFlag;
    short packetSequenceCount;
    unsigned short packetLength;
} PRIMARYHEADER;

#endif

#ifndef _L1BASETMI_S4_
#define _L1BASETMI_S4_

typedef struct {
    SCANTIME ScanTime;
    unsigned char ephemerisUsed[10];
    float Latitude;
    float Longitude;
    PRIMARYHEADER primaryHeader;
    unsigned short hotLoadTemperature1;
```

```
    unsigned short hotLoadTemperature2;
    unsigned short hotLoadTemperature3;
    unsigned short posBridgeVolt;
    unsigned short nearZeroVolt;
    unsigned char gain[9];
    L1BASETMI_S4_TMIHKPACKET TMIHKPACKET;
} L1BASETMI_S4;

#endif

#ifndef _L1BASETMI_S3_SUNDATA_
#define _L1BASETMI_S3_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BASETMI_S3_SUNDATA;

#endif

#ifndef _L1BASETMI_S3_CALCOUNTS_
#define _L1BASETMI_S3_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[2][16];
    unsigned short coldLoadReading[2][16];
    unsigned short hotLoadThermisterCount[3];
} L1BASETMI_S3_CALCOUNTS;

#endif

#ifndef _L1BASETMI_S3_CAL2_
#define _L1BASETMI_S3_CAL2_

typedef struct {
    unsigned short moonIndex[2];
    float hotLoadThermisterTemp[2][3];
```

```
    unsigned short WarmIntrusionToColdViewIndex[16][2];
} L1BASETMI_S3_CAL2;

#endif

#ifndef _L1BASETMI_S3_CALIBRATION_
#define _L1BASETMI_S3_CALIBRATION_

typedef struct {
    float hotLoadTemp[2];
    float coldSkyTemp[2];
    float onOrbitNonLinearity[2];
    unsigned short meanHotLoadCount[2];
    unsigned short meanColdSkyCount[2];
    float gain[2][2];
    float offset[2][2];
    float nonLinearGain[2];
    short calibrationQCflag;
    float receiverTemp[2];
    float receiverGain[2];
} L1BASETMI_S3_CALIBRATION;

#endif

#ifndef _L1BASETMI_S3_SCANSTATUS_
#define _L1BASETMI_S3_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    unsigned char tmiIsStatus;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
```

```
} L1BASETMI_S3_SCANSTATUS;

#endif

#ifndef _L1BASETMI_S3_
#define _L1BASETMI_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    float sunLocalTime[208];
    L1BASETMI_S3_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    NAVIGATION navigation;
    L1BASETMI_S3_CALIBRATION calibration;
    L1BASETMI_S3_CAL2 cal2;
    float moonVectorInstFrame[3];
    L1BASETMI_S3_CALCOUNTS calCounts;
    L1BASETMI_S3_SUNDATA sunData;
    float incidenceAngle[208];
    float satAzimuthAngle[208];
    float solarZenAngle[208];
    float solarAzimuthAngle[208];
    float sunGlintAngle[208];
    unsigned short earthViewCounts[208][2];
    float Tb[208][2];
    float Ta[208][2];
    float magneticFieldVector[3];
    short RFIFlag[208][1];
} L1BASETMI_S3;

#endif

#ifndef _L1BASETMI_S2_SUNDATA_
#define _L1BASETMI_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
```

```
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BASETMI_S2_SUNDATA;

#endif

#ifndef _L1BASETMI_S2_CALCOUNTS_
#define _L1BASETMI_S2_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[5][8];
    unsigned short coldLoadReading[5][8];
    unsigned short hotLoadThermisterCount[3];
} L1BASETMI_S2_CALCOUNTS;

#endif

#ifndef _L1BASETMI_S2_CAL2_
#define _L1BASETMI_S2_CAL2_

typedef struct {
    unsigned short moonIndex[5];
    float hotLoadThermisterTemp[5][3];
    unsigned short WarmIntrusionToColdViewIndex[8][5];
} L1BASETMI_S2_CAL2;

#endif

#ifndef _L1BASETMI_S2_CALIBRATION_
#define _L1BASETMI_S2_CALIBRATION_

typedef struct {
    float hotLoadTemp[5];
    float coldSkyTemp[5];
    float onOrbitNonLinearity[5];
    unsigned short meanHotLoadCount[5];
    unsigned short meanColdSkyCount[5];
    float gain[5][2];
    float offset[5][2];
    float nonLinearGain[5];
    short calibrationQCflag;
    float receiverTemp[5];
```

```
    float receiverGain[5];
} L1BASETMI_S2_CALIBRATION;

#endif

#ifndef _L1BASETMI_S2_SCANSTATUS_
#define _L1BASETMI_S2_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    unsigned char tmiIsStatus;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1BASETMI_S2_SCANSTATUS;

#endif

#ifndef _L1BASETMI_S2_
#define _L1BASETMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[104];
    float Longitude[104];
    float sunLocalTime[104];
    L1BASETMI_S2_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    NAVIGATION navigation;
    L1BASETMI_S2_CALIBRATION calibration;
    L1BASETMI_S2_CAL2 cal2;
    float moonVectorInstFrame[3];
    L1BASETMI_S2_CALCOUNTS calCounts;
```

```
    L1BASETMI_S2_SUNDATA sunData;
    float incidenceAngle[104];
    float satAzimuthAngle[104];
    float solarZenAngle[104];
    float solarAzimuthAngle[104];
    float sunGlintAngle[104];
    unsigned short earthViewCounts[104][5];
    float Tb[104][5];
    float Ta[104][5];
    float magneticFieldVector[3];
    short RFIFlag[104][1];
} L1BASETMI_S2;

#endif

#ifndef _L1BASETMI_S1_SUNDATA_
#define _L1BASETMI_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BASETMI_S1_SUNDATA;

#endif

#ifndef _L1BASETMI_S1_CALCOUNTS_
#define _L1BASETMI_S1_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[2][8];
    unsigned short coldLoadReading[2][8];
    unsigned short hotLoadThermisterCount[3];
} L1BASETMI_S1_CALCOUNTS;

#endif

#ifndef _L1BASETMI_S1_CAL2_
```

```
#define _L1BASETMI_S1_CAL2_

typedef struct {
    unsigned short moonIndex[2];
    float hotLoadThermisterTemp[2][3];
    unsigned short WarmIntrusionToColdViewIndex[8][2];
} L1BASETMI_S1_CAL2;

#endif

#ifndef _L1BASETMI_S1_CALIBRATION_
#define _L1BASETMI_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[2];
    float coldSkyTemp[2];
    float onOrbitNonLinearity[2];
    unsigned short meanHotLoadCount[2];
    unsigned short meanColdSkyCount[2];
    float gain[2][2];
    float offset[2][2];
    float nonLinearGain[2];
    short calibrationQCflag;
    float receiverTemp[2];
    float receiverGain[2];
} L1BASETMI_S1_CALIBRATION;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
```

```
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1BASETMI_S1_SCANSTATUS_
#define _L1BASETMI_S1_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    unsigned char tmiIsStatus;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1BASETMI_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
```

```
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASETMI_S1_
#define _L1BASETMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[104];
    float Longitude[104];
    float sunLocalTime[104];
    L1BASETMI_S1_SCANSTATUS scanStatus;
    unsigned char ephemerisUsed[10];
    NAVIGATION navigation;
    L1BASETMI_S1_CALIBRATION calibration;
    L1BASETMI_S1_CAL2 cal2;
    float moonVectorInstFrame[3];
    L1BASETMI_S1_CALCOUNTS calCounts;
    L1BASETMI_S1_SUNDATA sunData;
    float incidenceAngle[104][2];
    float satAzimuthAngle[104];
    float solarZenAngle[104];
    float solarAzimuthAngle[104];
    float sunGlintAngle[104];
    unsigned short earthViewCounts[104][2];
    float Tb[104][2];
    float Ta[104][2];
    float magneticFieldVector[3];
    short RFIFlag[104][1];
} L1BASETMI_S1;

#endif

#ifndef _L1BASETMI_SWATHS_
#define _L1BASETMI_SWATHS_

typedef struct {
    L1BASETMI_S1 S1;
```

```
    L1BASETMI_S2 S2;
    L1BASETMI_S3 S3;
    L1BASETMI_S4 S4;
} L1BASETMI_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BASETMI_S4_TMIHKPACKET/
    INTEGER*2 baptaMotorCurrent
    INTEGER*2 momentumUnbalance
    INTEGER*2 spu28vSecondary
    INTEGER*2 spu16vSecondary
    INTEGER*2 spu6vSecondary
    INTEGER*2 spu14vPostRegulatorOutput
    INTEGER*2 spu5vDigPostRegulatorOutput
    INTEGER*2 spu5vAnaPostRegulatorOutput
    INTEGER*2 spare(6)
    INTEGER*2 conditioningReferenceANearFullScale
    INTEGER*2 conditioningReferenceANearZeroScale
    INTEGER*2 powerSupplyShelfTemp
    INTEGER*2 baptaMotorTemp
    INTEGER*2 baptaForwardBearingTemp
    INTEGER*2 aftMountingPlaceTemp
    INTEGER*2 spuTemp
    INTEGER*2 bceTemp
    INTEGER*2 admTemp
    INTEGER*2 admDeploymentStatusA
    INTEGER*2 receiverShelfTemperature
    INTEGER*2 droShelfTemp
    INTEGER*2 topRadiatorTemp
    INTEGER*2 admDeploymentStatusB
    INTEGER*2 spare2(2)
    INTEGER*2 conditioningReferenceBNearFullScale
    INTEGER*2 conditioningReferenceBNearZeroScale
    CHARACTER spare3
    CHARACTER receiverCmdStatus
    CHARACTER spinupCmdStatus
    CHARACTER spareCmd1Status
    CHARACTER spareCmd2Status
```

```
    CHARACTER clockSelectCmdStatus
    CHARACTER spareCmd3Status
    CHARACTER spareCmd4Status
    CHARACTER spareCmd5Status
END STRUCTURE

STRUCTURE /PRIMARYHEADER/
    BYTE version
    BYTE type
    BYTE secHeaderFlag
    INTEGER*2 APID
    BYTE sequenceFlag
    INTEGER*2 packetSequenceCount
    INTEGER*2 packetLength
END STRUCTURE

STRUCTURE /L1BASETMI_S4/
    RECORD /SCANTIME/ ScanTime
    CHARACTER ephemerisUsed(10)
    REAL*4 Latitude
    REAL*4 Longitude
    RECORD /PRIMARYHEADER/ primaryHeader
    INTEGER*2 hotLoadTemperature1
    INTEGER*2 hotLoadTemperature2
    INTEGER*2 hotLoadTemperature3
    INTEGER*2 posBridgeVolt
    INTEGER*2 nearZeroVolt
    CHARACTER gain(9)
    RECORD /L1BASETMI_S4_TMIHKPACKET/ TMIHKPACKET
END STRUCTURE

STRUCTURE /L1BASETMI_S3_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BASETMI_S3_CALCOUNTS/
```

```
    INTEGER*2 hotLoadReading(16,2)
    INTEGER*2 coldLoadReading(16,2)
    INTEGER*2 hotLoadThermisterCount(3)
END STRUCTURE

STRUCTURE /L1BASETMI_S3_CAL2/
    INTEGER*2 moonIndex(2)
    REAL*4 hotLoadThermisterTemp(3,2)
    INTEGER*2 WarmIntrusionToColdViewIndex(2,16)
END STRUCTURE

STRUCTURE /L1BASETMI_S3_CALIBRATION/
    REAL*4 hotLoadTemp(2)
    REAL*4 coldSkyTemp(2)
    REAL*4 onOrbitNonLinearity(2)
    INTEGER*2 meanHotLoadCount(2)
    INTEGER*2 meanColdSkyCount(2)
    REAL*4 gain(2,2)
    REAL*4 offset(2,2)
    REAL*4 nonLinearGain(2)
    INTEGER*2 calibrationQCflag
    REAL*4 receiverTemp(2)
    REAL*4 receiverGain(2)
END STRUCTURE

STRUCTURE /L1BASETMI_S3_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    CHARACTER tmiIsStatus
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE
```

```
STRUCTURE /L1BASETMI_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    REAL*4 sunLocalTime(208)
    RECORD /L1BASETMI_S3_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /NAVIGATION/ navigation
    RECORD /L1BASETMI_S3_CALIBRATION/ calibration
    RECORD /L1BASETMI_S3_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BASETMI_S3_CALCOUNTS/ calCounts
    RECORD /L1BASETMI_S3_SUNDATA/ sunData
    REAL*4 incidenceAngle(208)
    REAL*4 satAzimuthAngle(208)
    REAL*4 solarZenAngle(208)
    REAL*4 solarAzimuthAngle(208)
    REAL*4 sunGlintAngle(208)
    INTEGER*2 earthViewCounts(2,208)
    REAL*4 Tb(2,208)
    REAL*4 Ta(2,208)
    REAL*4 magneticFieldVector(3)
    INTEGER*2 RFIFlag(1,208)
END STRUCTURE

STRUCTURE /L1BASETMI_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BASETMI_S2_CALCOUNTS/
    INTEGER*2 hotLoadReading(8,5)
    INTEGER*2 coldLoadReading(8,5)
    INTEGER*2 hotLoadThermisterCount(3)
END STRUCTURE

STRUCTURE /L1BASETMI_S2_CAL2/
```

```
    INTEGER*2 moonIndex(5)
    REAL*4 hotLoadThermisterTemp(3,5)
    INTEGER*2 WarmIntrusionToColdViewIndex(5,8)
END STRUCTURE

STRUCTURE /L1BASETMI_S2_CALIBRATION/
    REAL*4 hotLoadTemp(5)
    REAL*4 coldSkyTemp(5)
    REAL*4 onOrbitNonLinearity(5)
    INTEGER*2 meanHotLoadCount(5)
    INTEGER*2 meanColdSkyCount(5)
    REAL*4 gain(2,5)
    REAL*4 offset(2,5)
    REAL*4 nonLinearGain(5)
    INTEGER*2 calibrationQCflag
    REAL*4 receiverTemp(5)
    REAL*4 receiverGain(5)
END STRUCTURE

STRUCTURE /L1BASETMI_S2_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    CHARACTER tmiIsStatus
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE

STRUCTURE /L1BASETMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(104)
    REAL*4 Longitude(104)
    REAL*4 sunLocalTime(104)
    RECORD /L1BASETMI_S2_SCANSTATUS/ scanStatus
```

```
    CHARACTER ephemerisUsed(10)
    RECORD /NAVIGATION/ navigation
    RECORD /L1BASETMI_S2_CALIBRATION/ calibration
    RECORD /L1BASETMI_S2_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BASETMI_S2_CALCOUNTS/ calCounts
    RECORD /L1BASETMI_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(104)
    REAL*4 satAzimuthAngle(104)
    REAL*4 solarZenAngle(104)
    REAL*4 solarAzimuthAngle(104)
    REAL*4 sunGlintAngle(104)
    INTEGER*2 earthViewCounts(5,104)
    REAL*4 Tb(5,104)
    REAL*4 Ta(5,104)
    REAL*4 magneticFieldVector(3)
    INTEGER*2 RFIFlag(1,104)
END STRUCTURE

STRUCTURE /L1BASETMI_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BASETMI_S1_CALCOUNTS/
    INTEGER*2 hotLoadReading(8,2)
    INTEGER*2 coldLoadReading(8,2)
    INTEGER*2 hotLoadThermisterCount(3)
END STRUCTURE

STRUCTURE /L1BASETMI_S1_CAL2/
    INTEGER*2 moonIndex(2)
    REAL*4 hotLoadThermisterTemp(3,2)
    INTEGER*2 WarmIntrusionToColdViewIndex(2,8)
END STRUCTURE

STRUCTURE /L1BASETMI_S1_CALIBRATION/
```

```
    REAL*4 hotLoadTemp(2)
    REAL*4 coldSkyTemp(2)
    REAL*4 onOrbitNonLinearity(2)
    INTEGER*2 meanHotLoadCount(2)
    INTEGER*2 meanColdSkyCount(2)
    REAL*4 gain(2,2)
    REAL*4 offset(2,2)
    REAL*4 nonLinearGain(2)
    INTEGER*2 calibrationQCflag
    REAL*4 receiverTemp(2)
    REAL*4 receiverGain(2)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BASETMI_S1_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
```

```
    CHARACTER tmiIsStatus
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASETMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(104)
    REAL*4 Longitude(104)
    REAL*4 sunLocalTime(104)
    RECORD /L1BASETMI_S1_SCANSTATUS/ scanStatus
    CHARACTER ephemerisUsed(10)
    RECORD /NAVIGATION/ navigation
    RECORD /L1BASETMI_S1_CALIBRATION/ calibration
    RECORD /L1BASETMI_S1_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BASETMI_S1_CALCOUNTS/ calCounts
    RECORD /L1BASETMI_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(2,104)
    REAL*4 satAzimuthAngle(104)
    REAL*4 solarZenAngle(104)
    REAL*4 solarAzimuthAngle(104)
    REAL*4 sunGlintAngle(104)
    INTEGER*2 earthViewCounts(2,104)
    REAL*4 Tb(2,104)
    REAL*4 Ta(2,104)
    REAL*4 magneticFieldVector(3)
    INTEGER*2 RFIFlag(1,104)
```

```
END STRUCTURE

STRUCTURE /L1BASETMI_SWATHS/
    RECORD /L1BASETMI_S1/ S1;
    RECORD /L1BASETMI_S2/ S2;
    RECORD /L1BASETMI_S3/ S3;
    RECORD /L1BASETMI_S4/ S4;
END STRUCTURE
```

5.5 1BASEGMI - GMI Brightness Temperatures

The GMI BASE Product, 1BASEGMI, "GMI Brightness Temperatures," is written as a multi-Swath Structure. Swath S1 has channels 1-9: 10V 10H 19V 19H 23V 37V 37H 89V 89H. Swath S2 has channels 10-13: 166V 166H 183+/-3V 183+/-8V. Swath S3 is like S1 but full scan. Swath S4 is like S2 but full scan. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchan1	9	Number of channels in Swath 1.
nchan2	4	Number of channels in Swath 2.
nfreq1	5	Number of frequencies in Swath 1.
nfreq2	2	Number of frequencies in Swath 2.
npix1	221	Number of pixels in Swath 1.
npix2	221	Number of pixels in Swath 2.
npix3	500	Number of pixels in Swath 3.
npix4	500	Number of pixels in Swath 4.
ncolds1	85	Maximum number of cold samples in Swath 1.
ncolds2	85	Maximum number of cold samples in Swath 2.
nhots1	65	Maximum number of hot samples in Swath 1.
nhots2	65	Maximum number of hot samples in Swath 2.
ntherm	11	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nsamt	4	Number of sample types. The types are: total science GSDR, earth-view, hot load, cold sky.
ntach	32	Number of tachometer readings.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.
nndiode	6	Number of noise diodes.
n7	7	Number seven.
SVBFd	3	SunVectorinBodyFrame dimension.

Figure 120 through Figure 154 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

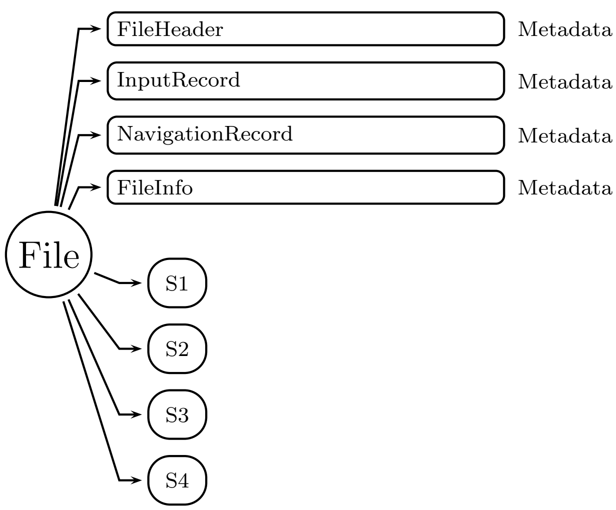


Figure 120: Data Format Structure for 1BASEGMI, GMI Brightness Temperatures

S1

S1_SwathHeader		Metadata
ScanTime	19 bytes	Group: nscan
Latitude	4 bytes	Array: npix1 x nscan
Longitude	4 bytes	Array: npix1 x nscan
sunLocalTime	4 bytes	Array: npix1 x nscan
scanStatus	22 bytes	Group: nscan
sampleHeader	273 bytes	Group: nscan
NEDTinfo	36 bytes	Group: nscan
navigation	92 bytes	Group: nscan
nav2	4 bytes	Group: nscan
calibration	580 bytes	Group: nscan
cal2	2098 bytes	Group: nscan
moonVectorInstFrame	4 bytes	Array: GMIxyz x nscan
calCounts	5422 bytes	Group: nscan
sunData	40 bytes	Group: nscan
incidenceAngle	4 bytes	Array: npix1 x nscan
satAzimuthAngle	4 bytes	Array: npix1 x nscan
solarZenAngle	4 bytes	Array: npix1 x nscan
solarAzimuthAngle	4 bytes	Array: npix1 x nscan
sunGlintAngle	4 bytes	Array: npix1 x nscan
magneticFieldVector	4 bytes	Array: GMIxyz x nscan
TAMmagneticFieldVector	4 bytes	Array: GMIxyz x nscan
earthViewCounts	2 bytes	Array: nchan1 x npix1 x nscan
Tb	4 bytes	Array: nchan1 x npix1 x nscan

continued on next figure

•
•
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Figure 121: Data Format Structure for 1BASEGMI, S1,

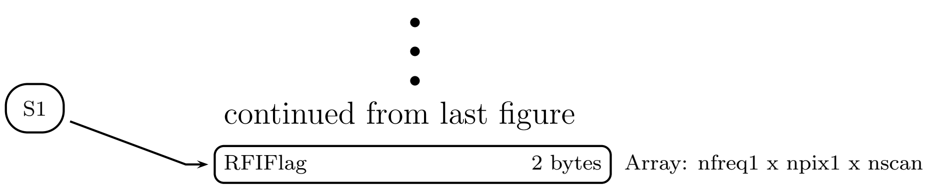

Figure 122: Data Format Structure for 1BASEGMI, S1

S2

S2_SwathHeader		Metadata
ScanTime	19 bytes	Group: nscan
Latitude	4 bytes	Array: npix2 x nscan
Longitude	4 bytes	Array: npix2 x nscan
sunLocalTime	4 bytes	Array: npix2 x nscan
scanStatus	22 bytes	Group: nscan
sampleHeader	233 bytes	Group: nscan
NEDTinfo	16 bytes	Group: nscan
navigation	92 bytes	Group: nscan
nav2	4 bytes	Group: nscan
calibration	260 bytes	Group: nscan
cal2	998 bytes	Group: nscan
moonVectorInstFrame	4 bytes	Array: GMIxyz x nscan
calCounts	2422 bytes	Group: nscan
sunData	40 bytes	Group: nscan
incidenceAngle	4 bytes	Array: npix2 x nscan
satAzimuthAngle	4 bytes	Array: npix2 x nscan
solarZenAngle	4 bytes	Array: npix2 x nscan
solarAzimuthAngle	4 bytes	Array: npix2 x nscan
sunGlintAngle	4 bytes	Array: npix2 x nscan
magneticFieldVector	4 bytes	Array: GMIxyz x nscan
TAMmagneticFieldVector	4 bytes	Array: GMIxyz x nscan
earthViewCounts	2 bytes	Array: nchan2 x npix2 x nscan
Tb	4 bytes	Array: nchan2 x npix2 x nscan

continued on next figure

Figure 123: Data Format Structure for 1BASEGMI, S2,

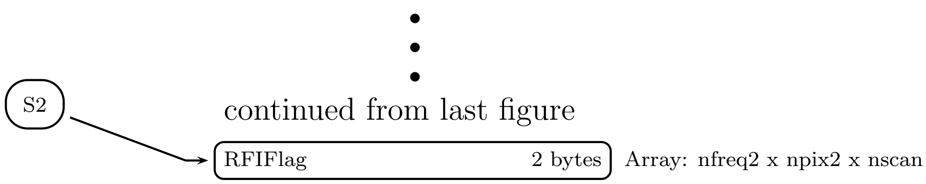

Figure 124: Data Format Structure for 1BASEGMI, S2

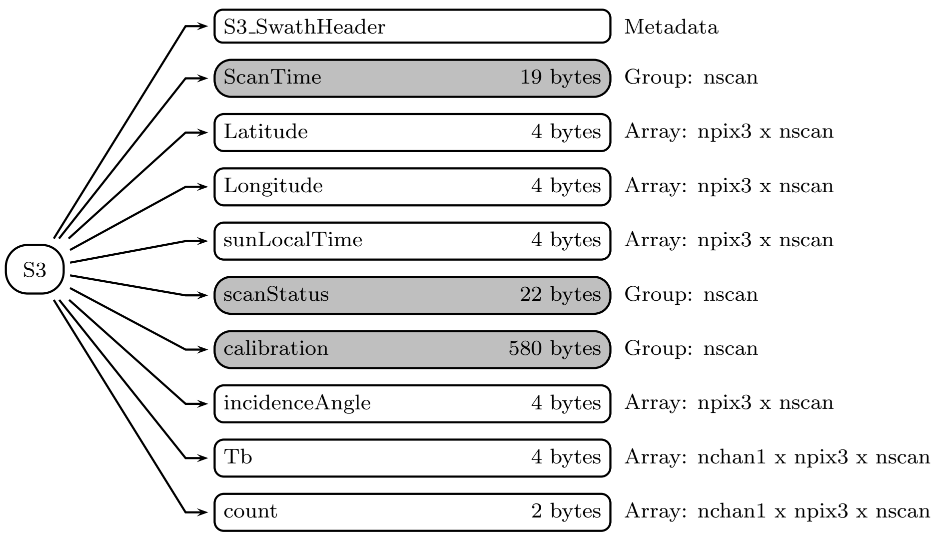

Figure 125: Data Format Structure for 1BASEGMI, S3

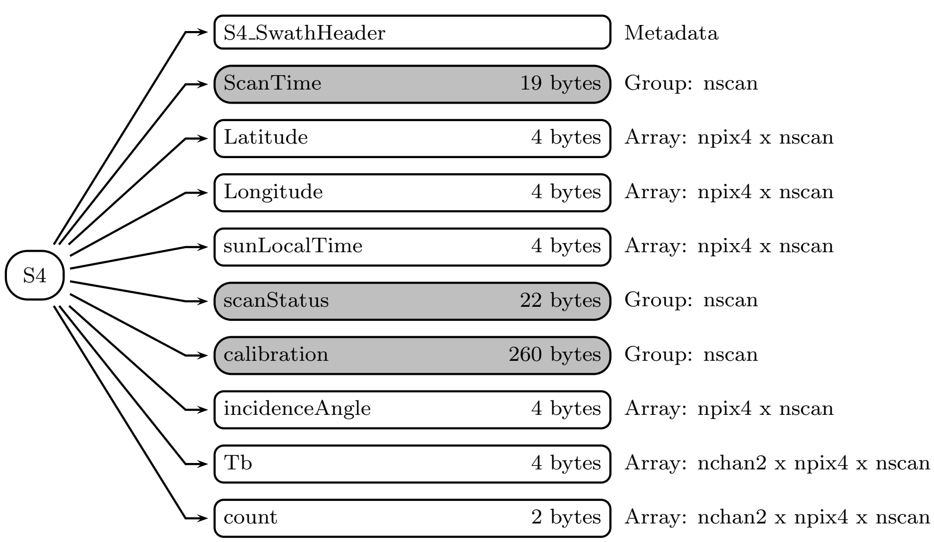

Figure 126: Data Format Structure for 1BASEGMI, S4

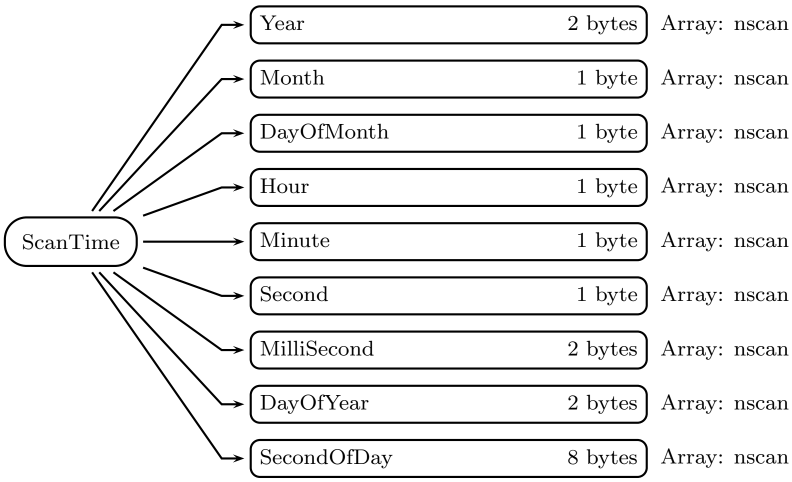

Figure 127: Data Format Structure for 1BASEGMI, S1, ScanTime

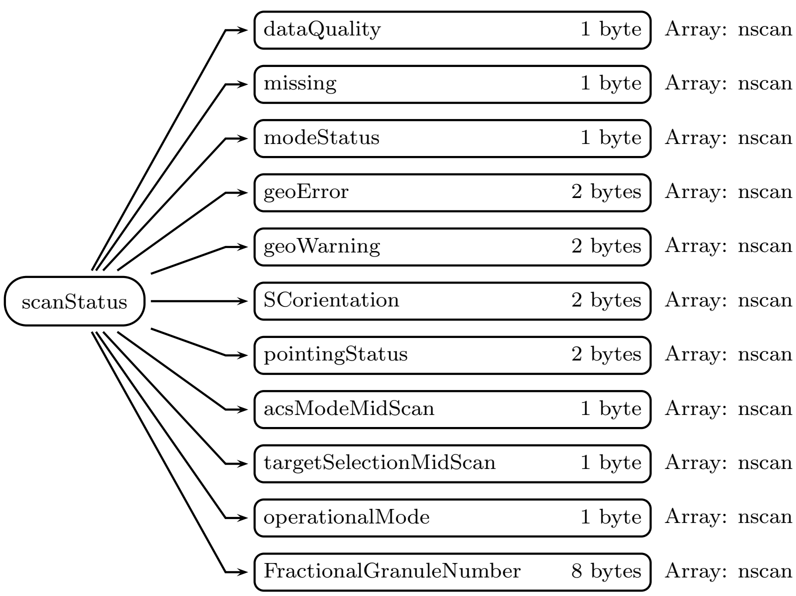

Figure 128: Data Format Structure for 1BASEGMI, S1, scanStatus

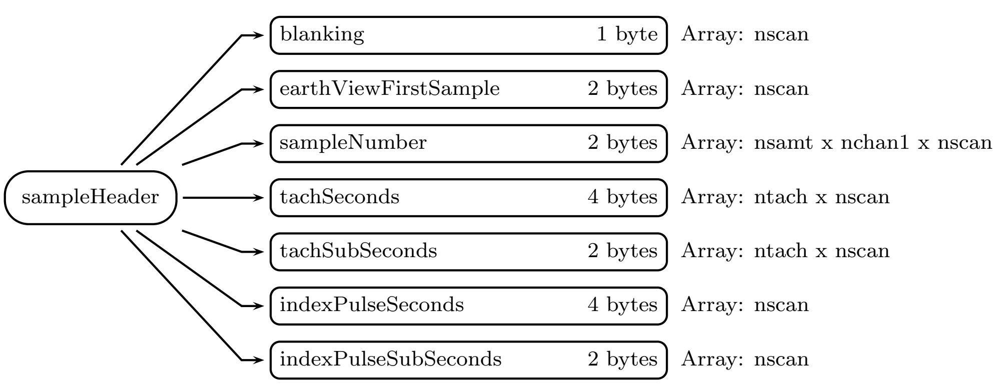

Figure 129: Data Format Structure for 1BASEGMI, S1, sampleHeader

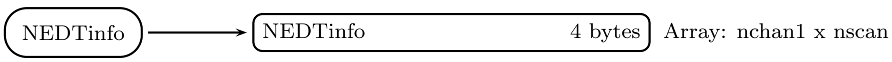

Figure 130: Data Format Structure for 1BASEGMI, S1, NEDTinfo

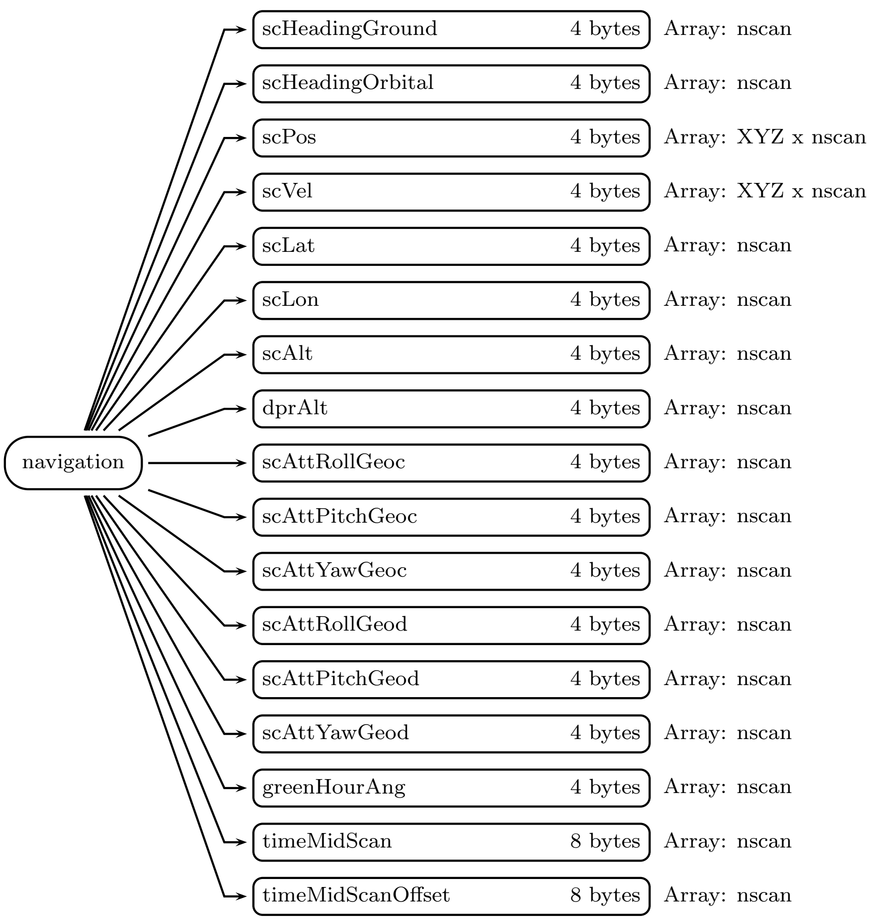

Figure 131: Data Format Structure for 1BASEGMI, S1, navigation

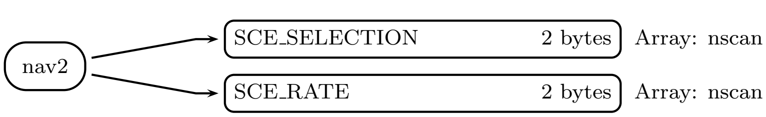

Figure 132: Data Format Structure for 1BASEGMI, S1, nav2

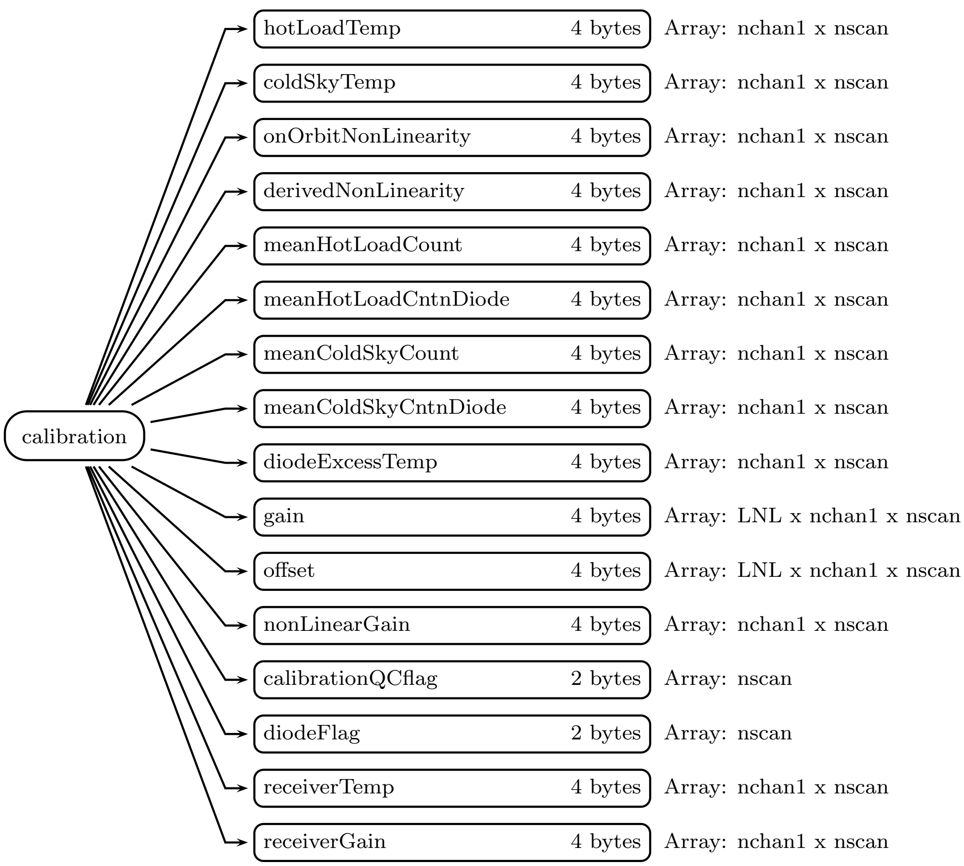

Figure 133: Data Format Structure for 1BASEGMI, S1, calibration

cal2

trayTemperatureCount	2 bytes	Array: nscan
trayTemperature	4 bytes	Array: nscan
moonIndex	2 bytes	Array: nchan1 x nscan
noiseDiodeTemp	4 bytes	Array: nndiode x nscan
TEMP_CALRES_2	2 bytes	Array: nscan
TEMP_CALRES_1	2 bytes	Array: nscan
RS_CALRES_2	2 bytes	Array: nscan
RS_CALRES_1	2 bytes	Array: nscan
BATC_CALRES_2	2 bytes	Array: nscan
BATC_CALRES_1	2 bytes	Array: nscan
NDIODE_MODE	2 bytes	Array: nscan
RSST_NDIODE_ST	2 bytes	Array: nscan
NDIODE10GHZNUM	2 bytes	Array: nscan
hotLoadThermisterTemp	4 bytes	Array: ntherm x nchan1 x nscan
TEMP_CALRES_4	2 bytes	Array: nscan
TEMP_CALRES_5	2 bytes	Array: nscan
TEMP_CALRES_6	2 bytes	Array: nscan
TEMP_89GHZ_LO	4 bytes	Array: nscan
TEMP_166GHZ_LO	4 bytes	Array: nscan
TEMP_183GHZ_LO	4 bytes	Array: nscan
TEMP_V89GHZMXR	4 bytes	Array: nscan
TEMP_H89GHZMXR	4 bytes	Array: nscan
TEMP_V166GHZMXR	4 bytes	Array: nscan
TEMP_H166GHZMXR	4 bytes	Array: nscan

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Figure 134: Data Format Structure for 1BASEGMI, S1, cal2,

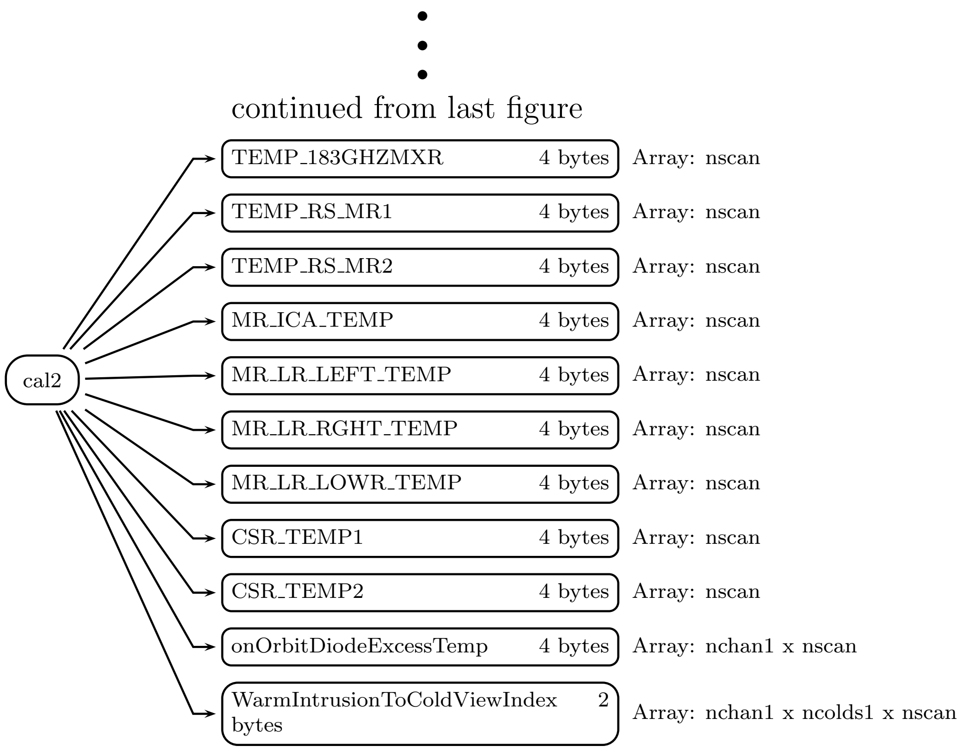

Figure 135: Data Format Structure for 1BASEGMI, S1, cal2

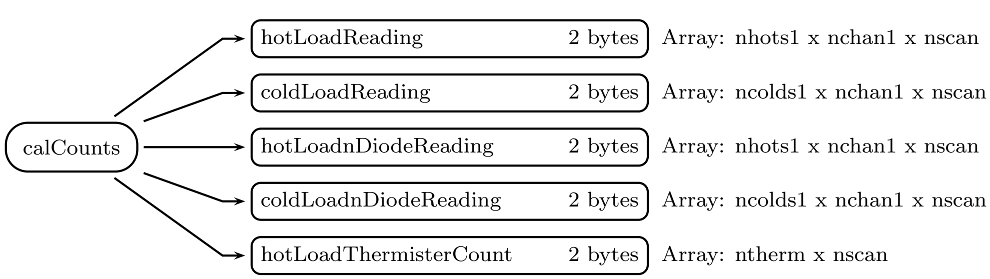

Figure 136: Data Format Structure for 1BASEGMI, S1, calCounts

sunData

solarBetaAngle	4 bytes	Array: nscan
phaseFromOrbitMidnight	4 bytes	Array: nscan
sunEarthSeparation	4 bytes	Array: nscan
earthAngularRadius	4 bytes	Array: nscan
phaseOfEclipseExit	4 bytes	Array: nscan
orbitRate	4 bytes	Array: nscan
timeSinceEclipseEntry	4 bytes	Array: nscan
sunVectorInBodyFrame	4 bytes	Array: SVBFd x nscan

Figure 137: Data Format Structure for 1BASEGMI, S1, sunData

ScanTime

Year	2 bytes	Array: nscan
Month	1 byte	Array: nscan
DayOfMonth	1 byte	Array: nscan
Hour	1 byte	Array: nscan
Minute	1 byte	Array: nscan
Second	1 byte	Array: nscan
MilliSecond	2 bytes	Array: nscan
DayOfYear	2 bytes	Array: nscan
SecondOfDay	8 bytes	Array: nscan

Figure 138: Data Format Structure for 1BASEGMI, S2, ScanTime

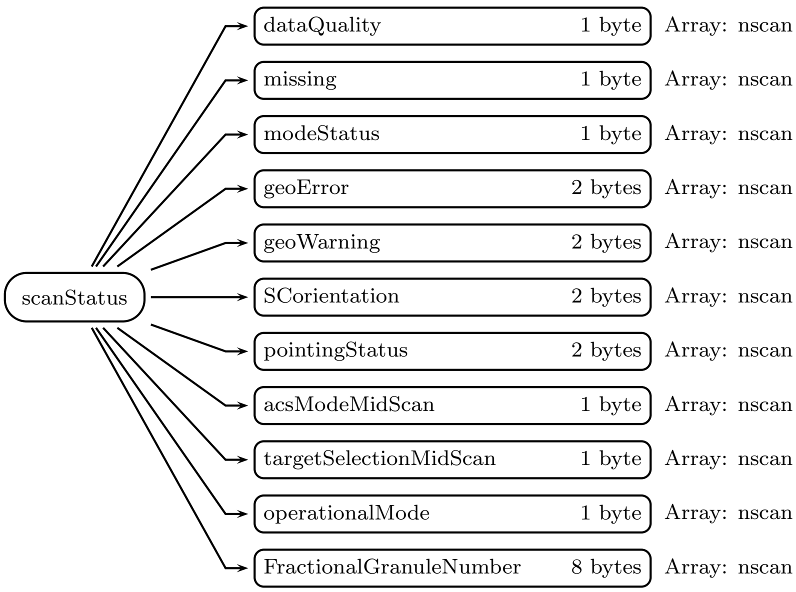

Figure 139: Data Format Structure for 1BASEGMI, S2, scanStatus

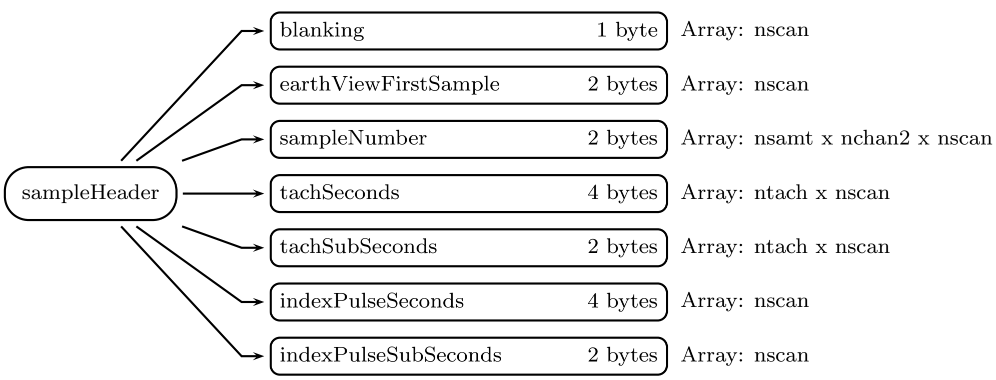

Figure 140: Data Format Structure for 1BASEGMI, S2, sampleHeader

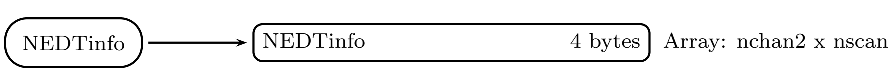

Figure 141: Data Format Structure for 1BASEGMI, S2, NEDTinfo

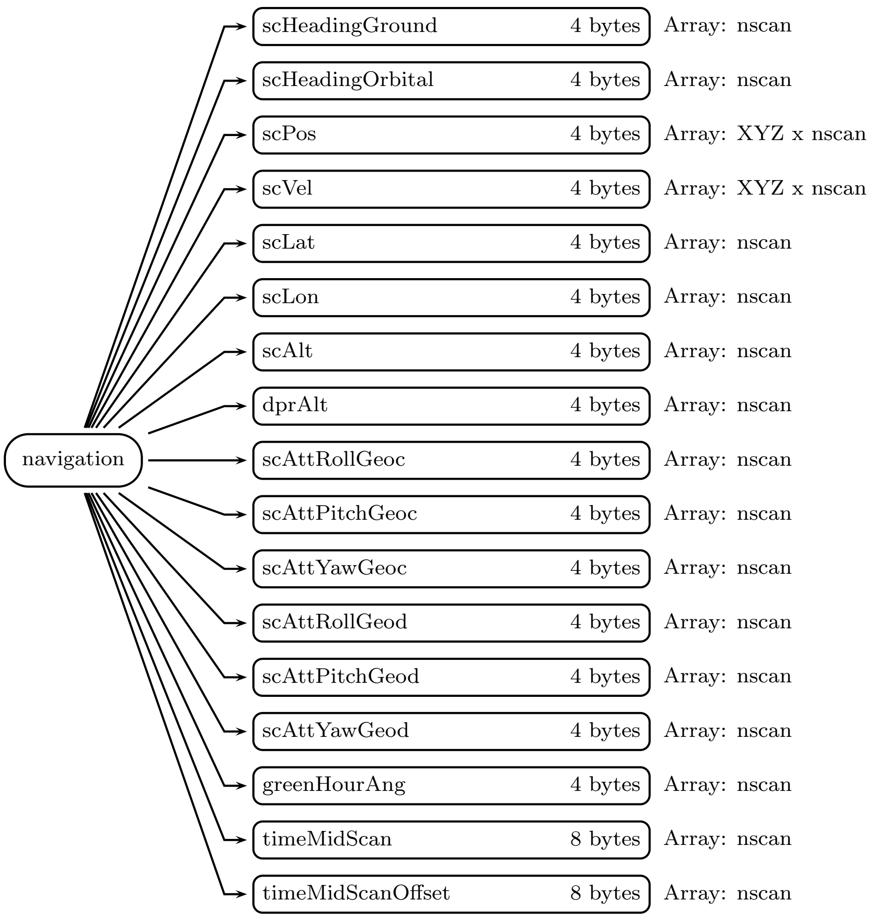

Figure 142: Data Format Structure for 1BASEGMI, S2, navigation

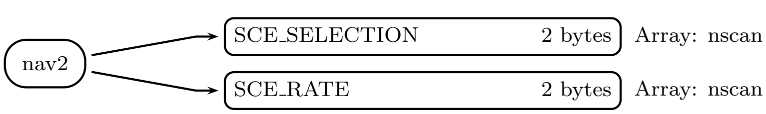

Figure 143: Data Format Structure for 1BASEGMI, S2, nav2

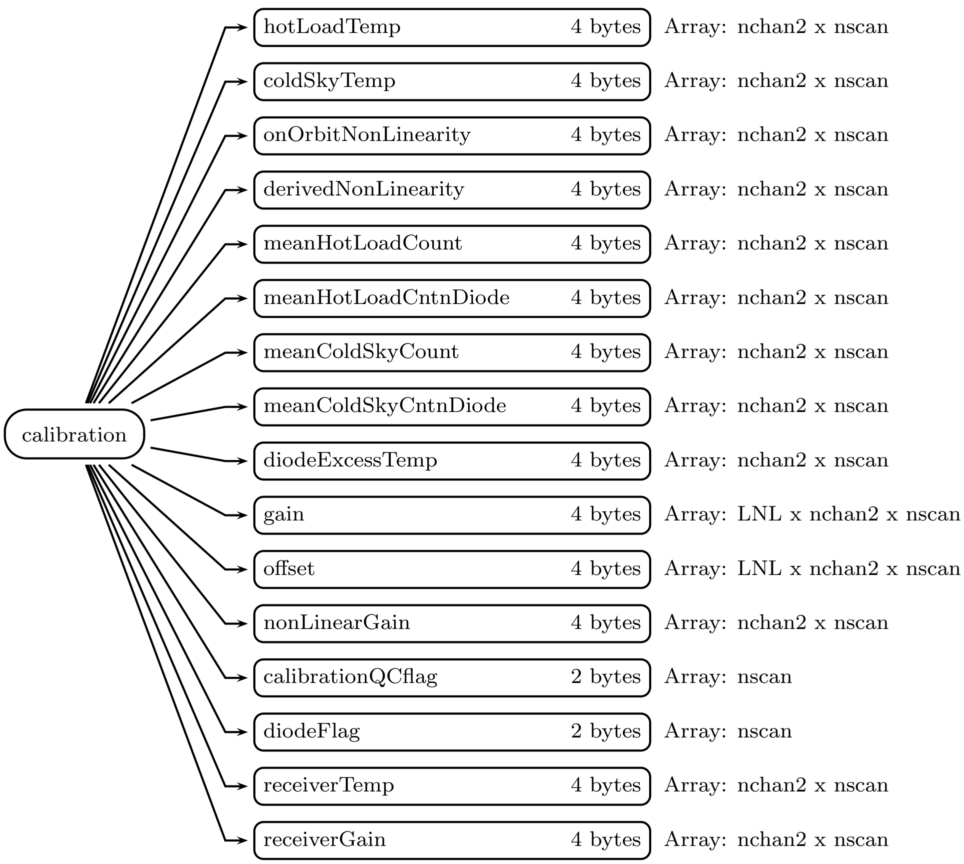

Figure 144: Data Format Structure for 1BASEGMI, S2, calibration

cal2

trayTemperatureCount	2 bytes	Array: nscan
trayTemperature	4 bytes	Array: nscan
moonIndex	2 bytes	Array: nchan2 x nscan
noiseDiodeTemp	4 bytes	Array: nndiode x nscan
TEMP_CALRES_2	2 bytes	Array: nscan
TEMP_CALRES_1	2 bytes	Array: nscan
RS_CALRES_2	2 bytes	Array: nscan
RS_CALRES_1	2 bytes	Array: nscan
BATC_CALRES_2	2 bytes	Array: nscan
BATC_CALRES_1	2 bytes	Array: nscan
NDIODE_MODE	2 bytes	Array: nscan
RSST_NDIODE_ST	2 bytes	Array: nscan
NDIODE10GHZNUM	2 bytes	Array: nscan
hotLoadThermisterTemp	4 bytes	Array: ntherm x nchan2 x nscan
TEMP_CALRES_4	2 bytes	Array: nscan
TEMP_CALRES_5	2 bytes	Array: nscan
TEMP_CALRES_6	2 bytes	Array: nscan
TEMP_89GHZ_LO	4 bytes	Array: nscan
TEMP_166GHZ_LO	4 bytes	Array: nscan
TEMP_183GHZ_LO	4 bytes	Array: nscan
TEMP_V89GHZMXR	4 bytes	Array: nscan
TEMP_H89GHZMXR	4 bytes	Array: nscan
TEMP_V166GHZMXR	4 bytes	Array: nscan
TEMP_H166GHZMXR	4 bytes	Array: nscan

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Figure 145: Data Format Structure for 1BASEGMI, S2, cal2,

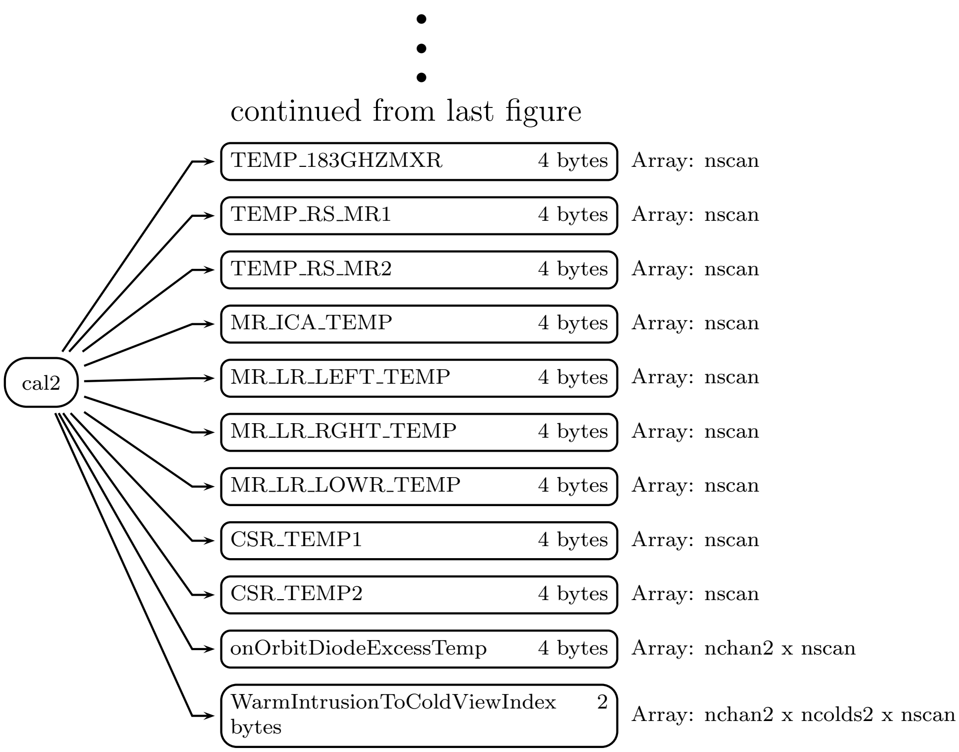

Figure 146: Data Format Structure for 1BASEGMI, S2, cal2

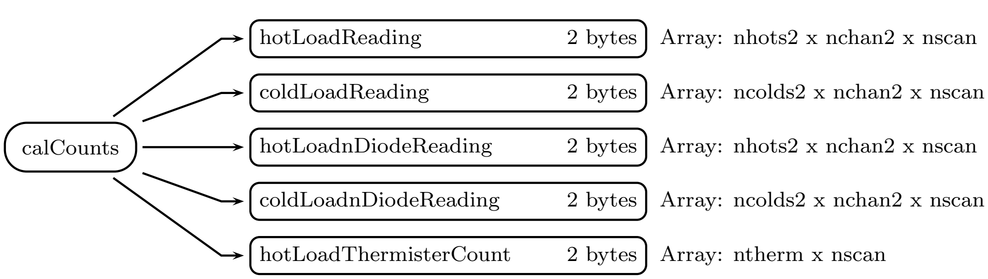

Figure 147: Data Format Structure for 1BASEGMI, S2, calCounts

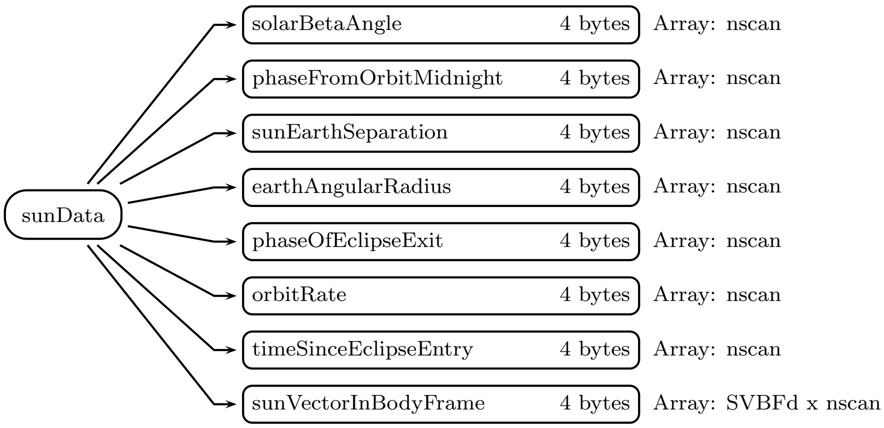

Figure 148: Data Format Structure for 1BASEGMI, S2, sunData

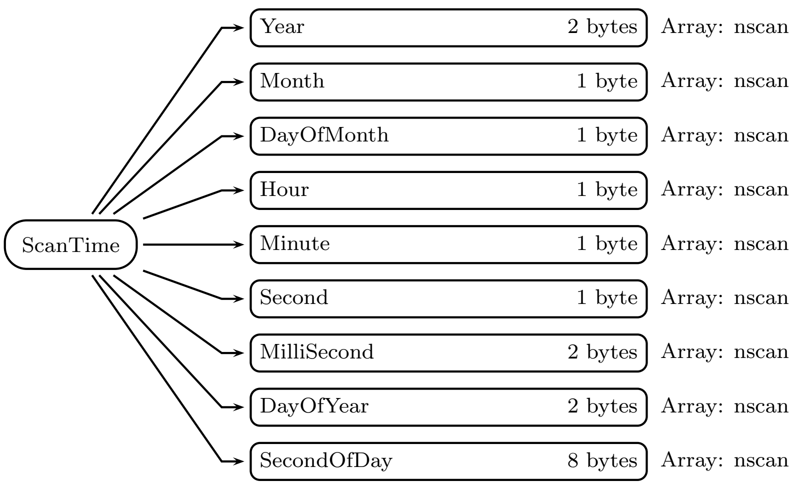

Figure 149: Data Format Structure for 1BASEGMI, S3, ScanTime

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in

scanStatus

dataQuality	1 byte	Array: nscan
missing	1 byte	Array: nscan
modeStatus	1 byte	Array: nscan
geoError	2 bytes	Array: nscan
geoWarning	2 bytes	Array: nscan
SCorientation	2 bytes	Array: nscan
pointingStatus	2 bytes	Array: nscan
acsModeMidScan	1 byte	Array: nscan
targetSelectionMidScan	1 byte	Array: nscan
operationalMode	1 byte	Array: nscan
FractionalGranuleNumber	8 bytes	Array: nscan

Figure 150: Data Format Structure for 1BASEGMI, S3, scanStatus

calibration

hotLoadTemp	4 bytes	Array: nchan1 x nscan
coldSkyTemp	4 bytes	Array: nchan1 x nscan
onOrbitNonLinearity	4 bytes	Array: nchan1 x nscan
derivedNonLinearity	4 bytes	Array: nchan1 x nscan
meanHotLoadCount	4 bytes	Array: nchan1 x nscan
meanHotLoadCntnDiode	4 bytes	Array: nchan1 x nscan
meanColdSkyCount	4 bytes	Array: nchan1 x nscan
meanColdSkyCntnDiode	4 bytes	Array: nchan1 x nscan
diodeExcessTemp	4 bytes	Array: nchan1 x nscan
gain	4 bytes	Array: LNL x nchan1 x nscan
offset	4 bytes	Array: LNL x nchan1 x nscan
nonLinearGain	4 bytes	Array: nchan1 x nscan
calibrationQCflag	2 bytes	Array: nscan
diodeFlag	2 bytes	Array: nscan
receiverTemp	4 bytes	Array: nchan1 x nscan
receiverGain	4 bytes	Array: nchan1 x nscan

Figure 151: Data Format Structure for 1BASEGMI, S3, calibration

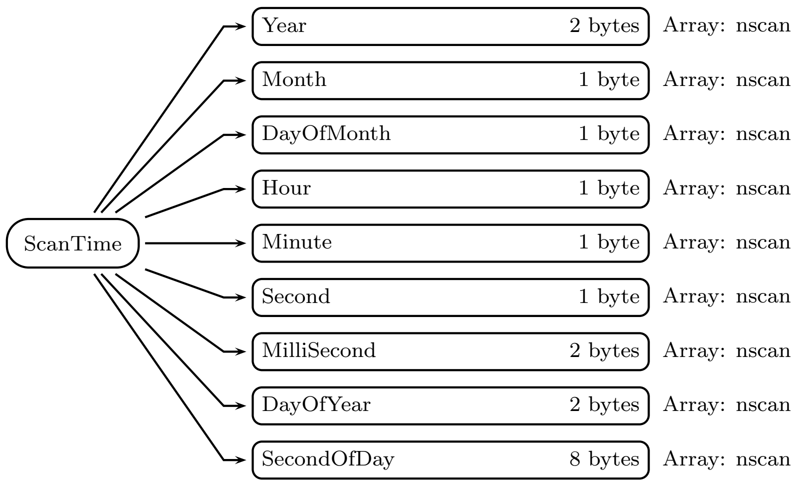

Figure 152: Data Format Structure for 1BASEGMI, S4, ScanTime

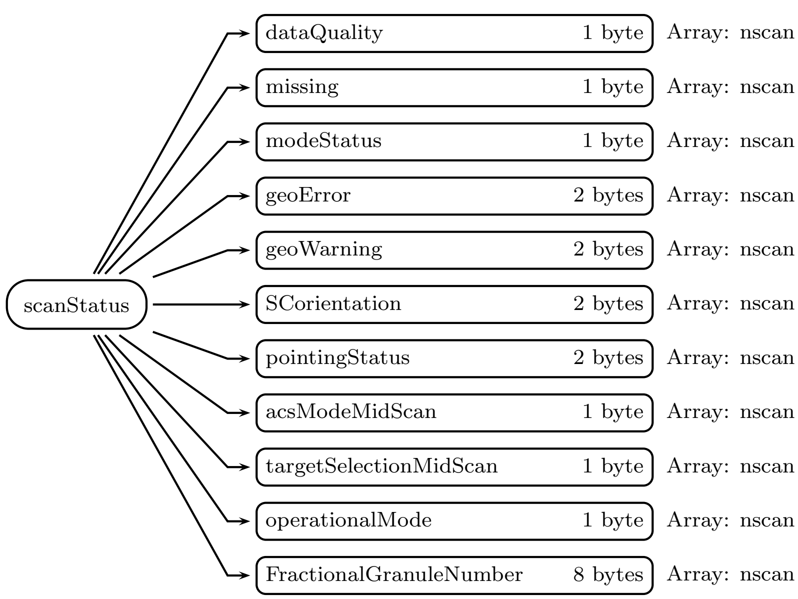

Figure 153: Data Format Structure for 1BASEGMI, S4, scanStatus

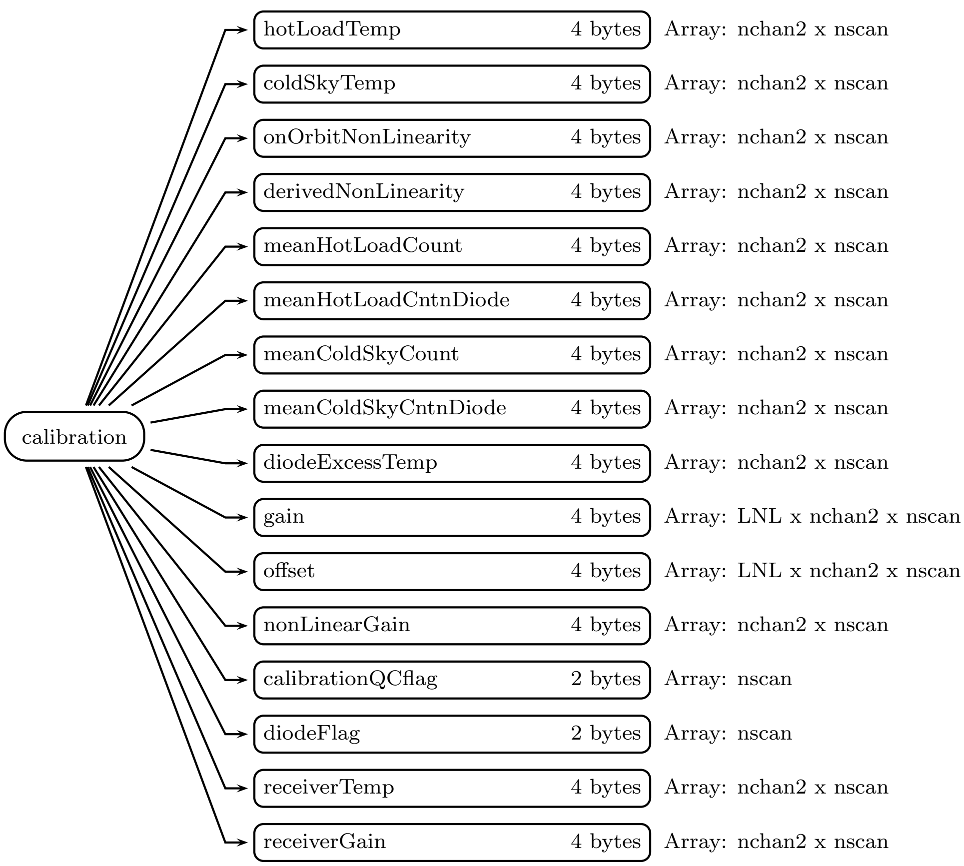

Figure 154: Data Format Structure for 1BASEGMI, S4, calibration

all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the

day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix1 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix1 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
```

```
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S1)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan1 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

NEDTinfo (Group in S1)

NEDTinfo (4-byte float, array size: nchan1 x nscan):

```
NEDT (Noise Equivalent Differential Temperature) for each channel.
```

navigation (Group in S1)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values

are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S1)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoad-Temp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S1)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan1 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2 = Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes

ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan1 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan1 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan1 x ncolds1 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are

defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from

0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix1 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix1 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix1 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like)

sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

TAMmagneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetic Field derived from GPM three-axis magnetometer (TAM). Values range from -1000 to 1000 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan1 x npix1 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Tb (4-byte float, array size: nchan1 x npix1 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npix1 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:      Not affected by RFI.
1:      Affected by RFI with X-cal filter.
2:      Affected by RFI with RSS filter.
3-7:    Spare
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix2 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix2 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix2 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be

useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S2)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan2 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

NEDTinfo (Group in S2)

NEDTinfo (4-byte float, array size: nchan2 x nscan):

```
NEDT (Noise Equivalent Differential Temperature) for each channel.
```

navigation (Group in S2)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed

using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coor-

dinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S2)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values

range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special

values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S2)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan2 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from

0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2 = Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan2 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:

0	Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:

0	Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:

0	Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan2 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan2 x ncolds2 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special

values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix2 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix2 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix2 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

TAMmagneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetic Field derived from GPM three-axis magnetometer (TAM). Values range from -1000 to 1000 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan2 x npix2 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Tb (4-byte float, array size: nchan2 x npix2 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq2 x npix2 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix3 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix3 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix3 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S3)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero,

so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
```

```
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S3)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix3 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan1 x npix3 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

count (2-byte unsigned integer, array size: nchan1 x npix3 x nscan):
Full scan count. Values range from 0 to 65534. Special values are defined as:
65535 Missing value

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix4 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix4 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix4 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined

as:
-9999.9 Missing value

scanStatus (Group in S4)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S4)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load.

For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGa-

ian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix4 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan2 x npix4 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

count (2-byte unsigned integer, array size: nchan2 x npix4 x nscan):
Full scan count. Values range from 0 to 65534. Special values are defined as:
65535 Missing value

C Structure Header file:

```
#ifndef _TK_1BASEGMI_H_
```

```
#define _TK_1BASEGMI_H_

#ifndef _L1BASEGMI_S4_CALIBRATION_
#define _L1BASEGMI_S4_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} L1BASEGMI_S4_CALIBRATION;

#endif

#ifndef _L1BASEGMI_S4_SCANSTATUS_
#define _L1BASEGMI_S4_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BASEGMI_S4_SCANSTATUS;
```

```
#endif

#ifndef _L1BASEGMI_S4_
#define _L1BASEGMI_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    float sunLocalTime[500];
    L1BASEGMI_S4_SCANSTATUS scanStatus;
    L1BASEGMI_S4_CALIBRATION calibration;
    float incidenceAngle[500];
    float Tb[500][4];
    unsigned short count[500][4];
} L1BASEGMI_S4;

#endif

#ifndef _L1BASEGMI_S3_CALIBRATION_
#define _L1BASEGMI_S3_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} L1BASEGMI_S3_CALIBRATION;

#endif
```

```
#ifndef _L1BASEGMI_S3_SCANSTATUS_
#define _L1BASEGMI_S3_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BASEGMI_S3_SCANSTATUS;

#endif

#ifndef _L1BASEGMI_S3_
#define _L1BASEGMI_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    float sunLocalTime[500];
    L1BASEGMI_S3_SCANSTATUS scanStatus;
    L1BASEGMI_S3_CALIBRATION calibration;
    float incidenceAngle[500];
    float Tb[500][9];
    unsigned short count[500][9];
} L1BASEGMI_S3;

#endif

#ifndef _L1BASEGMI_S2_SUNDATA_
#define _L1BASEGMI_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
```

```
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BASEGMI_S2_SUNDATA;

#endif

#ifndef _L1BASEGMI_S2_CALCOUNTS_
#define _L1BASEGMI_S2_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[4][65];
    unsigned short coldLoadReading[4][85];
    unsigned short hotLoadnDiodeReading[4][65];
    unsigned short coldLoadnDiodeReading[4][85];
    unsigned short hotLoadThermisterCount[11];
} L1BASEGMI_S2_CALCOUNTS;

#endif

#ifndef _L1BASEGMI_S2_CAL2_
#define _L1BASEGMI_S2_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[4];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[4][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
```

```
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[4];
    unsigned short WarmIntrusionToColdViewIndex[85][4];
} L1BASEGMI_S2_CAL2;

#endif

#ifndef _L1BASEGMI_S2_CALIBRATION_
#define _L1BASEGMI_S2_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} L1BASEGMI_S2_CALIBRATION;
```

```
#endif

#ifndef _L1BASEGMI_S2_NAV2_
#define _L1BASEGMI_S2_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} L1BASEGMI_S2_NAV2;

#endif

#ifndef _L1BASEGMI_S2_NEDTINFO_
#define _L1BASEGMI_S2_NEDTINFO_

typedef struct {
    float NEDTinfo[4];
} L1BASEGMI_S2_NEDTINFO;

#endif

#ifndef _L1BASEGMI_S2_SAMPLEHEADER_
#define _L1BASEGMI_S2_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[4][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} L1BASEGMI_S2_SAMPLEHEADER;

#endif

#ifndef _L1BASEGMI_S2_SCANSTATUS_
#define _L1BASEGMI_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
```

```
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BASEGMI_S2_SCANSTATUS;

#endif

#ifndef _L1BASEGMI_S2_
#define _L1BASEGMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    L1BASEGMI_S2_SCANSTATUS scanStatus;
    L1BASEGMI_S2_SAMPLEHEADER sampleHeader;
    L1BASEGMI_S2_NEDTINFO NEDTinfo;
    NAVIGATION navigation;
    L1BASEGMI_S2_NAV2 nav2;
    L1BASEGMI_S2_CALIBRATION calibration;
    L1BASEGMI_S2_CAL2 cal2;
    float moonVectorInstFrame[3];
    L1BASEGMI_S2_CALCOUNTS calCounts;
    L1BASEGMI_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    float TAMmagneticFieldVector[3];
    unsigned short earthViewCounts[221][4];
    float Tb[221][4];
    short RFIFlag[221][2];
} L1BASEGMI_S2;
```

```
#endif

#ifndef _L1BASEGMI_S1_SUNDATA_
#define _L1BASEGMI_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BASEGMI_S1_SUNDATA;

#endif

#ifndef _L1BASEGMI_S1_CALCOUNTS_
#define _L1BASEGMI_S1_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[9][65];
    unsigned short coldLoadReading[9][85];
    unsigned short hotLoadnDiodeReading[9][65];
    unsigned short coldLoadnDiodeReading[9][85];
    unsigned short hotLoadThermisterCount[11];
} L1BASEGMI_S1_CALCOUNTS;

#endif

#ifndef _L1BASEGMI_S1_CAL2_
#define _L1BASEGMI_S1_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[9];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
```

```
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[9][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[9];
    unsigned short WarmIntrusionToColdViewIndex[85][9];
} L1BASEGMI_S1_CAL2;

#endif

#ifndef _L1BASEGMI_S1_CALIBRATION_
#define _L1BASEGMI_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
```

```
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} L1BASEGMI_S1_CALIBRATION;

#endif

#ifndef _L1BASEGMI_S1_NAV2_
#define _L1BASEGMI_S1_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} L1BASEGMI_S1_NAV2;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
```

```
} NAVIGATION;

#endif

#ifndef _L1BASEGMI_S1_NEDTINFO_
#define _L1BASEGMI_S1_NEDTINFO_

typedef struct {
    float NEDTinfo[9];
} L1BASEGMI_S1_NEDTINFO;

#endif

#ifndef _L1BASEGMI_S1_SAMPLEHEADER_
#define _L1BASEGMI_S1_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[9][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} L1BASEGMI_S1_SAMPLEHEADER;

#endif

#ifndef _L1BASEGMI_S1_SCANSTATUS_
#define _L1BASEGMI_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
```

```
} L1BASEGMI_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASEGMI_S1_
#define _L1BASEGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    L1BASEGMI_S1_SCANSTATUS scanStatus;
    L1BASEGMI_S1_SAMPLEHEADER sampleHeader;
    L1BASEGMI_S1_NEDTINFO NEDTinfo;
    NAVIGATION navigation;
    L1BASEGMI_S1_NAV2 nav2;
    L1BASEGMI_S1_CALIBRATION calibration;
    L1BASEGMI_S1_CAL2 cal2;
    float moonVectorInstFrame[3];
    L1BASEGMI_S1_CALCOUNTS calCounts;
    L1BASEGMI_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
```

```
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    float TAMmagneticFieldVector[3];
    unsigned short earthViewCounts[221][9];
    float Tb[221][9];
    short RFIFlag[221][5];
} L1BASEGMI_S1;

#endif

#ifndef _L1BASEGMI_SWATHS_
#define _L1BASEGMI_SWATHS_

typedef struct {
    L1BASEGMI_S1 S1;
    L1BASEGMI_S2 S2;
    L1BASEGMI_S3 S3;
    L1BASEGMI_S4 S4;
} L1BASEGMI_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BASEGMI_S4_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
```

```
END STRUCTURE

STRUCTURE /L1BASEGMI_S4_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BASEGMI_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 sunLocalTime(500)
    RECORD /L1BASEGMI_S4_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMI_S4_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Tb(4,500)
    INTEGER*2 count(4,500)
END STRUCTURE

STRUCTURE /L1BASEGMI_S3_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
```

```
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /L1BASEGMI_S3_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BASEGMI_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 sunLocalTime(500)
    RECORD /L1BASEGMI_S3_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMI_S3_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Tb(9,500)
    INTEGER*2 count(9,500)
END STRUCTURE

STRUCTURE /L1BASEGMI_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BASEGMI_S2_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,4)
```

```
    INTEGER*2 coldLoadReading(85,4)
    INTEGER*2 hotLoadnDiodeReading(65,4)
    INTEGER*2 coldLoadnDiodeReading(85,4)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /L1BASEGMI_S2_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(4)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,4)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(4)
    INTEGER*2 WarmIntrusionToColdViewIndex(4,85)
END STRUCTURE
```

```
STRUCTURE /L1BASEGMI_S2_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /L1BASEGMI_S2_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE

STRUCTURE /L1BASEGMI_S2_NEDTINFO/
    REAL*4 NEDTinfo(4)
END STRUCTURE

STRUCTURE /L1BASEGMI_S2_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,4)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /L1BASEGMI_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
```

```
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BASEGMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /L1BASEGMI_S2_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMI_S2_SAMPLEHEADER/ sampleHeader
    RECORD /L1BASEGMI_S2_NEDTINFO/ NEDTinfo
    RECORD /NAVIGATION/ navigation
    RECORD /L1BASEGMI_S2_NAV2/ nav2
    RECORD /L1BASEGMI_S2_CALIBRATION/ calibration
    RECORD /L1BASEGMI_S2_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BASEGMI_S2_CALCOUNTS/ calCounts
    RECORD /L1BASEGMI_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    REAL*4 TAMmagneticFieldVector(3)
    INTEGER*2 earthViewCounts(4,221)
    REAL*4 Tb(4,221)
    INTEGER*2 RFIFlag(2,221)
END STRUCTURE

STRUCTURE /L1BASEGMI_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
```

```
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BASEGMI_S1_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,9)
    INTEGER*2 coldLoadReading(85,9)
    INTEGER*2 hotLoadnDiodeReading(65,9)
    INTEGER*2 coldLoadnDiodeReading(85,9)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /L1BASEGMI_S1_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(9)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,9)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
```

```
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(9)
    INTEGER*2 WarmIntrusionToColdViewIndex(9,85)
END STRUCTURE

STRUCTURE /L1BASEGMI_S1_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /L1BASEGMI_S1_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
```

```
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BASEGMI_S1_NEDTINFO/
    REAL*4 NEDTinfo(9)
END STRUCTURE

STRUCTURE /L1BASEGMI_S1_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,9)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /L1BASEGMI_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
```

```
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASEGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /L1BASEGMI_S1_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMI_S1_SAMPLEHEADER/ sampleHeader
    RECORD /L1BASEGMI_S1_NEDTINFO/ NEDTinfo
    RECORD /NAVIGATION/ navigation
    RECORD /L1BASEGMI_S1_NAV2/ nav2
    RECORD /L1BASEGMI_S1_CALIBRATION/ calibration
    RECORD /L1BASEGMI_S1_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BASEGMI_S1_CALCOUNTS/ calCounts
    RECORD /L1BASEGMI_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    REAL*4 TAMmagneticFieldVector(3)
    INTEGER*2 earthViewCounts(9,221)
    REAL*4 Tb(9,221)
    INTEGER*2 RFIFlag(5,221)
END STRUCTURE

STRUCTURE /L1BASEGMI_SWATHS/
    RECORD /L1BASEGMI_S1/ S1;
    RECORD /L1BASEGMI_S2/ S2;
    RECORD /L1BASEGMI_S3/ S3;
    RECORD /L1BASEGMI_S4/ S4;
END STRUCTURE
```

5.6 1BASEGMIRSS - GMI Brightness Temperatures

The GMI BASE Product, 1BASEGMIRSS, "GMI Brightness Temperatures," is written as a multi-Swath Structure. Swath S1 has channels 1-9: 10V 10H 19V 19H 23V 37V 37H 89V 89H. Swath S2 has channels 10-13: 166V 166H 183+/-3V 183+/-8V. 1BASEGMIRSS is like 1BASEGMI but has overlap of 200 scans on each end. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchan1	9	Number of channels in Swath 1.
nchan2	4	Number of channels in Swath 2.
nfreq1	5	Number of frequencies in Swath 1.
nfreq2	2	Number of frequencies in Swath 2.
npix1	221	Number of pixels in Swath 1.
npix2	221	Number of pixels in Swath 2.
npix3	500	Number of pixels in Swath 3.
npix4	500	Number of pixels in Swath 4.
ncolds1	85	Maximum number of cold samples in Swath 1.
ncolds2	85	Maximum number of cold samples in Swath 2.
nhots1	65	Maximum number of hot samples in Swath 1.
nhots2	65	Maximum number of hot samples in Swath 2.
ntherm	11	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nsamt	4	Number of sample types. The types are: total science GSDR, earth-view, hot load, cold sky.
ntach	32	Number of tachometer readings.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.
nndiode	6	Number of noise diodes.
n7	7	Number seven.
SVBFd	3	SunVectorinBodyFrame dimension.

Figure 155 through Figure 189 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

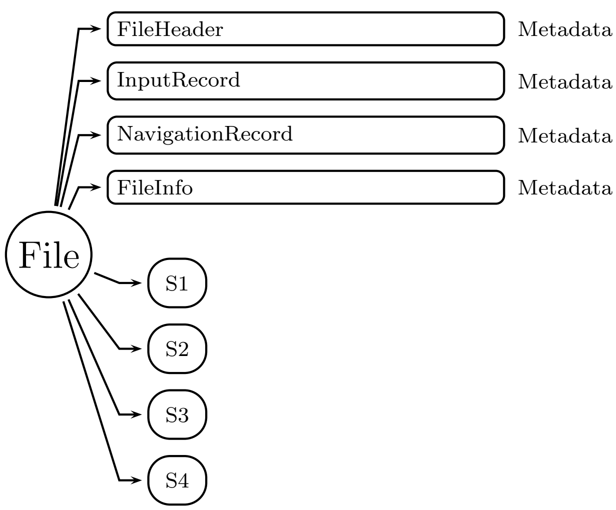

Figure 155: Data Format Structure for 1BASEGMIRSS, GMI Brightness Temperatures

S1

S1_SwathHeader		Metadata
ScanTime	19 bytes	Group: nscan
Latitude	4 bytes	Array: npix1 x nscan
Longitude	4 bytes	Array: npix1 x nscan
sunLocalTime	4 bytes	Array: npix1 x nscan
scanStatus	22 bytes	Group: nscan
sampleHeader	273 bytes	Group: nscan
NEDTinfo	36 bytes	Group: nscan
navigation	92 bytes	Group: nscan
nav2	4 bytes	Group: nscan
calibration	580 bytes	Group: nscan
cal2	2098 bytes	Group: nscan
moonVectorInstFrame	4 bytes	Array: GMIxyz x nscan
calCounts	5422 bytes	Group: nscan
sunData	40 bytes	Group: nscan
incidenceAngle	4 bytes	Array: npix1 x nscan
satAzimuthAngle	4 bytes	Array: npix1 x nscan
solarZenAngle	4 bytes	Array: npix1 x nscan
solarAzimuthAngle	4 bytes	Array: npix1 x nscan
sunGlintAngle	4 bytes	Array: npix1 x nscan
magneticFieldVector	4 bytes	Array: GMIxyz x nscan
TAMmagneticFieldVector	4 bytes	Array: GMIxyz x nscan
earthViewCounts	2 bytes	Array: nchan1 x npix1 x nscan
Tb	4 bytes	Array: nchan1 x npix1 x nscan

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Figure 156: Data Format Structure for 1BASEGMIRSS, S1,

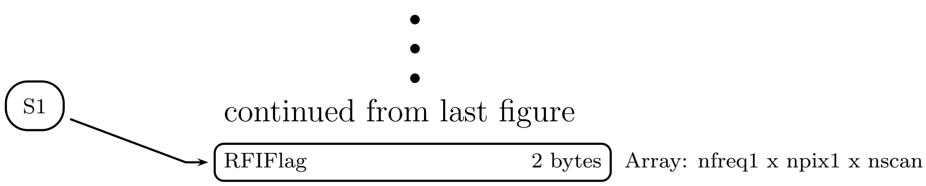

Figure 157: Data Format Structure for 1BASEGMIRSS, S1

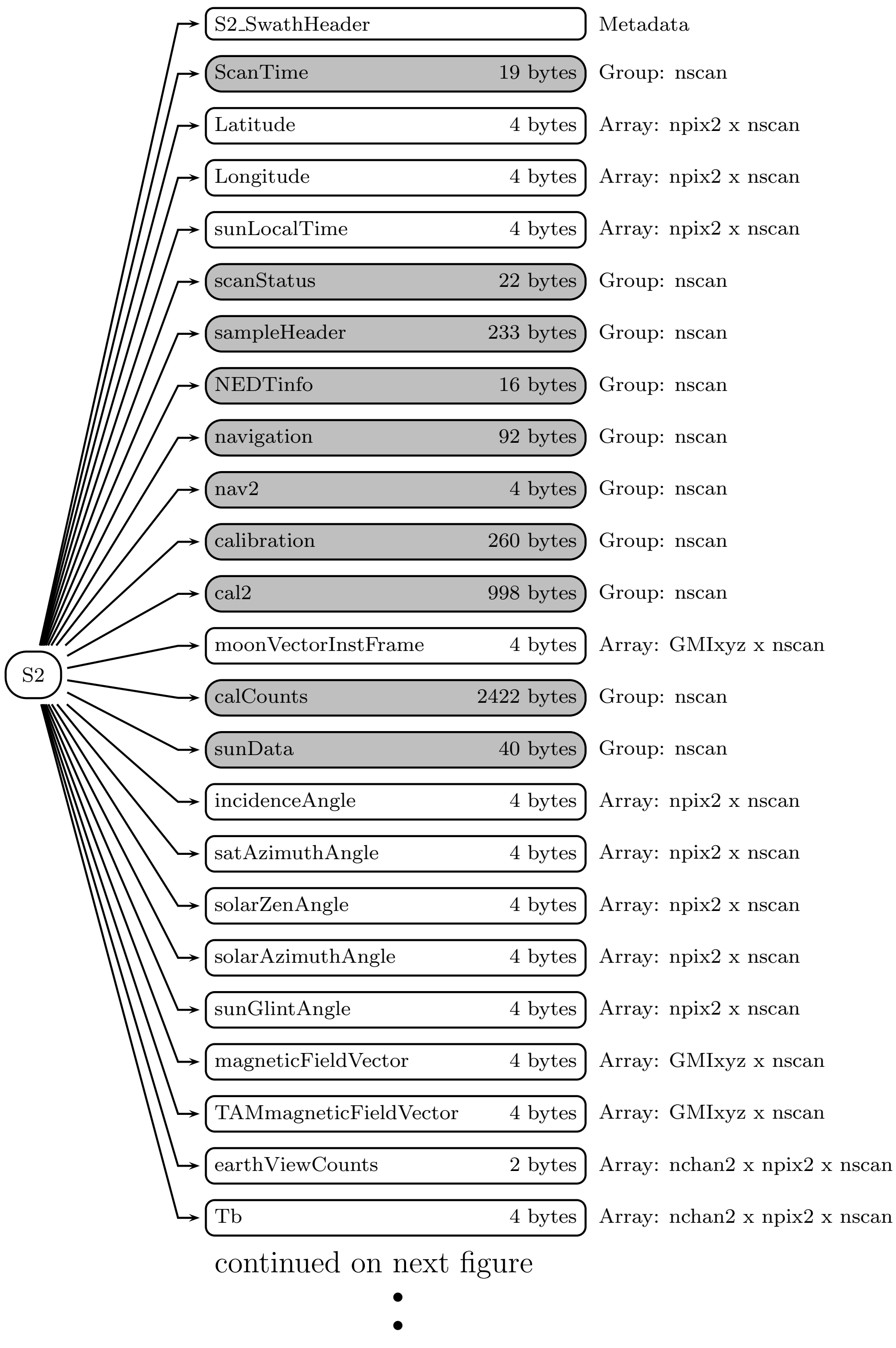

Figure 158: Data Format Structure for 1BASEGMIRSS, S2,

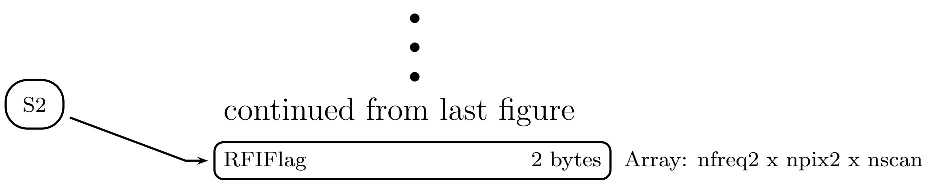

Figure 159: Data Format Structure for 1BASEGMIRSS, S2

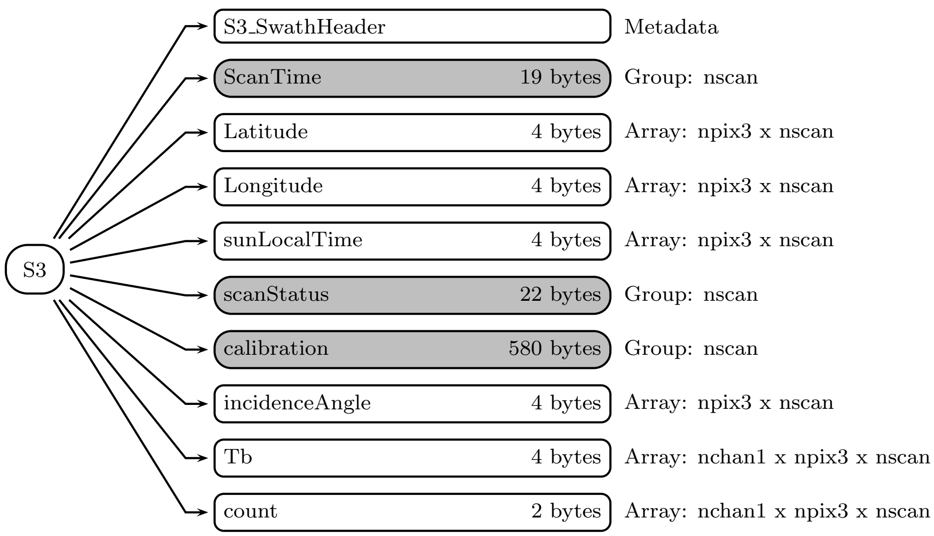

Figure 160: Data Format Structure for 1BASEGMIRSS, S3

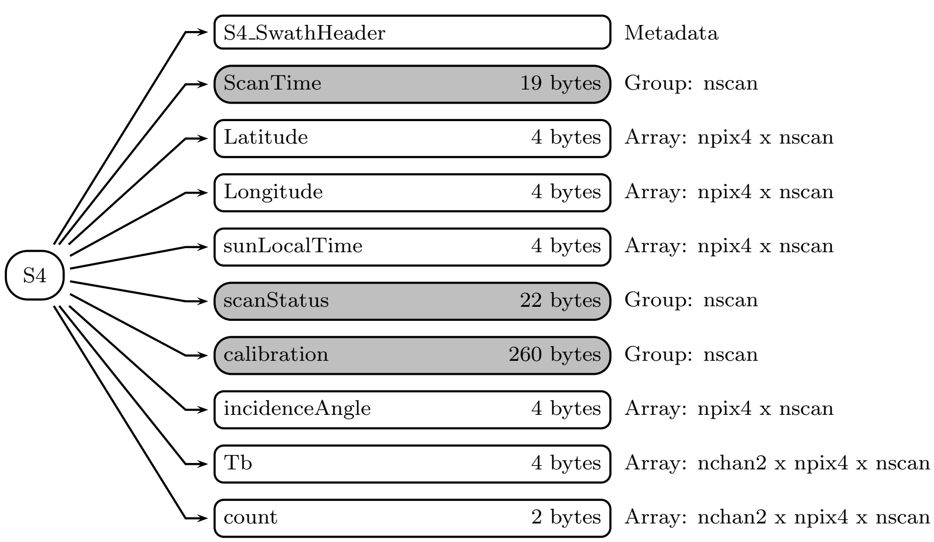

Figure 161: Data Format Structure for 1BASEGMIRSS, S4

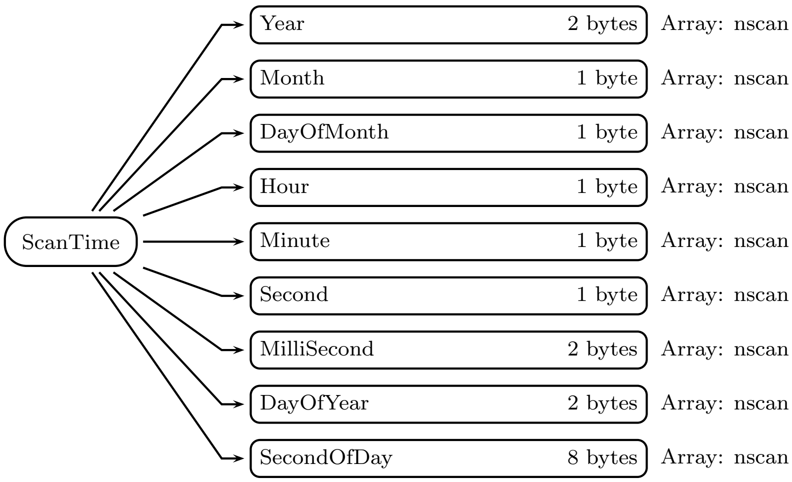

Figure 162: Data Format Structure for 1BASEGMIRSS, S1, ScanTime

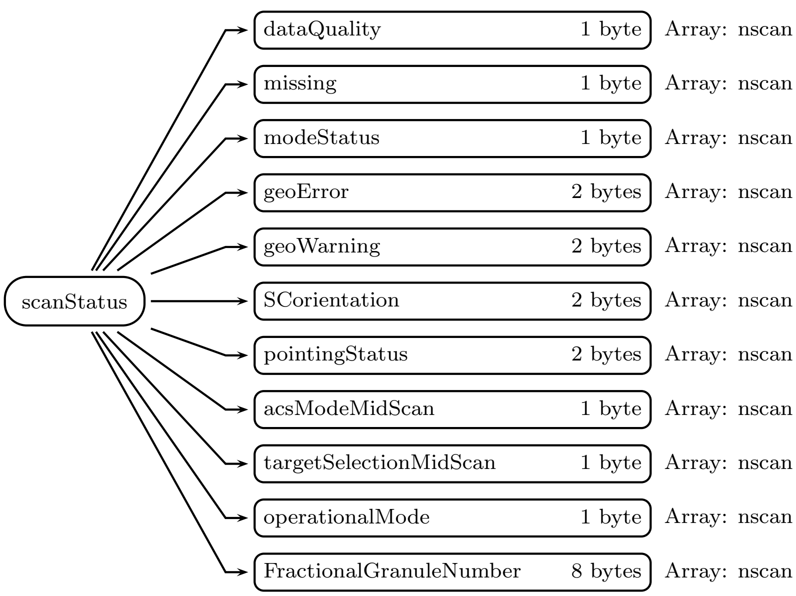

Figure 163: Data Format Structure for 1BASEGMIRSS, S1, scanStatus

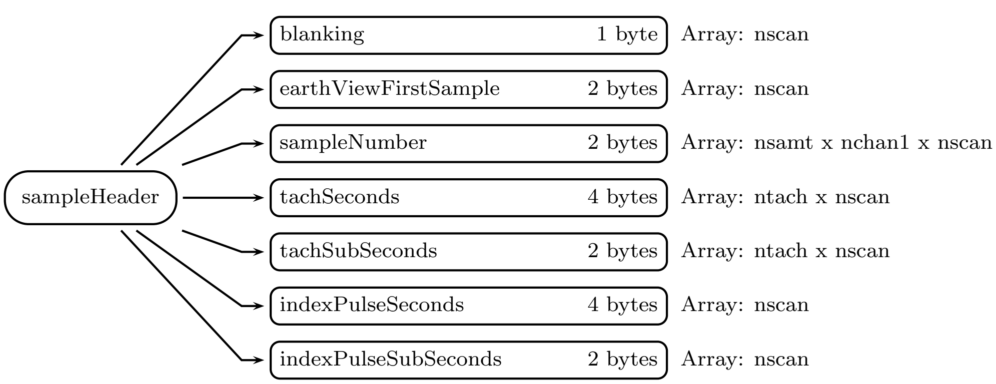

Figure 164: Data Format Structure for 1BASEGMIRSS, S1, sampleHeader

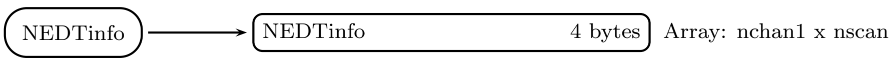

Figure 165: Data Format Structure for 1BASEGMIRSS, S1, NEDTinfo

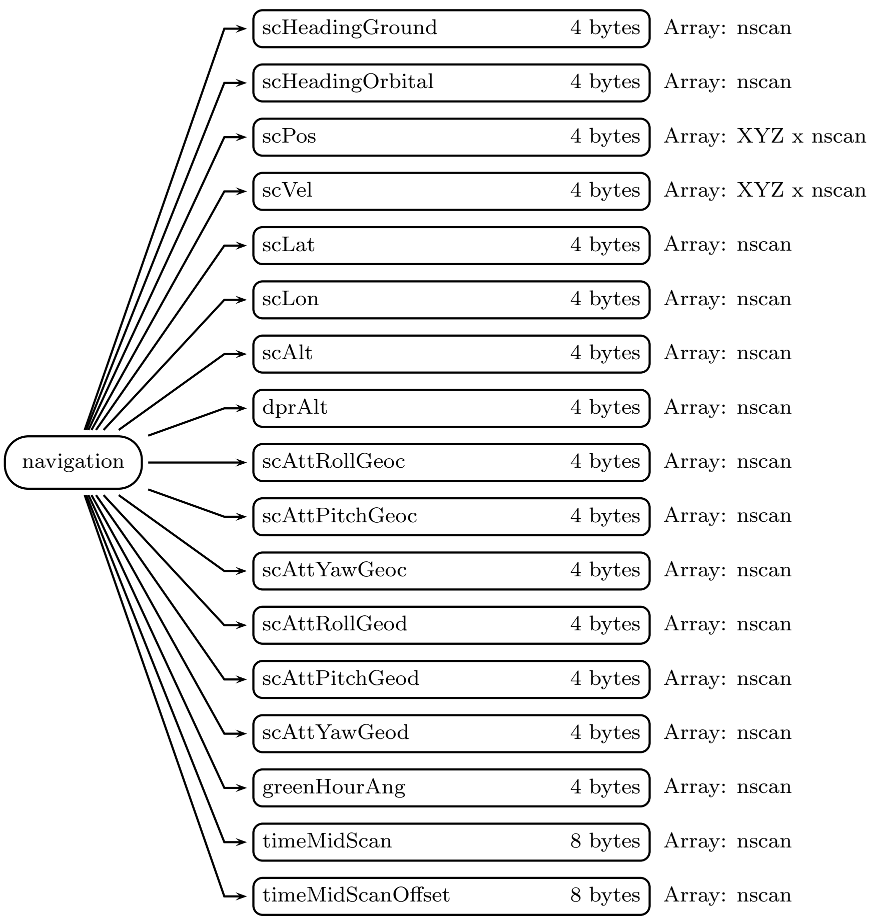

Figure 166: Data Format Structure for 1BASEGMIRSS, S1, navigation

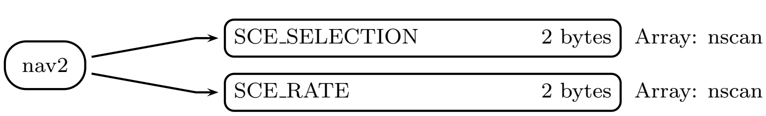

Figure 167: Data Format Structure for 1BASEGMIRSS, S1, nav2

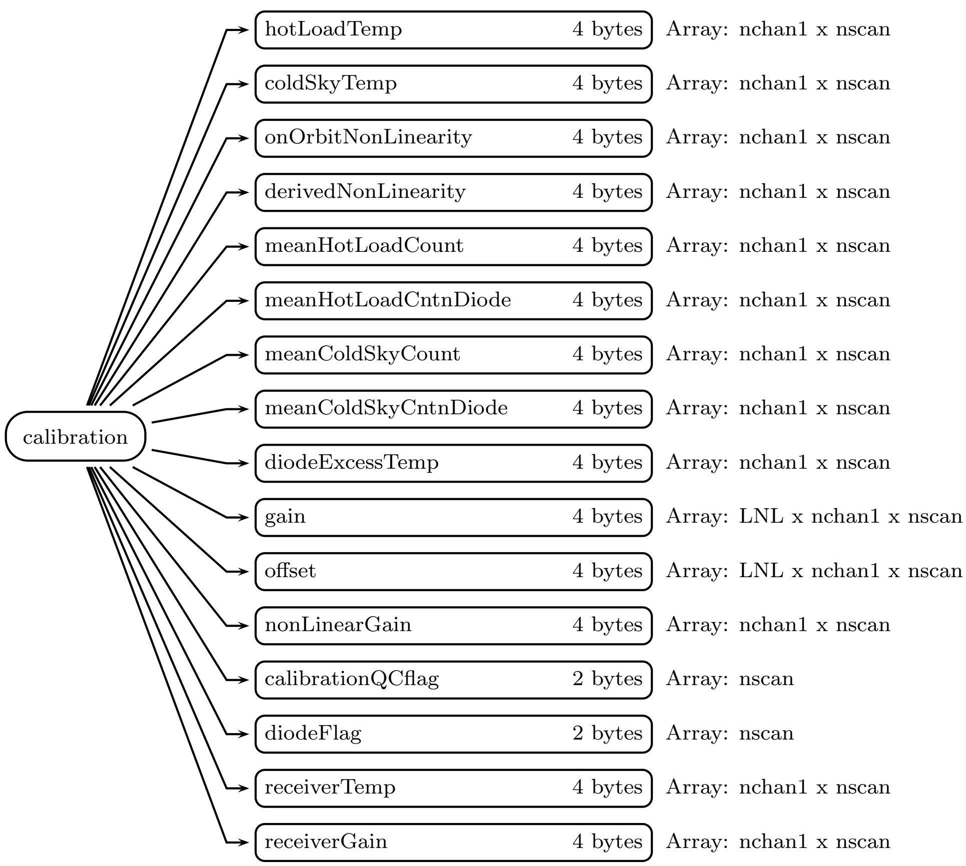

Figure 168: Data Format Structure for 1BASEGMIRSS, S1, calibration

cal2

trayTemperatureCount	2 bytes	Array: nscan
trayTemperature	4 bytes	Array: nscan
moonIndex	2 bytes	Array: nchan1 x nscan
noiseDiodeTemp	4 bytes	Array: nndiode x nscan
TEMP_CALRES_2	2 bytes	Array: nscan
TEMP_CALRES_1	2 bytes	Array: nscan
RS_CALRES_2	2 bytes	Array: nscan
RS_CALRES_1	2 bytes	Array: nscan
BATC_CALRES_2	2 bytes	Array: nscan
BATC_CALRES_1	2 bytes	Array: nscan
NDIODE_MODE	2 bytes	Array: nscan
RSST_NDIODE_ST	2 bytes	Array: nscan
NDIODE10GHZNUM	2 bytes	Array: nscan
hotLoadThermisterTemp	4 bytes	Array: ntherm x nchan1 x nscan
TEMP_CALRES_4	2 bytes	Array: nscan
TEMP_CALRES_5	2 bytes	Array: nscan
TEMP_CALRES_6	2 bytes	Array: nscan
TEMP_89GHZ_LO	4 bytes	Array: nscan
TEMP_166GHZ_LO	4 bytes	Array: nscan
TEMP_183GHZ_LO	4 bytes	Array: nscan
TEMP_V89GHZMXR	4 bytes	Array: nscan
TEMP_H89GHZMXR	4 bytes	Array: nscan
TEMP_V166GHZMXR	4 bytes	Array: nscan
TEMP_H166GHZMXR	4 bytes	Array: nscan

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Figure 169: Data Format Structure for 1BASEGMIRSS, S1, cal2,

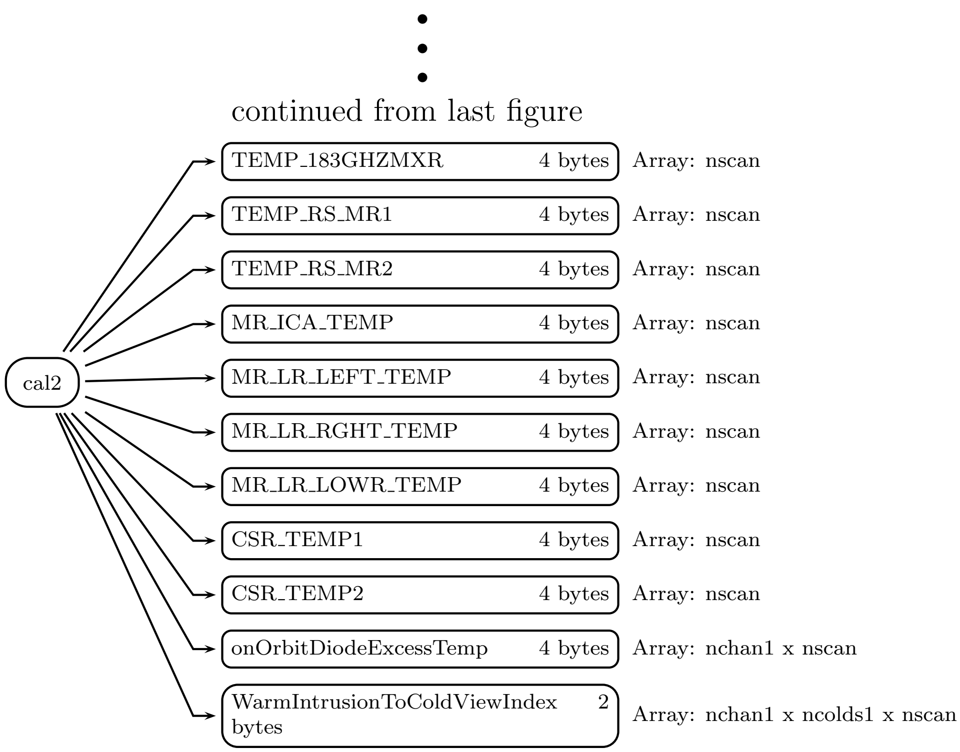

Figure 170: Data Format Structure for 1BASEGMIRSS, S1, cal2

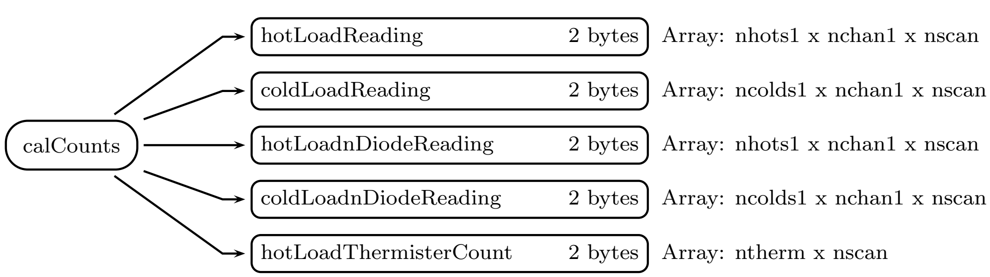

Figure 171: Data Format Structure for 1BASEGMIRSS, S1, calCounts

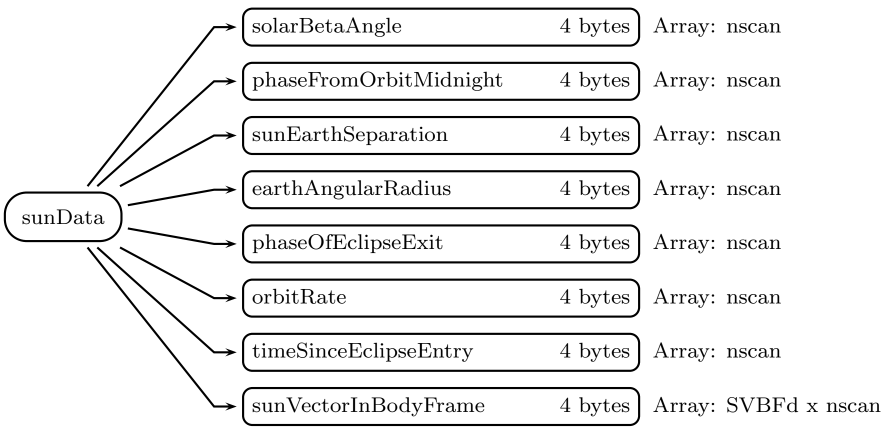

Figure 172: Data Format Structure for 1BASEGMIRSS, S1, sunData

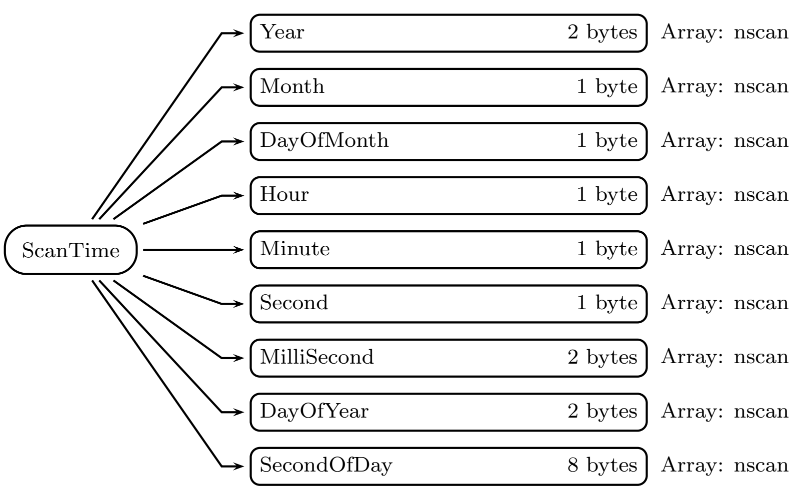

Figure 173: Data Format Structure for 1BASEGMIRSS, S2, ScanTime

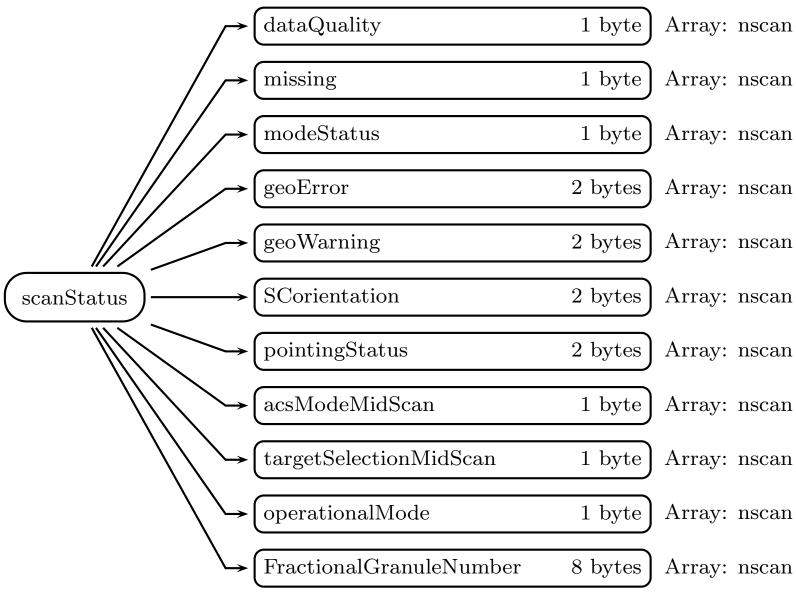

Figure 174: Data Format Structure for 1BASEGMIRSS, S2, scanStatus

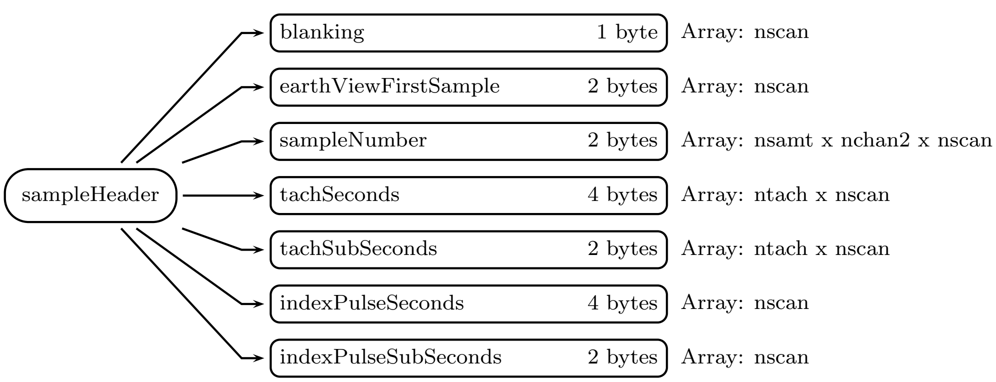

Figure 175: Data Format Structure for 1BASEGMIRSS, S2, sampleHeader

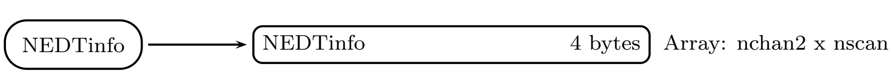

Figure 176: Data Format Structure for 1BASEGMIRSS, S2, NEDTinfo

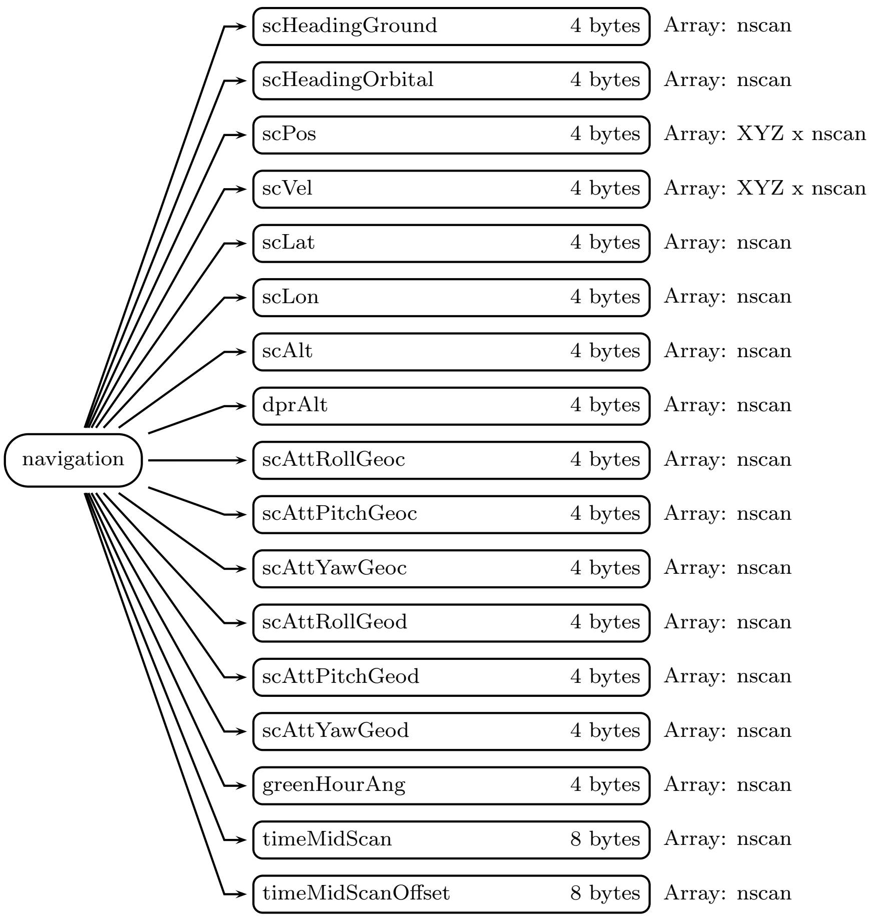

Figure 177: Data Format Structure for 1BASEGMIRSS, S2, navigation

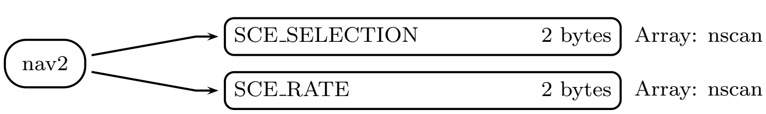

Figure 178: Data Format Structure for 1BASEGMIRSS, S2, nav2

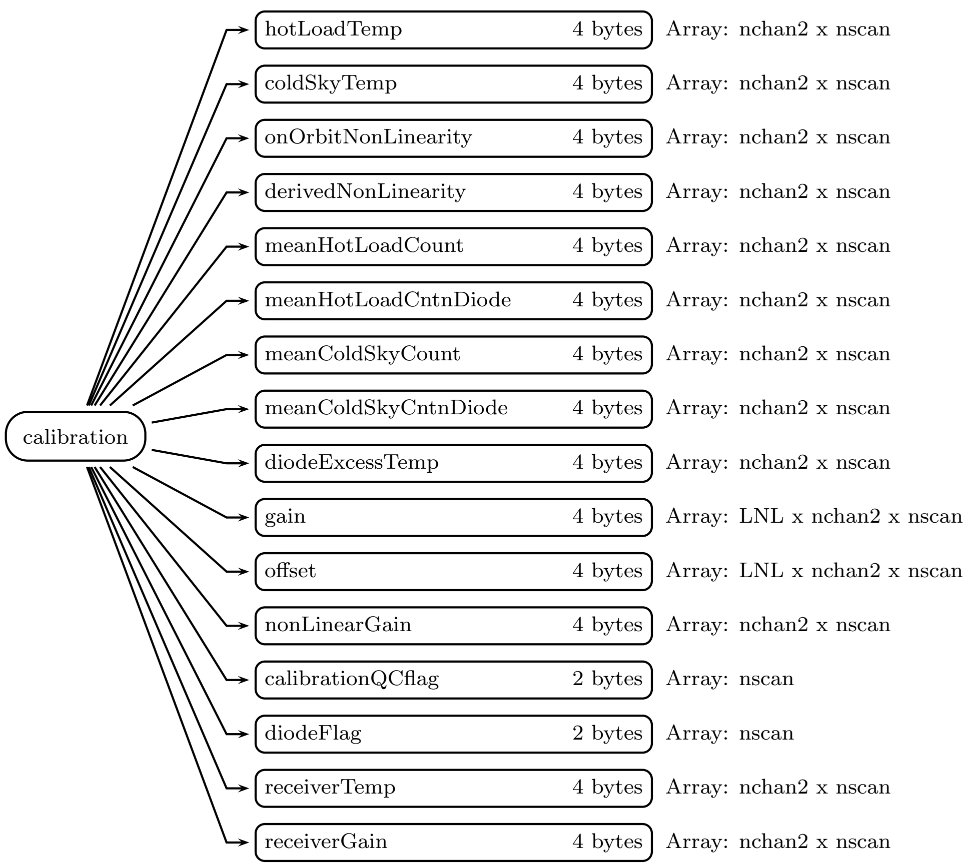

Figure 179: Data Format Structure for 1BASEGMIRSS, S2, calibration

cal2

trayTemperatureCount	2 bytes	Array: nscan
trayTemperature	4 bytes	Array: nscan
moonIndex	2 bytes	Array: nchan2 x nscan
noiseDiodeTemp	4 bytes	Array: nndiode x nscan
TEMP_CALRES_2	2 bytes	Array: nscan
TEMP_CALRES_1	2 bytes	Array: nscan
RS_CALRES_2	2 bytes	Array: nscan
RS_CALRES_1	2 bytes	Array: nscan
BATC_CALRES_2	2 bytes	Array: nscan
BATC_CALRES_1	2 bytes	Array: nscan
NDIODE_MODE	2 bytes	Array: nscan
RSST_NDIODE_ST	2 bytes	Array: nscan
NDIODE10GHZNUM	2 bytes	Array: nscan
hotLoadThermisterTemp	4 bytes	Array: ntherm x nchan2 x nscan
TEMP_CALRES_4	2 bytes	Array: nscan
TEMP_CALRES_5	2 bytes	Array: nscan
TEMP_CALRES_6	2 bytes	Array: nscan
TEMP_89GHZ_LO	4 bytes	Array: nscan
TEMP_166GHZ_LO	4 bytes	Array: nscan
TEMP_183GHZ_LO	4 bytes	Array: nscan
TEMP_V89GHZMXR	4 bytes	Array: nscan
TEMP_H89GHZMXR	4 bytes	Array: nscan
TEMP_V166GHZMXR	4 bytes	Array: nscan
TEMP_H166GHZMXR	4 bytes	Array: nscan

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Figure 180: Data Format Structure for 1BASEGMIRSS, S2, cal2,

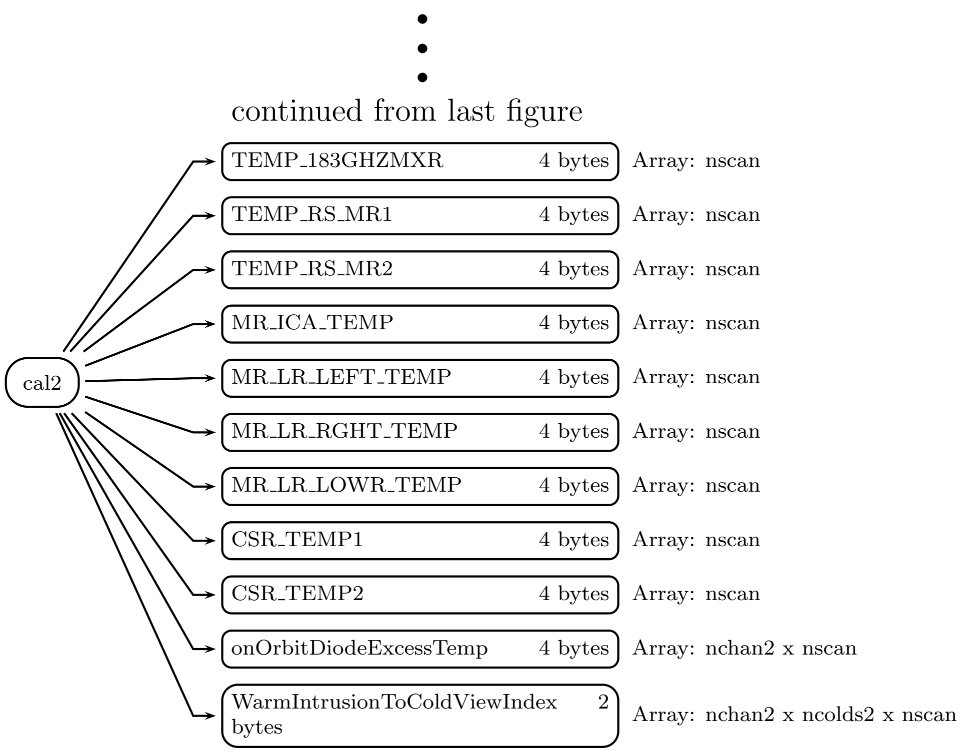


Figure 181: Data Format Structure for 1BASEGMIRSS, S2, cal2

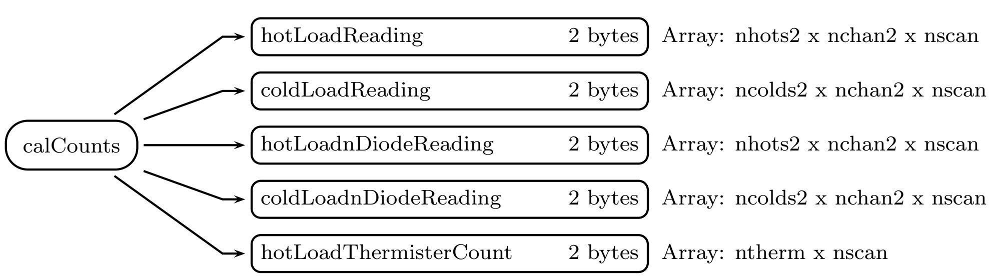


Figure 182: Data Format Structure for 1BASEGMIRSS, S2, calCounts

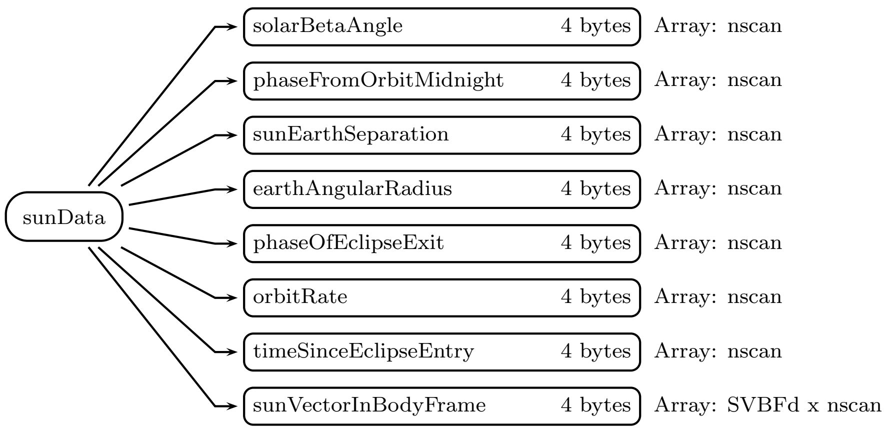


Figure 183: Data Format Structure for 1BASEGMIRSS, S2, sunData

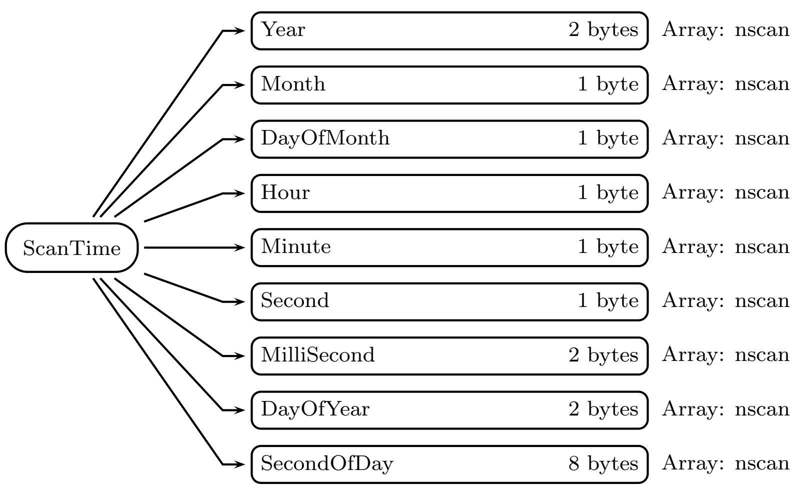


Figure 184: Data Format Structure for 1BASEGMIRSS, S3, ScanTime

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in

scanStatus	Size	Dimensions
dataQuality	1 byte	Array: nscan
missing	1 byte	Array: nscan
modeStatus	1 byte	Array: nscan
geoError	2 bytes	Array: nscan
geoWarning	2 bytes	Array: nscan
SCorientation	2 bytes	Array: nscan
pointingStatus	2 bytes	Array: nscan
acsModeMidScan	1 byte	Array: nscan
targetSelectionMidScan	1 byte	Array: nscan
operationalMode	1 byte	Array: nscan
FractionalGranuleNumber	8 bytes	Array: nscan

Figure 185: Data Format Structure for 1BASEGMIRSS, S3, scanStatus

calibration	Size	Dimensions
hotLoadTemp	4 bytes	Array: nchan1 x nscan
coldSkyTemp	4 bytes	Array: nchan1 x nscan
onOrbitNonLinearity	4 bytes	Array: nchan1 x nscan
derivedNonLinearity	4 bytes	Array: nchan1 x nscan
meanHotLoadCount	4 bytes	Array: nchan1 x nscan
meanHotLoadCntnDiode	4 bytes	Array: nchan1 x nscan
meanColdSkyCount	4 bytes	Array: nchan1 x nscan
meanColdSkyCntnDiode	4 bytes	Array: nchan1 x nscan
diodeExcessTemp	4 bytes	Array: nchan1 x nscan
gain	4 bytes	Array: LNL x nchan1 x nscan
offset	4 bytes	Array: LNL x nchan1 x nscan
nonLinearGain	4 bytes	Array: nchan1 x nscan
calibrationQCflag	2 bytes	Array: nscan
diodeFlag	2 bytes	Array: nscan
receiverTemp	4 bytes	Array: nchan1 x nscan
receiverGain	4 bytes	Array: nchan1 x nscan

Figure 186: Data Format Structure for 1BASEGMIRSS, S3, calibration

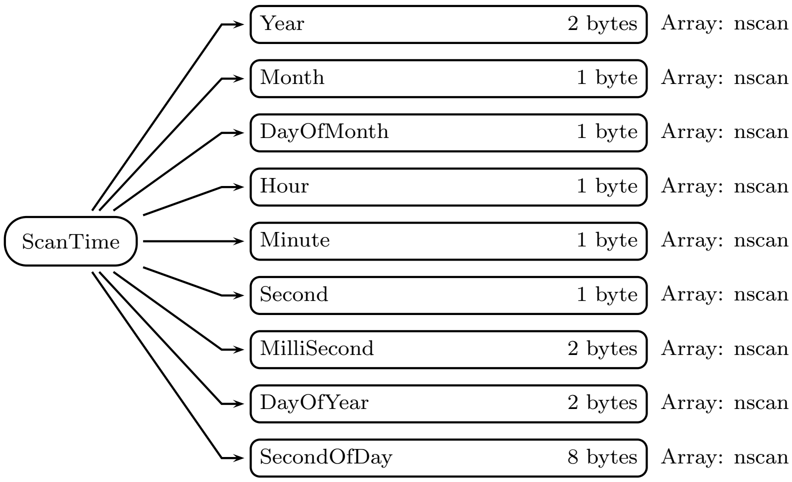


Figure 187: Data Format Structure for 1BASEGMIRSS, S4, ScanTime

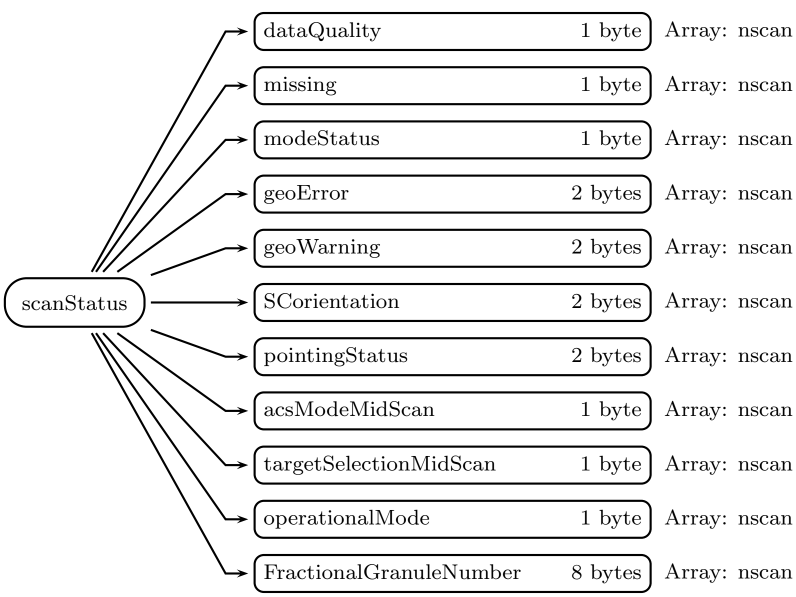


Figure 188: Data Format Structure for 1BASEGMIRSS, S4, scanStatus

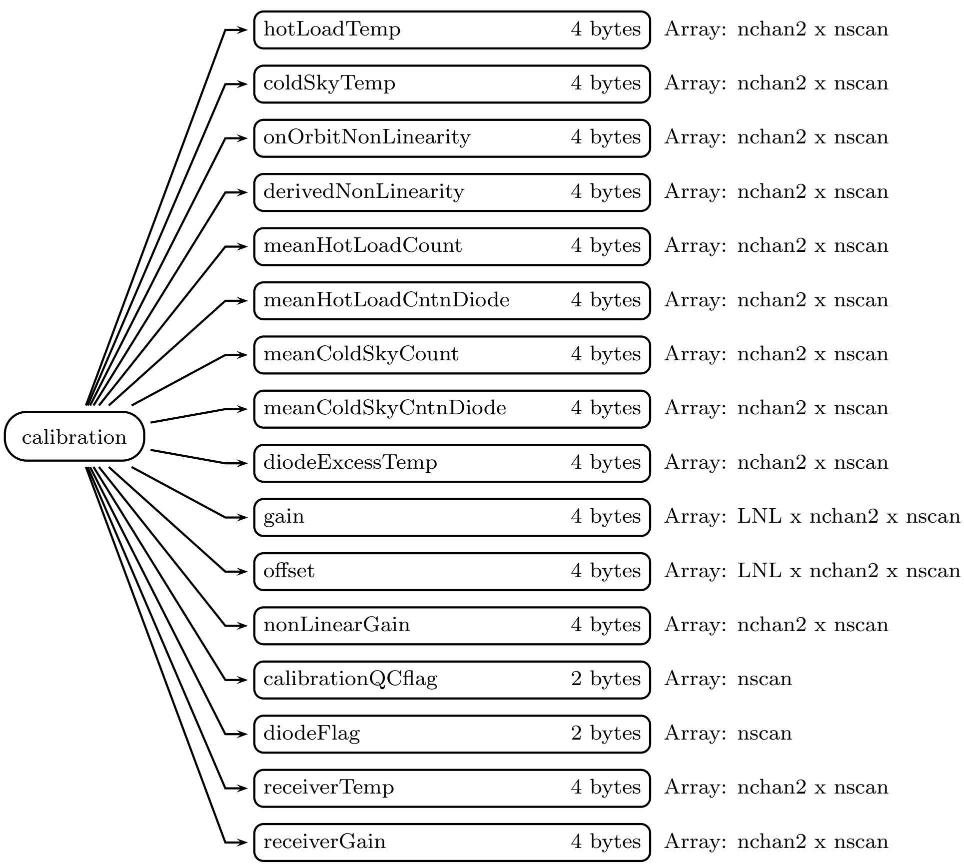


Figure 189: Data Format Structure for 1BASEGMIRSS, S4, calibration

all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the

day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix1 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix1 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
```

```
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S1)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan1 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

NEDTinfo (Group in S1)

NEDTinfo (4-byte float, array size: nchan1 x nscan):

```
NEDT (Noise Equivalent Differential Temperature) for each channel.
```

navigation (Group in S1)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values

are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S1)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoad-Temp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S1)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan1 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2 = Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes

ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan1 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan1 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan1 x ncolds1 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are

defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from

0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix1 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix1 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix1 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like)

sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

TAMmagneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetic Field derived from GPM three-axis magnetometer (TAM). Values range from -1000 to 1000 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan1 x npix1 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Tb (4-byte float, array size: nchan1 x npix1 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npix1 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix2 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix2 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix2 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be

useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S2)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan2 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

NEDTinfo (Group in S2)

NEDTinfo (4-byte float, array size: nchan2 x nscan):

```
NEDT (Noise Equivalent Differential Temperature) for each channel.
```

navigation (Group in S2)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed

using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coor-

dinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S2)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values

range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special

values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S2)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan2 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from

0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2 = Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan2 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:

0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:

0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:

0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9 Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9 Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9 Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan2 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:

-9999.9	Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan2 x ncolds2 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special

values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix2 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix2 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix2 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

TAMmagneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetic Field derived from GPM three-axis magnetometer (TAM). Values range from -1000 to 1000 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan2 x npix2 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Tb (4-byte float, array size: nchan2 x npix2 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq2 x npix2 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix3 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix3 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix3 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S3)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero,

so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
```

```
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S3)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix3 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan1 x npix3 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

count (2-byte unsigned integer, array size: nchan1 x npix3 x nscan):
Full scan count. Values range from 0 to 65534. Special values are defined as:
65535 Missing value

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix4 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix4 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix4 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined

as:
-9999.9 Missing value

scanStatus (Group in S4)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
```

```
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S4)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load.

For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:

-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:

-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:

-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:

-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGa-

ian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix4 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan2 x npix4 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

count (2-byte unsigned integer, array size: nchan2 x npix4 x nscan):
Full scan count. Values range from 0 to 65534. Special values are defined as:
65535 Missing value

C Structure Header file:

```
#ifndef _TK_1BASEGMIRSS_H_
```

```
#define _TK_1BASEGMIRSS_H_

#ifndef _L1BASEGMIRSS_S4_CALIBRATION_
#define _L1BASEGMIRSS_S4_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} L1BASEGMIRSS_S4_CALIBRATION;

#endif

#ifndef _L1BASEGMIRSS_S4_SCANSTATUS_
#define _L1BASEGMIRSS_S4_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BASEGMIRSS_S4_SCANSTATUS;
```

```
#endif

#ifndef _L1BASEGMIRSS_S4_
#define _L1BASEGMIRSS_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    float sunLocalTime[500];
    L1BASEGMIRSS_S4_SCANSTATUS scanStatus;
    L1BASEGMIRSS_S4_CALIBRATION calibration;
    float incidenceAngle[500];
    float Tb[500][4];
    unsigned short count[500][4];
} L1BASEGMIRSS_S4;

#endif

#ifndef _L1BASEGMIRSS_S3_CALIBRATION_
#define _L1BASEGMIRSS_S3_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} L1BASEGMIRSS_S3_CALIBRATION;

#endif
```

```
#ifndef _L1BASEGMIRSS_S3_SCANSTATUS_
#define _L1BASEGMIRSS_S3_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BASEGMIRSS_S3_SCANSTATUS;

#endif

#ifndef _L1BASEGMIRSS_S3_
#define _L1BASEGMIRSS_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    float sunLocalTime[500];
    L1BASEGMIRSS_S3_SCANSTATUS scanStatus;
    L1BASEGMIRSS_S3_CALIBRATION calibration;
    float incidenceAngle[500];
    float Tb[500][9];
    unsigned short count[500][9];
} L1BASEGMIRSS_S3;

#endif

#ifndef _L1BASEGMIRSS_S2_SUNDATA_
#define _L1BASEGMIRSS_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
```

```
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BASEGMIRSS_S2_SUNDATA;

#endif

#ifndef _L1BASEGMIRSS_S2_CALCOUNTS_
#define _L1BASEGMIRSS_S2_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[4][65];
    unsigned short coldLoadReading[4][85];
    unsigned short hotLoadnDiodeReading[4][65];
    unsigned short coldLoadnDiodeReading[4][85];
    unsigned short hotLoadThermisterCount[11];
} L1BASEGMIRSS_S2_CALCOUNTS;

#endif

#ifndef _L1BASEGMIRSS_S2_CAL2_
#define _L1BASEGMIRSS_S2_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[4];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[4][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
```

```
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[4];
    unsigned short WarmIntrusionToColdViewIndex[85][4];
} L1BASEGMIRSS_S2_CAL2;

#endif

#ifndef _L1BASEGMIRSS_S2_CALIBRATION_
#define _L1BASEGMIRSS_S2_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} L1BASEGMIRSS_S2_CALIBRATION;
```

```
#endif

#ifndef _L1BASEGMIRSS_S2_NAV2_
#define _L1BASEGMIRSS_S2_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} L1BASEGMIRSS_S2_NAV2;

#endif

#ifndef _L1BASEGMIRSS_S2_NEDTINFO_
#define _L1BASEGMIRSS_S2_NEDTINFO_

typedef struct {
    float NEDTinfo[4];
} L1BASEGMIRSS_S2_NEDTINFO;

#endif

#ifndef _L1BASEGMIRSS_S2_SAMPLEHEADER_
#define _L1BASEGMIRSS_S2_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[4][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} L1BASEGMIRSS_S2_SAMPLEHEADER;

#endif

#ifndef _L1BASEGMIRSS_S2_SCANSTATUS_
#define _L1BASEGMIRSS_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
```

```
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BASEGMIRSS_S2_SCANSTATUS;

#endif

#ifndef _L1BASEGMIRSS_S2_
#define _L1BASEGMIRSS_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    L1BASEGMIRSS_S2_SCANSTATUS scanStatus;
    L1BASEGMIRSS_S2_SAMPLEHEADER sampleHeader;
    L1BASEGMIRSS_S2_NEDTINFO NEDTinfo;
    NAVIGATION navigation;
    L1BASEGMIRSS_S2_NAV2 nav2;
    L1BASEGMIRSS_S2_CALIBRATION calibration;
    L1BASEGMIRSS_S2_CAL2 cal2;
    float moonVectorInstFrame[3];
    L1BASEGMIRSS_S2_CALCOUNTS calCounts;
    L1BASEGMIRSS_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    float TAMmagneticFieldVector[3];
    unsigned short earthViewCounts[221][4];
    float Tb[221][4];
    short RFIFlag[221][2];
} L1BASEGMIRSS_S2;
```

```
#endif

#ifndef _L1BASEGMIRSS_S1_SUNDATA_
#define _L1BASEGMIRSS_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BASEGMIRSS_S1_SUNDATA;

#endif

#ifndef _L1BASEGMIRSS_S1_CALCOUNTS_
#define _L1BASEGMIRSS_S1_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[9][65];
    unsigned short coldLoadReading[9][85];
    unsigned short hotLoadnDiodeReading[9][65];
    unsigned short coldLoadnDiodeReading[9][85];
    unsigned short hotLoadThermisterCount[11];
} L1BASEGMIRSS_S1_CALCOUNTS;

#endif

#ifndef _L1BASEGMIRSS_S1_CAL2_
#define _L1BASEGMIRSS_S1_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[9];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
```

```
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[9][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[9];
    unsigned short WarmIntrusionToColdViewIndex[85][9];
} L1BASEGMIRSS_S1_CAL2;

#endif

#ifndef _L1BASEGMIRSS_S1_CALIBRATION_
#define _L1BASEGMIRSS_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
```

```
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} L1BASEGMIRSS_S1_CALIBRATION;

#endif

#ifndef _L1BASEGMIRSS_S1_NAV2_
#define _L1BASEGMIRSS_S1_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} L1BASEGMIRSS_S1_NAV2;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
```

```
} NAVIGATION;

#endif

#ifndef _L1BASEGMIRSS_S1_NEDTINFO_
#define _L1BASEGMIRSS_S1_NEDTINFO_

typedef struct {
    float NEDTinfo[9];
} L1BASEGMIRSS_S1_NEDTINFO;

#endif

#ifndef _L1BASEGMIRSS_S1_SAMPLEHEADER_
#define _L1BASEGMIRSS_S1_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[9][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} L1BASEGMIRSS_S1_SAMPLEHEADER;

#endif

#ifndef _L1BASEGMIRSS_S1_SCANSTATUS_
#define _L1BASEGMIRSS_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
```

```
} L1BASEGMIRSS_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASEGMIRSS_S1_
#define _L1BASEGMIRSS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    L1BASEGMIRSS_S1_SCANSTATUS scanStatus;
    L1BASEGMIRSS_S1_SAMPLEHEADER sampleHeader;
    L1BASEGMIRSS_S1_NEDTINFO NEDTinfo;
    NAVIGATION navigation;
    L1BASEGMIRSS_S1_NAV2 nav2;
    L1BASEGMIRSS_S1_CALIBRATION calibration;
    L1BASEGMIRSS_S1_CAL2 cal2;
    float moonVectorInstFrame[3];
    L1BASEGMIRSS_S1_CALCOUNTS calCounts;
    L1BASEGMIRSS_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
```

```
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    float TAMmagneticFieldVector[3];
    unsigned short earthViewCounts[221][9];
    float Tb[221][9];
    short RFIFlag[221][5];
} L1BASEGMIRSS_S1;

#endif

#ifndef _L1BASEGMIRSS_SWATHS_
#define _L1BASEGMIRSS_SWATHS_

typedef struct {
    L1BASEGMIRSS_S1 S1;
    L1BASEGMIRSS_S2 S2;
    L1BASEGMIRSS_S3 S3;
    L1BASEGMIRSS_S4 S4;
} L1BASEGMIRSS_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BASEGMIRSS_S4_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
```

```
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S4_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 sunLocalTime(500)
    RECORD /L1BASEGMIRSS_S4_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMIRSS_S4_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Tb(4,500)
    INTEGER*2 count(4,500)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S3_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
```

```
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S3_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 sunLocalTime(500)
    RECORD /L1BASEGMIRSS_S3_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMIRSS_S3_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Tb(9,500)
    INTEGER*2 count(9,500)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S2_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,4)
```

```
    INTEGER*2 coldLoadReading(85,4)
    INTEGER*2 hotLoadnDiodeReading(65,4)
    INTEGER*2 coldLoadnDiodeReading(85,4)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S2_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(4)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,4)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(4)
    INTEGER*2 WarmIntrusionToColdViewIndex(4,85)
END STRUCTURE
```

```
STRUCTURE /L1BASEGMIRSS_S2_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S2_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S2_NEDTINFO/
    REAL*4 NEDTinfo(4)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S2_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,4)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
```

```
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /L1BASEGMIRSS_S2_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMIRSS_S2_SAMPLEHEADER/ sampleHeader
    RECORD /L1BASEGMIRSS_S2_NEDTINFO/ NEDTinfo
    RECORD /NAVIGATION/ navigation
    RECORD /L1BASEGMIRSS_S2_NAV2/ nav2
    RECORD /L1BASEGMIRSS_S2_CALIBRATION/ calibration
    RECORD /L1BASEGMIRSS_S2_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BASEGMIRSS_S2_CALCOUNTS/ calCounts
    RECORD /L1BASEGMIRSS_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    REAL*4 TAMmagneticFieldVector(3)
    INTEGER*2 earthViewCounts(4,221)
    REAL*4 Tb(4,221)
    INTEGER*2 RFIFlag(2,221)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
```

```
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S1_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,9)
    INTEGER*2 coldLoadReading(85,9)
    INTEGER*2 hotLoadnDiodeReading(65,9)
    INTEGER*2 coldLoadnDiodeReading(85,9)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S1_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(9)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,9)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
```

```
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(9)
    INTEGER*2 WarmIntrusionToColdViewIndex(9,85)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S1_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S1_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
```

```
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S1_NEDTINFO/
    REAL*4 NEDTinfo(9)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S1_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,9)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
```

```
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /L1BASEGMIRSS_S1_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMIRSS_S1_SAMPLEHEADER/ sampleHeader
    RECORD /L1BASEGMIRSS_S1_NEDTINFO/ NEDTinfo
    RECORD /NAVIGATION/ navigation
    RECORD /L1BASEGMIRSS_S1_NAV2/ nav2
    RECORD /L1BASEGMIRSS_S1_CALIBRATION/ calibration
    RECORD /L1BASEGMIRSS_S1_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BASEGMIRSS_S1_CALCOUNTS/ calCounts
    RECORD /L1BASEGMIRSS_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    REAL*4 TAMmagneticFieldVector(3)
    INTEGER*2 earthViewCounts(9,221)
    REAL*4 Tb(9,221)
    INTEGER*2 RFIFlag(5,221)
END STRUCTURE

STRUCTURE /L1BASEGMIRSS_SWATHS/
    RECORD /L1BASEGMIRSS_S1/ S1;
    RECORD /L1BASEGMIRSS_S2/ S2;
    RECORD /L1BASEGMIRSS_S3/ S3;
    RECORD /L1BASEGMIRSS_S4/ S4;
END STRUCTURE
```

5.7 1BASEGMIXCAL - GMI Brightness Temperatures

The GMI BASE Product, 1BASEGMIXCAL, "GMI Brightness Temperatures," is written as a multi-Swath Structure. Swath S1 has channels 1-9: 10V 10H 19V 19H 23V 37V 37H 89V 89H. Swath S2 has channels 10-13: 166V 166H 183+/-3V 183+/-8V. S3 S4 are full rotation versions of S1 S2. 1BASEGMIXCAL is like 1BASEGMI but has overlap of 200 scans on each end of S3 and S4. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchan1	9	Number of channels in Swath 1.
nchan2	4	Number of channels in Swath 2.
nfreq1	5	Number of frequencies in Swath 1.
nfreq2	2	Number of frequencies in Swath 2.
npix1	221	Number of pixels in Swath 1.
npix2	221	Number of pixels in Swath 2.
npix3	500	Number of pixels in Swath 3.
npix4	500	Number of pixels in Swath 4.
ncolds1	85	Maximum number of cold samples in Swath 1.
ncolds2	85	Maximum number of cold samples in Swath 2.
nhots1	65	Maximum number of hot samples in Swath 1.
nhots2	65	Maximum number of hot samples in Swath 2.
ntherm	11	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nsamt	4	Number of sample types. The types are: total science GSDR, earth-view, hot load, cold sky.
ntach	32	Number of tachometer readings.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.
nndiode	6	Number of noise diodes.
n7	7	Number seven.
SVBFd	3	SunVectorinBodyFrame dimension.

Figure 190 through Figure 224 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

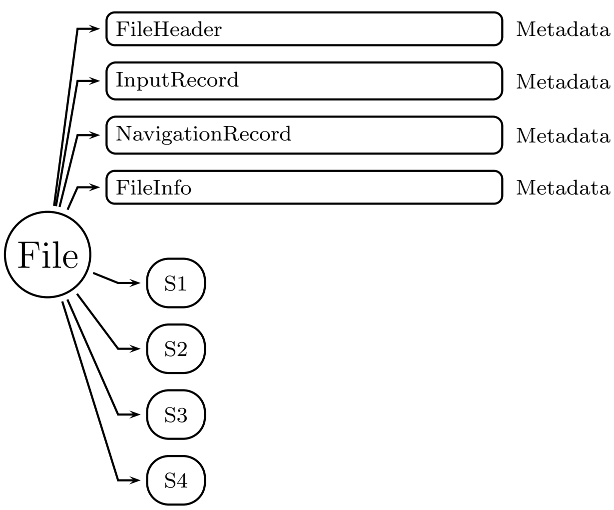
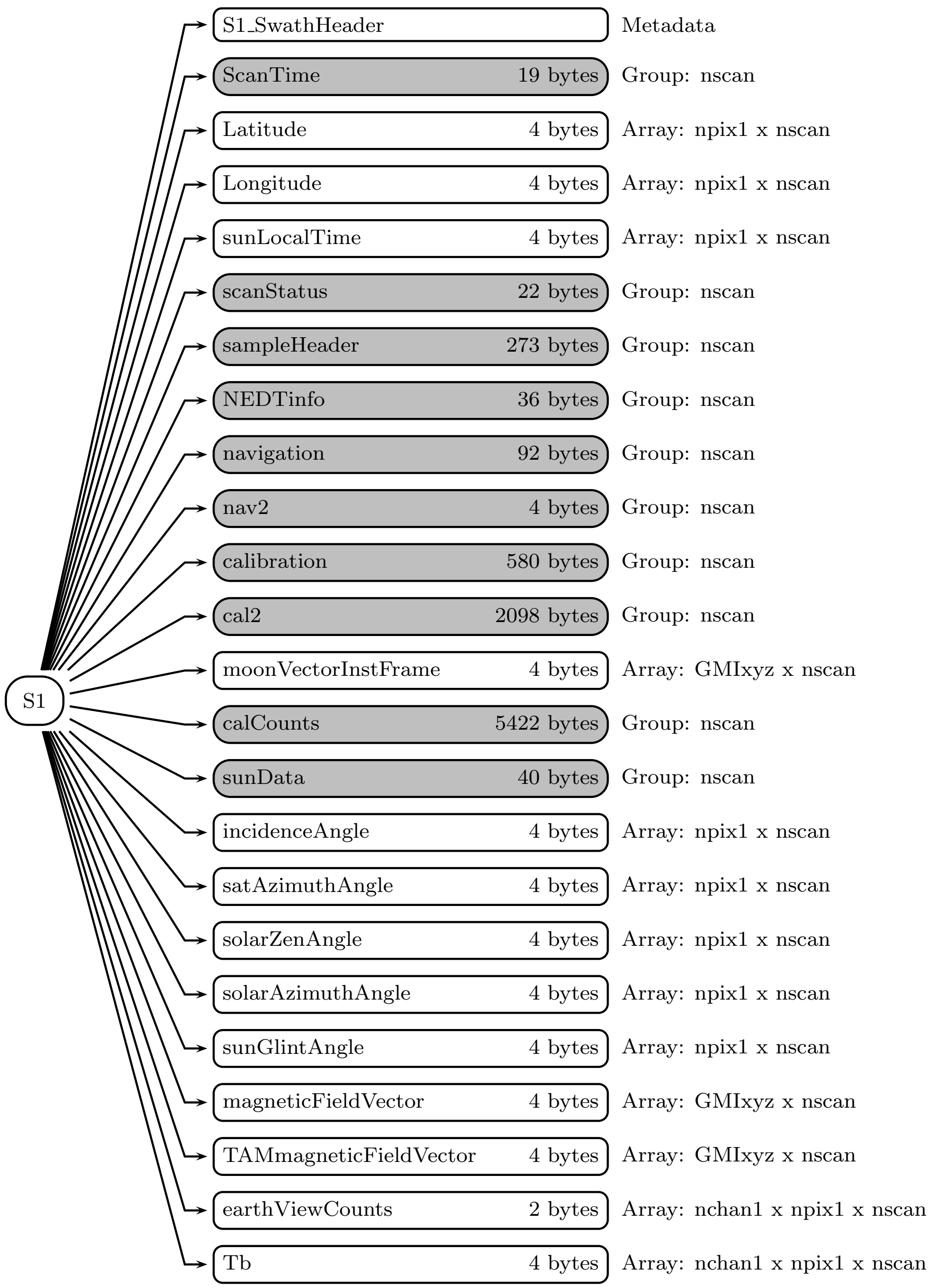


Figure 190: Data Format Structure for 1BASEGMIXCAL, GMI Brightness Temperatures



continued on next figure

Figure 191: Data Format Structure for 1BASEGMIXCAL, S1,

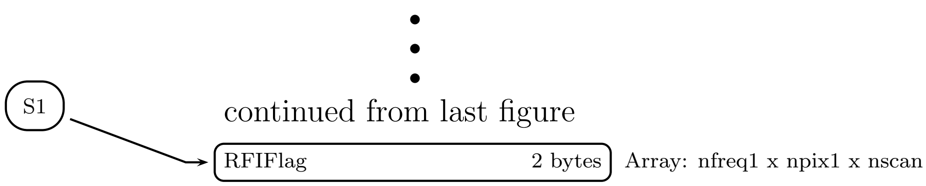


Figure 192: Data Format Structure for 1BASEGMIXCAL, S1

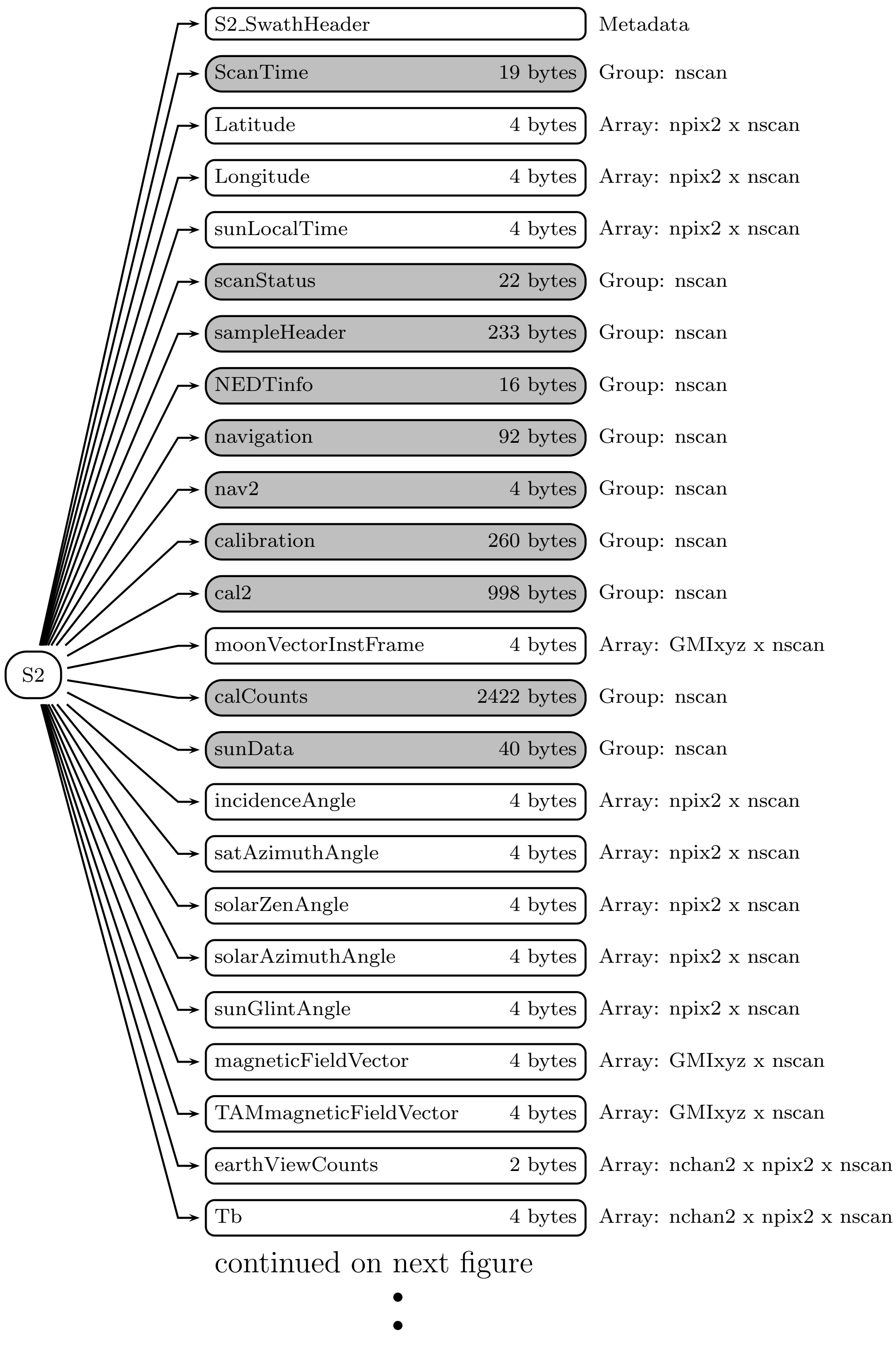


Figure 193: Data Format Structure for 1BASEGMIXCAL, S2,

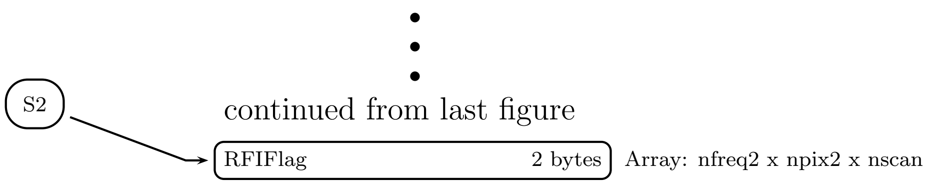


Figure 194: Data Format Structure for 1BASEGMIXCAL, S2

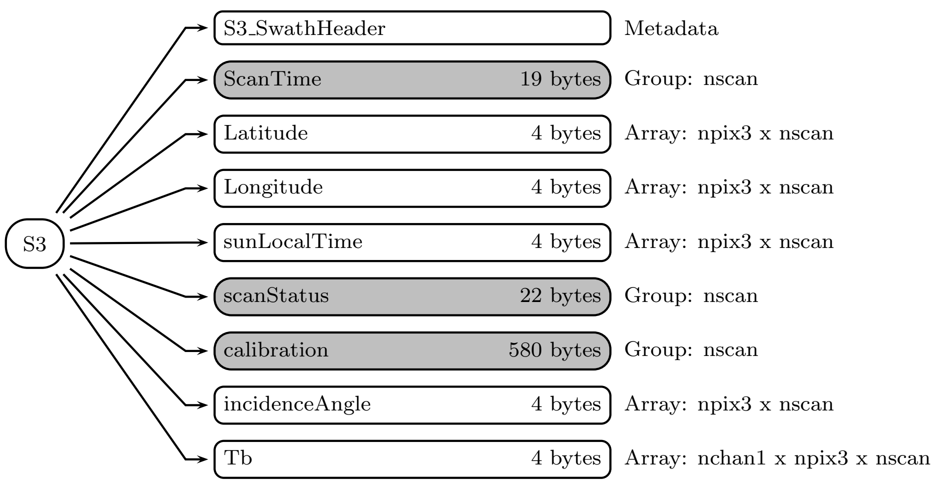


Figure 195: Data Format Structure for 1BASEGMIXCAL, S3

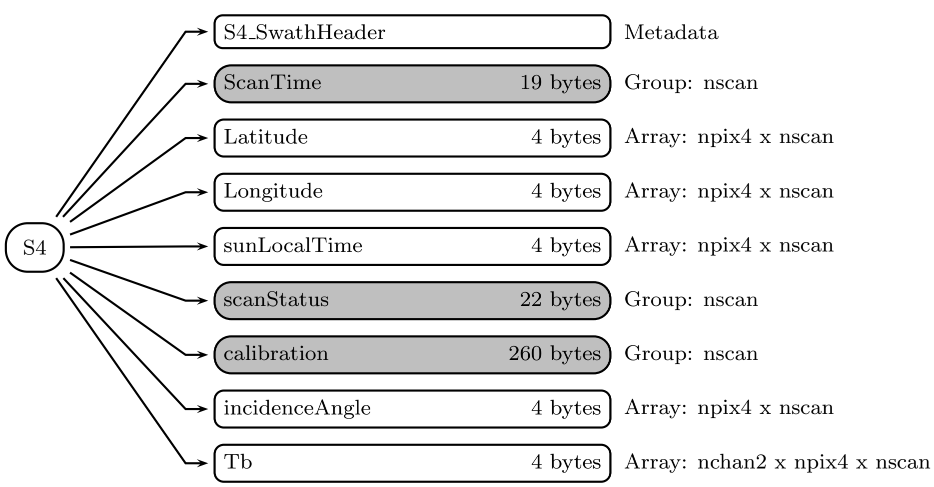


Figure 196: Data Format Structure for 1BASEGMIXCAL, S4

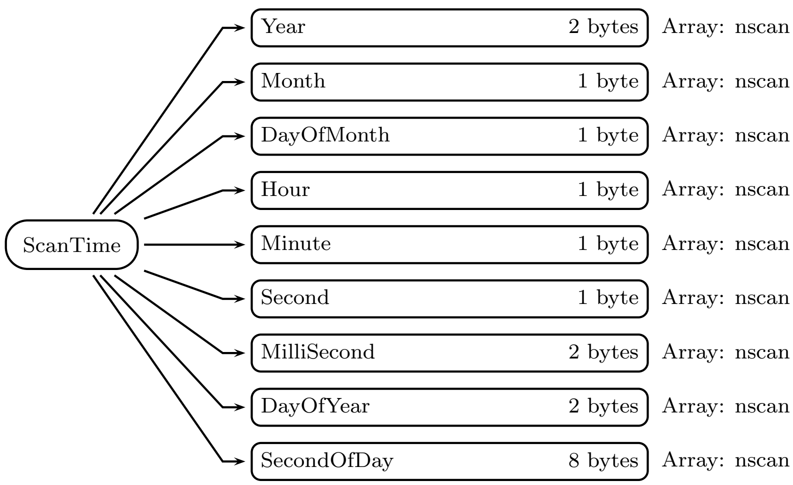


Figure 197: Data Format Structure for 1BASEGMIXCAL, S1, ScanTime

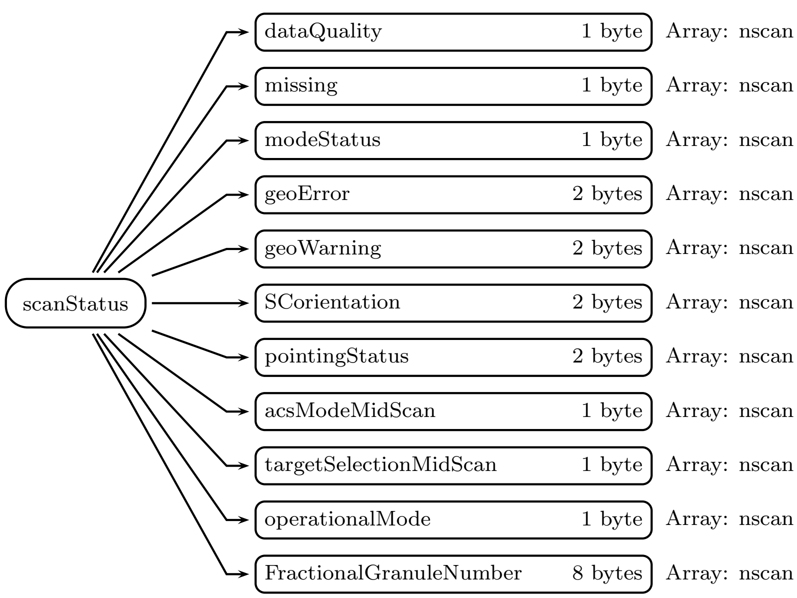


Figure 198: Data Format Structure for 1BASEGMIXCAL, S1, scanStatus

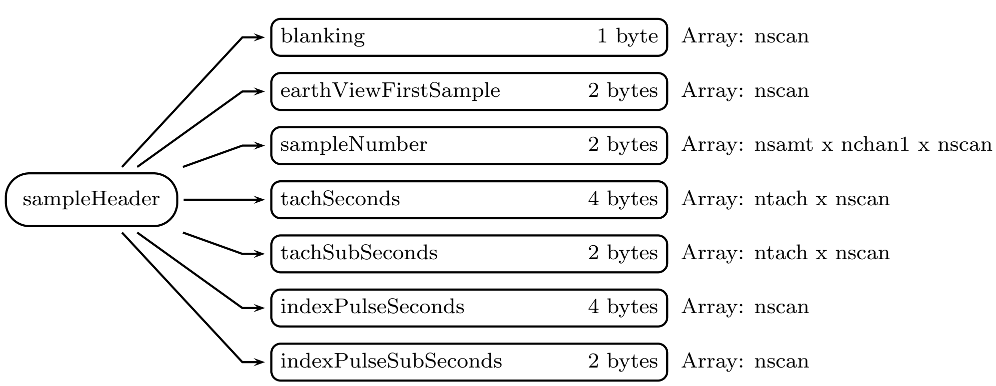


Figure 199: Data Format Structure for 1BASEGMIXCAL, S1, sampleHeader

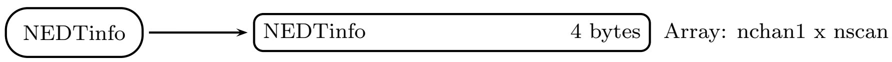


Figure 200: Data Format Structure for 1BASEGMIXCAL, S1, NEDTinfo

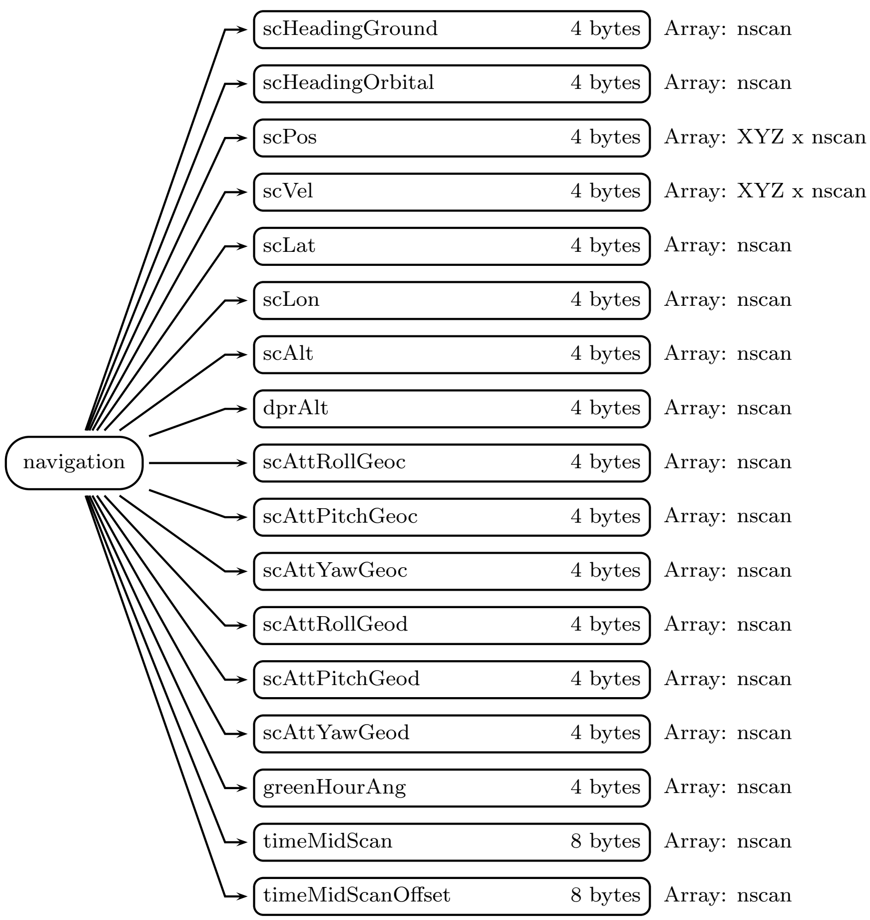


Figure 201: Data Format Structure for 1BASEGMIXCAL, S1, navigation

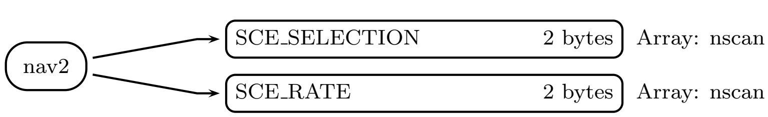


Figure 202: Data Format Structure for 1BASEGMIXCAL, S1, nav2

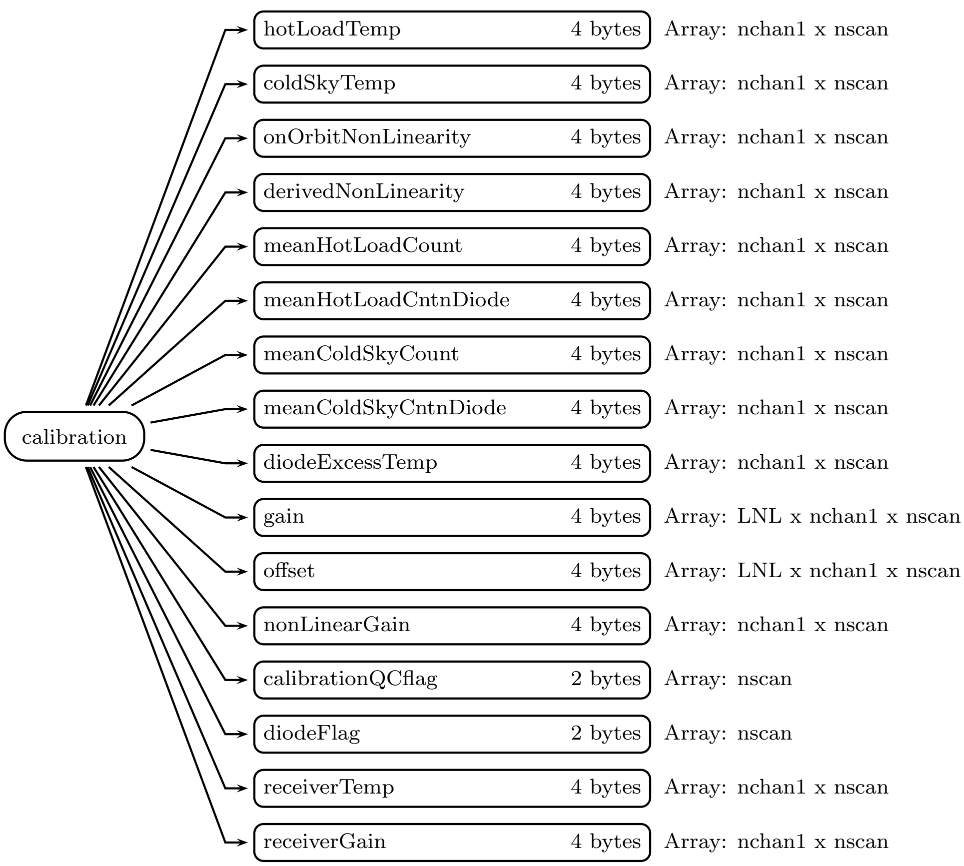


Figure 203: Data Format Structure for 1BASEGMIXCAL, S1, calibration

cal2

trayTemperatureCount	2 bytes	Array: nscan
trayTemperature	4 bytes	Array: nscan
moonIndex	2 bytes	Array: nchan1 x nscan
noiseDiodeTemp	4 bytes	Array: nndiode x nscan
TEMP_CALRES_2	2 bytes	Array: nscan
TEMP_CALRES_1	2 bytes	Array: nscan
RS_CALRES_2	2 bytes	Array: nscan
RS_CALRES_1	2 bytes	Array: nscan
BATC_CALRES_2	2 bytes	Array: nscan
BATC_CALRES_1	2 bytes	Array: nscan
NDIODE_MODE	2 bytes	Array: nscan
RSST_NDIODE_ST	2 bytes	Array: nscan
NDIODE10GHZNUM	2 bytes	Array: nscan
hotLoadThermisterTemp	4 bytes	Array: ntherm x nchan1 x nscan
TEMP_CALRES_4	2 bytes	Array: nscan
TEMP_CALRES_5	2 bytes	Array: nscan
TEMP_CALRES_6	2 bytes	Array: nscan
TEMP_89GHZ_LO	4 bytes	Array: nscan
TEMP_166GHZ_LO	4 bytes	Array: nscan
TEMP_183GHZ_LO	4 bytes	Array: nscan
TEMP_V89GHZMXR	4 bytes	Array: nscan
TEMP_H89GHZMXR	4 bytes	Array: nscan
TEMP_V166GHZMXR	4 bytes	Array: nscan
TEMP_H166GHZMXR	4 bytes	Array: nscan

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Figure 204: Data Format Structure for 1BASEGMIXCAL, S1, cal2,

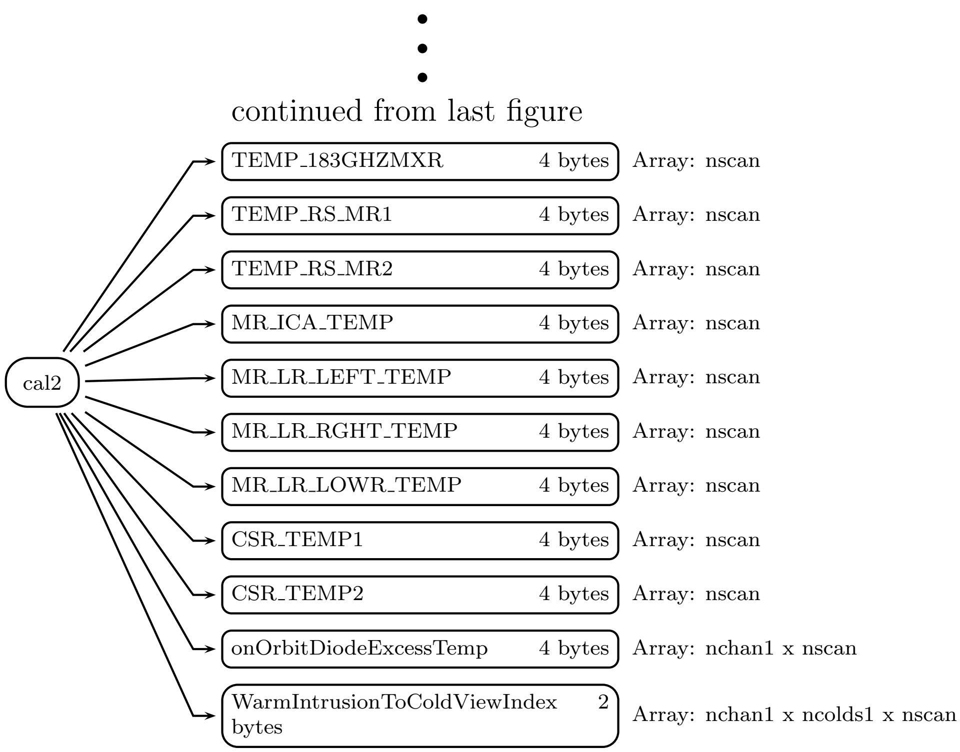

Figure 205: Data Format Structure for 1BASEGMIXCAL, S1, cal2

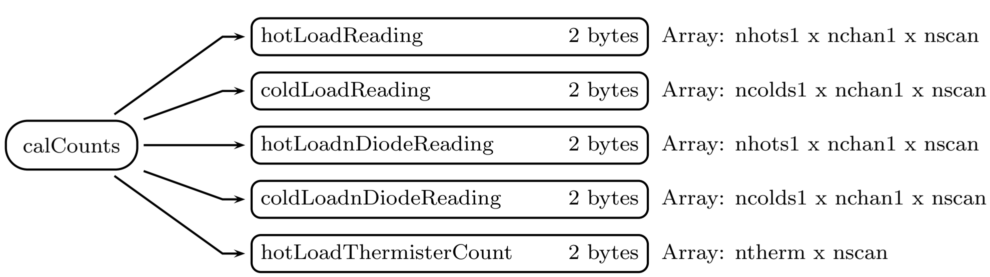

Figure 206: Data Format Structure for 1BASEGMIXCAL, S1, calCounts

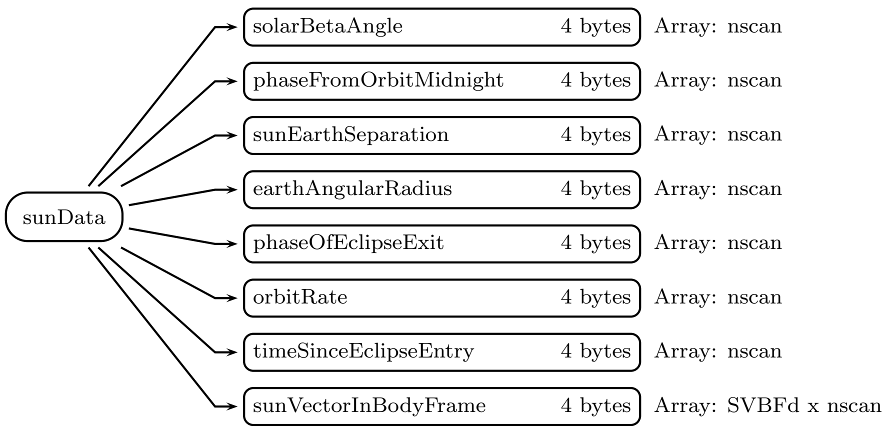

Figure 207: Data Format Structure for 1BASEGMIXCAL, S1, sunData

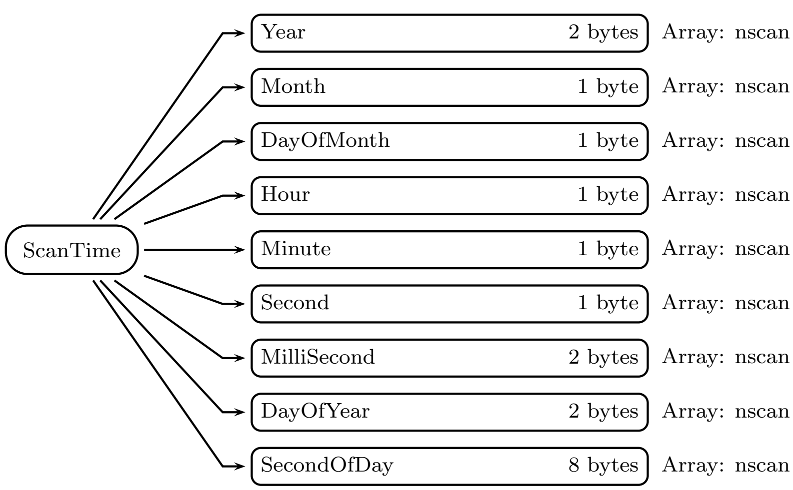

Figure 208: Data Format Structure for 1BASEGMIXCAL, S2, ScanTime

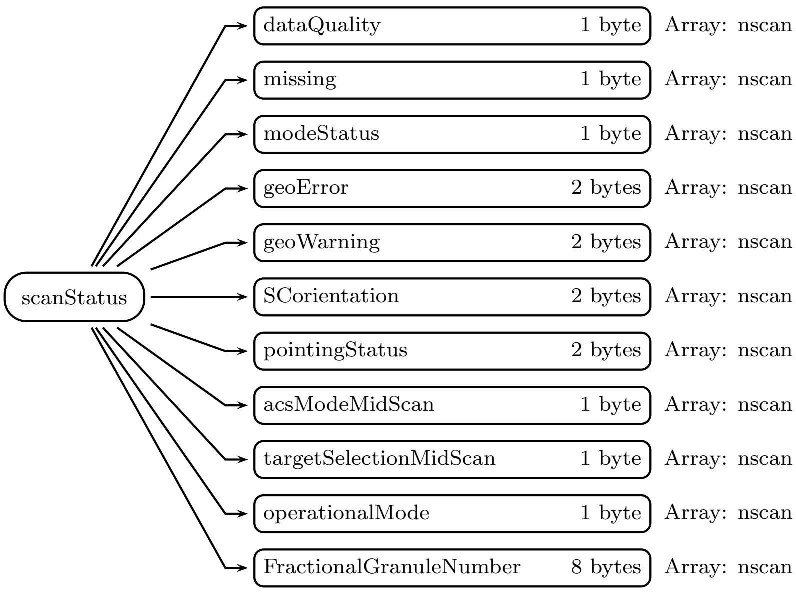

Figure 209: Data Format Structure for 1BASEGMIXCAL, S2, scanStatus

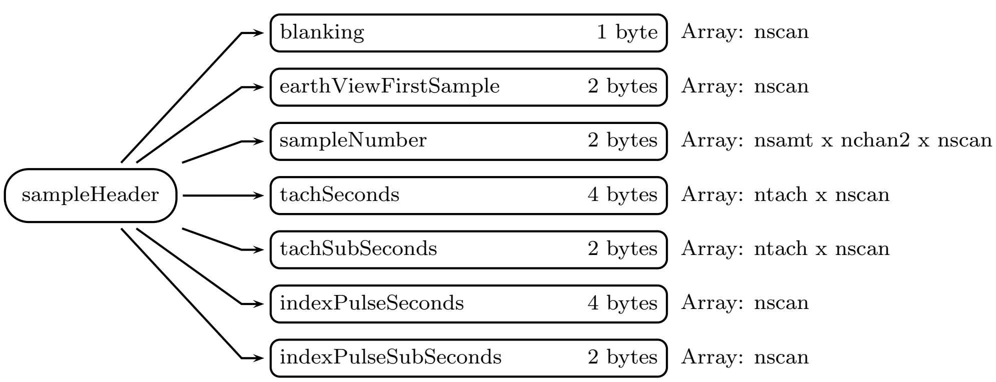

Figure 210: Data Format Structure for 1BASEGMIXCAL, S2, sampleHeader

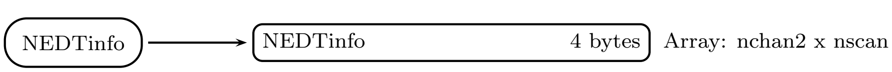

Figure 211: Data Format Structure for 1BASEGMIXCAL, S2, NEDTinfo

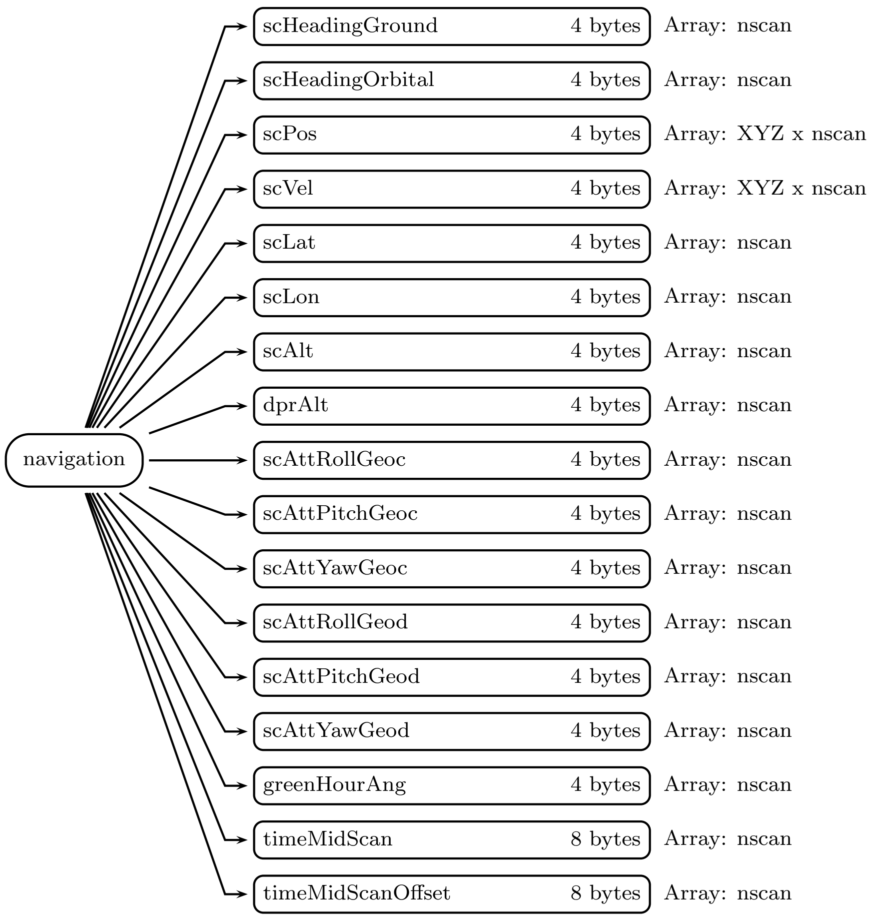

Figure 212: Data Format Structure for 1BASEGMIXCAL, S2, navigation

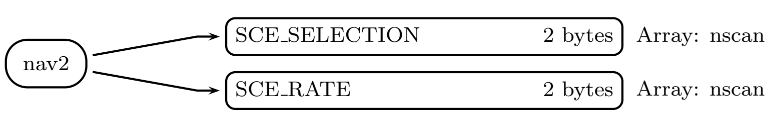

Figure 213: Data Format Structure for 1BASEGMIXCAL, S2, nav2

calibration

hotLoadTemp	4 bytes	Array: nchan2 x nscan
coldSkyTemp	4 bytes	Array: nchan2 x nscan
onOrbitNonLinearity	4 bytes	Array: nchan2 x nscan
derivedNonLinearity	4 bytes	Array: nchan2 x nscan
meanHotLoadCount	4 bytes	Array: nchan2 x nscan
meanHotLoadCntnDiode	4 bytes	Array: nchan2 x nscan
meanColdSkyCount	4 bytes	Array: nchan2 x nscan
meanColdSkyCntnDiode	4 bytes	Array: nchan2 x nscan
diodeExcessTemp	4 bytes	Array: nchan2 x nscan
gain	4 bytes	Array: LNL x nchan2 x nscan
offset	4 bytes	Array: LNL x nchan2 x nscan
nonLinearGain	4 bytes	Array: nchan2 x nscan
calibrationQCflag	2 bytes	Array: nscan
diodeFlag	2 bytes	Array: nscan
receiverTemp	4 bytes	Array: nchan2 x nscan
receiverGain	4 bytes	Array: nchan2 x nscan

Figure 214: Data Format Structure for 1BASEGMIXCAL, S2, calibration

cal2

trayTemperatureCount	2 bytes	Array: nscan
trayTemperature	4 bytes	Array: nscan
moonIndex	2 bytes	Array: nchan2 x nscan
noiseDiodeTemp	4 bytes	Array: nndiode x nscan
TEMP_CALRES_2	2 bytes	Array: nscan
TEMP_CALRES_1	2 bytes	Array: nscan
RS_CALRES_2	2 bytes	Array: nscan
RS_CALRES_1	2 bytes	Array: nscan
BATC_CALRES_2	2 bytes	Array: nscan
BATC_CALRES_1	2 bytes	Array: nscan
NDIODE_MODE	2 bytes	Array: nscan
RSST_NDIODE_ST	2 bytes	Array: nscan
NDIODE10GHZNUM	2 bytes	Array: nscan
hotLoadThermisterTemp	4 bytes	Array: ntherm x nchan2 x nscan
TEMP_CALRES_4	2 bytes	Array: nscan
TEMP_CALRES_5	2 bytes	Array: nscan
TEMP_CALRES_6	2 bytes	Array: nscan
TEMP_89GHZ_LO	4 bytes	Array: nscan
TEMP_166GHZ_LO	4 bytes	Array: nscan
TEMP_183GHZ_LO	4 bytes	Array: nscan
TEMP_V89GHZMXR	4 bytes	Array: nscan
TEMP_H89GHZMXR	4 bytes	Array: nscan
TEMP_V166GHZMXR	4 bytes	Array: nscan
TEMP_H166GHZMXR	4 bytes	Array: nscan

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Figure 215: Data Format Structure for 1BASEGMIXCAL, S2, cal2,

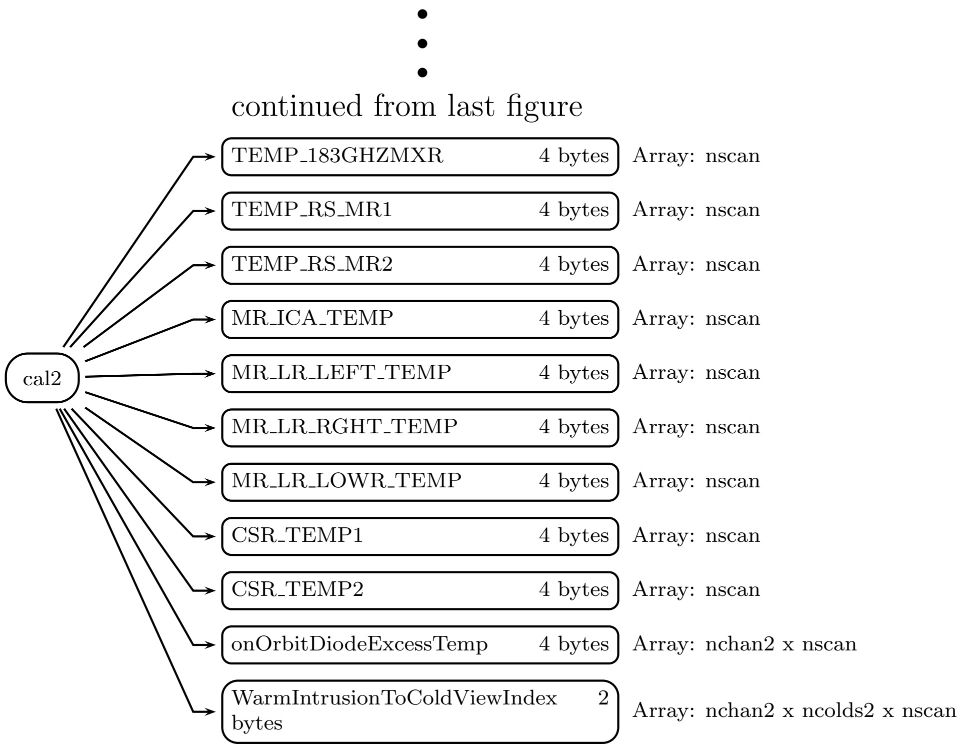


Figure 216: Data Format Structure for 1BASEGMIXCAL, S2, cal2

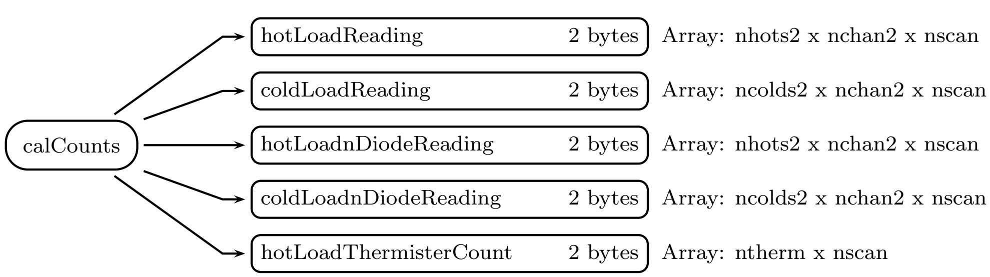


Figure 217: Data Format Structure for 1BASEGMIXCAL, S2, calCounts

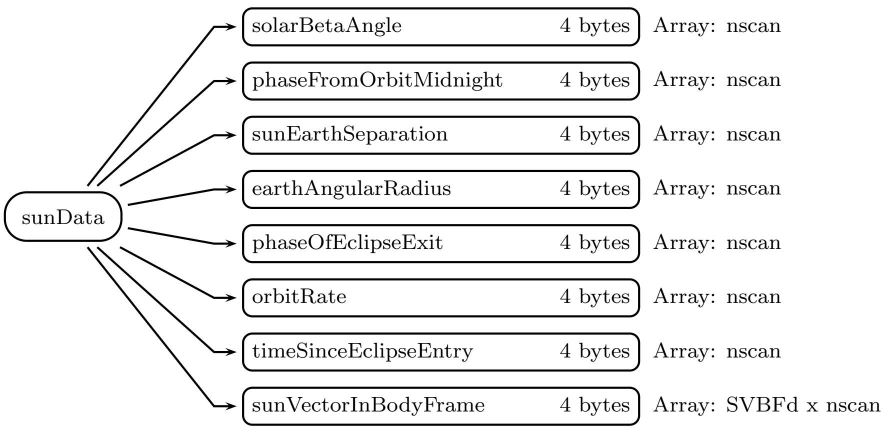


Figure 218: Data Format Structure for 1BASEGMIXCAL, S2, sunData

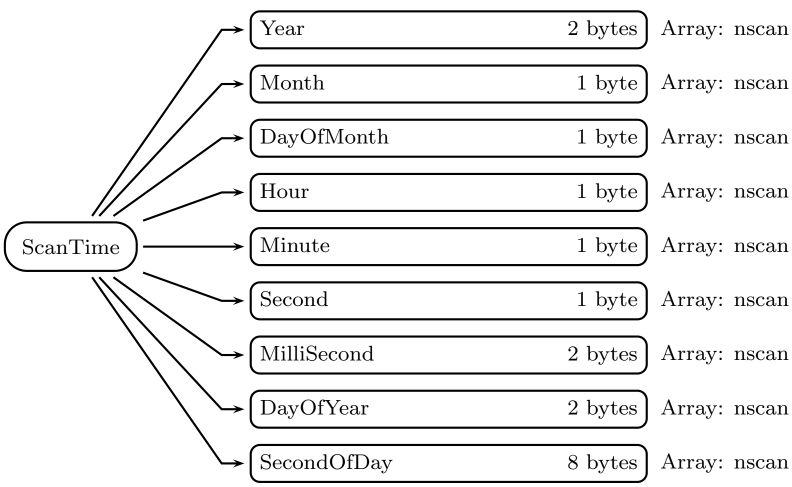


Figure 219: Data Format Structure for 1BASEGMIXCAL, S3, ScanTime

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in

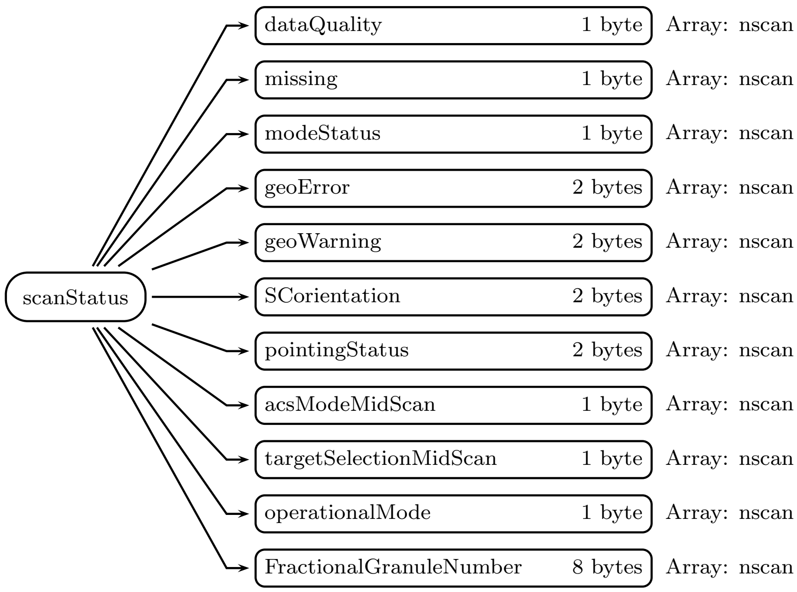


Figure 220: Data Format Structure for 1BASEGMIXCAL, S3, scanStatus

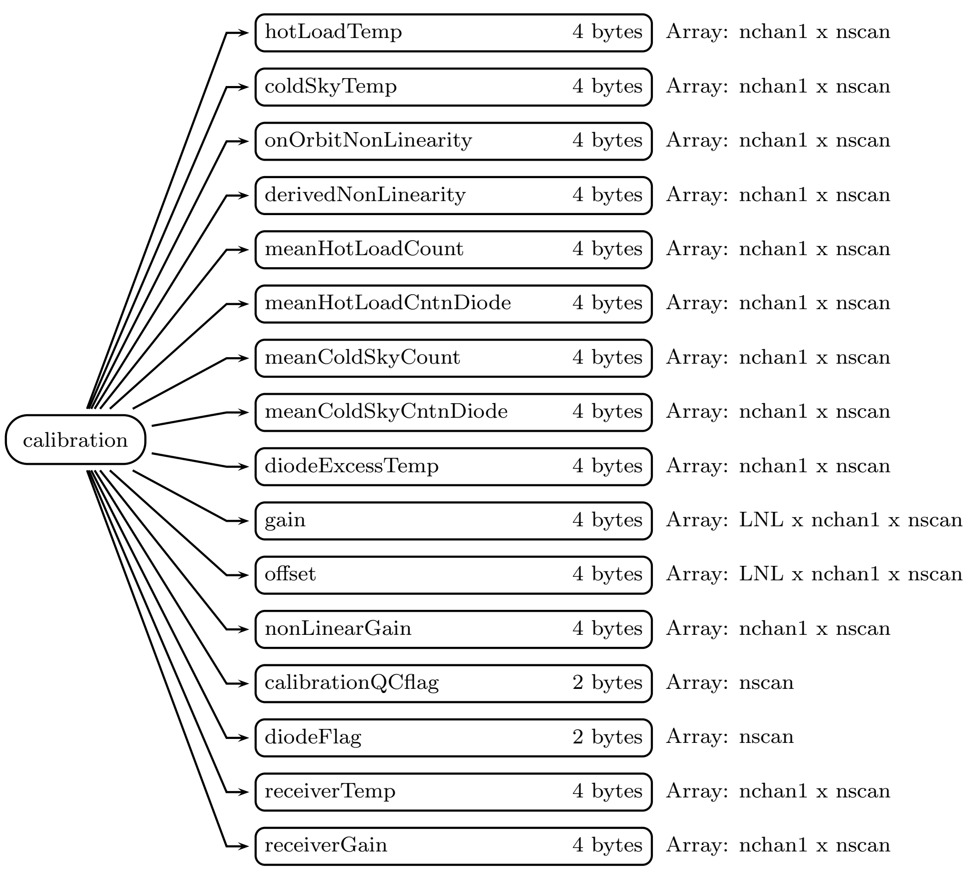


Figure 221: Data Format Structure for 1BASEGMIXCAL, S3, calibration

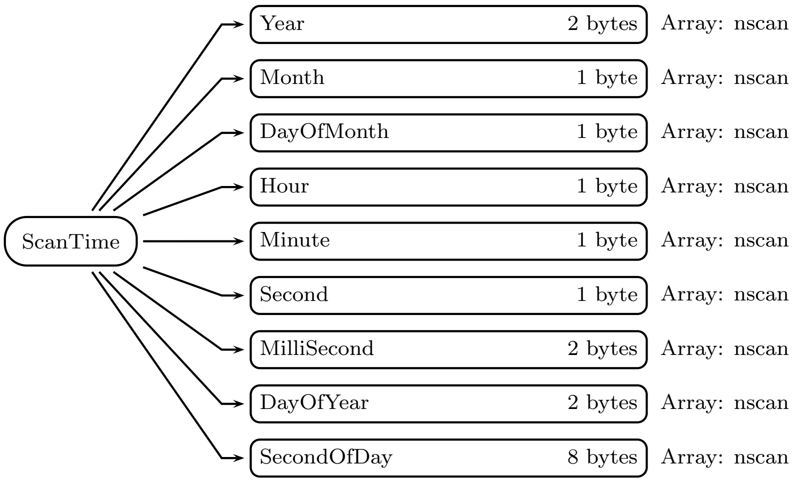


Figure 222: Data Format Structure for 1BASEGMIXCAL, S4, ScanTime

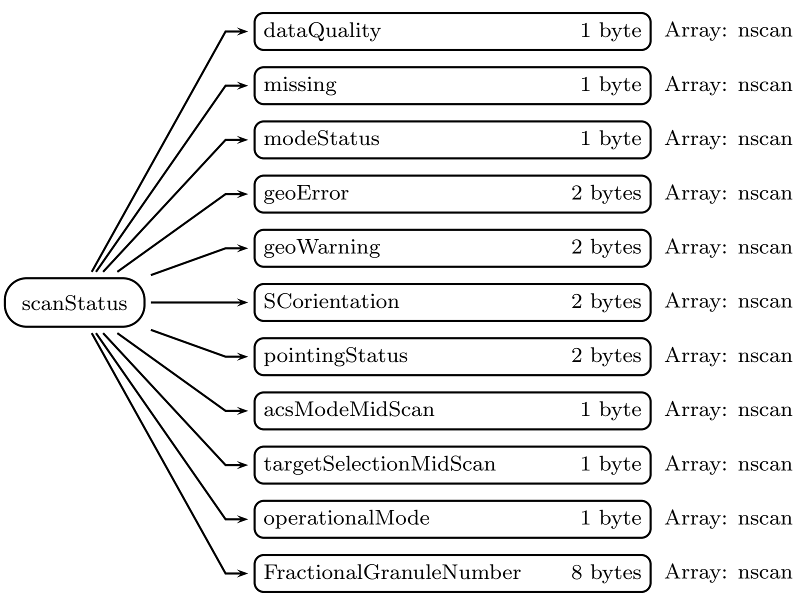


Figure 223: Data Format Structure for 1BASEGMIXCAL, S4, scanStatus

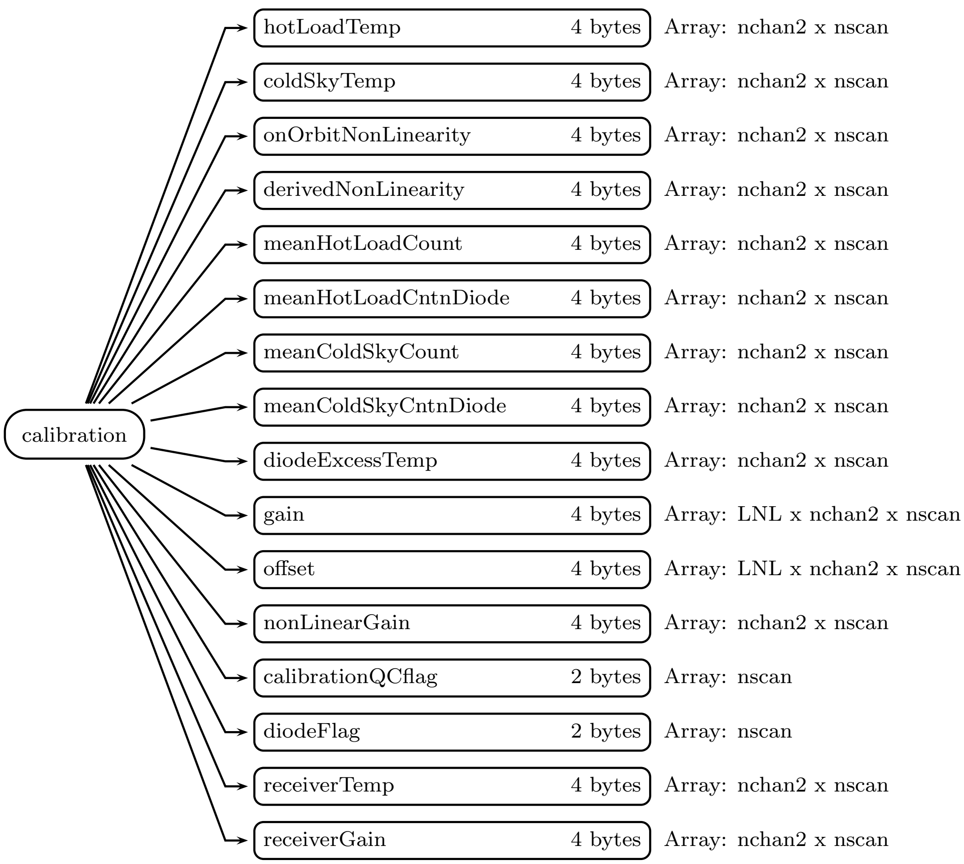


Figure 224: Data Format Structure for 1BASEGMIXCAL, S4, calibration

all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the

day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix1 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix1 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
```

```
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S1)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan1 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

NEDTinfo (Group in S1)

NEDTinfo (4-byte float, array size: nchan1 x nscan):

```
NEDT (Noise Equivalent Differential Temperature) for each channel.
```

navigation (Group in S1)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values

are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S1)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:

-9999.9	Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9	Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:

-9999.9	Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:

-9999.9	Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:

-9999.9	Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:

-9999.9	Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:

-9999.9	Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:

-9999.9	Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:

-9999.9	Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S1)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan1 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:

0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:

0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:

0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:

0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:

0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:

0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:

0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2 = Off. Values range from 0 to 2 count. Special values are defined as:

65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes

ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan1 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan1 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan1 x ncolds1 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are

defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from

0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix1 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix1 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix1 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like)

sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

TAMmagneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetic Field derived from GPM three-axis magnetometer (TAM). Values range from -1000 to 1000 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan1 x npix1 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Tb (4-byte float, array size: nchan1 x npix1 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npix1 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix2 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix2 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix2 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be

useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S2)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Blanking off
Value of 1 = Blanking on
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan2 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Values are in second. Special values are defined as:
0 Missing value

tachSubSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer sub_seconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

indexPulseSeconds (4-byte unsigned integer, array size: nscan):
Index Pulse seconds. Values are in second. Special values are defined as:
0 Missing value

indexPulseSubSeconds (2-byte unsigned integer, array size: nscan):
Index Pulse subseconds. Values range from 0 to 62499 in units of 16 microseconds. The missing value is 65535.

NEDTinfo (Group in S2)

NEDTinfo (4-byte float, array size: nchan2 x nscan):

```
NEDT (Noise Equivalent Differential Temperature) for each channel.
```

navigation (Group in S2)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed

using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coor-

dinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

nav2 (Group in S2)

SCE_SELECTION (2-byte unsigned integer, array size: nscan):
The current SCE selection setting. Special values are defined as:
0 Missing value

SCE_RATE (2-byte unsigned integer, array size: nscan):
The SMA rotational rate reported by the SCE. To obtain the spin rate in RPM, multiply SCE_RATE by 0.002999106 Values range from 1 to 65535 count. Special values are defined as:
0 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values

range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special

values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

cal2 (Group in S2)

trayTemperatureCount (2-byte unsigned integer, array size: nscan):
Counts to derive hot load tray temperature. Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

trayTemperature (4-byte float, array size: nscan):
Derive hot load tray temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

moonIndex (2-byte unsigned integer, array size: nchan2 x nscan):
Index determined by the angle between moon vector and cold sample vectors. 0 means angles between moon vector and all cold view vectors are greater than 5 degrees. Non-zero value means the number of cold samples that may be contaminated by moon. Values range from 0 to 100. Special values are defined as:
0 Missing value

noiseDiodeTemp (4-byte float, array size: nndiode x nscan):
Physical temperature of noise diode. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for PRT temperature retrieval. Values range from

0 to 65535 count. Special values are defined as:
0 Missing value

TEMP_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for PRT temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

RS_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for tray temperature and receiver temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_2 (2-byte unsigned integer, array size: nscan):
Count of high calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

BATC_CALRES_1 (2-byte unsigned integer, array size: nscan):
Count of low calibration resistor used for noise diode temperature retrieval. Values range from 0 to 65535 count. Special values are defined as:
0 Missing value

NDIODE_MODE (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Mode. 0 = On every scan, 1 = On every other scan, 2 = Off. Values range from 0 to 2 count. Special values are defined as:
65535 Missing value

RSST_NDIODE_ST (2-byte unsigned integer, array size: nscan):
Noise diode state during the scan. 0 = Noise diodes OFF for the scan, 1 = Noise diodes ON for the scan. Values range from 0 to 1 count. Special values are defined as:
65535 Missing value

NDIODE10GHZNUM (2-byte unsigned integer, array size: nscan):
RS configuration of Noise Diode Start Sample Number, i.e., the sample number where noise diodes are turned on. Values range from 0 to 500 count. Special values are defined as:
65535 Missing value

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan2 x nscan):
Hot Load Thermister Temperature of 11 PRTs. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

TEMP_CALRES_4 (2-byte unsigned integer, array size: nscan):
Low calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:

0	Missing value

TEMP_CALRES_5 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:

0	Missing value

TEMP_CALRES_6 (2-byte unsigned integer, array size: nscan):
High calibration resistor count. Values range from 0 to 65535 count. Special values are defined as:

0	Missing value

TEMP_89GHZ_LO (4-byte float, array size: nscan):
89 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_166GHZ_LO (4-byte float, array size: nscan):
166 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_183GHZ_LO (4-byte float, array size: nscan):
183 GHZ Local Oscillator Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_V89GHZMXR (4-byte float, array size: nscan):
89 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_H89GHZMXR (4-byte float, array size: nscan):
89 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_V166GHZMXR (4-byte float, array size: nscan):
166 GHZ V channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_H166GHZMXR (4-byte float, array size: nscan):
166 GHZ H channel Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:

-9999.9	Missing value

TEMP_183GHZMXR (4-byte float, array size: nscan):
183 GHZ Mixer PRE-AMP Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR1 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

TEMP_RS_MR2 (4-byte float, array size: nscan):
Main Reflector Temperature Read By RS 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_ICA_TEMP (4-byte float, array size: nscan):
Main Reflector Temperature Read By ICA Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LEFT_TEMP (4-byte float, array size: nscan):
Main Reflector left Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_RGHT_TEMP (4-byte float, array size: nscan):
Main Reflector right Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

MR_LR_LOWR_TEMP (4-byte float, array size: nscan):
Main Reflector lower Launch Restraint Temperature Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP1 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 1 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

CSR_TEMP2 (4-byte float, array size: nscan):
Cold Sky Reflector Temperature 2 Values range from 0 to 500 K. Special values are defined as:
-9999.9 Missing value

onOrbitDiodeExcessTemp (4-byte float, array size: nchan2 x nscan):
Diode Excess Temperature derived from on orbit trended look-up tables as a function of noise diode temperature from telemetry. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

WarmIntrusionToColdViewIndex (2-byte unsigned integer, array size: nchan2 x ncolds2 x nscan):
Index flag to determine if a cold view sample is contaminated by certain warmer sources. If the value is 0, the sample is good and the count is used in calibration. If the value is non-zero, the sample is contaminated and excluded in calibration.

```
0:  Good sample
1:  Bad sample determined by limit check
2:  Bad sample determined by 2D medium filter
```

Values range from 0 to 2. Special values are defined as:
65535 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

hotLoadThermisterCount (2-byte unsigned integer, array size: ntherm x nscan):
Counts from 11 PRTs in the hot load Values range from 0 to 65534 count. Special values are defined as:
65535 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special

values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix2 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix2 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix2 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

magneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetometer volt reading in TAM (x, y, z) coordinate system. Used to perform along-scan correction of earth view counts. (The TAM (x,y,z) coordinate system is similar to GPM S/C coordinate system but y and z axis are rotated by 180 degrees.) Values range from -500 to 500 V. Special values are defined as:
-9999.9 Missing value

TAMmagneticFieldVector (4-byte float, array size: GMIxyz x nscan):
Magnetic Field derived from GPM three-axis magnetometer (TAM). Values range from -1000 to 1000 V. Special values are defined as:
-9999.9 Missing value

earthViewCounts (2-byte unsigned integer, array size: nchan2 x npix2 x nscan):
Earth view counts. Values range from 0 to 65535 counts. Special values are defined as:
0 Missing value

Tb (4-byte float, array size: nchan2 x npix2 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq2 x npix2 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix3 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix3 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix3 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S3)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero,

so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
```

```
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S3)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan1 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan1 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan1 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan1 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix3 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan1 x npix3 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix4 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix4 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix4 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S4)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
```

```
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
```

```
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

calibration (Group in S4)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. For 10, 166, 183 GHZ channles, they are averages of PRT 1,7,8,9,10. For 18, 23, 36, 89 GHZ channels, they are averages of PRT 2,11,12,13,14. The values are corrected by tray temperature and averaged over closest 5 scans Values range from 0 to 400 K. Special

values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity Tnl computed from ground calibrated u look-up table . Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
Non-Linearity Tnl derived from 4-point calibration. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (4-byte float, array size: nchan2 x nscan):
The mean Hot Load Count. Averaged over all Hot samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanHotLoadCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Hot Load Plus Noise Diode counts Averaged over all samples and closest 5 scans. Values range from 0 to 65535. Special values are defined as:
-9999.9 Missing value

meanColdSkyCount (4-byte float, array size: nchan2 x nscan):
The mean Cold Sky Count.Averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

meanColdSkyCntnDiode (4-byte float, array size: nchan2 x nscan):
The mean coupled Cold Sky Plus Noise Diode counts, averaged over all samples and closest 5 scans. Values range from 0 to 65535 count. Special values are defined as:
-9999.9 Missing value

diodeExcessTemp (4-byte float, array size: nchan2 x nscan):
The Noise Diode Excess Temperature. Cold and diode Coupled Temperature=diodeExcessTemp + coldSkyTemp. Hot and diode Coupled Temperature=diodeExcessTemp + hotLoadTemp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
gain[0] determine the total Ta gain. Ta=offset[0]+gain[0]*earthCount+ nonLinearGaian*earthCount*earthCount. Nonlinearity=offset[1]+gain[1]*earthCount+ nonLinearGaian*earthCount*earthCount. Values range from 0 to 1 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset[0] determine the total Ta offset. min=-999 K (from -1 K), max=999 K (from 1 K). Missing value is -9999.9.

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Values range from -1 to 1 K. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. value 0 indicates good calibration. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

```
Diode flag.
0, Noise Diode on
2, Noise Diode off
5, Noise Diode status unknown
```

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix4 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan2 x npix4 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_1BASEGMIXCAL_H_
#define _TK_1BASEGMIXCAL_H_

#ifndef _L1BASEGMIXCAL_S4_CALIBRATION_
#define _L1BASEGMIXCAL_S4_CALIBRATION_

typedef struct {
```

```
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} L1BASEGMIXCAL_S4_CALIBRATION;

#endif

#ifndef _L1BASEGMIXCAL_S4_SCANSTATUS_
#define _L1BASEGMIXCAL_S4_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BASEGMIXCAL_S4_SCANSTATUS;

#endif

#ifndef _L1BASEGMIXCAL_S4_
#define _L1BASEGMIXCAL_S4_

typedef struct {
```

```
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    float sunLocalTime[500];
    L1BASEGMIXCAL_S4_SCANSTATUS scanStatus;
    L1BASEGMIXCAL_S4_CALIBRATION calibration;
    float incidenceAngle[500];
    float Tb[500][4];
} L1BASEGMIXCAL_S4;

#endif

#ifndef _L1BASEGMIXCAL_S3_CALIBRATION_
#define _L1BASEGMIXCAL_S3_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} L1BASEGMIXCAL_S3_CALIBRATION;

#endif

#ifndef _L1BASEGMIXCAL_S3_SCANSTATUS_
#define _L1BASEGMIXCAL_S3_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
```

```
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BASEGMIXCAL_S3_SCANSTATUS;

#endif

#ifndef _L1BASEGMIXCAL_S3_
#define _L1BASEGMIXCAL_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[500];
    float Longitude[500];
    float sunLocalTime[500];
    L1BASEGMIXCAL_S3_SCANSTATUS scanStatus;
    L1BASEGMIXCAL_S3_CALIBRATION calibration;
    float incidenceAngle[500];
    float Tb[500][9];
} L1BASEGMIXCAL_S3;

#endif

#ifndef _L1BASEGMIXCAL_S2_SUNDATA_
#define _L1BASEGMIXCAL_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BASEGMIXCAL_S2_SUNDATA;

#endif
```

```
#ifndef _L1BASEGMIXCAL_S2_CALCOUNTS_
#define _L1BASEGMIXCAL_S2_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[4][65];
    unsigned short coldLoadReading[4][85];
    unsigned short hotLoadnDiodeReading[4][65];
    unsigned short coldLoadnDiodeReading[4][85];
    unsigned short hotLoadThermisterCount[11];
} L1BASEGMIXCAL_S2_CALCOUNTS;

#endif

#ifndef _L1BASEGMIXCAL_S2_CAL2_
#define _L1BASEGMIXCAL_S2_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[4];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[4][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
```

```
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[4];
    unsigned short WarmIntrusionToColdViewIndex[85][4];
} L1BASEGMIXCAL_S2_CAL2;

#endif

#ifndef _L1BASEGMIXCAL_S2_CALIBRATION_
#define _L1BASEGMIXCAL_S2_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    float meanHotLoadCount[4];
    float meanHotLoadCntnDiode[4];
    float meanColdSkyCount[4];
    float meanColdSkyCntnDiode[4];
    float diodeExcessTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} L1BASEGMIXCAL_S2_CALIBRATION;

#endif

#ifndef _L1BASEGMIXCAL_S2_NAV2_
#define _L1BASEGMIXCAL_S2_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
```

```
    unsigned short SCE_RATE;
} L1BASEGMIXCAL_S2_NAV2;

#endif

#ifndef _L1BASEGMIXCAL_S2_NEDTINFO_
#define _L1BASEGMIXCAL_S2_NEDTINFO_

typedef struct {
    float NEDTinfo[4];
} L1BASEGMIXCAL_S2_NEDTINFO;

#endif

#ifndef _L1BASEGMIXCAL_S2_SAMPLEHEADER_
#define _L1BASEGMIXCAL_S2_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[4][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} L1BASEGMIXCAL_S2_SAMPLEHEADER;

#endif

#ifndef _L1BASEGMIXCAL_S2_SCANSTATUS_
#define _L1BASEGMIXCAL_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
```

```
    double FractionalGranuleNumber;
} L1BASEGMIXCAL_S2_SCANSTATUS;

#endif

#ifndef _L1BASEGMIXCAL_S2_
#define _L1BASEGMIXCAL_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    L1BASEGMIXCAL_S2_SCANSTATUS scanStatus;
    L1BASEGMIXCAL_S2_SAMPLEHEADER sampleHeader;
    L1BASEGMIXCAL_S2_NEDTINFO NEDTinfo;
    NAVIGATION navigation;
    L1BASEGMIXCAL_S2_NAV2 nav2;
    L1BASEGMIXCAL_S2_CALIBRATION calibration;
    L1BASEGMIXCAL_S2_CAL2 cal2;
    float moonVectorInstFrame[3];
    L1BASEGMIXCAL_S2_CALCOUNTS calCounts;
    L1BASEGMIXCAL_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    float TAMmagneticFieldVector[3];
    unsigned short earthViewCounts[221][4];
    float Tb[221][4];
    short RFIFlag[221][2];
} L1BASEGMIXCAL_S2;

#endif

#ifndef _L1BASEGMIXCAL_S1_SUNDATA_
#define _L1BASEGMIXCAL_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
```

```
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BASEGMIXCAL_S1_SUNDATA;

#endif

#ifndef _L1BASEGMIXCAL_S1_CALCOUNTS_
#define _L1BASEGMIXCAL_S1_CALCOUNTS_

typedef struct {
    unsigned short hotLoadReading[9][65];
    unsigned short coldLoadReading[9][85];
    unsigned short hotLoadnDiodeReading[9][65];
    unsigned short coldLoadnDiodeReading[9][85];
    unsigned short hotLoadThermisterCount[11];
} L1BASEGMIXCAL_S1_CALCOUNTS;

#endif

#ifndef _L1BASEGMIXCAL_S1_CAL2_
#define _L1BASEGMIXCAL_S1_CAL2_

typedef struct {
    unsigned short trayTemperatureCount;
    float trayTemperature;
    unsigned short moonIndex[9];
    float noiseDiodeTemp[6];
    unsigned short TEMP_CALRES_2;
    unsigned short TEMP_CALRES_1;
    unsigned short RS_CALRES_2;
    unsigned short RS_CALRES_1;
    unsigned short BATC_CALRES_2;
    unsigned short BATC_CALRES_1;
    unsigned short NDIODE_MODE;
    unsigned short RSST_NDIODE_ST;
    unsigned short NDIODE10GHZNUM;
    float hotLoadThermisterTemp[9][11];
    unsigned short TEMP_CALRES_4;
    unsigned short TEMP_CALRES_5;
```

```
    unsigned short TEMP_CALRES_6;
    float TEMP_89GHZ_LO;
    float TEMP_166GHZ_LO;
    float TEMP_183GHZ_LO;
    float TEMP_V89GHZMXR;
    float TEMP_H89GHZMXR;
    float TEMP_V166GHZMXR;
    float TEMP_H166GHZMXR;
    float TEMP_183GHZMXR;
    float TEMP_RS_MR1;
    float TEMP_RS_MR2;
    float MR_ICA_TEMP;
    float MR_LR_LEFT_TEMP;
    float MR_LR_RGHT_TEMP;
    float MR_LR_LOWR_TEMP;
    float CSR_TEMP1;
    float CSR_TEMP2;
    float onOrbitDiodeExcessTemp[9];
    unsigned short WarmIntrusionToColdViewIndex[85][9];
} L1BASEGMIXCAL_S1_CAL2;

#endif

#ifndef _L1BASEGMIXCAL_S1_CALIBRATION_
#define _L1BASEGMIXCAL_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    float meanHotLoadCount[9];
    float meanHotLoadCntnDiode[9];
    float meanColdSkyCount[9];
    float meanColdSkyCntnDiode[9];
    float diodeExcessTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
```

```
} L1BASEGMIXCAL_S1_CALIBRATION;

#endif

#ifndef _L1BASEGMIXCAL_S1_NAV2_
#define _L1BASEGMIXCAL_S1_NAV2_

typedef struct {
    unsigned short SCE_SELECTION;
    unsigned short SCE_RATE;
} L1BASEGMIXCAL_S1_NAV2;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1BASEGMIXCAL_S1_NEDTINFO_
#define _L1BASEGMIXCAL_S1_NEDTINFO_

typedef struct {
```

```
    float NEDTinfo[9];
} L1BASEGMIXCAL_S1_NEDTINFO;

#endif

#ifndef _L1BASEGMIXCAL_S1_SAMPLEHEADER_
#define _L1BASEGMIXCAL_S1_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[9][4];
    unsigned int tachSeconds[32];
    unsigned short tachSubSeconds[32];
    unsigned int indexPulseSeconds;
    unsigned short indexPulseSubSeconds;
} L1BASEGMIXCAL_S1_SAMPLEHEADER;

#endif

#ifndef _L1BASEGMIXCAL_S1_SCANSTATUS_
#define _L1BASEGMIXCAL_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BASEGMIXCAL_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
```

```
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASEGMIXCAL_S1_
#define _L1BASEGMIXCAL_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    L1BASEGMIXCAL_S1_SCANSTATUS scanStatus;
    L1BASEGMIXCAL_S1_SAMPLEHEADER sampleHeader;
    L1BASEGMIXCAL_S1_NEDTINFO NEDTinfo;
    NAVIGATION navigation;
    L1BASEGMIXCAL_S1_NAV2 nav2;
    L1BASEGMIXCAL_S1_CALIBRATION calibration;
    L1BASEGMIXCAL_S1_CAL2 cal2;
    float moonVectorInstFrame[3];
    L1BASEGMIXCAL_S1_CALCOUNTS calCounts;
    L1BASEGMIXCAL_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float magneticFieldVector[3];
    float TAMmagneticFieldVector[3];
    unsigned short earthViewCounts[221][9];
    float Tb[221][9];
    short RFIFlag[221][5];
} L1BASEGMIXCAL_S1;
```

```
#endif

#ifndef _L1BASEGMIXCAL_SWATHS_
#define _L1BASEGMIXCAL_SWATHS_

typedef struct {
    L1BASEGMIXCAL_S1 S1;
    L1BASEGMIXCAL_S2 S2;
    L1BASEGMIXCAL_S3 S3;
    L1BASEGMIXCAL_S4 S4;
} L1BASEGMIXCAL_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BASEGMIXCAL_S4_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S4_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
```

```
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 sunLocalTime(500)
    RECORD /L1BASEGMIXCAL_S4_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMIXCAL_S4_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Tb(4,500)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S3_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S3_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
```

```
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(500)
    REAL*4 Longitude(500)
    REAL*4 sunLocalTime(500)
    RECORD /L1BASEGMIXCAL_S3_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMIXCAL_S3_CALIBRATION/ calibration
    REAL*4 incidenceAngle(500)
    REAL*4 Tb(9,500)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S2_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,4)
    INTEGER*2 coldLoadReading(85,4)
    INTEGER*2 hotLoadnDiodeReading(65,4)
    INTEGER*2 coldLoadnDiodeReading(85,4)
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S2_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(4)
```

```
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,4)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(4)
    INTEGER*2 WarmIntrusionToColdViewIndex(4,85)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S2_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    REAL*4 meanHotLoadCount(4)
    REAL*4 meanHotLoadCntnDiode(4)
    REAL*4 meanColdSkyCount(4)
    REAL*4 meanColdSkyCntnDiode(4)
```

```
    REAL*4 diodeExcessTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S2_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S2_NEDTINFO/
    REAL*4 NEDTinfo(4)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S2_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,4)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE
```

```
STRUCTURE /L1BASEGMIXCAL_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /L1BASEGMIXCAL_S2_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMIXCAL_S2_SAMPLEHEADER/ sampleHeader
    RECORD /L1BASEGMIXCAL_S2_NEDTINFO/ NEDTinfo
    RECORD /NAVIGATION/ navigation
    RECORD /L1BASEGMIXCAL_S2_NAV2/ nav2
    RECORD /L1BASEGMIXCAL_S2_CALIBRATION/ calibration
    RECORD /L1BASEGMIXCAL_S2_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BASEGMIXCAL_S2_CALCOUNTS/ calCounts
    RECORD /L1BASEGMIXCAL_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    REAL*4 TAMmagneticFieldVector(3)
    INTEGER*2 earthViewCounts(4,221)
    REAL*4 Tb(4,221)
    INTEGER*2 RFIFlag(2,221)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S1_CALCOUNTS/
    INTEGER*2 hotLoadReading(65,9)
    INTEGER*2 coldLoadReading(85,9)
    INTEGER*2 hotLoadnDiodeReading(65,9)
    INTEGER*2 coldLoadnDiodeReading(85,9)
```

```
    INTEGER*2 hotLoadThermisterCount(11)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S1_CAL2/
    INTEGER*2 trayTemperatureCount
    REAL*4 trayTemperature
    INTEGER*2 moonIndex(9)
    REAL*4 noiseDiodeTemp(6)
    INTEGER*2 TEMP_CALRES_2
    INTEGER*2 TEMP_CALRES_1
    INTEGER*2 RS_CALRES_2
    INTEGER*2 RS_CALRES_1
    INTEGER*2 BATC_CALRES_2
    INTEGER*2 BATC_CALRES_1
    INTEGER*2 NDIODE_MODE
    INTEGER*2 RSST_NDIODE_ST
    INTEGER*2 NDIODE10GHZNUM
    REAL*4 hotLoadThermisterTemp(11,9)
    INTEGER*2 TEMP_CALRES_4
    INTEGER*2 TEMP_CALRES_5
    INTEGER*2 TEMP_CALRES_6
    REAL*4 TEMP_89GHZ_LO
    REAL*4 TEMP_166GHZ_LO
    REAL*4 TEMP_183GHZ_LO
    REAL*4 TEMP_V89GHZMXR
    REAL*4 TEMP_H89GHZMXR
    REAL*4 TEMP_V166GHZMXR
    REAL*4 TEMP_H166GHZMXR
    REAL*4 TEMP_183GHZMXR
    REAL*4 TEMP_RS_MR1
    REAL*4 TEMP_RS_MR2
    REAL*4 MR_ICA_TEMP
    REAL*4 MR_LR_LEFT_TEMP
    REAL*4 MR_LR_RGHT_TEMP
    REAL*4 MR_LR_LOWR_TEMP
    REAL*4 CSR_TEMP1
    REAL*4 CSR_TEMP2
    REAL*4 onOrbitDiodeExcessTemp(9)
    INTEGER*2 WarmIntrusionToColdViewIndex(9,85)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S1_CALIBRATION/
    REAL*4 hotLoadTemp(9)
```

```
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    REAL*4 meanHotLoadCount(9)
    REAL*4 meanHotLoadCntnDiode(9)
    REAL*4 meanColdSkyCount(9)
    REAL*4 meanColdSkyCntnDiode(9)
    REAL*4 diodeExcessTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S1_NAV2/
    INTEGER*2 SCE_SELECTION
    INTEGER*2 SCE_RATE
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S1_NEDTINFO/
```

```
    REAL*4 NEDTinfo(9)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S1_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,9)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachSubSeconds(32)
    INTEGER*4 indexPulseSeconds
    INTEGER*2 indexPulseSubSeconds
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
```

```
    REAL*4 sunLocalTime(221)
    RECORD /L1BASEGMIXCAL_S1_SCANSTATUS/ scanStatus
    RECORD /L1BASEGMIXCAL_S1_SAMPLEHEADER/ sampleHeader
    RECORD /L1BASEGMIXCAL_S1_NEDTINFO/ NEDTinfo
    RECORD /NAVIGATION/ navigation
    RECORD /L1BASEGMIXCAL_S1_NAV2/ nav2
    RECORD /L1BASEGMIXCAL_S1_CALIBRATION/ calibration
    RECORD /L1BASEGMIXCAL_S1_CAL2/ cal2
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BASEGMIXCAL_S1_CALCOUNTS/ calCounts
    RECORD /L1BASEGMIXCAL_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 magneticFieldVector(3)
    REAL*4 TAMmagneticFieldVector(3)
    INTEGER*2 earthViewCounts(9,221)
    REAL*4 Tb(9,221)
    INTEGER*2 RFIFlag(5,221)
END STRUCTURE

STRUCTURE /L1BASEGMIXCAL_SWATHS/
    RECORD /L1BASEGMIXCAL_S1/ S1;
    RECORD /L1BASEGMIXCAL_S2/ S2;
    RECORD /L1BASEGMIXCAL_S3/ S3;
    RECORD /L1BASEGMIXCAL_S4/ S4;
END STRUCTURE
```

5.8 1BASESSMI - SSMI base

1BASESSMI contains both antenna temperature and brightness temperature. These files contain all the information from the TDR files plus additions Wesley Berg made creating fcdr files plus the isMissing flag. 1BASESSMI is written as one swath, but the 1C product will have 2 swaths.

NOTE: the filespec does not draw the swath. NOTE: ranges may be wrong

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel1	64	Number pixels for low res.
npixel2	128	Number pixels for high res.
nchan1	5	Number pixels for low res.
nchan2	2	Number pixels for high res.
scandim	2	Number scan array dim (A scan, B scan).
loaddim	5	Number of (hot or cold) load array dimensions.
timedim	6	Number of time array dim (year, month, day, hour, minute, second, and millisecond)
one	1	Number one.
ntest	9	Number of quality tests.

Figure 225 through Figure 232 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

spacecraft_id (4-byte integer, array size: one):
Satellite ID number.

ascend_time (4-byte integer, array size: timedim):
Ascending time.

TLE_xtime (8-byte float, array size: one):
TLE time.

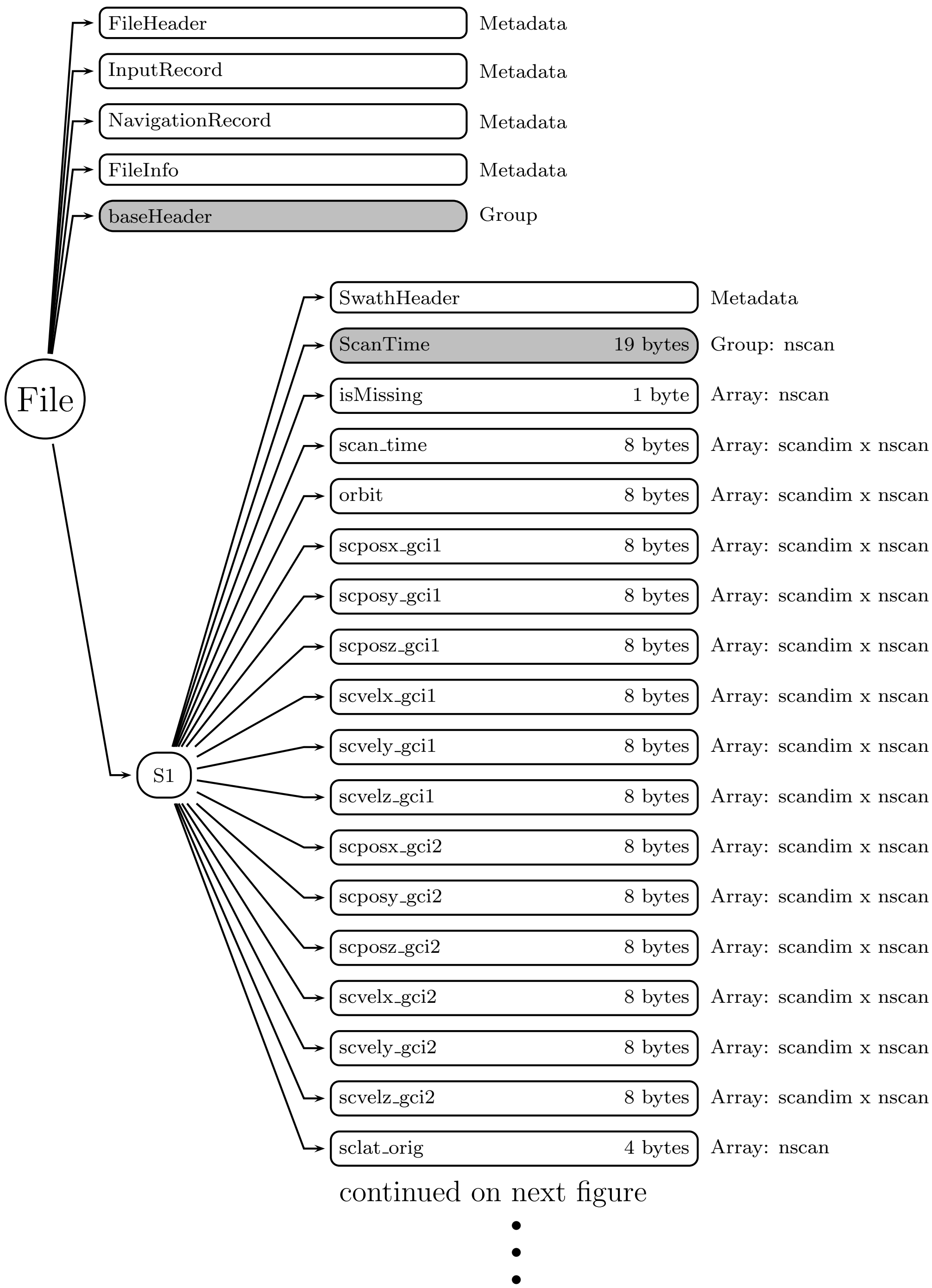


Figure 225: Data Format Structure for 1BASESSMI, SSMI base

continued from last figure

S1

sclon_orig	4 bytes	Array: nscan
scalt_orig	4 bytes	Array: nscan
sctime_orig	8 bytes	Array: nscan
spacecraft_lat	4 bytes	Array: scandim x nscan
spacecraft_lon	4 bytes	Array: scandim x nscan
spacecraft_alt	4 bytes	Array: scandim x nscan
solar_beta_angle	4 bytes	Array: scandim x nscan
sun_elevation_angle	4 bytes	Array: scandim x nscan
sun_azimuth_angle	4 bytes	Array: scandim x nscan
phase_orbit_midnight	4 bytes	Array: scandim x nscan
sun_earth_separation	4 bytes	Array: scandim x nscan
earth_angle_radius	4 bytes	Array: scandim x nscan
phase_eclipse_exit	4 bytes	Array: scandim x nscan
eclipse_status	1 byte	Array: scandim x nscan
time_since_eclipse	4 bytes	Array: scandim x nscan
autogain1a	4 bytes	Array: nscan
autogain2a	4 bytes	Array: nscan
autogain3a	4 bytes	Array: nscan
autogain1b	4 bytes	Array: nscan
autogain2b	4 bytes	Array: nscan
autogain3b	4 bytes	Array: nscan
rfmxrtemp	4 bytes	Array: nscan
forwardradtemp	4 bytes	Array: nscan

continued on next figure

Figure 226: Data Format Structure for 1BASESSMI, SSMI base

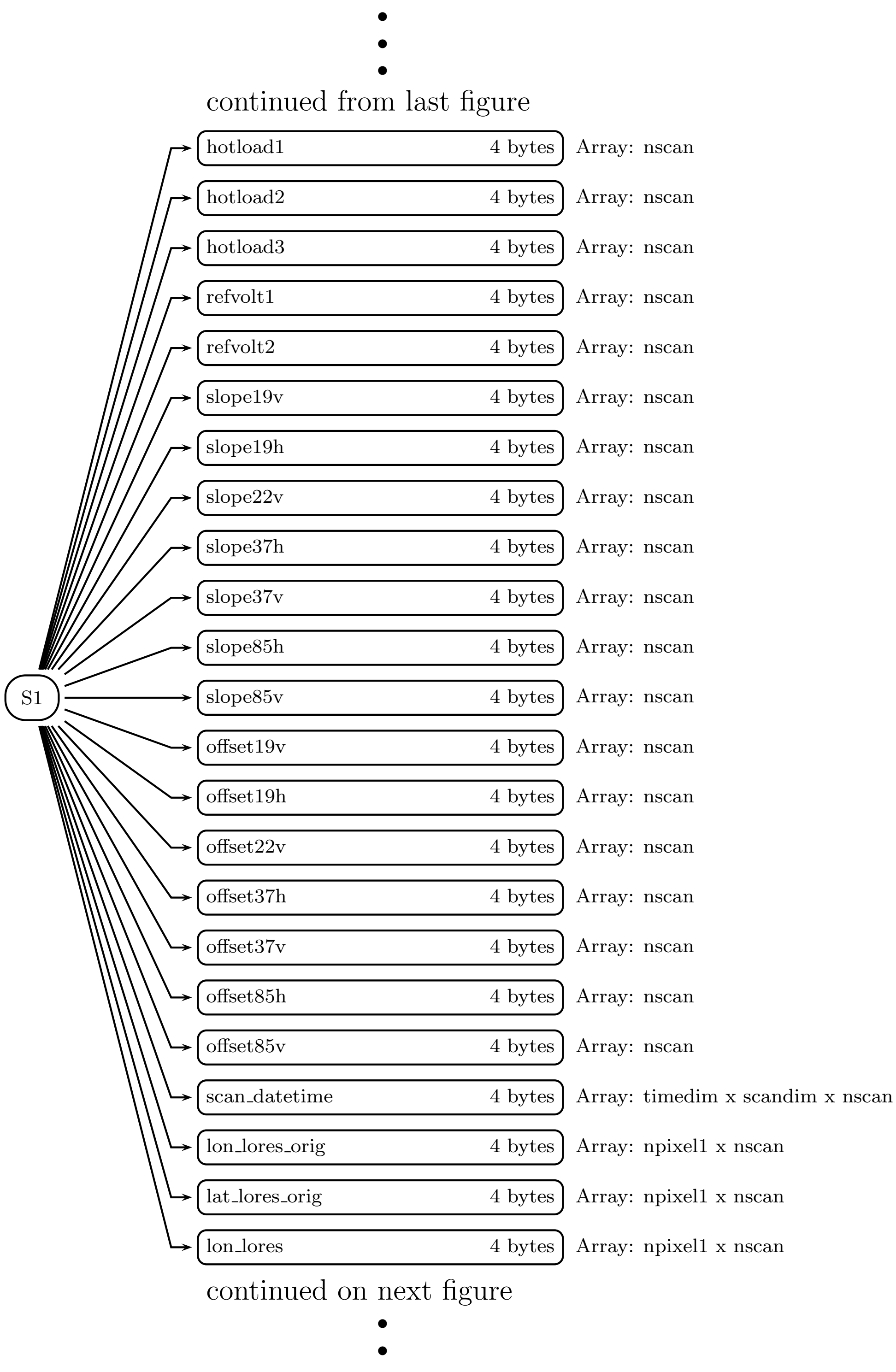


Figure 227: Data Format Structure for 1BASESSMI, SSMI base

continued from last figure

S1

Field	Size	Dimensions
lat_lores	4 bytes	Array: npixel1 x nscan
sfctype_lores	4 bytes	Array: npixel1 x nscan
quality_lores	1 byte	Array: npixel1 x nscan
sun_glint_lores	4 bytes	Array: npixel1 x nscan
eia_lores	4 bytes	Array: npixel1 x nscan
sunzenith_lores	4 bytes	Array: npixel1 x nscan
scazimuth_lores	4 bytes	Array: npixel1 x nscan
sunazimuth_lores	4 bytes	Array: npixel1 x nscan
ta19v	4 bytes	Array: npixel1 x nscan
tb19v	4 bytes	Array: npixel1 x nscan
ta19h	4 bytes	Array: npixel1 x nscan
tb19h	4 bytes	Array: npixel1 x nscan
ta22v	4 bytes	Array: npixel1 x nscan
tb22v	4 bytes	Array: npixel1 x nscan
ta37v	4 bytes	Array: npixel1 x nscan
tb37v	4 bytes	Array: npixel1 x nscan
ta37h	4 bytes	Array: npixel1 x nscan
tb37h	4 bytes	Array: npixel1 x nscan
lon_hires_orig	4 bytes	Array: npixel2 x scandim x nscan
lat_hires_orig	4 bytes	Array: npixel2 x scandim x nscan
lon_hires	4 bytes	Array: npixel2 x scandim x nscan
lat_hires	4 bytes	Array: npixel2 x scandim x nscan
sunLocalTime_lores	4 bytes	Array: npixel1 x nscan

continued on next figure

Figure 228: Data Format Structure for 1BASESSMI, SSMI base

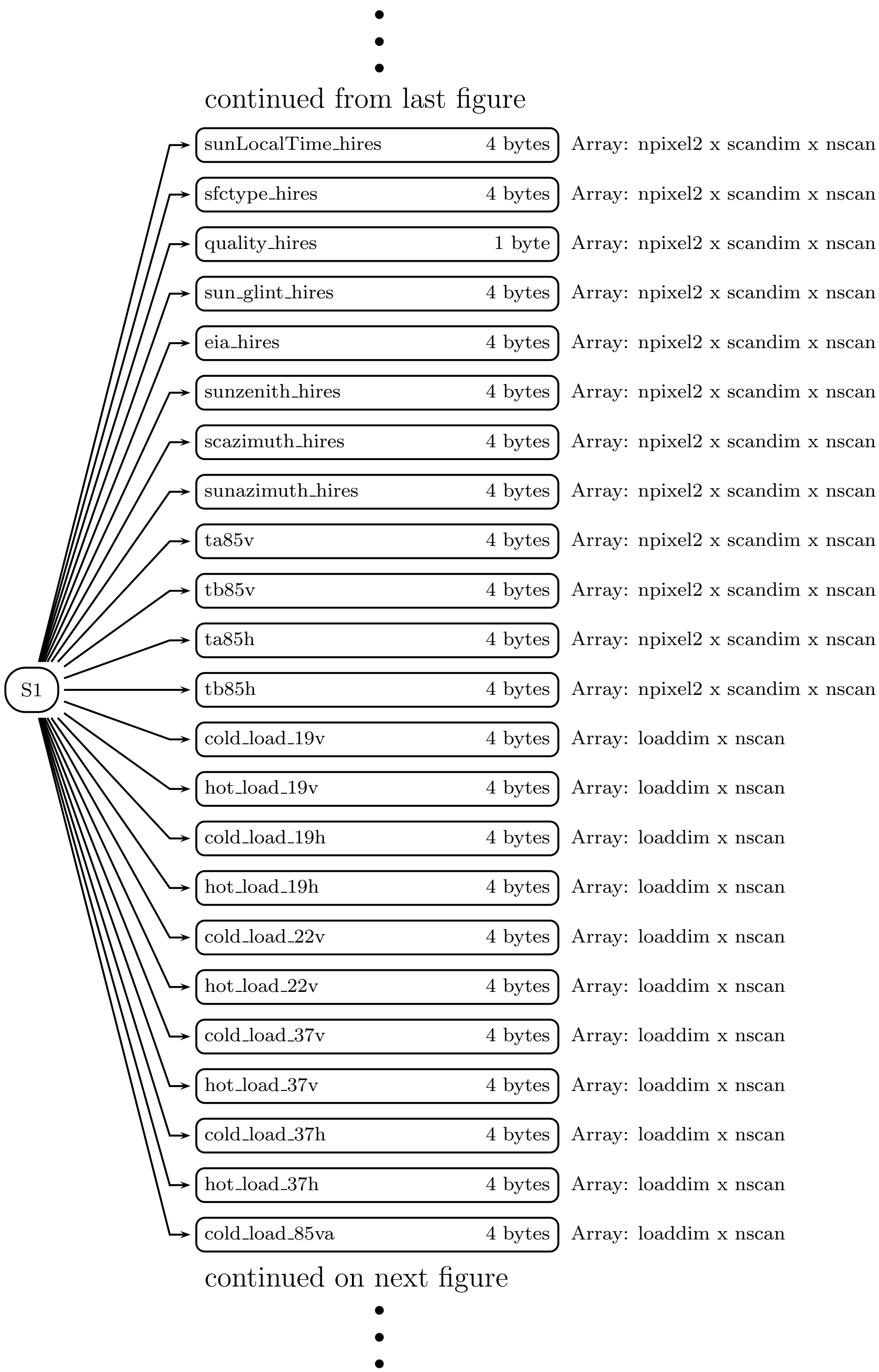


Figure 229: Data Format Structure for 1BASESSMI, SSMI base

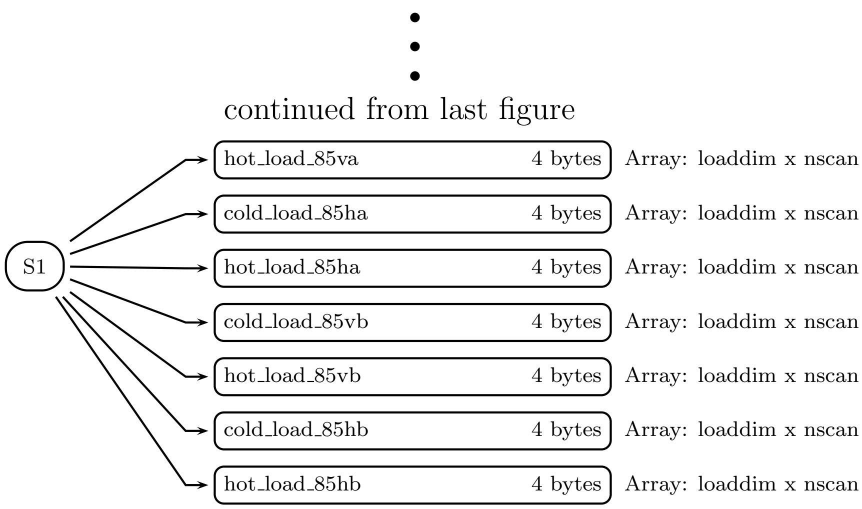


Figure 230: Data Format Structure for 1BASESSMI, SSMI base

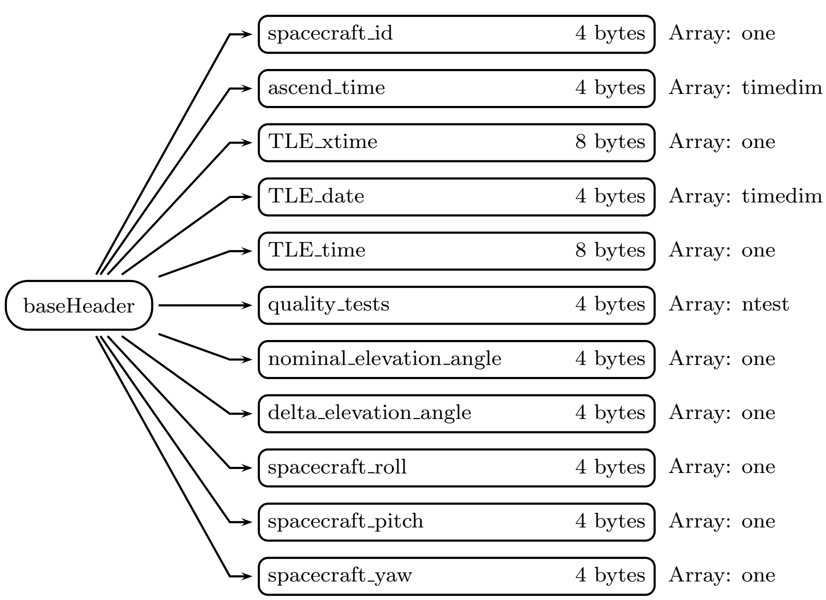


Figure 231: Data Format Structure for 1BASESSMI, baseHeader

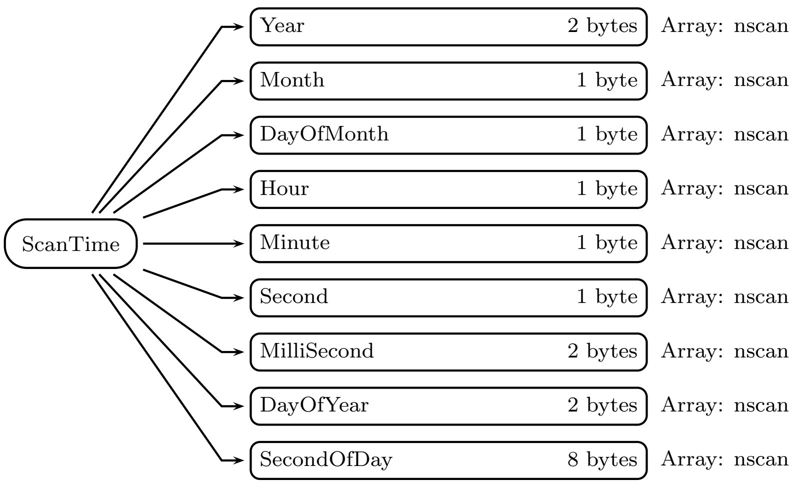


Figure 232: Data Format Structure for 1BASESSMI, ScanTime

TLE_date (4-byte integer, array size: timedim):
TLE date time arrays.

TLE_time (8-byte float, array size: one):
TLE time as in two line element.

quality_tests (4-byte integer, array size: ntest):
Results from Wes Berg's fcdr quality control tests.

nominal_elevation_angle (4-byte float, array size: one):
Nominal sensor elevation angle.

delta_elevation_angle (4-byte float, array size: one):
Offset in the sensor elevation angle from nominal.

spacecraft_roll (4-byte float, array size: one):
Spacecraft roll angle offset from nominal.

spacecraft_pitch (4-byte float, array size: one):
Spacecraft pitch angle offset from nominal.

spacecraft_yaw (4-byte float, array size: one):
Spacecraft yaw angle offset from nominal.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

scan_time (8-byte float, array size: scandim x nscan):
A and B scan start time in seconds since 1987-01-01T00:00:00.00Z.

orbit (8-byte float, array size: scandim x nscan):
Fractional orbit number for A and B scans.

scposx_gci1 (8-byte float, array size: scandim x nscan):
Orbital Position Vector X in Geocentric Inertial Coordinates for the first pixel.

scposy_gci1 (8-byte float, array size: scandim x nscan):
Orbital Position Vector Y in Geocentric Inertial Coordinates for the first pixel.

scposz_gci1 (8-byte float, array size: scandim x nscan):
Orbital Position Vector Z in Geocentric Inertial Coordinates for the first pixel.

scvelx_gci1 (8-byte float, array size: scandim x nscan):
Orbital Velocity Vector X in Geocentric Inertial Coordinates for the first pixel.

scvely_gci1 (8-byte float, array size: scandim x nscan):
Orbital Velocity Vector Y in Geocentric Inertial Coordinates for the first pixel.

scvelz_gci1 (8-byte float, array size: scandim x nscan):
Orbital Velocity Vector Z in Geocentric Inertial Coordinates for the first pixel.

scposx_gci2 (8-byte float, array size: scandim x nscan):
Orbital Position Vector X in Geocentric Inertial Coordinates for the last pixel.

scposy_gci2 (8-byte float, array size: scandim x nscan):
Orbital Position Vector Y in Geocentric Inertial Coordinates for the last pixel.

scposz_gci2 (8-byte float, array size: scandim x nscan):
Orbital Position Vector Z in Geocentric Inertial Coordinates for the last pixel.

scvelx_gci2 (8-byte float, array size: scandim x nscan):
Orbital Velocity Vector X in Geocentric Inertial Coordinates for the last pixel.

scvely_gci2 (8-byte float, array size: scandim x nscan):
Orbital Velocity Vector Y in Geocentric Inertial Coordinates for the last pixel.

scvelz_gci2 (8-byte float, array size: scandim x nscan):
Orbital Velocity Vector Z in Geocentric Inertial Coordinates for the last pixel.

sclat_orig (4-byte float, array size: nscan):
Original spacecraft latitude from TDR data.

sclon_orig (4-byte float, array size: nscan):
Original spacecraft longitude from TDR data.

scalt_orig (4-byte float, array size: nscan):
Original spacecraft altitude from TDR data.

sctime_orig (8-byte float, array size: nscan):
Original spacecraft time from TDR data.

spacecraft_lat (4-byte float, array size: scandim x nscan):
Computed spacecraft latitude using TLE corresponding to A and B scan_time.

spacecraft_lon (4-byte float, array size: scandim x nscan):
Computed spacecraft longitude using TLE corresponding to A and B scan_time.

spacecraft_alt (4-byte float, array size: scandim x nscan):
Computed Spacecraft altitude using TLE corresponding to A and B scan._time

solar_beta_angle (4-byte float, array size: scandim x nscan):
Solar beta angle for A and B scans.

sun_elevation_angle (4-byte float, array size: scandim x nscan):
Sun elevation angle from spacecraft for A and B scans.

sun_azimuth_angle (4-byte float, array size: scandim x nscan):
Sun azimuth angle from spacecraft for A and B scans.

phase_orbit_midnight (4-byte float, array size: scandim x nscan):
Phase from orbit midnight for A and B scans.

sun_earth_separation (4-byte float, array size: scandim x nscan):
Sun Earth separation angle for A and B scans.

earth_angle_radius (4-byte float, array size: scandim x nscan):
Earth angle radius for A and B scans.

phase_eclipse_exit (4-byte float, array size: scandim x nscan):
Orbit phase for eclipse exit or entr for A and B scans.

eclipse_status (1-byte integer, array size: scandim x nscan):
Eclipse status (0=sun, 1=shadow) for A and B scans.

time_since_eclipse (4-byte float, array size: scandim x nscan):
Time since eclipse for A and B scans.

autogain1a (4-byte float, array size: nscan):
Auto gain control setting 1 (scan A) from scan header 1.

autogain2a (4-byte float, array size: nscan):
Auto gain control setting 2 (scan A) from scan header 1.

autogain3a (4-byte float, array size: nscan):
Auto gain control setting 3 (scan A) from scan header 1.

autogain1b (4-byte float, array size: nscan):
Auto gain control setting 1 (scan B) from scan header 1.

autogain2b (4-byte float, array size: nscan):
Auto gain control setting 2 (scan B) from scan header 1.

autogain3b (4-byte float, array size: nscan):
Auto gain control setting 3 (scan B) from scan header 1.

rfmxrtemp (4-byte float, array size: nscan):
RF Mixer temperature.

forwardradtemp (4-byte float, array size: nscan):
Forward Radiator Temperature.

hotload1 (4-byte float, array size: nscan):
Hot Load Thermal Temperature 1.

hotload2 (4-byte float, array size: nscan):
Hot Load Thermal Temperature 2.

hotload3 (4-byte float, array size: nscan):
Hot Load Thermal Temperature 3.

refvolt1 (4-byte float, array size: nscan):
Reference Voltage 1.

refvolt2 (4-byte float, array size: nscan):
Reference Voltage 2.

slope19v (4-byte float, array size: nscan):
19.35 GHz V-Pol channel slope.

slope19h (4-byte float, array size: nscan):
19.35 GHz H-Pol channel slope.

slope22v (4-byte float, array size: nscan):
22.235 GHz V-Pol channel slop.

slope37h (4-byte float, array size: nscan):
37.0 GHz H-Pol channel slope.

slope37v (4-byte float, array size: nscan):
37.0 GHz V-Pol channel slope.

slope85h (4-byte float, array size: nscan):
85.5 GHz H-Pol channel slope.

slope85v (4-byte float, array size: nscan):
85.5 GHz V-Pol channel slope.

offset19v (4-byte float, array size: nscan):
19.35 GHz V-Pol channel offset.

offset19h (4-byte float, array size: nscan):
19.35 GHz H-Pol channel offset.

offset22v (4-byte float, array size: nscan):
22.235 GHz V-Pol channel offset.

offset37h (4-byte float, array size: nscan):
37.0 GHz H-Pol channel offset.

offset37v (4-byte float, array size: nscan):
37.0 GHz V-Pol channel offset.

offset85h (4-byte float, array size: nscan):
85.5 GHz H-Pol channel offset.

offset85v (4-byte float, array size: nscan):
85.5 GHz V-Pol channel offset.

scan_datetime (4-byte float, array size: timedim x scandim x nscan):
Scan date time array.

lon_lores_orig (4-byte float, array size: npixel1 x nscan):
Original pixel longitude from TDR data for low resolution channels.

lat_lores_orig (4-byte float, array size: npixel1 x nscan):
Original pixel latitude from TDR data for low resolution channels.

lon_lores (4-byte float, array size: npixel1 x nscan):
TLE Computed longitude for low resolution channels.

lat_lores (4-byte float, array size: npixel1 x nscan):
TLE Computed latitude for low resolution channels.

sfctype_lores (4-byte integer, array size: npixel1 x nscan):
Surface type for low resolution channels.

quality_lores (1-byte integer, array size: npixel1 x nscan):
Quality flag for low resolution channels. 0=Good data, 1-99=Minor issue (use with caution), 100-255=Major issue (set to missing).

```
0  Good data
1  Possible sun glint
2  Climatology check warning (19V Channel)
3  Climatology check warning (19H Channel)
4  Climatology check warning (22V Channel)
5  Climatology check warning (37V Channel)
6  Climatology check warning (37H Channel)
7  Climatology check warning (85V Channel)
8  Climatology check warning (85H Channel)
9  Climatology check warning (Multiple low-res channels)
10  Climatology check warning (Multiple high-res channels)
11  Warning adjacent/cross-pol pixel flagged as bad
12  Warning of increased noise in 85V channel on DMSP F08
13  RADCAL correction applied to Tb22v (do not use for climate)
14  Correction made to Ta by correcting for spikes in warm/cold load cal data
100  Data is missing from file or unreadable
101  Geolocation check flagged in input BASE file
102  Climatology check flagged in input BASE file
103  Climatology check failed (19V Channel)
104  Climatology check failed (19H Channel)
105  Climatology check failed (22V Channel)
106  Climatology check failed (37V Channel)
107  Climatology check failed (37H Channel)
108  Climatology check failed (85V Channel)
109  Climatology check failed (85H Channel)
110  Climatology check failed (Multiple low-res channels)
111  Climatology check failed (Multiple high-res channels)
112  Distance between pixels is nonphysical
113  Antenna temperatures are lt 50 or gt 350 K
114  Lat/Lon values are out of range
115  Failure of 85V channel on DMSP F08
116  Failure of 85V and increased noise in 85H on DMSP F08
117  Failure of both 85V and 85H channels on DMSP F08
```

```
118  Invalid scan time
119  Ta set to missing due to bad cal data
120  All data set to missing
```

sun_glint_lores (4-byte float, array size: npixel1 x nscan):
Sun glint angle for low resolution channels.

eia_lores (4-byte float, array size: npixel1 x nscan):
Earth incidence angle for low resolution channels.

sunzenith_lores (4-byte float, array size: npixel1 x nscan):
Sun zenith angle for low resolution channels.

scazimuth_lores (4-byte float, array size: npixel1 x nscan):
Satellite azimuth angle for low resolution channels.

sunazimuth_lores (4-byte float, array size: npixel1 x nscan):
Sun azimuth angle for low resolution channels.

ta19v (4-byte float, array size: npixel1 x nscan):
19.35 GHz V-Pol Antenna Temperature.

tb19v (4-byte float, array size: npixel1 x nscan):
19.35 GHz V-Pol Brightness Temperature.

ta19h (4-byte float, array size: npixel1 x nscan):
19.35 GHz H-Pol Antenna Temperature.

tb19h (4-byte float, array size: npixel1 x nscan):
19.35 GHz H-Pol Brightness Temperature.

ta22v (4-byte float, array size: npixel1 x nscan):
22.235 GHz V-Pol Antenna Temperature.

tb22v (4-byte float, array size: npixel1 x nscan):
22.235 GHz V-Pol Brightness Temperature.

ta37v (4-byte float, array size: npixel1 x nscan):
37.0 GHz V-Pol Antenna Temperature.

tb37v (4-byte float, array size: npixel1 x nscan):
37.0 GHz V-Pol Brightness Temperature.

ta37h (4-byte float, array size: npixel1 x nscan):
37.0 GHz H-Pol Antenna Temperature.

tb37h (4-byte float, array size: npixel1 x nscan):
37.0 GHz H-Pol Brightness Temperature.

lon_hires_orig (4-byte float, array size: npixel2 x scandim x nscan):
Original pixel longitude from TDR data for high resulotion channels.

lat_hires_orig (4-byte float, array size: npixel2 x scandim x nscan):
Original pixel latitude from TDR data for high resulotion channels.

lon_hires (4-byte float, array size: npixel2 x scandim x nscan):
TLE Computed longitude for high resulotion channels.

lat_hires (4-byte float, array size: npixel2 x scandim x nscan):
TLE Computed latitude for high resulotion channels.

sunLocalTime_lores (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_hires (4-byte float, array size: npixel2 x scandim x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sfctype_hires (4-byte integer, array size: npixel2 x scandim x nscan):
Surface type for high resulotion channels.

quality_hires (1-byte integer, array size: npixel2 x scandim x nscan):
Quality flag for high resolution channels. See quality_lores description for flag definition.

sun_glint_hires (4-byte float, array size: npixel2 x scandim x nscan):
Sun glint angle for high resolution channels.

eia_hires (4-byte float, array size: npixel2 x scandim x nscan):
Earth incidence angle for high resolution channels.

sunzenith_hires (4-byte float, array size: npixel2 x scandim x nscan):
Sun zenith angle for high resolution channels.

scazimuth_hires (4-byte float, array size: npixel2 x scandim x nscan):
Satellite azimuth angle for high resolution channels.

sunazimuth_hires (4-byte float, array size: npixel2 x scandim x nscan):
Sun azimuth angle for high resolution channels.

ta85v (4-byte float, array size: npixel2 x scandim x nscan):
85.5 GHz V-Pol Antenna Temperature.

tb85v (4-byte float, array size: npixel2 x scandim x nscan):
85.5 GHz V-Pol Brightness Temperature.

ta85h (4-byte float, array size: npixel2 x scandim x nscan):
85.5 GHz H-Pol Antenna Temperature.

tb85h (4-byte float, array size: npixel2 x scandim x nscan):
85.5 GHz H-Pol Brightness Temperature.

cold_load_19v (4-byte float, array size: loaddim x nscan):
19.35 GHz V-Pol Cold Load Reading.

hot_load_19v (4-byte float, array size: loaddim x nscan):
19.35 GHz V-Pol Hot Load Reading.

cold_load_19h (4-byte float, array size: loaddim x nscan):
19.35 GHz H-Pol Cold Load Reading.

hot_load_19h (4-byte float, array size: loaddim x nscan):
19.35 GHz V-Pol Hot Load Reading.

cold_load_22v (4-byte float, array size: loaddim x nscan):
22.235 GHz V-Pol Cold Load Reading.

hot_load_22v (4-byte float, array size: loaddim x nscan):
22.235 GHz V-Pol Hot Load Reading.

cold_load_37v (4-byte float, array size: loaddim x nscan):
37.0 GHz V-Pol Cold Load Reading.

hot_load_37v (4-byte float, array size: loaddim x nscan):
37.0 GHz V-Pol Hot Load Reading.

cold_load_37h (4-byte float, array size: loaddim x nscan):
37.0 GHz H-Pol Cold Load Reading.

hot_load_37h (4-byte float, array size: loaddim x nscan):
37.0 GHz H-Pol Hot Load Reading.

cold_load_85va (4-byte float, array size: loaddim x nscan):
85.5 GHz V-Pol Cold Load Reading (A-scan).

hot_load_85va (4-byte float, array size: loaddim x nscan):
85.5 GHz V-Pol Hot Load Reading (A-scan).

cold_load_85ha (4-byte float, array size: loaddim x nscan):
85.5 GHz H-Pol Cold Load Reading (A-scan).

hot_load_85ha (4-byte float, array size: loaddim x nscan):
85.5 GHz H-Pol Hot Load Reading (A-scan).

cold_load_85vb (4-byte float, array size: loaddim x nscan):
85.5 GHz V-Pol Cold Load Reading (B-scan).

hot_load_85vb (4-byte float, array size: loaddim x nscan):
85.5 GHz V-Pol Hot Load Reading (B-scan).

cold_load_85hb (4-byte float, array size: loaddim x nscan):
85.5 GHz H-Pol Cold Load Reading (B-scan).

hot_load_85hb (4-byte float, array size: loaddim x nscan):
85.5 GHz H-Pol Hot Load Reading (B-scan).

C Structure Header file:

```
#ifndef _TK_1BASESSMI_H_
#define _TK_1BASESSMI_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASESSMI_S1_
#define _L1BASESSMI_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    double scan_time[2];
    double orbit[2];
    double scposx_gci1[2];
    double scposy_gci1[2];
    double scposz_gci1[2];
    double scvelx_gci1[2];
    double scvely_gci1[2];
    double scvelz_gci1[2];
    double scposx_gci2[2];
    double scposy_gci2[2];
    double scposz_gci2[2];
    double scvelx_gci2[2];
    double scvely_gci2[2];
    double scvelz_gci2[2];
    float sclat_orig;
```

```
float sclon_orig;
float scalt_orig;
double sctime_orig;
float spacecraft_lat[2];
float spacecraft_lon[2];
float spacecraft_alt[2];
float solar_beta_angle[2];
float sun_elevation_angle[2];
float sun_azimuth_angle[2];
float phase_orbit_midnight[2];
float sun_earth_separation[2];
float earth_angle_radius[2];
float phase_eclipse_exit[2];
signed char eclipse_status[2];
float time_since_eclipse[2];
float autogain1a;
float autogain2a;
float autogain3a;
float autogain1b;
float autogain2b;
float autogain3b;
float rfmxrtemp;
float forwardradtemp;
float hotload1;
float hotload2;
float hotload3;
float refvolt1;
float refvolt2;
float slope19v;
float slope19h;
float slope22v;
float slope37h;
float slope37v;
float slope85h;
float slope85v;
float offset19v;
float offset19h;
float offset22v;
float offset37h;
float offset37v;
float offset85h;
float offset85v;
float scan_datetime[2][6];
```

```
float lon_lores_orig[64];
float lat_lores_orig[64];
float lon_lores[64];
float lat_lores[64];
int sfctype_lores[64];
signed char quality_lores[64];
float sun_glint_lores[64];
float eia_lores[64];
float sunzenith_lores[64];
float scazimuth_lores[64];
float sunazimuth_lores[64];
float ta19v[64];
float tb19v[64];
float ta19h[64];
float tb19h[64];
float ta22v[64];
float tb22v[64];
float ta37v[64];
float tb37v[64];
float ta37h[64];
float tb37h[64];
float lon_hires_orig[2][128];
float lat_hires_orig[2][128];
float lon_hires[2][128];
float lat_hires[2][128];
float sunLocalTime_lores[64];
float sunLocalTime_hires[2][128];
int sfctype_hires[2][128];
signed char quality_hires[2][128];
float sun_glint_hires[2][128];
float eia_hires[2][128];
float sunzenith_hires[2][128];
float scazimuth_hires[2][128];
float sunazimuth_hires[2][128];
float ta85v[2][128];
float tb85v[2][128];
float ta85h[2][128];
float tb85h[2][128];
float cold_load_19v[5];
float hot_load_19v[5];
float cold_load_19h[5];
float hot_load_19h[5];
float cold_load_22v[5];
```

```
    float hot_load_22v[5];
    float cold_load_37v[5];
    float hot_load_37v[5];
    float cold_load_37h[5];
    float hot_load_37h[5];
    float cold_load_85va[5];
    float hot_load_85va[5];
    float cold_load_85ha[5];
    float hot_load_85ha[5];
    float cold_load_85vb[5];
    float hot_load_85vb[5];
    float cold_load_85hb[5];
    float hot_load_85hb[5];
} L1BASESSMI_S1;

#endif

#ifndef _L1BASESSMI_BASEHEADER_
#define _L1BASESSMI_BASEHEADER_

typedef struct {
    int spacecraft_id[1];
    int ascend_time[6];
    double TLE_xtime[1];
    int TLE_date[6];
    double TLE_time[1];
    int quality_tests[9];
    float nominal_elevation_angle[1];
    float delta_elevation_angle[1];
    float spacecraft_roll[1];
    float spacecraft_pitch[1];
    float spacecraft_yaw[1];
} L1BASESSMI_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
```

```
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASESSMI_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    REAL*8 scan_time(2)
    REAL*8 orbit(2)
    REAL*8 scposx_gci1(2)
    REAL*8 scposy_gci1(2)
    REAL*8 scposz_gci1(2)
    REAL*8 scvelx_gci1(2)
    REAL*8 scvely_gci1(2)
    REAL*8 scvelz_gci1(2)
    REAL*8 scposx_gci2(2)
    REAL*8 scposy_gci2(2)
    REAL*8 scposz_gci2(2)
    REAL*8 scvelx_gci2(2)
    REAL*8 scvely_gci2(2)
    REAL*8 scvelz_gci2(2)
    REAL*4 sclat_orig
    REAL*4 sclon_orig
    REAL*4 scalt_orig
    REAL*8 sctime_orig
    REAL*4 spacecraft_lat(2)
    REAL*4 spacecraft_lon(2)
    REAL*4 spacecraft_alt(2)
    REAL*4 solar_beta_angle(2)
    REAL*4 sun_elevation_angle(2)
    REAL*4 sun_azimuth_angle(2)
    REAL*4 phase_orbit_midnight(2)
    REAL*4 sun_earth_separation(2)
    REAL*4 earth_angle_radius(2)
    REAL*4 phase_eclipse_exit(2)
    BYTE eclipse_status(2)
    REAL*4 time_since_eclipse(2)
    REAL*4 autogain1a
```

```
REAL*4 autogain2a
REAL*4 autogain3a
REAL*4 autogain1b
REAL*4 autogain2b
REAL*4 autogain3b
REAL*4 rfmxrtemp
REAL*4 forwardradtemp
REAL*4 hotload1
REAL*4 hotload2
REAL*4 hotload3
REAL*4 refvolt1
REAL*4 refvolt2
REAL*4 slope19v
REAL*4 slope19h
REAL*4 slope22v
REAL*4 slope37h
REAL*4 slope37v
REAL*4 slope85h
REAL*4 slope85v
REAL*4 offset19v
REAL*4 offset19h
REAL*4 offset22v
REAL*4 offset37h
REAL*4 offset37v
REAL*4 offset85h
REAL*4 offset85v
REAL*4 scan_datetime(6,2)
REAL*4 lon_lores_orig(64)
REAL*4 lat_lores_orig(64)
REAL*4 lon_lores(64)
REAL*4 lat_lores(64)
INTEGER*4 sfctype_lores(64)
BYTE quality_lores(64)
REAL*4 sun_glint_lores(64)
REAL*4 eia_lores(64)
REAL*4 sunzenith_lores(64)
REAL*4 scazimuth_lores(64)
REAL*4 sunazimuth_lores(64)
REAL*4 ta19v(64)
REAL*4 tb19v(64)
REAL*4 ta19h(64)
REAL*4 tb19h(64)
REAL*4 ta22v(64)
```

```
    REAL*4 tb22v(64)
    REAL*4 ta37v(64)
    REAL*4 tb37v(64)
    REAL*4 ta37h(64)
    REAL*4 tb37h(64)
    REAL*4 lon_hires_orig(128,2)
    REAL*4 lat_hires_orig(128,2)
    REAL*4 lon_hires(128,2)
    REAL*4 lat_hires(128,2)
    REAL*4 sunLocalTime_lores(64)
    REAL*4 sunLocalTime_hires(128,2)
    INTEGER*4 sfctype_hires(128,2)
    BYTE quality_hires(128,2)
    REAL*4 sun_glint_hires(128,2)
    REAL*4 eia_hires(128,2)
    REAL*4 sunzenith_hires(128,2)
    REAL*4 scazimuth_hires(128,2)
    REAL*4 sunazimuth_hires(128,2)
    REAL*4 ta85v(128,2)
    REAL*4 tb85v(128,2)
    REAL*4 ta85h(128,2)
    REAL*4 tb85h(128,2)
    REAL*4 cold_load_19v(5)
    REAL*4 hot_load_19v(5)
    REAL*4 cold_load_19h(5)
    REAL*4 hot_load_19h(5)
    REAL*4 cold_load_22v(5)
    REAL*4 hot_load_22v(5)
    REAL*4 cold_load_37v(5)
    REAL*4 hot_load_37v(5)
    REAL*4 cold_load_37h(5)
    REAL*4 hot_load_37h(5)
    REAL*4 cold_load_85va(5)
    REAL*4 hot_load_85va(5)
    REAL*4 cold_load_85ha(5)
    REAL*4 hot_load_85ha(5)
    REAL*4 cold_load_85vb(5)
    REAL*4 hot_load_85vb(5)
    REAL*4 cold_load_85hb(5)
    REAL*4 hot_load_85hb(5)
END STRUCTURE

STRUCTURE /L1BASESSMI_BASEHEADER/
```

```
    INTEGER*4 spacecraft_id(1)
    INTEGER*4 ascend_time(6)
    REAL*8 TLE_xtime(1)
    INTEGER*4 TLE_date(6)
    REAL*8 TLE_time(1)
    INTEGER*4 quality_tests(9)
    REAL*4 nominal_elevation_angle(1)
    REAL*4 delta_elevation_angle(1)
    REAL*4 spacecraft_roll(1)
    REAL*4 spacecraft_pitch(1)
    REAL*4 spacecraft_yaw(1)
END STRUCTURE
```

5.9 1BASESSMIS - SSMIS base

1BASESSMIS contains both antenna temperature and brightness temperature. In Version V07 1BASESSMIS, the brightness temperature is GPM Common Calibrated brightness temperature. These files contain some information from the TDR files and additions Wesley Berg made creating his fcdr files plus the isMissing flag. 1BASESSMIS is written as one swath, but the 1C product will have 4 swaths.

NOTE: the filespec does not draw the swath. NOTE: ranges may be wrong

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel_img	180	Number of samples per imager scanline.
npixel_env	90	Number of samples per environmental scanline.
nephem	3	Number of ephem.
ndatetime	6	Number of date time array dimension.
ntime	7	Number of time array dimension (year, month, day, hour, minute, second, and millisecond)
nsunvec	3	Number of sun vector.
nsatpos	2	Number of satellite position.
nchannel	24	Number of channels.
nwarmload	3	Number of warm load array dimension.
nmuxhouse	4	Number of mux housing.
nbasepoint	28	Number of basepoint.
ntest	6	Number of quality tests.
nsensor	6	Number of sensor.
one	1	Number one.

Figure 233 through Figure 240 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

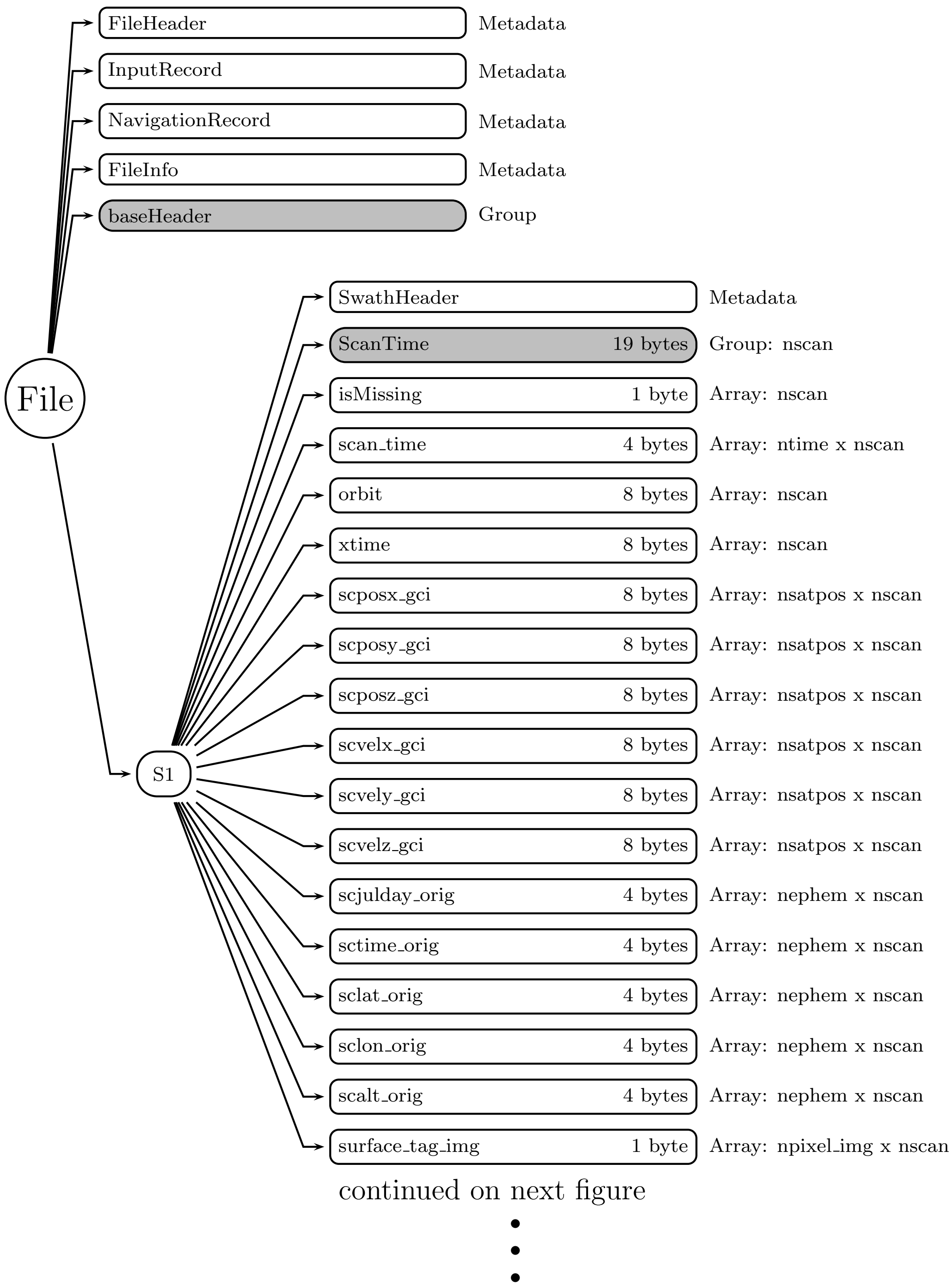


Figure 233: Data Format Structure for 1BASESSMIS, SSMIS base

continued from last figure

S1

rain_flag_img	1 byte	Array: npixel_img x nscan
lat_img1_orig	4 bytes	Array: npixel_img x nscan
lon_img1_orig	4 bytes	Array: npixel_img x nscan
ta150h_img1	4 bytes	Array: npixel_img x nscan
ta183_1h_img1	4 bytes	Array: npixel_img x nscan
ta183_3h_img1	4 bytes	Array: npixel_img x nscan
ta183_7h_img1	4 bytes	Array: npixel_img x nscan
lat_img2_orig	4 bytes	Array: npixel_img x nscan
lon_img2_orig	4 bytes	Array: npixel_img x nscan
ta91v_img2	4 bytes	Array: npixel_img x nscan
ta91h_img2	4 bytes	Array: npixel_img x nscan
surface_tag_env	1 byte	Array: npixel_env x nscan
lat_env1_orig	4 bytes	Array: npixel_env x nscan
lon_env1_orig	4 bytes	Array: npixel_env x nscan
ta19v_env1	4 bytes	Array: npixel_env x nscan
ta19h_env1	4 bytes	Array: npixel_env x nscan
ta22v_env1	4 bytes	Array: npixel_env x nscan
lat_env2_orig	4 bytes	Array: npixel_env x nscan
lon_env2_orig	4 bytes	Array: npixel_env x nscan
ta37v_env2	4 bytes	Array: npixel_env x nscan
ta37h_env2	4 bytes	Array: npixel_env x nscan
aux_warmcal	2 bytes	Array: nchannel x nscan
aux_coldcal	2 bytes	Array: nchannel x nscan

continued on next figure

Figure 234: Data Format Structure for 1BASESSMIS, SSMIS base

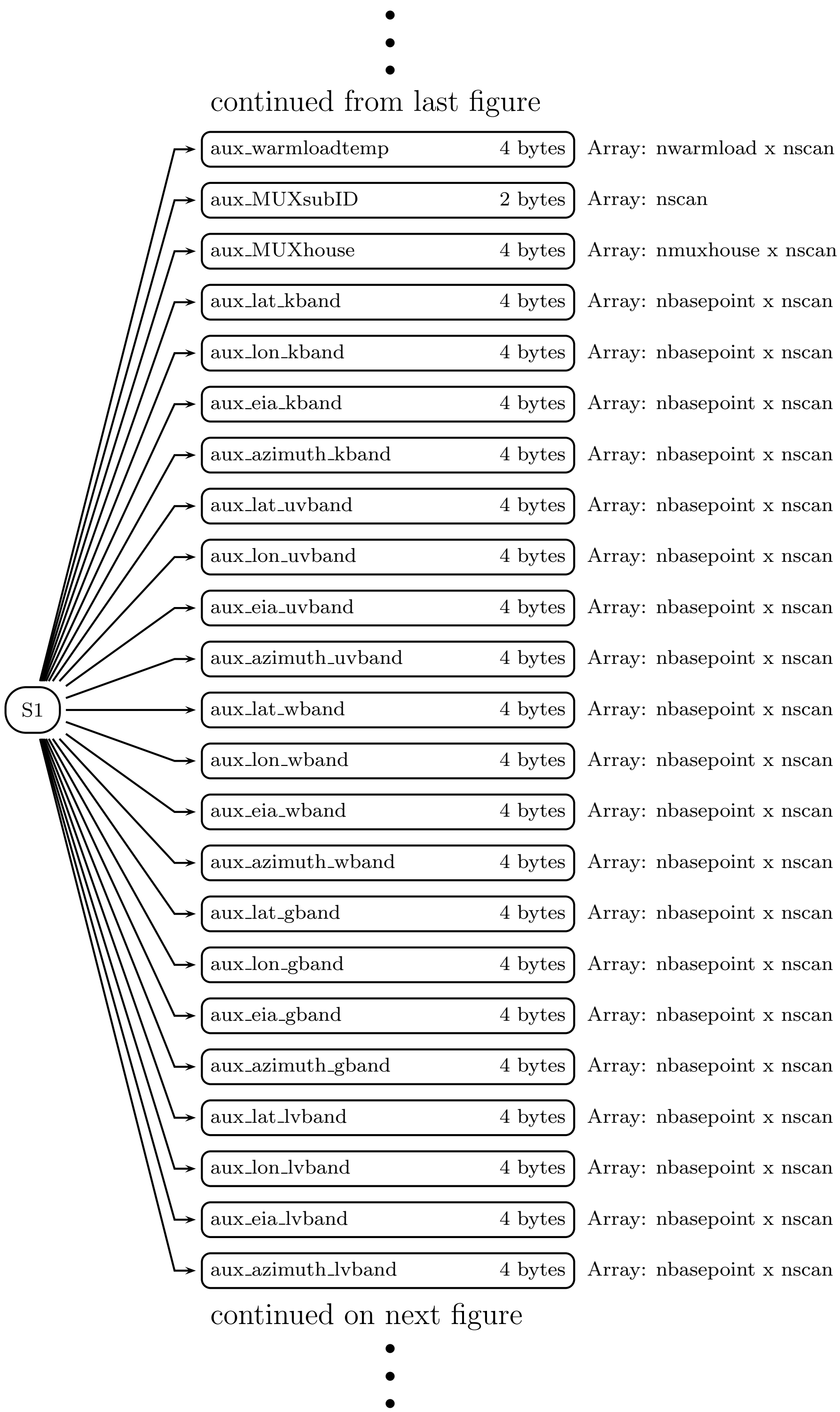


Figure 235: Data Format Structure for 1BASESSMIS, SSMIS base

continued from last figure

S1

aux_lat_kaband	4 bytes	Array: nbasepoint x nscan
aux_lon_kaband	4 bytes	Array: nbasepoint x nscan
aux_eia_kaband	4 bytes	Array: nbasepoint x nscan
aux_azimuth_kaband	4 bytes	Array: nbasepoint x nscan
spacecraft_lat	4 bytes	Array: nscan
spacecraft_lon	4 bytes	Array: nscan
spacecraft_alt	4 bytes	Array: nscan
sun_vector	4 bytes	Array: nsunvec x nscan
sun_elevation_angle	4 bytes	Array: nscan
sun_azimuth_angle	4 bytes	Array: nscan
solar_beta_angle	4 bytes	Array: nscan
time_since_eclipse	4 bytes	Array: nscan
eclipse_status	1 byte	Array: nscan
phase_orbit_midnight	4 bytes	Array: nscan
sun_earth_separation	4 bytes	Array: nscan
phase_eclipse_exit	4 bytes	Array: nscan
earth_angle_radius	4 bytes	Array: nscan
temp_arm	4 bytes	Array: nscan
temp_reflector	4 bytes	Array: nscan
original_gain	4 bytes	Array: nchannel x nscan
corrected_gain	4 bytes	Array: nchannel x nscan
delta_gain	4 bytes	Array: nchannel x nscan
lat_img1	4 bytes	Array: npixel_img x nscan

continued on next figure

Figure 236: Data Format Structure for 1BASESSMIS, SSMIS base

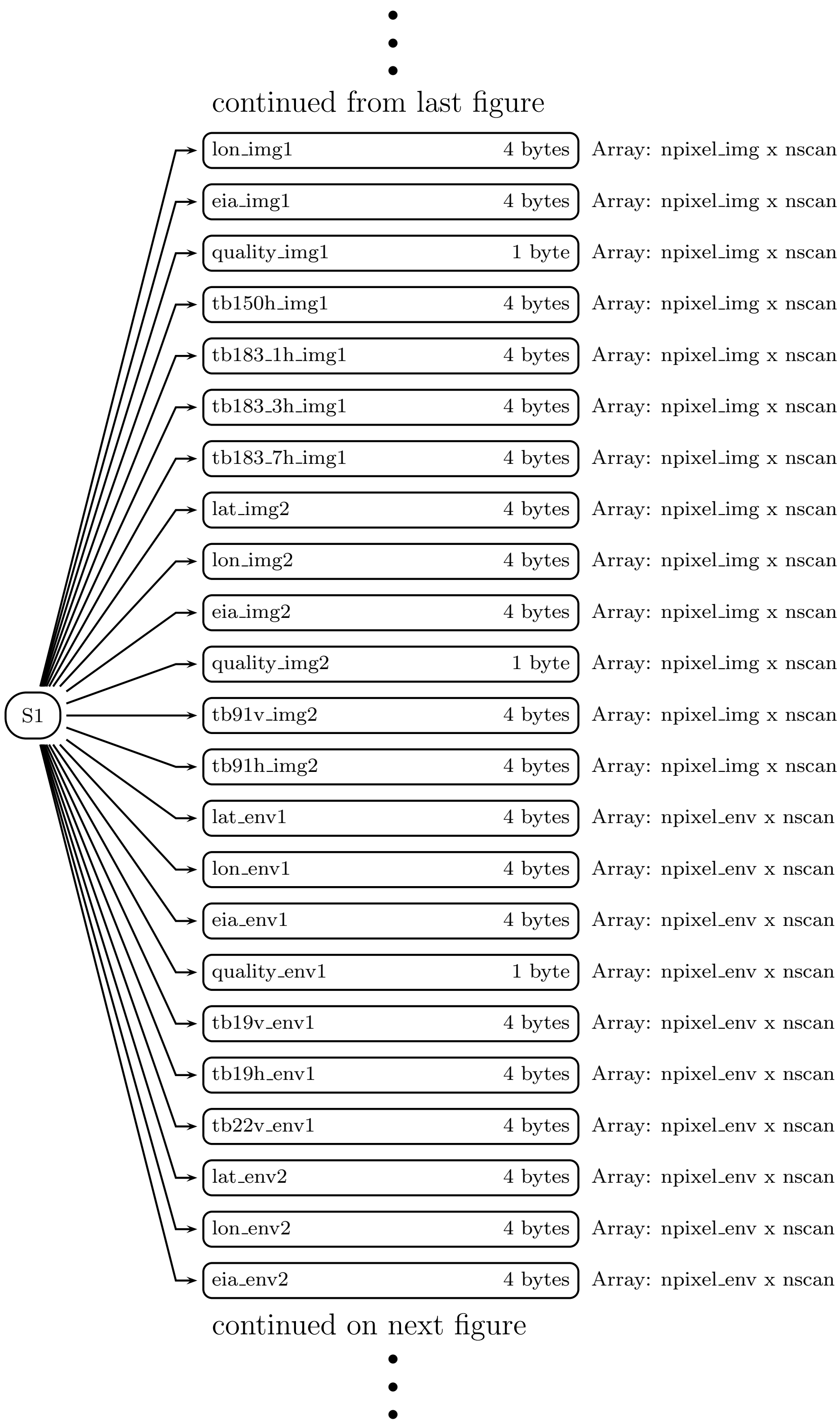


Figure 237: Data Format Structure for 1BASESSMIS, SSMIS base

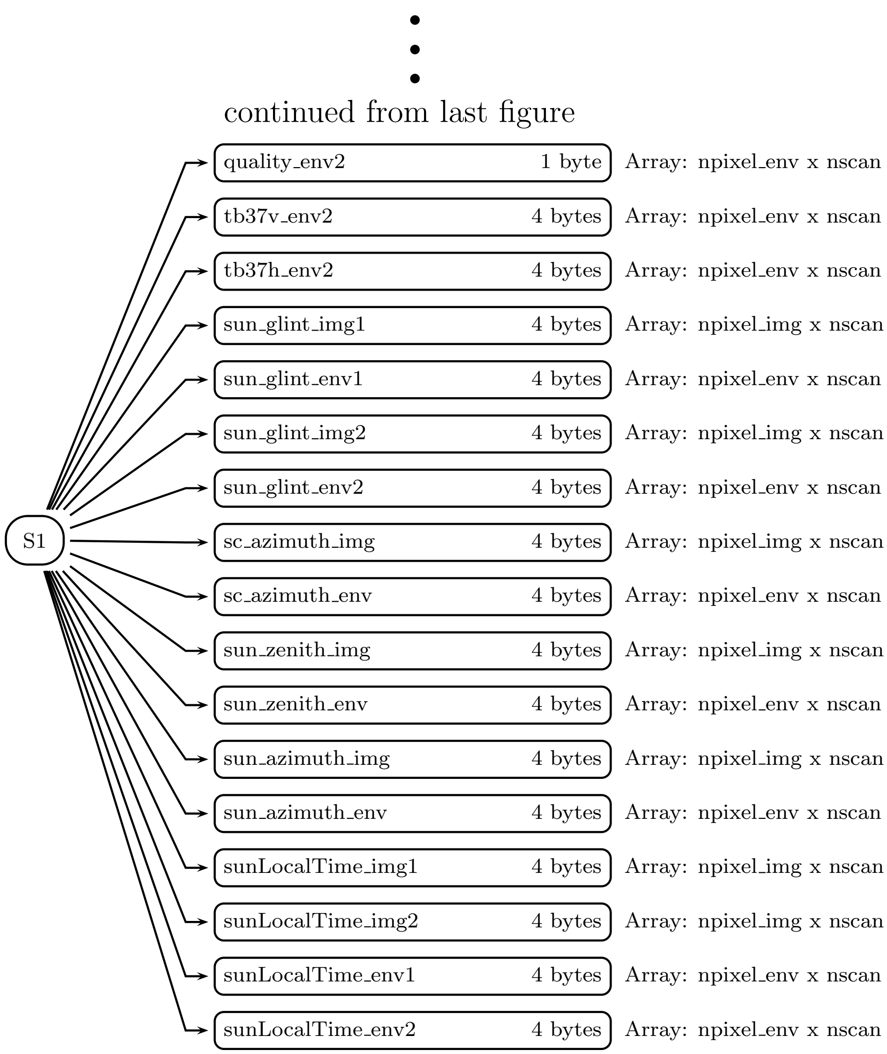


Figure 238: Data Format Structure for 1BASESSMIS, SSMIS base

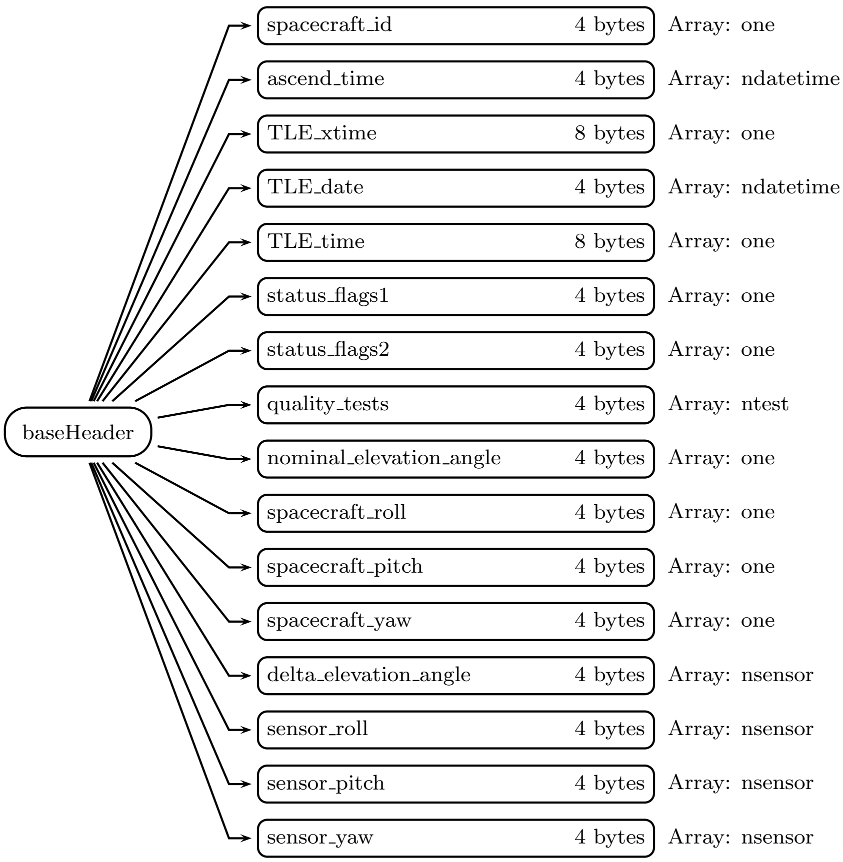


Figure 239: Data Format Structure for 1BASESSMIS, baseHeader

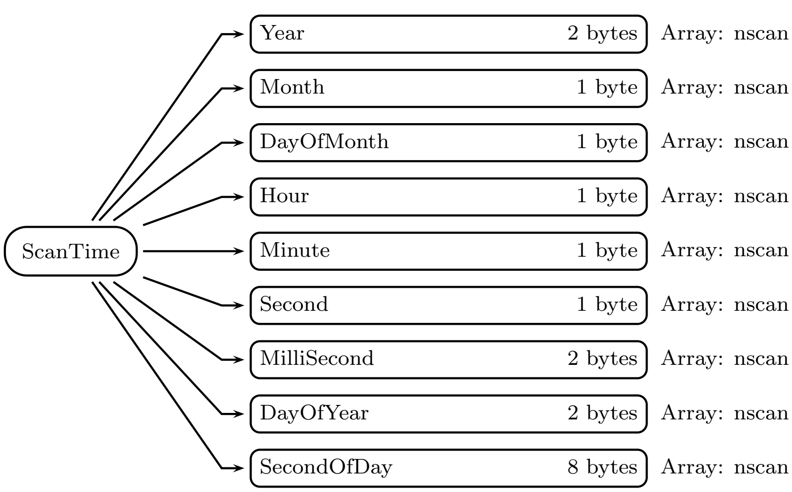


Figure 240: Data Format Structure for 1BASESSMIS, ScanTime

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

spacecraft_id (4-byte integer, array size: one):
Satellite ID number.

ascend_time (4-byte integer, array size: ndatetime):
Ascending time.

TLE_xtime (8-byte float, array size: one):
TLE time.

TLE_date (4-byte integer, array size: ndatetime):
TLE date time arrays.

TLE_time (8-byte float, array size: one):
TLE time as in two line element.

status_flags1 (4-byte integer, array size: one):
Processing status flags 1.

status_flags2 (4-byte integer, array size: one):
Processing status flags 2.

quality_tests (4-byte integer, array size: ntest):
Results from quality control tests.

nominal_elevation_angle (4-byte float, array size: one):
Nominal sensor elevation angle.

spacecraft_roll (4-byte float, array size: one):
Spacecraft roll angle offset from nominal.

spacecraft_pitch (4-byte float, array size: one):
Spacecraft pitch angle offset from nominal.

spacecraft_yaw (4-byte float, array size: one):
Spacecraft yaw angle offset from nominal.

delta_elevation_angle (4-byte float, array size: nsensor):
Offset in the sensor elevation angle from nominal.

sensor_roll (4-byte float, array size: nsensor):
Sensor offset from spacecraft roll angle for each of the six feedhorns (env1, env2, img1, img2, las, uas).

sensor_pitch (4-byte float, array size: nsensor):
Sensor offset from spacecraft pitch angle for each of the six feedhorns (env1, env2, img1, img2, las, uas).

sensor_yaw (4-byte float, array size: nsensor):
Sensor offset from spacecraft yaw angle for each of the six feedhorns (env1, env2, img1, img2, las, uas).

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

scan_time (4-byte integer, array size: ntime x nscan):
Scan start time.

orbit (8-byte float, array size: nscan):
Fractional orbit number.

xtime (8-byte float, array size: nscan):
scan time, seconds since 1987-01-01 00:00:00.

scposx_gci (8-byte float, array size: nsatpos x nscan):
Orbital Position Vector X in Geocentric Inertial Coordinates.

scposy_gci (8-byte float, array size: nsatpos x nscan):
Orbital Position Vector Y in Geocentric Inertial Coordinates.

scposz_gci (8-byte float, array size: nsatpos x nscan):
Orbital Position Vector Z in Geocentric Inertial Coordinates.

scvelx_gci (8-byte float, array size: nsatpos x nscan):
Orbital Velocity Vector X in Geocentric Inertial Coordinates.

scvely_gci (8-byte float, array size: nsatpos x nscan):
Orbital Velocity Vector Y in Geocentric Inertial Coordinates.

scvelz_gci (8-byte float, array size: nsatpos x nscan):
Orbital Velocity Vector Z in Geocentric Inertial Coordinates.

scjulday_orig (4-byte integer, array size: nephem x nscan):
Original spacecraft julian day from TDR data.

sctime_orig (4-byte float, array size: nephem x nscan):
Original spacecraft time from TDR data.

sclat_orig (4-byte float, array size: nephem x nscan):
Original spacecraft latitude from TDR data.

sclon_orig (4-byte float, array size: nephem x nscan):
Original spacecraft longitude from TDR data.

scalt_orig (4-byte float, array size: nephem x nscan):
Original spacecraft altitude from TDR data.

surface_tag_img (1-byte integer, array size: npixel_img x nscan):
Surface tag for imager channels.

rain_flag_img (1-byte integer, array size: npixel_img x nscan):
Rain flag (-1=indeterminate, 0=no rain, 1=rain).

lat_img1_orig (4-byte float, array size: npixel_img x nscan):
Original pixel latitude for channels 150, 183 GHz.

lon_img1_orig (4-byte float, array size: npixel_img x nscan):
Original pixel longitude for channels 150, 183 GHz.

ta150h_img1 (4-byte float, array size: npixel_img x nscan):
150.0 GHz H-Pol Antenna Temperature.

ta183_1h_img1 (4-byte float, array size: npixel_img x nscan):
183.31 +/- 1 GHz H-Pol Antenna Temperature.

ta183_3h_img1 (4-byte float, array size: npixel_img x nscan):
183.31 +/- 3 GHz H-Pol Antenna Temperature.

ta183_7h_img1 (4-byte float, array size: npixel_img x nscan):
183.31 +/- 6.6 GHz H-Pol Antenna Temperature.

lat_img2_orig (4-byte float, array size: npixel_img x nscan):
Original pixel latitude for channels 91 GHz.

lon_img2_orig (4-byte float, array size: npixel_img x nscan):
Original pixel longitude for channels 91 GHz.

ta91v_img2 (4-byte float, array size: npixel_img x nscan):
91.655 GHz V-Pol Antenna Temperature.

ta91h_img2 (4-byte float, array size: npixel_img x nscan):
91.655 GHz H-Pol Antenna Temperature.

surface_tag_env (1-byte integer, array size: npixel_env x nscan):
Surface tag for environmental scene channels.

lat_env1_orig (4-byte float, array size: npixel_env x nscan):
Original pixel latitude for channels 19, 22 GHz.

lon_env1_orig (4-byte float, array size: npixel_env x nscan):
Original pixel longitude for channels 19, 22 GHz.

ta19v_env1 (4-byte float, array size: npixel_env x nscan):
19.35 GHz V-Pol Antenna Temperature.

ta19h_env1 (4-byte float, array size: npixel_env x nscan):
19.35 GHz H-Pol Antenna Temperature.

ta22v_env1 (4-byte float, array size: npixel_env x nscan):
22.235 GHz V-Pol Antenna Temperature.

lat_env2_orig (4-byte float, array size: npixel_env x nscan):
Original pixel latitude for channels 37 GHz.

lon_env2_orig (4-byte float, array size: npixel_env x nscan):
Original pixel longitude for channels 37 GHz.

ta37v_env2 (4-byte float, array size: npixel_env x nscan):
37.0 GHz V-Pol Antenna Temperature.

ta37h_env2 (4-byte float, array size: npixel_env x nscan):
37.0 GHz H-Pol Antenna Temperature.

aux_warmcal (2-byte integer, array size: nchannel x nscan):
Warm load calibration by channel (1-24).

aux_coldcal (2-byte integer, array size: nchannel x nscan):
Cold load calibration by channel (1-24).

aux_warmloadtemp (4-byte float, array size: nwarmload x nscan):
Warm load temperatures (1-3).

aux_MUXsubID (2-byte integer, array size: nscan):
Subframe ID number.

aux_MUXhouse (4-byte float, array size: nmuxhouse x nscan):
MUX housekeeping values (1-4).

aux_lat_kband (4-byte float, array size: nbasepoint x nscan):
K-Band Base Point latitude (1-28).

aux_lon_kband (4-byte float, array size: nbasepoint x nscan):
K-Band Base Point longitude (1-28).

aux_eia_kband (4-byte float, array size: nbasepoint x nscan):
K-Band Base Point EIA (1-28).

aux_azimuth_kband (4-byte float, array size: nbasepoint x nscan):
K-Band Base Point Azimuth (1-28).

aux_lat_uvband (4-byte float, array size: nbasepoint x nscan):
UV-Band Base Point latitude.

aux_lon_uvband (4-byte float, array size: nbasepoint x nscan):
UV-Band Base Point longitude.

aux_eia_uvband (4-byte float, array size: nbasepoint x nscan):
UV-Band Base Point EIA.

aux_azimuth_uvband (4-byte float, array size: nbasepoint x nscan):
UV-Band Base Point azimuth.

aux_lat_wband (4-byte float, array size: nbasepoint x nscan):
W-Band Base Point latitude.

aux_lon_wband (4-byte float, array size: nbasepoint x nscan):
W-Band Base Point longitude.

aux_eia_wband (4-byte float, array size: nbasepoint x nscan):
W-Band Base Point EIA.

aux_azimuth_wband (4-byte float, array size: nbasepoint x nscan):
W-Band Base Point azimuth.

aux_lat_gband (4-byte float, array size: nbasepoint x nscan):
G-Band Base Point latitude.

aux_lon_gband (4-byte float, array size: nbasepoint x nscan):
G-Band Base Point longitude.

aux_eia_gband (4-byte float, array size: nbasepoint x nscan):
G-Band Base Point EIA.

aux_azimuth_gband (4-byte float, array size: nbasepoint x nscan):
G-Band Base Point azimuth.

aux_lat_lvband (4-byte float, array size: nbasepoint x nscan):
LV-Band Base Point latitude.

aux_lon_lvband (4-byte float, array size: nbasepoint x nscan):
LV-Band Base Point longitude.

aux_eia_lvband (4-byte float, array size: nbasepoint x nscan):
LV-Band Base Point EIA.

aux_azimuth_lvband (4-byte float, array size: nbasepoint x nscan):
LV-Band Base Point azimuth.

aux_lat_kaband (4-byte float, array size: nbasepoint x nscan):
Ka-Band Base Point latitude.

aux_lon_kaband (4-byte float, array size: nbasepoint x nscan):
Ka-Band Base Point longitude.

aux_eia_kaband (4-byte float, array size: nbasepoint x nscan):
Ka-Band Base Point EIA.

aux_azimuth_kaband (4-byte float, array size: nbasepoint x nscan):
Ka-Band Base Point azimuth.

spacecraft_lat (4-byte float, array size: nscan):
Spacecraft latitude.

spacecraft_lon (4-byte float, array size: nscan):
Spacecraft longitude.

spacecraft_alt (4-byte float, array size: nscan):
Spacecraft altitude.

sun_vector (4-byte float, array size: nsunvec x nscan):
Sun vector from spacecraft in GCI coordinates.

sun_elevation_angle (4-byte float, array size: nscan):
Sun elevation angle from spacecraft.

sun_azimuth_angle (4-byte float, array size: nscan):
Sun azimuth angle from spacecraft.

solar_beta_angle (4-byte float, array size: nscan):
Solar beta angle.

time_since_eclipse (4-byte float, array size: nscan):
Time since eclipse.

eclipse_status (1-byte integer, array size: nscan):
Eclipse status (0=sun, 1=shadow).

phase_orbit_midnight (4-byte float, array size: nscan):
Phase from orbit midnight.

sun_earth_separation (4-byte float, array size: nscan):
Sun Earth separation angle.

phase_eclipse_exit (4-byte float, array size: nscan):
Orbit phase for eclipse exit or entry.

earth_angle_radius (4-byte float, array size: nscan):
Earth angle radius.

temp_arm (4-byte float, array size: nscan):
Temperature of the reflector arm (measured).

temp_reflector (4-byte float, array size: nscan):
Temperature of the main reflector (estimated from refletor arm temp).

original_gain (4-byte float, array size: nchannel x nscan):
Original smoothed gain.

corrected_gain (4-byte float, array size: nchannel x nscan):
Smoothed gain corrected for solar intrusion.

delta_gain (4-byte float, array size: nchannel x nscan):
Delta gain change for solar intrusion correction.

lat_img1 (4-byte float, array size: npixel_img x nscan):
Pixel latitude for channels 8-11 (150, 183 GHz).

lon_img1 (4-byte float, array size: npixel_img x nscan):
Pixel longitude for channels 8-11 (150, 183 GHz).

eia_img1 (4-byte float, array size: npixel_img x nscan):
Earth Incidence Angle for imager scene channels (150 and 183 +/- 1,3,7).

quality_img1 (1-byte integer, array size: npixel_img x nscan):
Quality flags for imager scene channels (150 and 183 +/- 1,3,7). Flag definition:

```
0  Good Data
1  Possible sun glint
2  Climatology check warning (19V Channel)
3  Climatology check warning (19H Channel)
4  Climatology check warning (22V Channel)
5  Climatology check warning (37V Channel)
6  Climatology check warning (37H Channel)
7  Climatology check warning (91V Channel)
8  Climatology check warning (91H Channel)
9  Climatology check warning (150H Channel)
10  Climatology check warning (183+/-1 Channel)
11  Climatology check warning (183+/-3 Channel)
12  Climatology check warning (183+/-7 Channel)
13  Climatology check warning (Multiple enviro sensor channels)
14  Climatology check warning (Multiple imager sensor channels)
15  Climatology check warning (Multiple LAS sensor channels)
16  Climatology check warning (Multiple UAS sensor channels)
17  Correction for lunar intrusion into warm load
18  Correction for solar intrusion into warm load
19  No sun angle correction warning in multiple channels
20  Sensor data issue in multiple imager sensor channels
21  Sensor data issue in multiple enviro sensor channels
22  Sensor data issue in 91H channel
101  Geolocation check flagged in input BASE file
102  Climatology check flagged in input BASE file
103  Antenna temperatures are less than 50 or greater than 350
110  Climatology check failure (19V Channel)
111  Climatology check failure (19H Channel)
112  Climatology check failure (22V Channel)
113  Climatology check failure (37V Channel)
114  Climatology check failure (37H Channel)
115  Climatology check failure (91V Channel)
116  Climatology check failure (91H Channel)
117  Climatology check failure (150H Channel)
118  Climatology check failure (183+/-1 Channel)
119  Climatology check failure (183+/-3 Channel)
120  Climatology check failure (183+/-7 Channel)
121  Climatology check failure (Multiple enviro sensor channels)
122  Climatology check failure (Multiple imager sensor channels)
123  Climatology check failure (Multiple LAS sensor channels)
124  Climatology check failure (Multiple UAS sensor channels)
```

```
125  Failure of 150H channel
126  Failure of multiple imager sensor channel
127  Failure of 37V channel
```

tb150h_img1 (4-byte float, array size: npixel_img x nscan):
150.0 GHz H-Pol Brightness Temperature.

tb183_1h_img1 (4-byte float, array size: npixel_img x nscan):
183.31 +/- 1 GHz H-Pol Brightness Temperature.

tb183_3h_img1 (4-byte float, array size: npixel_img x nscan):
183.31 +/- 3 GHz H-Pol Brightness Temperature.

tb183_7h_img1 (4-byte float, array size: npixel_img x nscan):
183.31 +/- 6.6 GHz H-Pol Brightness Temperature.

lat_img2 (4-byte float, array size: npixel_img x nscan):
Pixel latitude for channels 17-18 (91 GHz).

lon_img2 (4-byte float, array size: npixel_img x nscan):
Pixel longitude for channels 17-18 (91 GHz).

eia_img2 (4-byte float, array size: npixel_img x nscan):
Earth Incidence Angle for imager scene channels (91v and 91h).

quality_img2 (1-byte integer, array size: npixel_img x nscan):
Quality flags for imager scene channels (91v and 91h).

tb91v_img2 (4-byte float, array size: npixel_img x nscan):
19.35 GHz V-Pol Brightness Temperature.

tb91h_img2 (4-byte float, array size: npixel_img x nscan):
19.35 GHz H-Pol Brightness Temperature.

lat_env1 (4-byte float, array size: npixel_env x nscan):
Pixel latitude for channels 12-14 (19, 22 GHz).

lon_env1 (4-byte float, array size: npixel_env x nscan):
Pixel longitude for channels 12-14 (19, 22 GHz).

eia_env1 (4-byte float, array size: npixel_env x nscan):
Earth Incidence Angle for environmental scene channels (19v, 19h, and 22v).

quality_env1 (1-byte integer, array size: npixel_env x nscan):
Quality flags for environmental scene channels (19v, 19h, and 22v.

tb19v_env1 (4-byte float, array size: npixel_env x nscan):
19.35 GHz V-Pol Brightness Temperature.

tb19h_env1 (4-byte float, array size: npixel_env x nscan):
19.35 GHz H-Pol Brightness Temperature.

tb22v_env1 (4-byte float, array size: npixel_env x nscan):
22.235 GHz V-Pol Brightness Temperature.

lat_env2 (4-byte float, array size: npixel_env x nscan):
Pixel latitude for channels 15-16 (37 GHz).

lon_env2 (4-byte float, array size: npixel_env x nscan):
Pixel longitude for channels 15-16 (37 GHz).

eia_env2 (4-byte float, array size: npixel_env x nscan):
Earth Incidence Angle for environmental scene channels (37v and 37h).

quality_env2 (1-byte integer, array size: npixel_env x nscan):
Quality flags for environmental scene channels (37v and 37h).

tb37v_env2 (4-byte float, array size: npixel_env x nscan):
37.0 GHz V-Pol Brightness Temperature.

tb37h_env2 (4-byte float, array size: npixel_env x nscan):
37.0 GHz H-Pol Brightness Temperature.

sun_glint_img1 (4-byte float, array size: npixel_img x nscan):
Sun glint angle for channels 8-11 (150, 183 GHz).

sun_glint_env1 (4-byte float, array size: npixel_env x nscan):
Sun glint angle for channels 12-14 (19, 22 GHz).

sun_glint_img2 (4-byte float, array size: npixel_img x nscan):
Sun glint angle for channels 17-18 (91 GHz).

sun_glint_env2 (4-byte float, array size: npixel_env x nscan):
Sun glint angle for channels 15-16 (37 GHz)

sc_azimuth_img (4-byte float, array size: npixel_img x nscan):
Satellite azimuth angle for channels 8-11, 17-18 (91, 150, 183 GHz).

sc_azimuth_env (4-byte float, array size: npixel_env x nscan):
Satellite azimuth angle for channels 12-16 (19, 22, 37 GHz).

sun_zenith_img (4-byte float, array size: npixel_img x nscan):
Sun zenith angle for channels 8-11, 17-18 (91, 150, 183 GHz).

sun_zenith_env (4-byte float, array size: npixel_env x nscan):
Sun zenith angle for channels 12-16 (19, 22, 37 GHz).

sun_azimuth_img (4-byte float, array size: npixel_img x nscan):
Sun azimuth angle for channels 8-11, 17-18 (91, 150, 183 GHz).

sun_azimuth_env (4-byte float, array size: npixel_env x nscan):
Sun azimuth angle for channels 12-16 (19, 22, 37 GHz).

sunLocalTime_img1 (4-byte float, array size: npixel_img x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9	Missing value

sunLocalTime_img2 (4-byte float, array size: npixel_img x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

sunLocalTime_env1 (4-byte float, array size: npixel_env x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

sunLocalTime_env2 (4-byte float, array size: npixel_env x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_1BASESSMIS_H_
#define _TK_1BASESSMIS_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif
```

```
#ifndef _L1BASESSMIS_S1_
#define _L1BASESSMIS_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    int scan_time[7];
    double orbit;
    double xtime;
    double scposx_gci[2];
    double scposy_gci[2];
    double scposz_gci[2];
    double scvelx_gci[2];
    double scvely_gci[2];
    double scvelz_gci[2];
    int scjulday_orig[3];
    float sctime_orig[3];
    float sclat_orig[3];
    float sclon_orig[3];
    float scalt_orig[3];
    signed char surface_tag_img[180];
    signed char rain_flag_img[180];
    float lat_img1_orig[180];
    float lon_img1_orig[180];
    float ta150h_img1[180];
    float ta183_1h_img1[180];
    float ta183_3h_img1[180];
    float ta183_7h_img1[180];
    float lat_img2_orig[180];
    float lon_img2_orig[180];
    float ta91v_img2[180];
    float ta91h_img2[180];
    signed char surface_tag_env[90];
    float lat_env1_orig[90];
    float lon_env1_orig[90];
    float ta19v_env1[90];
    float ta19h_env1[90];
    float ta22v_env1[90];
    float lat_env2_orig[90];
    float lon_env2_orig[90];
    float ta37v_env2[90];
    float ta37h_env2[90];
```

```
short aux_warmcal[24];
short aux_coldcal[24];
float aux_warmloadtemp[3];
short aux_MUXsubID;
float aux_MUXhouse[4];
float aux_lat_kband[28];
float aux_lon_kband[28];
float aux_eia_kband[28];
float aux_azimuth_kband[28];
float aux_lat_uvband[28];
float aux_lon_uvband[28];
float aux_eia_uvband[28];
float aux_azimuth_uvband[28];
float aux_lat_wband[28];
float aux_lon_wband[28];
float aux_eia_wband[28];
float aux_azimuth_wband[28];
float aux_lat_gband[28];
float aux_lon_gband[28];
float aux_eia_gband[28];
float aux_azimuth_gband[28];
float aux_lat_lvband[28];
float aux_lon_lvband[28];
float aux_eia_lvband[28];
float aux_azimuth_lvband[28];
float aux_lat_kaband[28];
float aux_lon_kaband[28];
float aux_eia_kaband[28];
float aux_azimuth_kaband[28];
float spacecraft_lat;
float spacecraft_lon;
float spacecraft_alt;
float sun_vector[3];
float sun_elevation_angle;
float sun_azimuth_angle;
float solar_beta_angle;
float time_since_eclipse;
signed char eclipse_status;
float phase_orbit_midnight;
float sun_earth_separation;
float phase_eclipse_exit;
float earth_angle_radius;
float temp_arm;
```

```
float temp_reflector;
float original_gain[24];
float corrected_gain[24];
float delta_gain[24];
float lat_img1[180];
float lon_img1[180];
float eia_img1[180];
signed char quality_img1[180];
float tb150h_img1[180];
float tb183_1h_img1[180];
float tb183_3h_img1[180];
float tb183_7h_img1[180];
float lat_img2[180];
float lon_img2[180];
float eia_img2[180];
signed char quality_img2[180];
float tb91v_img2[180];
float tb91h_img2[180];
float lat_env1[90];
float lon_env1[90];
float eia_env1[90];
signed char quality_env1[90];
float tb19v_env1[90];
float tb19h_env1[90];
float tb22v_env1[90];
float lat_env2[90];
float lon_env2[90];
float eia_env2[90];
signed char quality_env2[90];
float tb37v_env2[90];
float tb37h_env2[90];
float sun_glint_img1[180];
float sun_glint_env1[90];
float sun_glint_img2[180];
float sun_glint_env2[90];
float sc_azimuth_img[180];
float sc_azimuth_env[90];
float sun_zenith_img[180];
float sun_zenith_env[90];
float sun_azimuth_img[180];
float sun_azimuth_env[90];
float sunLocalTime_img1[180];
float sunLocalTime_img2[180];
```

```
    float sunLocalTime_env1[90];
    float sunLocalTime_env2[90];
} L1BASESSMIS_S1;

#endif

#ifndef _L1BASESSMIS_BASEHEADER_
#define _L1BASESSMIS_BASEHEADER_

typedef struct {
    int spacecraft_id[1];
    int ascend_time[6];
    double TLE_xtime[1];
    int TLE_date[6];
    double TLE_time[1];
    int status_flags1[1];
    int status_flags2[1];
    int quality_tests[6];
    float nominal_elevation_angle[1];
    float spacecraft_roll[1];
    float spacecraft_pitch[1];
    float spacecraft_yaw[1];
    float delta_elevation_angle[6];
    float sensor_roll[6];
    float sensor_pitch[6];
    float sensor_yaw[6];
} L1BASESSMIS_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
```

```
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASESSMIS_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    INTEGER*4 scan_time(7)
    REAL*8 orbit
    REAL*8 xtime
    REAL*8 scposx_gci(2)
    REAL*8 scposy_gci(2)
    REAL*8 scposz_gci(2)
    REAL*8 scvelx_gci(2)
    REAL*8 scvely_gci(2)
    REAL*8 scvelz_gci(2)
    INTEGER*4 scjulday_orig(3)
    REAL*4 sctime_orig(3)
    REAL*4 sclat_orig(3)
    REAL*4 sclon_orig(3)
    REAL*4 scalt_orig(3)
    BYTE surface_tag_img(180)
    BYTE rain_flag_img(180)
    REAL*4 lat_img1_orig(180)
    REAL*4 lon_img1_orig(180)
    REAL*4 ta150h_img1(180)
    REAL*4 ta183_1h_img1(180)
    REAL*4 ta183_3h_img1(180)
    REAL*4 ta183_7h_img1(180)
    REAL*4 lat_img2_orig(180)
    REAL*4 lon_img2_orig(180)
    REAL*4 ta91v_img2(180)
    REAL*4 ta91h_img2(180)
    BYTE surface_tag_env(90)
    REAL*4 lat_env1_orig(90)
    REAL*4 lon_env1_orig(90)
    REAL*4 ta19v_env1(90)
    REAL*4 ta19h_env1(90)
    REAL*4 ta22v_env1(90)
    REAL*4 lat_env2_orig(90)
    REAL*4 lon_env2_orig(90)
    REAL*4 ta37v_env2(90)
    REAL*4 ta37h_env2(90)
    INTEGER*2 aux_warmcal(24)
```

```
INTEGER*2 aux_coldcal(24)
REAL*4 aux_warmloadtemp(3)
INTEGER*2 aux_MUXsubID
REAL*4 aux_MUXhouse(4)
REAL*4 aux_lat_kband(28)
REAL*4 aux_lon_kband(28)
REAL*4 aux_eia_kband(28)
REAL*4 aux_azimuth_kband(28)
REAL*4 aux_lat_uvband(28)
REAL*4 aux_lon_uvband(28)
REAL*4 aux_eia_uvband(28)
REAL*4 aux_azimuth_uvband(28)
REAL*4 aux_lat_wband(28)
REAL*4 aux_lon_wband(28)
REAL*4 aux_eia_wband(28)
REAL*4 aux_azimuth_wband(28)
REAL*4 aux_lat_gband(28)
REAL*4 aux_lon_gband(28)
REAL*4 aux_eia_gband(28)
REAL*4 aux_azimuth_gband(28)
REAL*4 aux_lat_lvband(28)
REAL*4 aux_lon_lvband(28)
REAL*4 aux_eia_lvband(28)
REAL*4 aux_azimuth_lvband(28)
REAL*4 aux_lat_kaband(28)
REAL*4 aux_lon_kaband(28)
REAL*4 aux_eia_kaband(28)
REAL*4 aux_azimuth_kaband(28)
REAL*4 spacecraft_lat
REAL*4 spacecraft_lon
REAL*4 spacecraft_alt
REAL*4 sun_vector(3)
REAL*4 sun_elevation_angle
REAL*4 sun_azimuth_angle
REAL*4 solar_beta_angle
REAL*4 time_since_eclipse
BYTE eclipse_status
REAL*4 phase_orbit_midnight
REAL*4 sun_earth_separation
REAL*4 phase_eclipse_exit
REAL*4 earth_angle_radius
REAL*4 temp_arm
REAL*4 temp_reflector
```

```
REAL*4 original_gain(24)
REAL*4 corrected_gain(24)
REAL*4 delta_gain(24)
REAL*4 lat_img1(180)
REAL*4 lon_img1(180)
REAL*4 eia_img1(180)
BYTE quality_img1(180)
REAL*4 tb150h_img1(180)
REAL*4 tb183_1h_img1(180)
REAL*4 tb183_3h_img1(180)
REAL*4 tb183_7h_img1(180)
REAL*4 lat_img2(180)
REAL*4 lon_img2(180)
REAL*4 eia_img2(180)
BYTE quality_img2(180)
REAL*4 tb91v_img2(180)
REAL*4 tb91h_img2(180)
REAL*4 lat_env1(90)
REAL*4 lon_env1(90)
REAL*4 eia_env1(90)
BYTE quality_env1(90)
REAL*4 tb19v_env1(90)
REAL*4 tb19h_env1(90)
REAL*4 tb22v_env1(90)
REAL*4 lat_env2(90)
REAL*4 lon_env2(90)
REAL*4 eia_env2(90)
BYTE quality_env2(90)
REAL*4 tb37v_env2(90)
REAL*4 tb37h_env2(90)
REAL*4 sun_glint_img1(180)
REAL*4 sun_glint_env1(90)
REAL*4 sun_glint_img2(180)
REAL*4 sun_glint_env2(90)
REAL*4 sc_azimuth_img(180)
REAL*4 sc_azimuth_env(90)
REAL*4 sun_zenith_img(180)
REAL*4 sun_zenith_env(90)
REAL*4 sun_azimuth_img(180)
REAL*4 sun_azimuth_env(90)
REAL*4 sunLocalTime_img1(180)
REAL*4 sunLocalTime_img2(180)
REAL*4 sunLocalTime_env1(90)
```

```
    REAL*4 sunLocalTime_env2(90)
END STRUCTURE

STRUCTURE /L1BASESSMIS_BASEHEADER/
    INTEGER*4 spacecraft_id(1)
    INTEGER*4 ascend_time(6)
    REAL*8 TLE_xtime(1)
    INTEGER*4 TLE_date(6)
    REAL*8 TLE_time(1)
    INTEGER*4 status_flags1(1)
    INTEGER*4 status_flags2(1)
    INTEGER*4 quality_tests(6)
    REAL*4 nominal_elevation_angle(1)
    REAL*4 spacecraft_roll(1)
    REAL*4 spacecraft_pitch(1)
    REAL*4 spacecraft_yaw(1)
    REAL*4 delta_elevation_angle(6)
    REAL*4 sensor_roll(6)
    REAL*4 sensor_pitch(6)
    REAL*4 sensor_yaw(6)
END STRUCTURE
```

5.10 1BASEAMSRE - AMSRE base

1BASEAMSRE contains brightness temperature. These files contain all the information from the AMSR-E Level 1B files produced by JAXA plus the isMissing flag, sun_Glint_Angle, solarBetaAngle and timeSinceEclipseEntry. 1BASEAMSRE is written as one swath, but the 1C product will have 6 swaths. More detailed information on some variables may be found in the document "AMSRE Level 1 Product Format Specification" written by JAXA

NOTE: the filespec does not draw the swath. NOTE: ranges may be wrong

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel1	243	Number of pixels for low res.
npixel2	486	Number of pixels for high res.
count1	16	Number of (hot or cold) load for 6GHz to 36GHz.
count2	32	Number of (hot or cold) load for 89GHz.
freq1	12	Number of freq. for 6GHz to 36GHz.
freq2	4	Number of freq. for 89GHz.
ncoregistration	6	Number of co-registration parameter (A1 or A2) values.
two	2	Number two.
three	3	Number three.
six	6	Number six.
number248	248	Number 248.
nnav	6	Number of navigation data values.
ncoef	32	Number of antenna temperature conversion coefficients.
ngainoffset	32	Number of gain and offset values.
nspctemp	34	Number of SPC temperatures.
nspstemp	46	Number of SPS temperatures.
nquality	128	Number of quality floats.

Figure 241 through Figure 246 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

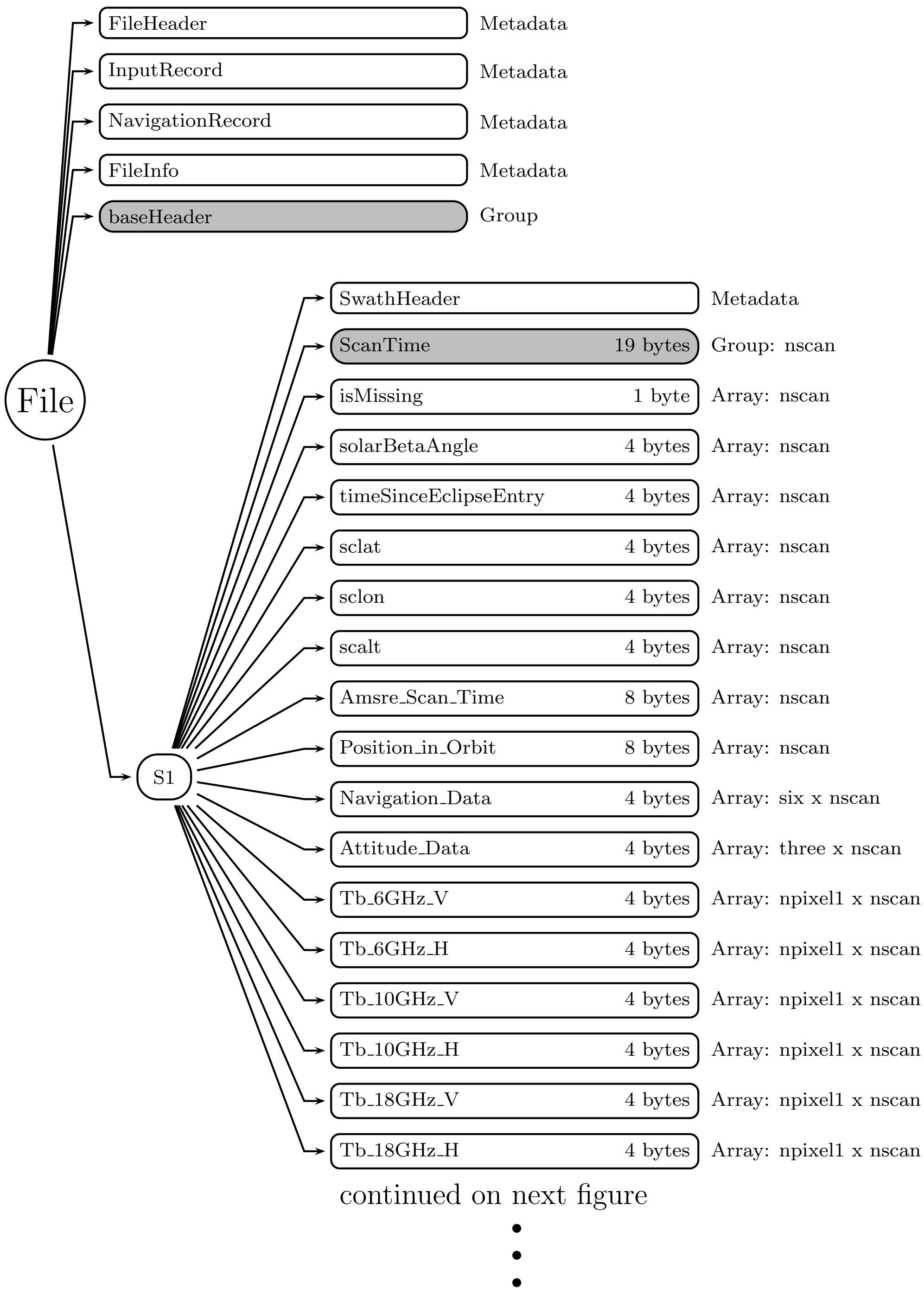


Figure 241: Data Format Structure for 1BASEAMSRE, AMSRE base

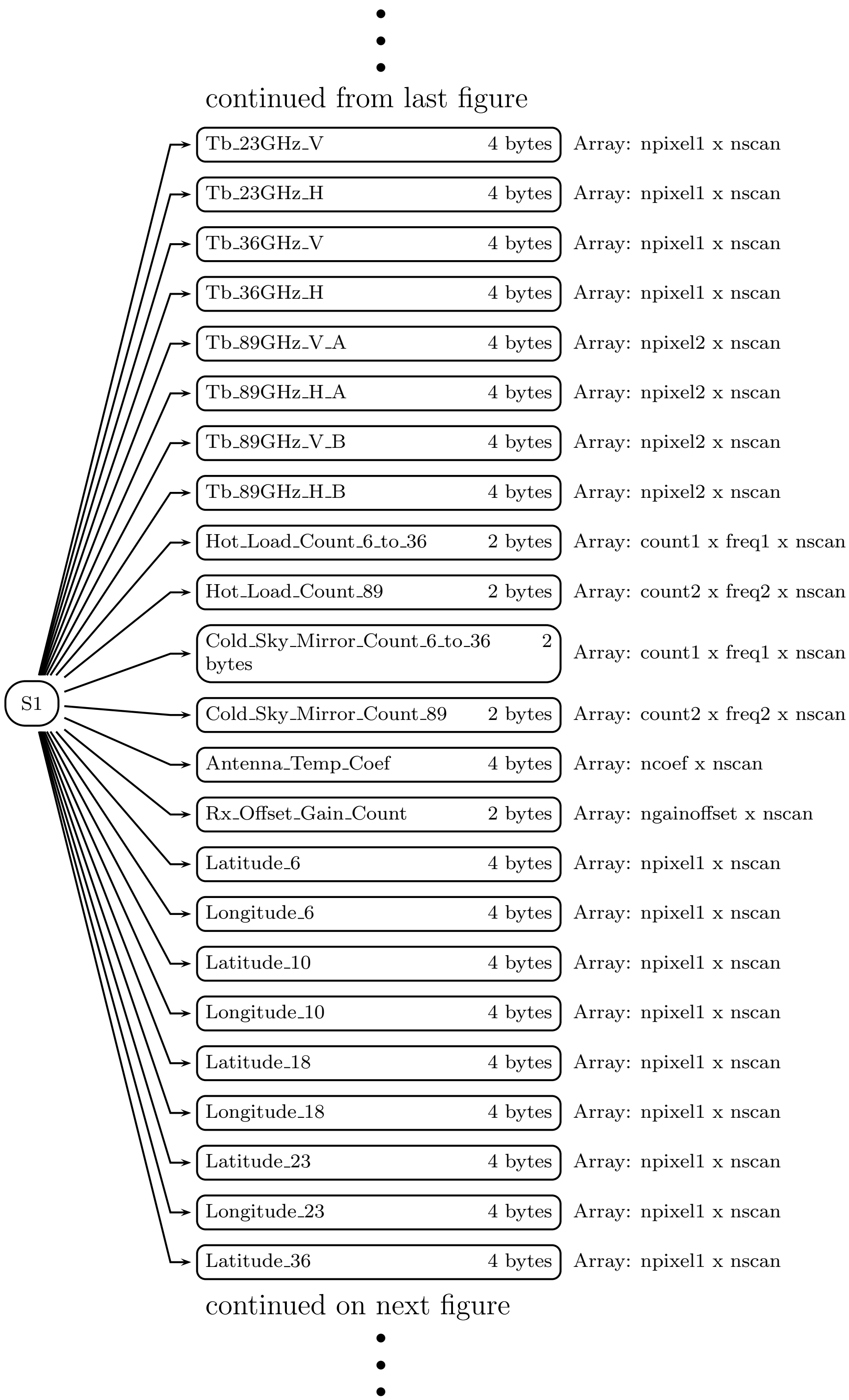


Figure 242: Data Format Structure for 1BASEAMSRE, AMSRE base

continued from last figure

S1

Longitude_36	4 bytes	Array: npixel1 x nscan
Latitude_89A	4 bytes	Array: npixel2 x nscan
Longitude_89A	4 bytes	Array: npixel2 x nscan
Latitude_89B	4 bytes	Array: npixel2 x nscan
Longitude_89B	4 bytes	Array: npixel2 x nscan
sunLocalTime_6	4 bytes	Array: npixel1 x nscan
sunLocalTime_10	4 bytes	Array: npixel1 x nscan
sunLocalTime_18	4 bytes	Array: npixel1 x nscan
sunLocalTime_23	4 bytes	Array: npixel1 x nscan
sunLocalTime_36	4 bytes	Array: npixel1 x nscan
sunLocalTime_89A	4 bytes	Array: npixel2 x nscan
sunLocalTime_89B	4 bytes	Array: npixel2 x nscan
Sun_Azimuth	4 bytes	Array: npixel1 x nscan
Sun_Elevation	4 bytes	Array: npixel1 x nscan
Earth_Incidence_6	4 bytes	Array: npixel1 x nscan
Earth_Incidence_10	4 bytes	Array: npixel1 x nscan
Earth_Incidence_18	4 bytes	Array: npixel1 x nscan
Earth_Incidence_23	4 bytes	Array: npixel1 x nscan
Earth_Incidence_36	4 bytes	Array: npixel1 x nscan
Earth_Incidence_89A	4 bytes	Array: npixel2 x nscan
Earth_Incidence_89B	4 bytes	Array: npixel2 x nscan
Sun_Glint_Angle	4 bytes	Array: npixel1 x nscan
Earth_Azimuth	4 bytes	Array: npixel1 x nscan

continued on next figure

Figure 243: Data Format Structure for 1BASEAMSRE, AMSRE base

continued from last figure

S1	Land_Ocean_Flag_6_to_36	1 byte	Array: npixel1 x six x nscan
	Land_Ocean_Flag_89	1 byte	Array: npixel2 x two x nscan
	Observation_Supplement	1 byte	Array: number248 x nscan
	SPC_Temperature_Count	2 bytes	Array: nspctemp x nscan
	SPS_Temperature_Count	2 bytes	Array: nspstemp x nscan
	Data_Quality	4 bytes	Array: nquality x nscan
	Interpolation_Flag_6_to_36	1 byte	Array: count1 x freq1 x nscan
	Interpolation_Flag_89	1 byte	Array: count2 x freq2 x nscan
	Spill_Over	4 bytes	Array: npixel1 x two x nscan

Figure 244: Data Format Structure for 1BASEAMSRE, AMSRE base

baseHeader	CoRegistrationParameterA1	4 bytes	Array: ncoregistration
	CoRegistrationParameterA2	4 bytes	Array: ncoregistration

Figure 245: Data Format Structure for 1BASEAMSRE, baseHeader

ScanTime	Year	2 bytes	Array: nscan
	Month	1 byte	Array: nscan
	DayOfMonth	1 byte	Array: nscan
	Hour	1 byte	Array: nscan
	Minute	1 byte	Array: nscan
	Second	1 byte	Array: nscan
	MilliSecond	2 bytes	Array: nscan
	DayOfYear	2 bytes	Array: nscan
	SecondOfDay	8 bytes	Array: nscan

Figure 246: Data Format Structure for 1BASEAMSRE, ScanTime

CoRegistrationParameterA1 (4-byte float, array size: ncoregistration):
Co-registration parameter A1. The co-registration parameters are used for calculating the position (latitude and longitude) of the observing point for each frequency except 89 GHz.

CoRegistrationParameterA2 (4-byte float, array size: ncoregistration):
Co-registration parameter A2. The co-registration parameters are used for calculating the position (latitude and longitude) of the observing point for each frequency except 89 GHz.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow.

sclat (4-byte float, array size: nscan):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan):
Spacecraft altitude. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

Amsre_Scan_Time (8-byte float, array size: nscan):
The observation start time of 89GHz A-horn. This time is a total second (TAI) from 00:00 (UTC) on January 1st, 1993.

Position_in_Orbit (8-byte float, array size: nscan):
Fractional orbit number.

Navigation_Data (4-byte float, array size: six x nscan):
Satellite position and velocity corresponding to the observation start time (Amsre_Scan_Time) of each scan. Data is in WGS84 earth fixed coordinate system.

Attitude_Data (4-byte float, array size: three x nscan):
Roll, Pitch and Yaw corresponding to the observation start time (Amsre_Scan_Time) of

each scan. The coordinate system is a right-hand system that is Roll for the satellite flight direction and Yaw for the earth center direction.

Tb_6GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_6GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_10GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_10GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_18GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_18GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_23GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_23GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_36GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_36GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_89GHz_V_A (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Tb_89GHz_H_A (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Tb_89GHz_V_B (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Tb_89GHz_H_B (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Hot_Load_Count_6_to_36 (2-byte integer, array size: count1 x freq1 x nscan):
The observed count of HTS and polarization for each frequency except 89 GHz. The number of observation data for one scan is 16 points.

Hot_Load_Count_89 (2-byte integer, array size: count2 x freq2 x nscan):
The observed count of HTS and polarization for 89 GHz.The number of observation data for one scan is 32 points.

Cold_Sky_Mirror_Count_6_to_36 (2-byte integer, array size: count1 x freq1 x nscan):
The observed count of CSM and polarization for each frequency except 89 GHz. In the

AMSR-E level 1B (HDF5) product, there are 7GHz-V and 7GHz-H regions of observation frequencies which is not present in AMSR-E. Information on 6GHz-V and 6GHz-H is stored in these areas.

Cold_Sky_Mirror_Count_89 (2-byte integer, array size: count2 x freq2 x nscan):
The observed count of CSM and polarization for 89 GHz.

Antenna_Temp_Coef (4-byte float, array size: ncoef x nscan):
The antenna temperature conversion coefficients used for converting the observed count value into antenna temperature.

Rx_Offset_Gain_Count (2-byte unsigned integer, array size: ngainoffset x nscan):
The gain and offset values for receiver (RX).

Latitude_6 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 6 GHz coregistration parameters to the 89A GHz location.

Longitude_6 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 6 GHz coregistration parameters to the 89A GHz location.

Latitude_10 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 10 GHz coregistration parameters to the 89A GHz location.

Longitude_10 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 10 GHz coregistration parameters to the 89A GHz location.

Latitude_18 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 18 GHz coregistration parameters to the 89A GHz location.

Longitude_18 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 18 GHz coregistration parameters to the 89A GHz location.

Latitude_23 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude_23 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Latitude_36 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 36 GHz coregistration parameters to the 89A GHz location.

Longitude_36 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 36 GHz coregistration parameters to the 89A GHz location.

Latitude_89A (4-byte float, array size: npixel2 x nscan):
Latitude of the observation point on the earth surface at 89GHz A-horn.

Longitude_89A (4-byte float, array size: npixel2 x nscan):
Longitude of the observation point on the earth surface at 89GHz A-horn.

Latitude_89B (4-byte float, array size: npixel2 x nscan):
Latitude of the observation point on the earth surface at 89GHz B-horn.

Longitude_89B (4-byte float, array size: npixel2 x nscan):
Longitude of the observation point on the earth surface at 89GHz B-horn.

sunLocalTime_6 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_10 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_18 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_23 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_36 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local

noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_89A (4-byte float, array size: npixel2 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_89B (4-byte float, array size: npixel2 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

Sun_Azimuth (4-byte float, array size: npixel1 x nscan):
The sun azimuth angle on odd observation points (origin 1) of 89 GHz A-horn.

Sun_Elevation (4-byte float, array size: npixel1 x nscan):
The sun elevation angle on odd observation points (origin 1) of 89 GHz A-horn.

Earth_Incidence_6 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 6 GHz.

Earth_Incidence_10 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 10 GHz.

Earth_Incidence_18 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 18 GHz.

Earth_Incidence_23 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 23 GHz.

Earth_Incidence_36 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 36 GHz.

Earth_Incidence_89A (4-byte float, array size: npixel2 x nscan):
The earth incidence angle 89 GHz A.

Earth_Incidence_89B (4-byte float, array size: npixel2 x nscan):
The earth incidence angle 89 GHz B.

Sun_Glint_Angle (4-byte float, array size: npixel1 x nscan):
Sun glint angle calculated for 89A odd numbered pixels.

Earth_Azimuth (4-byte float, array size: npixel1 x nscan):
The earth azimuth angle on odd observation points (origin 1) of 89 GHz A-horn.

Land_Ocean_Flag_6_to_36 (1-byte char, array size: npixel1 x six x nscan):
The land coverage percentage of the observation footprint.

Land_Ocean_Flag_89 (1-byte char, array size: npixel2 x two x nscan):
The land coverage percentage of the observation footprint.

Observation_Supplement (1-byte char, array size: number248 x nscan):
Observation supplement raw data such as a H/W state. If the scan is missing data, all 1 are stored in it.

SPC_Temperature_Count (2-byte unsigned integer, array size: nspctemp x nscan):
The temperature of SPC (Signal Processor Control unit) in each scan is stored with the value of 12 bits of raw data acquired from the satellite. If it is a missing scan, all 1 are stored in it.

SPS_Temperature_Count (2-byte unsigned integer, array size: nspstemp x nscan):
The temperature of SPS (Signal Processor Sensor unit) in each scan is stored with the value of 12 bits of raw data acquired from the satellite. If it is a missing scan, all 1 are stored in it.

Data_Quality (4-byte float, array size: nquality x nscan):
The scan data quality information and supplementary information flags. These correspond to observation data and calculation result in each scan. See AMSRE Level 1 Product Format Specification for details.

Interpolation_Flag_6_to_36 (1-byte char, array size: count1 x freq1 x nscan):
The interpolation flag for CSM data.

Interpolation_Flag_89 (1-byte char, array size: count2 x freq2 x nscan):
The interpolation flag for CSM data.

Spill_Over (4-byte float, array size: npixel1 x two x nscan):
The observaton voltage of 6GHz before 200 scans is stored from the hear scan of the product. This information is used for calibrating the ground radiation on CSM.

C Structure Header file:

```
#ifndef _TK_1BASEAMSRE_H_
#define _TK_1BASEAMSRE_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
```

```
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASEAMSRE_S1_
#define _L1BASEAMSRE_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    float solarBetaAngle;
    float timeSinceEclipseEntry;
    float sclat;
    float sclon;
    float scalt;
    double Amsre_Scan_Time;
    double Position_in_Orbit;
    float Navigation_Data[6];
    float Attitude_Data[3];
    float Tb_6GHz_V[243];
    float Tb_6GHz_H[243];
    float Tb_10GHz_V[243];
    float Tb_10GHz_H[243];
    float Tb_18GHz_V[243];
    float Tb_18GHz_H[243];
    float Tb_23GHz_V[243];
    float Tb_23GHz_H[243];
    float Tb_36GHz_V[243];
    float Tb_36GHz_H[243];
    float Tb_89GHz_V_A[486];
    float Tb_89GHz_H_A[486];
    float Tb_89GHz_V_B[486];
    float Tb_89GHz_H_B[486];
    short Hot_Load_Count_6_to_36[12][16];
    short Hot_Load_Count_89[4][32];
    short Cold_Sky_Mirror_Count_6_to_36[12][16];
    short Cold_Sky_Mirror_Count_89[4][32];
```

```
float Antenna_Temp_Coef[32];
unsigned short Rx_Offset_Gain_Count[32];
float Latitude_6[243];
float Longitude_6[243];
float Latitude_10[243];
float Longitude_10[243];
float Latitude_18[243];
float Longitude_18[243];
float Latitude_23[243];
float Longitude_23[243];
float Latitude_36[243];
float Longitude_36[243];
float Latitude_89A[486];
float Longitude_89A[486];
float Latitude_89B[486];
float Longitude_89B[486];
float sunLocalTime_6[243];
float sunLocalTime_10[243];
float sunLocalTime_18[243];
float sunLocalTime_23[243];
float sunLocalTime_36[243];
float sunLocalTime_89A[486];
float sunLocalTime_89B[486];
float Sun_Azimuth[243];
float Sun_Elevation[243];
float Earth_Incidence_6[243];
float Earth_Incidence_10[243];
float Earth_Incidence_18[243];
float Earth_Incidence_23[243];
float Earth_Incidence_36[243];
float Earth_Incidence_89A[486];
float Earth_Incidence_89B[486];
float Sun_Glint_Angle[243];
float Earth_Azimuth[243];
unsigned char Land_Ocean_Flag_6_to_36[6][243];
unsigned char Land_Ocean_Flag_89[2][486];
unsigned char Observation_Supplement[248];
unsigned short SPC_Temperature_Count[34];
unsigned short SPS_Temperature_Count[46];
float Data_Quality[128];
unsigned char Interpolation_Flag_6_to_36[12][16];
unsigned char Interpolation_Flag_89[4][32];
float Spill_Over[2][243];
```

```
} L1BASEAMSRE_S1;

#endif

#ifndef _L1BASEAMSRE_BASEHEADER_
#define _L1BASEAMSRE_BASEHEADER_

typedef struct {
    float CoRegistrationParameterA1[6];
    float CoRegistrationParameterA2[6];
} L1BASEAMSRE_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASEAMSRE_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    REAL*4 solarBetaAngle
    REAL*4 timeSinceEclipseEntry
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*8 Amsre_Scan_Time
    REAL*8 Position_in_Orbit
    REAL*4 Navigation_Data(6)
    REAL*4 Attitude_Data(3)
    REAL*4 Tb_6GHz_V(243)
```

```
REAL*4 Tb_6GHz_H(243)
REAL*4 Tb_10GHz_V(243)
REAL*4 Tb_10GHz_H(243)
REAL*4 Tb_18GHz_V(243)
REAL*4 Tb_18GHz_H(243)
REAL*4 Tb_23GHz_V(243)
REAL*4 Tb_23GHz_H(243)
REAL*4 Tb_36GHz_V(243)
REAL*4 Tb_36GHz_H(243)
REAL*4 Tb_89GHz_V_A(486)
REAL*4 Tb_89GHz_H_A(486)
REAL*4 Tb_89GHz_V_B(486)
REAL*4 Tb_89GHz_H_B(486)
INTEGER*2 Hot_Load_Count_6_to_36(16,12)
INTEGER*2 Hot_Load_Count_89(32,4)
INTEGER*2 Cold_Sky_Mirror_Count_6_to_36(16,12)
INTEGER*2 Cold_Sky_Mirror_Count_89(32,4)
REAL*4 Antenna_Temp_Coef(32)
INTEGER*2 Rx_Offset_Gain_Count(32)
REAL*4 Latitude_6(243)
REAL*4 Longitude_6(243)
REAL*4 Latitude_10(243)
REAL*4 Longitude_10(243)
REAL*4 Latitude_18(243)
REAL*4 Longitude_18(243)
REAL*4 Latitude_23(243)
REAL*4 Longitude_23(243)
REAL*4 Latitude_36(243)
REAL*4 Longitude_36(243)
REAL*4 Latitude_89A(486)
REAL*4 Longitude_89A(486)
REAL*4 Latitude_89B(486)
REAL*4 Longitude_89B(486)
REAL*4 sunLocalTime_6(243)
REAL*4 sunLocalTime_10(243)
REAL*4 sunLocalTime_18(243)
REAL*4 sunLocalTime_23(243)
REAL*4 sunLocalTime_36(243)
REAL*4 sunLocalTime_89A(486)
REAL*4 sunLocalTime_89B(486)
REAL*4 Sun_Azimuth(243)
REAL*4 Sun_Elevation(243)
REAL*4 Earth_Incidence_6(243)
```

```
    REAL*4 Earth_Incidence_10(243)
    REAL*4 Earth_Incidence_18(243)
    REAL*4 Earth_Incidence_23(243)
    REAL*4 Earth_Incidence_36(243)
    REAL*4 Earth_Incidence_89A(486)
    REAL*4 Earth_Incidence_89B(486)
    REAL*4 Sun_Glint_Angle(243)
    REAL*4 Earth_Azimuth(243)
    CHARACTER Land_Ocean_Flag_6_to_36(243,6)
    CHARACTER Land_Ocean_Flag_89(486,2)
    CHARACTER Observation_Supplement(248)
    INTEGER*2 SPC_Temperature_Count(34)
    INTEGER*2 SPS_Temperature_Count(46)
    REAL*4 Data_Quality(128)
    CHARACTER Interpolation_Flag_6_to_36(16,12)
    CHARACTER Interpolation_Flag_89(32,4)
    REAL*4 Spill_Over(243,2)
END STRUCTURE

STRUCTURE /L1BASEAMSRE_BASEHEADER/
    REAL*4 CoRegistrationParameterA1(6)
    REAL*4 CoRegistrationParameterA2(6)
END STRUCTURE
```

5.11 1BASEAMSR2 - AMSR2 base

1BASEAMSR2 contains brightness temperature. 1BASEAMSR2 is written as one swath, but the 1C product will have 6 swaths. More detailed information on some variables may be found in the document

```
Global Change Observation Mission Water (GCOM-W1)
AMSR2 Level 1 Product Format Specification
written by JAXA
```

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel1	243	Number pixels for low res.
npixel2	486	Number pixels for high res.
count1	16	Number of (hot or cold) load for 6GHz to 36GHz.
count2	32	Number of (hot or cold) load for 89GHz.
freq1	12	Number of freq. for 6GHz to 36GHz.
freq2	4	Number of freq. for 89GHz.
nchanRFI	8	Number of channels for rfiFlag.
ncoregistration	6	Number of co-registration parameter (A1 or A2) values.
two	2	Number two.
three	3	Number three.
six	6	Number six.
number248	248	Number 248.
nnav	6	Number of navigation data values.
ncoef	32	Number of antenna temperature conversion coefficients.
ngainoffset	32	Number of gain and offset values.
nspctemp	34	Number of SPC temperatures.
nspstemp	46	Number of SPS temperatures.
npcd	64	Number of PCD (Payload Correction Data).
nquality	512	Number of quality bytes.

Figure 247 through Figure 252 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

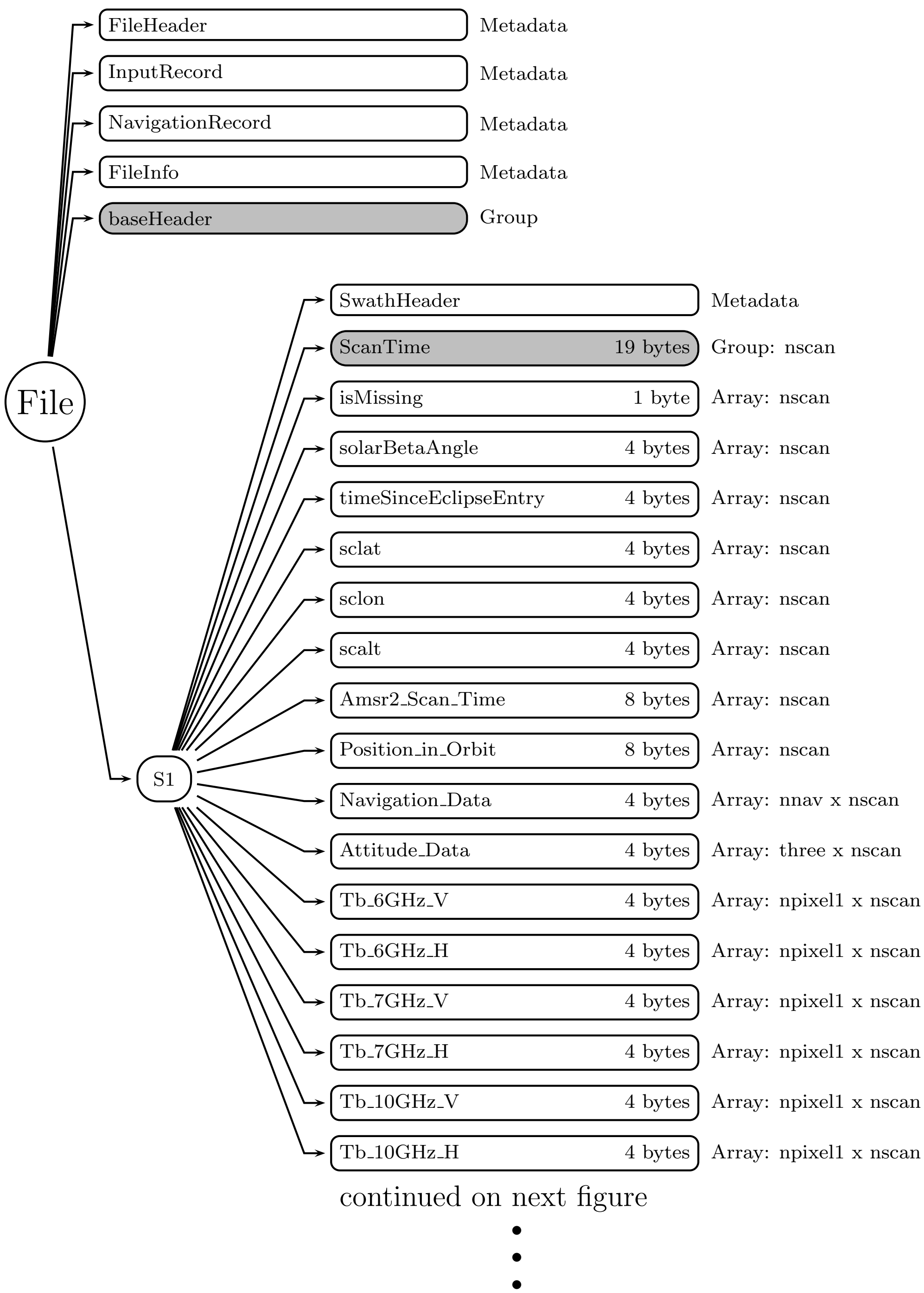


Figure 247: Data Format Structure for 1BASEAMSR2, AMSR2 base

continued from last figure

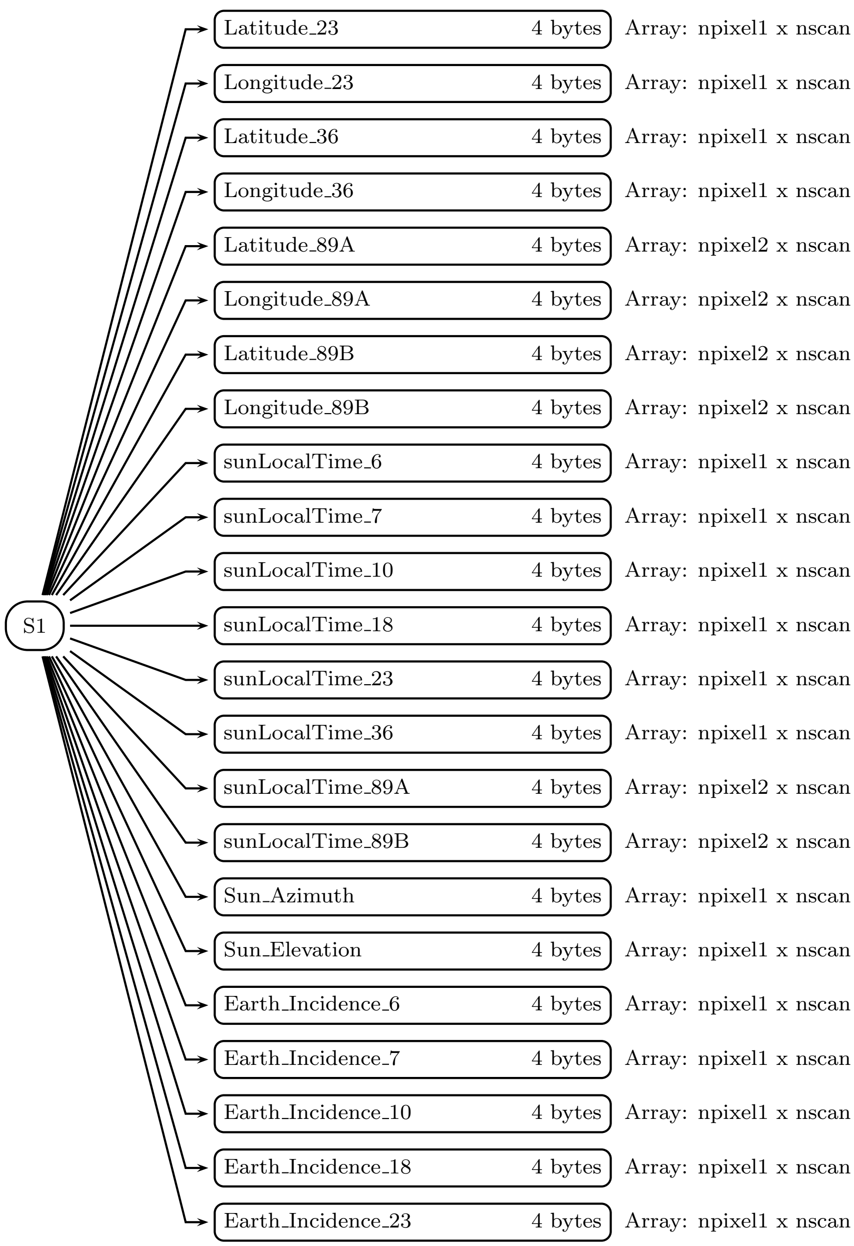
S1

Tb_18GHz_V	4 bytes	Array: npixel1 x nscan
Tb_18GHz_H	4 bytes	Array: npixel1 x nscan
Tb_23GHz_V	4 bytes	Array: npixel1 x nscan
Tb_23GHz_H	4 bytes	Array: npixel1 x nscan
Tb_36GHz_V	4 bytes	Array: npixel1 x nscan
Tb_36GHz_H	4 bytes	Array: npixel1 x nscan
Tb_89GHz_V_A	4 bytes	Array: npixel2 x nscan
Tb_89GHz_H_A	4 bytes	Array: npixel2 x nscan
Tb_89GHz_V_B	4 bytes	Array: npixel2 x nscan
Tb_89GHz_H_B	4 bytes	Array: npixel2 x nscan
Hot_Load_Count_6_to_36	2 bytes	Array: count1 x freq1 x nscan
Hot_Load_Count_89	2 bytes	Array: count2 x freq2 x nscan
Cold_Sky_Mirror_Count_6_to_36	2 bytes	Array: count1 x freq1 x nscan
Cold_Sky_Mirror_Count_89	2 bytes	Array: count2 x freq2 x nscan
Rx_Offset_Gain_Count	2 bytes	Array: ngainoffset x nscan
Latitude_6	4 bytes	Array: npixel1 x nscan
Longitude_6	4 bytes	Array: npixel1 x nscan
Latitude_7	4 bytes	Array: npixel1 x nscan
Longitude_7	4 bytes	Array: npixel1 x nscan
Latitude_10	4 bytes	Array: npixel1 x nscan
Longitude_10	4 bytes	Array: npixel1 x nscan
Latitude_18	4 bytes	Array: npixel1 x nscan
Longitude_18	4 bytes	Array: npixel1 x nscan

continued on next figure

Figure 248: Data Format Structure for 1BASEAMSR2, AMSR2 base

continued from last figure



continued on next figure

Figure 249: Data Format Structure for 1BASEAMSR2, AMSR2 base

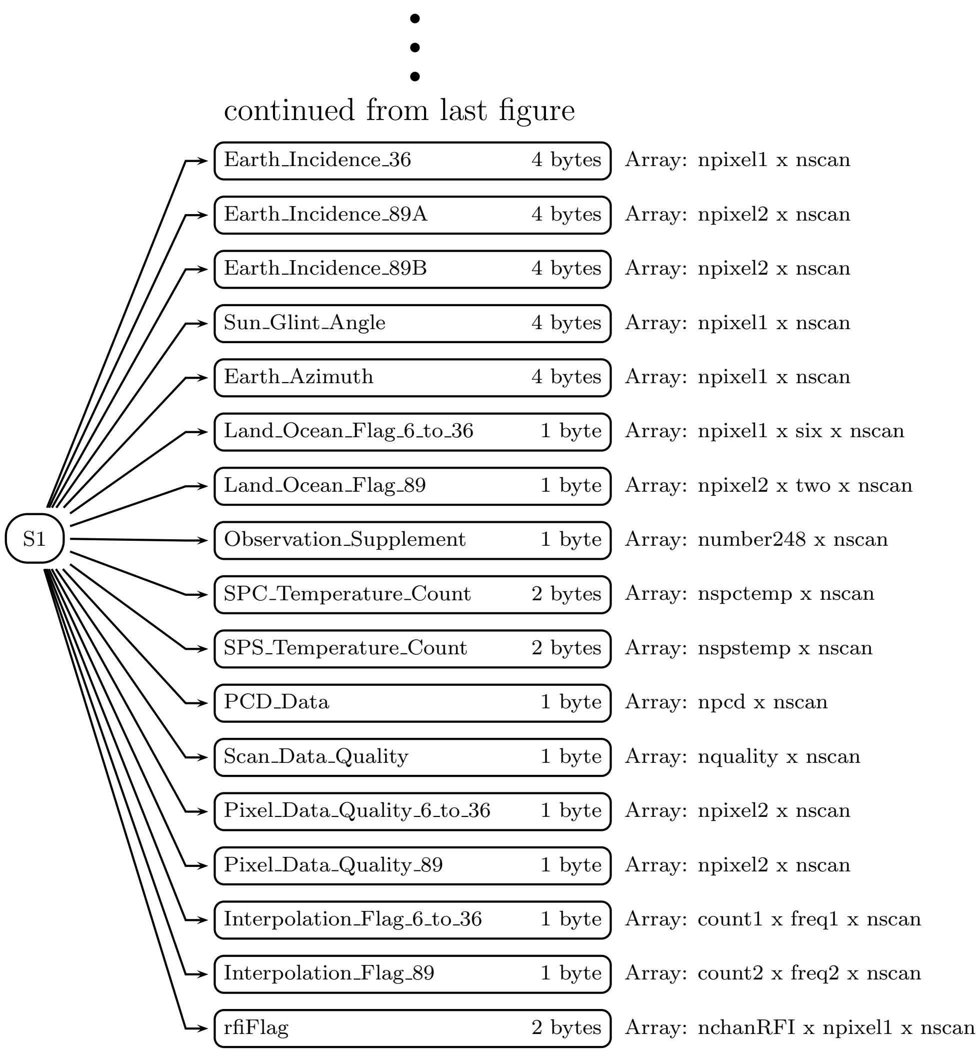


Figure 250: Data Format Structure for 1BASEAMSR2, AMSR2 base

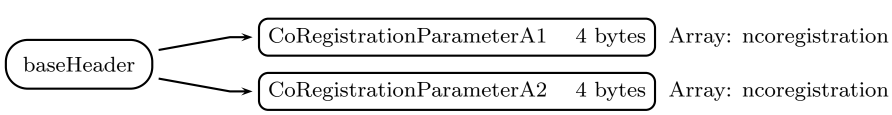


Figure 251: Data Format Structure for 1BASEAMSR2, baseHeader

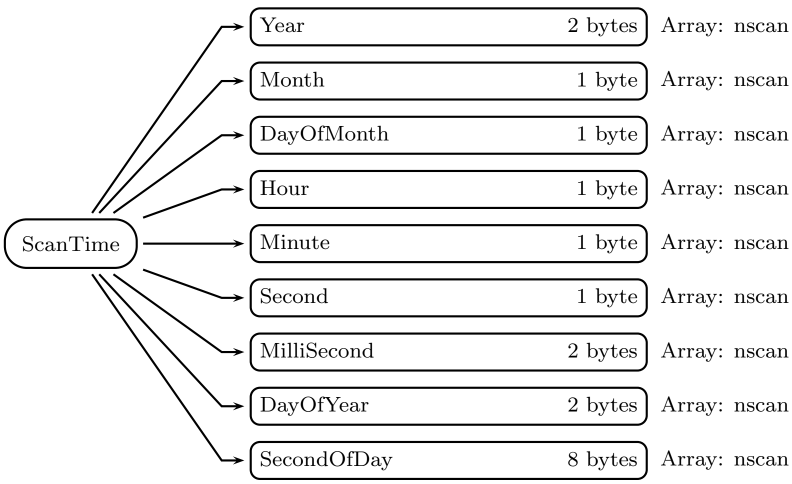


Figure 252: Data Format Structure for 1BASEAMSR2, ScanTime

CoRegistrationParameterA1 (4-byte float, array size: ncoregistration):
Co-registration parameter A1. The co-registration parameters are used for calculating the position (latitude and longitude) of the observing point for each frequency except 89 GHz.

CoRegistrationParameterA2 (4-byte float, array size: ncoregistration):
Co-registration parameter A2. The co-registration parameters are used for calculating the position (latitude and longitude) of the observing point for each frequency except 89 GHz.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow.

sclat (4-byte float, array size: nscan):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan):
Spacecraft altitude. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

Amsr2_Scan_Time (8-byte float, array size: nscan):
The observation start time of 89GHz A-horn. This time is a total second (TAI) from 00:00 (UTC) on January 1st, 1993.

Position_in_Orbit (8-byte float, array size: nscan):
Fractional orbit number.

Navigation_Data (4-byte float, array size: nnav x nscan):
Satellite position and velocity corresponding to the observation start time (Amsr2_Scan_Time) of each scan. Data is in WGS84 earth fixed coordinate system.

Attitude_Data (4-byte float, array size: three x nscan):
Roll, Pitch and Yaw.

Tb_6GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_6GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_7GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_7GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_10GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_10GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_18GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_18GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_23GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_23GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_36GHz_V (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_36GHz_H (4-byte float, array size: npixel1 x nscan):
Brightness temperature.

Tb_89GHz_V_A (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Tb_89GHz_H_A (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Tb_89GHz_V_B (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Tb_89GHz_H_B (4-byte float, array size: npixel2 x nscan):
Brightness temperature.

Hot_Load_Count_6_to_36 (2-byte integer, array size: count1 x freq1 x nscan):
The observed count of HTS and polarization for each frequency except 89 GHz.

Hot_Load_Count_89 (2-byte integer, array size: count2 x freq2 x nscan):
The observed count of HTS and polarization for 89 GHz.

Cold_Sky_Mirror_Count_6_to_36 (2-byte integer, array size: count1 x freq1 x nscan):
The observed count of CSM and polarization for each frequency except 89 GHz.

Cold_Sky_Mirror_Count_89 (2-byte integer, array size: count2 x freq2 x nscan):
The observed count of CSM and polarization for 89 GHz.

Rx_Offset_Gain_Count (2-byte unsigned integer, array size: ngainoffset x nscan):
The gain and offset values for receiver (RX).

Latitude_6 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 6 GHz coregistration parameters to the 89A GHz location.

Longitude_6 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 6 GHz coregistration parameters to the 89A GHz location.

Latitude_7 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 7 GHz coregistration parameters to the 89A GHz location.

Longitude_7 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 7 GHz coregistration parameters to the 89A GHz location.

Latitude_10 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 10 GHz coregistration parameters to the 89A GHz location.

Longitude_10 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 10 GHz coregistration parameters to the 89A GHz location.

Latitude_18 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 18 GHz coregistration parameters to the 89A GHz location.

Longitude_18 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 18 GHz coregistration parameters to the 89A GHz location.

Latitude_23 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude_23 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Latitude_36 (4-byte float, array size: npixel1 x nscan):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 36 GHz coregistration parameters to the 89A GHz location.

Longitude_36 (4-byte float, array size: npixel1 x nscan):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 36 GHz coregistration parameters to the 89A GHz location.

Latitude_89A (4-byte float, array size: npixel2 x nscan):
Latitude of the observation point on the earth surface at 89GHz A-horn.

Longitude_89A (4-byte float, array size: npixel2 x nscan):
Longitude of the observation point on the earth surface at 89GHz A-horn.

Latitude_89B (4-byte float, array size: npixel2 x nscan):
Latitude of the observation point on the earth surface at 89GHz B-horn.

Longitude_89B (4-byte float, array size: npixel2 x nscan):
Longitude of the observation point on the earth surface at 89GHz B-horn.

sunLocalTime_6 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

sunLocalTime_7 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

sunLocalTime_10 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any

location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_18 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_23 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_36 (4-byte float, array size: npixel1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_89A (4-byte float, array size: npixel2 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

sunLocalTime_89B (4-byte float, array size: npixel2 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

Sun_Azimuth (4-byte float, array size: npixel1 x nscan):
The sun azimuth angle on odd observation points (origin 1) of 89 GHz A-horn.

Sun_Elevation (4-byte float, array size: npixel1 x nscan):
The sun elevation angle on odd observation points (origin 1) of 89 GHz A-horn.

Earth_Incidence_6 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 6 GHz.

Earth_Incidence_7 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 7 GHz.

Earth_Incidence_10 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 10 GHz.

Earth_Incidence_18 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 18 GHz.

Earth_Incidence_23 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 23 GHz.

Earth_Incidence_36 (4-byte float, array size: npixel1 x nscan):
The earth incidence angle 36 GHz.

Earth_Incidence_89A (4-byte float, array size: npixel2 x nscan):
The earth incidence angle 89 GHz A.

Earth_Incidence_89B (4-byte float, array size: npixel2 x nscan):
The earth incidence angle 89 GHz B.

Sun_Glint_Angle (4-byte float, array size: npixel1 x nscan):
Sun glint angle calculated for 89A odd numbered pixels.

Earth_Azimuth (4-byte float, array size: npixel1 x nscan):
The earth azimuth angle on odd observation points (origin 1) of 89 GHz A-horn.

Land_Ocean_Flag_6_to_36 (1-byte char, array size: npixel1 x six x nscan):
The land coverage percentage of the observation footprint.

Land_Ocean_Flag_89 (1-byte char, array size: npixel2 x two x nscan):
The land coverage percentage of the observation footprint.

Observation_Supplement (1-byte char, array size: number248 x nscan):
Observation supplement raw data such as a H/W state. If the scan is missing data, all 1 are stored in it.

SPC_Temperature_Count (2-byte unsigned integer, array size: nspctemp x nscan):
The temperature of SPC (Signal Processor Control unit) in each scan is stored with the value of 12 bits of raw data acquired from the satellite. If it is a missing scan, all 1 are stored in it.

SPS_Temperature_Count (2-byte unsigned integer, array size: nspstemp x nscan):
The temperature of SPS (Signal Processor Sensor unit) in each scan is stored with the value of 12 bits of raw data acquired from the satellite. If it is a missing scan, all 1 are stored in it.

PCD_Data (1-byte char, array size: npcd x nscan):
The PCD (Payload Correction Data) data ID. If the scan is missing, 1 is stored in all bits.

Scan_Data_Quality (1-byte char, array size: nquality x nscan):
Array of scan data quality information and supplementary information flags. These correspond to observation data and calculation result in each scan. See AMSR2 Level 1 Product Format Specification for details.

Pixel_Data_Quality_6_to_36 (1-byte char, array size: npixel2 x nscan):
Pixel quality bit flags for frequencies 6 GHz to 36GHz. See AMSR2 Level 1 Product Format Specification for details.

Pixel_Data_Quality_89 (1-byte char, array size: npixel2 x nscan):
Pixel quality bit flags for frequency 89GHz. See AMSR2 Level 1 Product Format Specification for details.

Interpolation_Flag_6_to_36 (1-byte char, array size: count1 x freq1 x nscan):
The interpolation flag for CSM data.

Interpolation_Flag_89 (1-byte char, array size: count2 x freq2 x nscan):
The interpolation flag for CSM data.

rfiFlag (2-byte integer, array size: nchanRFI x npixel1 x nscan):
Radio frequency Interference (RFI) Flag for channels 6V, 6H, 7V, 7H, 10V, 10H, 18V and 18H. The flag is set to 1 if the pixel is contaminated by RFI.

C Structure Header file:

```
#ifndef _TK_1BASEAMSR2_H_
#define _TK_1BASEAMSR2_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif
```

```
#ifndef _L1BASEAMSR2_S1_
#define _L1BASEAMSR2_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    float solarBetaAngle;
    float timeSinceEclipseEntry;
    float sclat;
    float sclon;
    float scalt;
    double Amsr2_Scan_Time;
    double Position_in_Orbit;
    float Navigation_Data[6];
    float Attitude_Data[3];
    float Tb_6GHz_V[243];
    float Tb_6GHz_H[243];
    float Tb_7GHz_V[243];
    float Tb_7GHz_H[243];
    float Tb_10GHz_V[243];
    float Tb_10GHz_H[243];
    float Tb_18GHz_V[243];
    float Tb_18GHz_H[243];
    float Tb_23GHz_V[243];
    float Tb_23GHz_H[243];
    float Tb_36GHz_V[243];
    float Tb_36GHz_H[243];
    float Tb_89GHz_V_A[486];
    float Tb_89GHz_H_A[486];
    float Tb_89GHz_V_B[486];
    float Tb_89GHz_H_B[486];
    short Hot_Load_Count_6_to_36[12][16];
    short Hot_Load_Count_89[4][32];
    short Cold_Sky_Mirror_Count_6_to_36[12][16];
    short Cold_Sky_Mirror_Count_89[4][32];
    unsigned short Rx_Offset_Gain_Count[32];
    float Latitude_6[243];
    float Longitude_6[243];
    float Latitude_7[243];
    float Longitude_7[243];
    float Latitude_10[243];
    float Longitude_10[243];
```

```
    float Latitude_18[243];
    float Longitude_18[243];
    float Latitude_23[243];
    float Longitude_23[243];
    float Latitude_36[243];
    float Longitude_36[243];
    float Latitude_89A[486];
    float Longitude_89A[486];
    float Latitude_89B[486];
    float Longitude_89B[486];
    float sunLocalTime_6[243];
    float sunLocalTime_7[243];
    float sunLocalTime_10[243];
    float sunLocalTime_18[243];
    float sunLocalTime_23[243];
    float sunLocalTime_36[243];
    float sunLocalTime_89A[486];
    float sunLocalTime_89B[486];
    float Sun_Azimuth[243];
    float Sun_Elevation[243];
    float Earth_Incidence_6[243];
    float Earth_Incidence_7[243];
    float Earth_Incidence_10[243];
    float Earth_Incidence_18[243];
    float Earth_Incidence_23[243];
    float Earth_Incidence_36[243];
    float Earth_Incidence_89A[486];
    float Earth_Incidence_89B[486];
    float Sun_Glint_Angle[243];
    float Earth_Azimuth[243];
    unsigned char Land_Ocean_Flag_6_to_36[6][243];
    unsigned char Land_Ocean_Flag_89[2][486];
    unsigned char Observation_Supplement[248];
    unsigned short SPC_Temperature_Count[34];
    unsigned short SPS_Temperature_Count[46];
    unsigned char PCD_Data[64];
    unsigned char Scan_Data_Quality[512];
    unsigned char Pixel_Data_Quality_6_to_36[486];
    unsigned char Pixel_Data_Quality_89[486];
    unsigned char Interpolation_Flag_6_to_36[12][16];
    unsigned char Interpolation_Flag_89[4][32];
    short rfiFlag[243][8];
} L1BASEAMSR2_S1;
```

```
#endif

#ifndef _L1BASEAMSR2_BASEHEADER_
#define _L1BASEAMSR2_BASEHEADER_

typedef struct {
    float CoRegistrationParameterA1[6];
    float CoRegistrationParameterA2[6];
} L1BASEAMSR2_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASEAMSR2_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    REAL*4 solarBetaAngle
    REAL*4 timeSinceEclipseEntry
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*8 Amsr2_Scan_Time
    REAL*8 Position_in_Orbit
    REAL*4 Navigation_Data(6)
    REAL*4 Attitude_Data(3)
    REAL*4 Tb_6GHz_V(243)
    REAL*4 Tb_6GHz_H(243)
```

```
REAL*4 Tb_7GHz_V(243)
REAL*4 Tb_7GHz_H(243)
REAL*4 Tb_10GHz_V(243)
REAL*4 Tb_10GHz_H(243)
REAL*4 Tb_18GHz_V(243)
REAL*4 Tb_18GHz_H(243)
REAL*4 Tb_23GHz_V(243)
REAL*4 Tb_23GHz_H(243)
REAL*4 Tb_36GHz_V(243)
REAL*4 Tb_36GHz_H(243)
REAL*4 Tb_89GHz_V_A(486)
REAL*4 Tb_89GHz_H_A(486)
REAL*4 Tb_89GHz_V_B(486)
REAL*4 Tb_89GHz_H_B(486)
INTEGER*2 Hot_Load_Count_6_to_36(16,12)
INTEGER*2 Hot_Load_Count_89(32,4)
INTEGER*2 Cold_Sky_Mirror_Count_6_to_36(16,12)
INTEGER*2 Cold_Sky_Mirror_Count_89(32,4)
INTEGER*2 Rx_Offset_Gain_Count(32)
REAL*4 Latitude_6(243)
REAL*4 Longitude_6(243)
REAL*4 Latitude_7(243)
REAL*4 Longitude_7(243)
REAL*4 Latitude_10(243)
REAL*4 Longitude_10(243)
REAL*4 Latitude_18(243)
REAL*4 Longitude_18(243)
REAL*4 Latitude_23(243)
REAL*4 Longitude_23(243)
REAL*4 Latitude_36(243)
REAL*4 Longitude_36(243)
REAL*4 Latitude_89A(486)
REAL*4 Longitude_89A(486)
REAL*4 Latitude_89B(486)
REAL*4 Longitude_89B(486)
REAL*4 sunLocalTime_6(243)
REAL*4 sunLocalTime_7(243)
REAL*4 sunLocalTime_10(243)
REAL*4 sunLocalTime_18(243)
REAL*4 sunLocalTime_23(243)
REAL*4 sunLocalTime_36(243)
REAL*4 sunLocalTime_89A(486)
REAL*4 sunLocalTime_89B(486)
```

```
    REAL*4 Sun_Azimuth(243)
    REAL*4 Sun_Elevation(243)
    REAL*4 Earth_Incidence_6(243)
    REAL*4 Earth_Incidence_7(243)
    REAL*4 Earth_Incidence_10(243)
    REAL*4 Earth_Incidence_18(243)
    REAL*4 Earth_Incidence_23(243)
    REAL*4 Earth_Incidence_36(243)
    REAL*4 Earth_Incidence_89A(486)
    REAL*4 Earth_Incidence_89B(486)
    REAL*4 Sun_Glint_Angle(243)
    REAL*4 Earth_Azimuth(243)
    CHARACTER Land_Ocean_Flag_6_to_36(243,6)
    CHARACTER Land_Ocean_Flag_89(486,2)
    CHARACTER Observation_Supplement(248)
    INTEGER*2 SPC_Temperature_Count(34)
    INTEGER*2 SPS_Temperature_Count(46)
    CHARACTER PCD_Data(64)
    CHARACTER Scan_Data_Quality(512)
    CHARACTER Pixel_Data_Quality_6_to_36(486)
    CHARACTER Pixel_Data_Quality_89(486)
    CHARACTER Interpolation_Flag_6_to_36(16,12)
    CHARACTER Interpolation_Flag_89(32,4)
    INTEGER*2 rfiFlag(8,243)
END STRUCTURE

STRUCTURE /L1BASEAMSR2_BASEHEADER/
    REAL*4 CoRegistrationParameterA1(6)
    REAL*4 CoRegistrationParameterA2(6)
END STRUCTURE
```

5.12 1BASEAMSUA - AMSUA base

1BASEAMSUA contains antenna temperature from the AMSUA passive microwave instrument flown on the NOAA and METOPS satellites. Swath S1 is the only swath.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	15	Number of Swath 1 channels.
npixel1	30	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
three	3	Number of spacial dimensions.
TLEDd	6	Number of TLE_date words.
TLETd	1	Number of TLE_time words.

Figure 253 through Figure 256 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

TLE_date (4-byte integer, array size: TLEDd):
TLE date time arrays.

TLE_time (8-byte float, array size: TLETd):
TLE time as in two line element.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

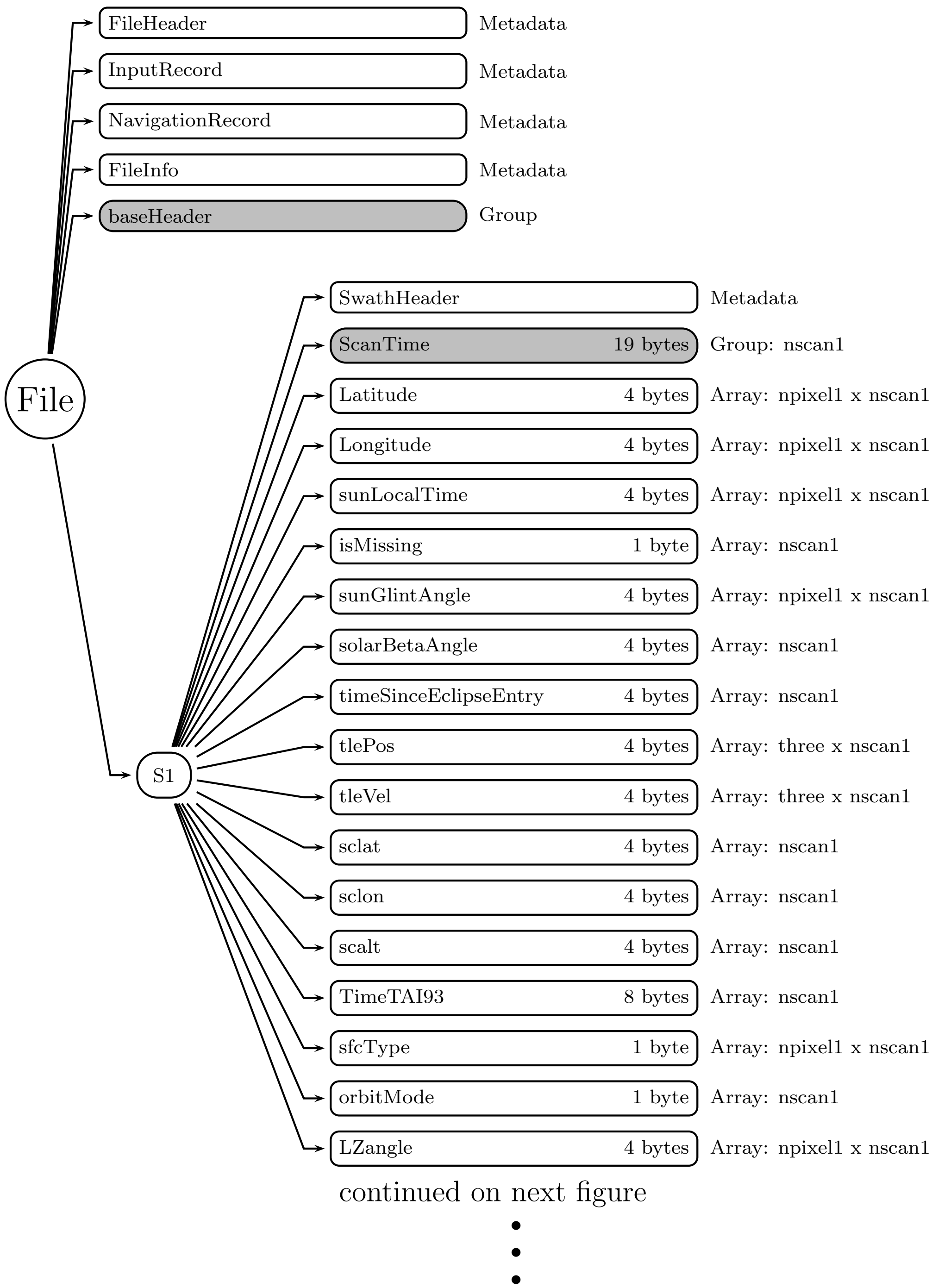


Figure 253: Data Format Structure for 1BASEAMSUA, AMSUA base

continued from last figure

S1

SZangle	4 bytes	Array: npixel1 x nscan1
Chan1AT	4 bytes	Array: npixel1 x nscan1
Chan2AT	4 bytes	Array: npixel1 x nscan1
Chan3AT	4 bytes	Array: npixel1 x nscan1
Chan4AT	4 bytes	Array: npixel1 x nscan1
Chan5AT	4 bytes	Array: npixel1 x nscan1
Chan6AT	4 bytes	Array: npixel1 x nscan1
Chan7AT	4 bytes	Array: npixel1 x nscan1
Chan8AT	4 bytes	Array: npixel1 x nscan1
Chan9AT	4 bytes	Array: npixel1 x nscan1
Chan10AT	4 bytes	Array: npixel1 x nscan1
Chan11AT	4 bytes	Array: npixel1 x nscan1
Chan12AT	4 bytes	Array: npixel1 x nscan1
Chan13AT	4 bytes	Array: npixel1 x nscan1
Chan14AT	4 bytes	Array: npixel1 x nscan1
Chan15AT	4 bytes	Array: npixel1 x nscan1
TPW	4 bytes	Array: npixel1 x nscan1
CLW	4 bytes	Array: npixel1 x nscan1
Sice	4 bytes	Array: npixel1 x nscan1
Tsfc	4 bytes	Array: npixel1 x nscan1
Emis23	4 bytes	Array: npixel1 x nscan1
Emis31	4 bytes	Array: npixel1 x nscan1
Emis50	4 bytes	Array: npixel1 x nscan1

Figure 254: Data Format Structure for 1BASEAMSUA, AMSUA base

baseHeader

TLE_date	4 bytes	Array: TLEDd
TLE_time	8 bytes	Array: TLETd

Figure 255: Data Format Structure for 1BASEAMSUA, baseHeader

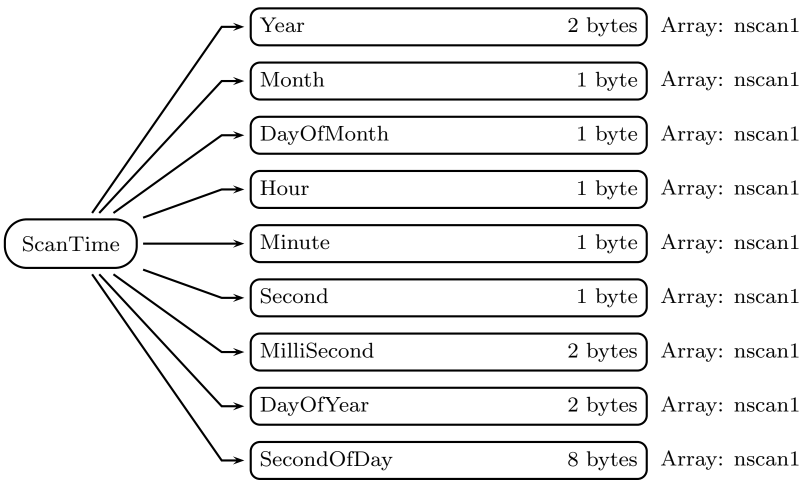


Figure 256: Data Format Structure for 1BASEAMSUA, ScanTime

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan1):
Missing scan flag.

sunGlintAngle (4-byte float, array size: npixel1 x nscan1):
Unpacked sun glint angle. Not sure about the range.

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow.

tlePos (4-byte float, array size: three x nscan1):
TLE satellite position. Values are in m. Special values are defined as:
-9999.9 Missing value

tleVel (4-byte float, array size: three x nscan1):
TLE satellite velocity. Values are in m/s. Special values are defined as:

-9999.9 Missing value

sclat (4-byte float, array size: nscan1):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan1):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan1):
Spacecraft altitude. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

TimeTAI93 (8-byte float, array size: nscan1):
Number of seconds since 0000 Jan 1, 1993.

sfcType (1-byte integer, array size: npixel1 x nscan1):
Surface type: 0=ocean, 1=land, 2=coast

orbitMode (1-byte integer, array size: nscan1):
Orbit direction: 1=ascending 2=descending.

LZangle (4-byte float, array size: npixel1 x nscan1):
Local zenith angle. Not sure about the range and units.

SZangle (4-byte float, array size: npixel1 x nscan1):
Solar zenith angle. Not sure about the range and units.

Chan1AT (4-byte float, array size: npixel1 x nscan1):
Channel 1 Antenna Temperature.

Chan2AT (4-byte float, array size: npixel1 x nscan1):
Channel 2 Antenna Temperature.

Chan3AT (4-byte float, array size: npixel1 x nscan1):
Channel 3 Antenna Temperature.

Chan4AT (4-byte float, array size: npixel1 x nscan1):
Channel 4 Antenna Temperature.

Chan5AT (4-byte float, array size: npixel1 x nscan1):
Channel 5 Antenna Temperature.

Chan6AT (4-byte float, array size: npixel1 x nscan1):
Channel 6 Antenna Temperature.

Chan7AT (4-byte float, array size: npixel1 x nscan1):
Channel 7 Antenna Temperature.

Chan8AT (4-byte float, array size: npixel1 x nscan1):
Channel 8 Antenna Temperature.

Chan9AT (4-byte float, array size: npixel1 x nscan1):
Channel 9 Antenna Temperature.

Chan10AT (4-byte float, array size: npixel1 x nscan1):
Channel 10 Antenna Temperature.

Chan11AT (4-byte float, array size: npixel1 x nscan1):
Channel 11 Antenna Temperature.

Chan12AT (4-byte float, array size: npixel1 x nscan1):
Channel 12 Antenna Temperature.

Chan13AT (4-byte float, array size: npixel1 x nscan1):
Channel 13 Antenna Temperature.

Chan14AT (4-byte float, array size: npixel1 x nscan1):
Channel 14 Antenna Temperature.

Chan15AT (4-byte float, array size: npixel1 x nscan1):
Channel 15 Antenna Temperature.

TPW (4-byte float, array size: npixel1 x nscan1):
Total Precipitable Water.

CLW (4-byte float, array size: npixel1 x nscan1):
Cloud Liquid Water.

Sice (4-byte float, array size: npixel1 x nscan1):
Sea Ice Concentration.

Tsfc (4-byte float, array size: npixel1 x nscan1):
Surface Temperature.

Emis23 (4-byte float, array size: npixel1 x nscan1):
Emissivity at 23.8 GHz.

Emis31 (4-byte float, array size: npixel1 x nscan1):
Emissivity at 31.4 GHz.

Emis50 (4-byte float, array size: npixel1 x nscan1):
Emissivity at 50.3 GHz.

C Structure Header file:

```
#ifndef _TK_1BASEAMSUA_H_
#define _TK_1BASEAMSUA_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
```

```
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASEAMSUA_S1_
#define _L1BASEAMSUA_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[30];
    float Longitude[30];
    float sunLocalTime[30];
    signed char isMissing;
    float sunGlintAngle[30];
    float solarBetaAngle;
    float timeSinceEclipseEntry;
    float tlePos[3];
    float tleVel[3];
    float sclat;
    float sclon;
    float scalt;
    double TimeTAI93;
    signed char sfcType[30];
    signed char orbitMode;
    float LZangle[30];
    float SZangle[30];
    float Chan1AT[30];
    float Chan2AT[30];
    float Chan3AT[30];
    float Chan4AT[30];
    float Chan5AT[30];
    float Chan6AT[30];
    float Chan7AT[30];
    float Chan8AT[30];
    float Chan9AT[30];
```

```
    float Chan10AT[30];
    float Chan11AT[30];
    float Chan12AT[30];
    float Chan13AT[30];
    float Chan14AT[30];
    float Chan15AT[30];
    float TPW[30];
    float CLW[30];
    float Sice[30];
    float Tsfc[30];
    float Emis23[30];
    float Emis31[30];
    float Emis50[30];
} L1BASEAMSUA_S1;

#endif

#ifndef _L1BASEAMSUA_BASEHEADER_
#define _L1BASEAMSUA_BASEHEADER_

typedef struct {
    int TLE_date[6];
    double TLE_time[1];
} L1BASEAMSUA_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE
```

```
STRUCTURE /L1BASEAMSUA_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(30)
    REAL*4 Longitude(30)
    REAL*4 sunLocalTime(30)
    BYTE isMissing
    REAL*4 sunGlintAngle(30)
    REAL*4 solarBetaAngle
    REAL*4 timeSinceEclipseEntry
    REAL*4 tlePos(3)
    REAL*4 tleVel(3)
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*8 TimeTAI93
    BYTE sfcType(30)
    BYTE orbitMode
    REAL*4 LZangle(30)
    REAL*4 SZangle(30)
    REAL*4 Chan1AT(30)
    REAL*4 Chan2AT(30)
    REAL*4 Chan3AT(30)
    REAL*4 Chan4AT(30)
    REAL*4 Chan5AT(30)
    REAL*4 Chan6AT(30)
    REAL*4 Chan7AT(30)
    REAL*4 Chan8AT(30)
    REAL*4 Chan9AT(30)
    REAL*4 Chan10AT(30)
    REAL*4 Chan11AT(30)
    REAL*4 Chan12AT(30)
    REAL*4 Chan13AT(30)
    REAL*4 Chan14AT(30)
    REAL*4 Chan15AT(30)
    REAL*4 TPW(30)
    REAL*4 CLW(30)
    REAL*4 Sice(30)
    REAL*4 Tsfc(30)
    REAL*4 Emis23(30)
    REAL*4 Emis31(30)
    REAL*4 Emis50(30)
END STRUCTURE
```

```
STRUCTURE /L1BASEAMSUA_BASEHEADER/
    INTEGER*4 TLE_date(6)
    REAL*8 TLE_time(1)
END STRUCTURE
```

5.13 1BASEAMSUB - AMSUB base

1BASEAMSUB contains brightness temperature from the AMSU-B passive microwave instrument flown on the NOAA satellites. Swath S1 is the only swath. Swath S1 contains 5 channels: 89.0 +/- 0.9 GHz, 150.0 +/- 0.9 GHz, 183.31 +/- 1 GHz, 183.31 +/- 3 GHz, 183.31 +/- 7 GHz. The scan period is 2.667s. The input is Level-2 AMSU-B Orbital products in HDF-EOS format archived at CLASS. All of the data of the input are included. Brightness temperature was obtained by applying the Antena Pattern Correction to the antena temperature. Please see the Microwave Surface and Precipitation Products System (MSPPS) User's Manual and NOAA KLM User's Guide for details.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	5	Number of Swath 1 channels.
n270	270	Number of 270.
npixel1	90	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
three	3	Number of spacial dimensions.
TLEDd	6	Number of TLE_date words.
TLETd	1	Number of TLE_time words.

Figure 257 through Figure 260 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

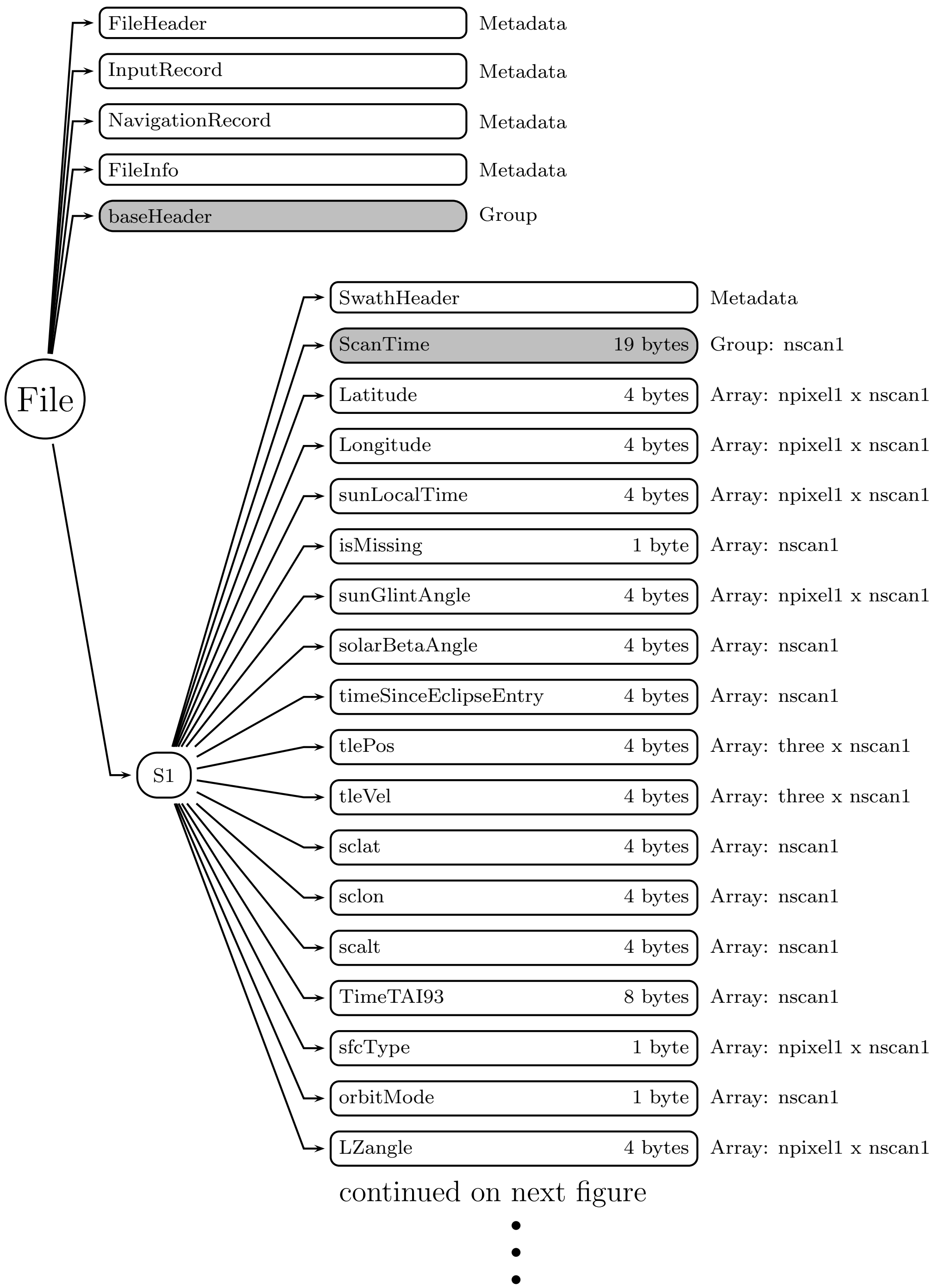


Figure 257: Data Format Structure for 1BASEAMSUB, AMSUB base

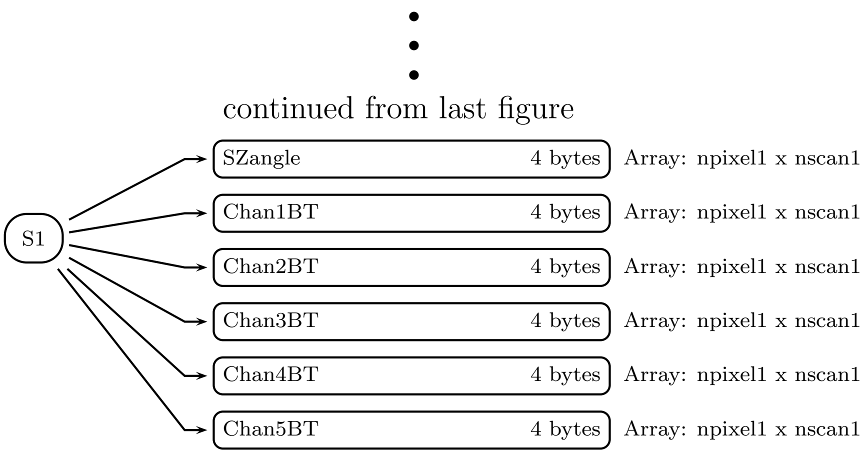


Figure 258: Data Format Structure for 1BASEAMSUB, AMSUB base

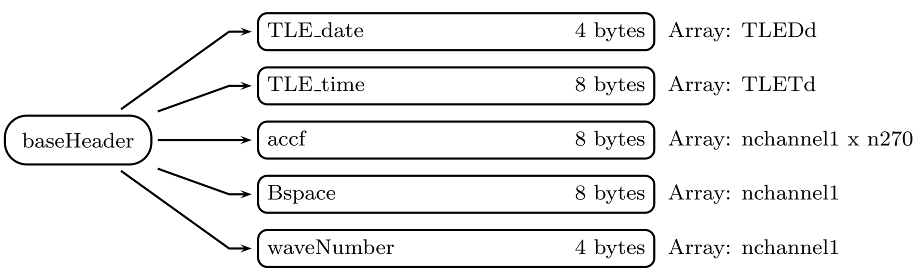


Figure 259: Data Format Structure for 1BASEAMSUB, baseHeader

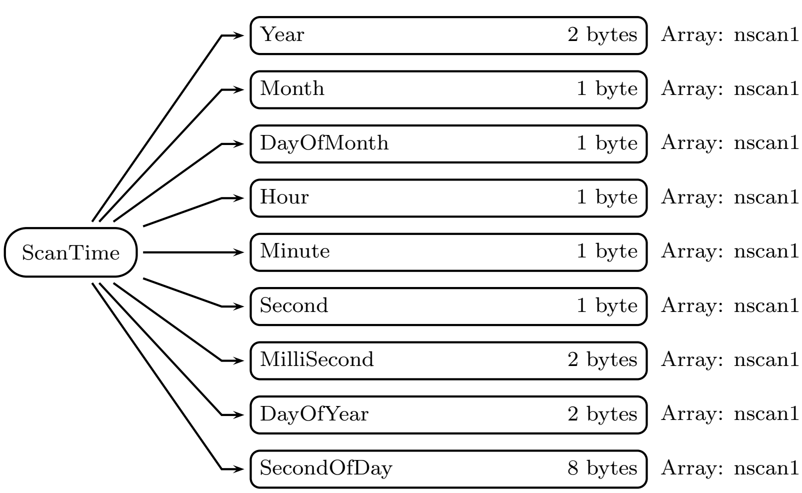


Figure 260: Data Format Structure for 1BASEAMSUB, ScanTime

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

TLE_date (4-byte integer, array size: TLEDd):
TLE date time arrays.

TLE_time (8-byte float, array size: TLETd):
TLE time as in two line element.

accf (8-byte float, array size: nchannel1 x n270):
The correction due to angular dependence of reflectivity.

Bspace (8-byte float, array size: nchannel1):
The channel offset derived from deep space calibration.

waveNumber (4-byte float, array size: nchannel1):
Wave number.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan1):
Missing scan flag.

sunGlintAngle (4-byte float, array size: npixel1 x nscan1):
sunGlintAngle is the angular separation between the Reflected Satellite View Vector and

the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection.

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow.

tlePos (4-byte float, array size: three x nscan1):
Spacecraft position at the ScanTime. Values are in m. Special values are defined as:
-9999.9 Missing value

tleVel (4-byte float, array size: three x nscan1):
Spacecraft velocity at the ScanTime. Values are in m/s. Special values are defined as:
-9999.9 Missing value

sclat (4-byte float, array size: nscan1):
Spacecraft latitude at the ScanTime. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan1):
Spacecraft longitude at the ScanTime. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan1):
Spacecraft altitude at the ScanTime. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

TimeTAI93 (8-byte float, array size: nscan1):
Number of seconds since 0000 Jan 1, 1993.

sfcType (1-byte integer, array size: npixel1 x nscan1):
Surface type: 0=ocean, 1=land, 2=coast

orbitMode (1-byte integer, array size: nscan1):
Orbit direction: 1=ascending 2=descending.

LZangle (4-byte float, array size: npixel1 x nscan1):
Local zenith angle. Values range from -60 to 60 degrees. Special values are defined as:
-9999.9 Missing value

SZangle (4-byte float, array size: npixel1 x nscan1):
Solar zenith angle. Not sure about the range and units.

Chan1BT (4-byte float, array size: npixel1 x nscan1):
Channel 1 brightness Temperature.

Chan2BT (4-byte float, array size: npixel1 x nscan1):
Channel 2 brightness Temperature.

Chan3BT (4-byte float, array size: npixel1 x nscan1):
Channel 3 brightness Temperature.

Chan4BT (4-byte float, array size: npixel1 x nscan1):
Channel 4 brightness Temperature.

Chan5BT (4-byte float, array size: npixel1 x nscan1):
Channel 5 brightness Temperature.

C Structure Header file:

```
#ifndef _TK_1BASEAMSUB_H_
#define _TK_1BASEAMSUB_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASEAMSUB_S1_
#define _L1BASEAMSUB_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    float sunLocalTime[90];
    signed char isMissing;
```

```
    float sunGlintAngle[90];
    float solarBetaAngle;
    float timeSinceEclipseEntry;
    float tlePos[3];
    float tleVel[3];
    float sclat;
    float sclon;
    float scalt;
    double TimeTAI93;
    signed char sfcType[90];
    signed char orbitMode;
    float LZangle[90];
    float SZangle[90];
    float Chan1BT[90];
    float Chan2BT[90];
    float Chan3BT[90];
    float Chan4BT[90];
    float Chan5BT[90];
} L1BASEAMSUB_S1;

#endif

#ifndef _L1BASEAMSUB_BASEHEADER_
#define _L1BASEAMSUB_BASEHEADER_

typedef struct {
    int TLE_date[6];
    double TLE_time[1];
    double accf[270][5];
    double Bspace[5];
    float waveNumber[5];
} L1BASEAMSUB_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
```

```
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASEAMSUB_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    REAL*4 sunLocalTime(90)
    BYTE isMissing
    REAL*4 sunGlintAngle(90)
    REAL*4 solarBetaAngle
    REAL*4 timeSinceEclipseEntry
    REAL*4 tlePos(3)
    REAL*4 tleVel(3)
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*8 TimeTAI93
    BYTE sfcType(90)
    BYTE orbitMode
    REAL*4 LZangle(90)
    REAL*4 SZangle(90)
    REAL*4 Chan1BT(90)
    REAL*4 Chan2BT(90)
    REAL*4 Chan3BT(90)
    REAL*4 Chan4BT(90)
    REAL*4 Chan5BT(90)
END STRUCTURE

STRUCTURE /L1BASEAMSUB_BASEHEADER/
    INTEGER*4 TLE_date(6)
    REAL*8 TLE_time(1)
    REAL*8 accf(5,270)
    REAL*8 Bspace(5)
    REAL*4 waveNumber(5)
END STRUCTURE
```

5.14 1BASEMHS - MHS base

1BASEMHS contains brightness temperature from the MHS passive microwave instrument flown on the NOAA and METOPS satellites. Swath S1 is the only swath. Swath S1 contains 5 channels: 89.0 GHzV, 157.0 GHzV, 183.3 +/- 1 GHzH, 183.3 +/- 3 GHzH, 190.3 GHzV. MHS is very similar to AMSU-B. The scan period is 2.667s. The input is the TIROS Operational Vertical Sounder (TOVS) MHS Level 1b product, described in the NOAA KLM User's Guide. Brightness temperature was obtained by applying the Antena Pattern Correction to the antena temperature.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	5	Number of Swath 1 channels.
n270	270	Number of 270.
npixel1	90	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
three	3	Number of spacial dimensions.
TLEDd	6	Number of TLE_date words.
TLETd	1	Number of TLE_time words.
eight	8	Number of spacial dimensions.
sixteen	16	Number of spacial dimensions.
thirtytwo	32	Number of spacial dimensions.

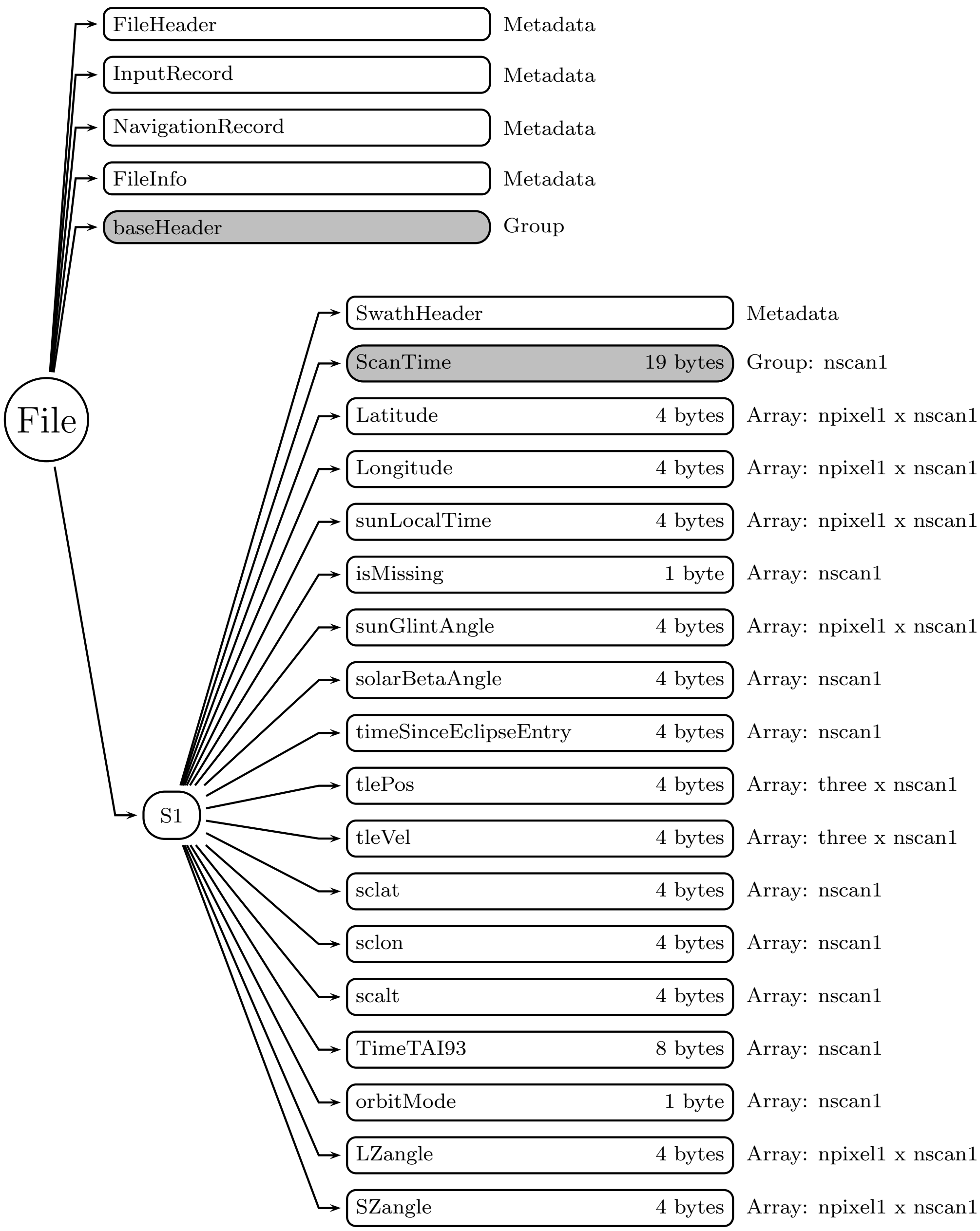
Figure 261 through Figure 264 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.



continued on next figure

Figure 261: Data Format Structure for 1BASEMHS, MHS base

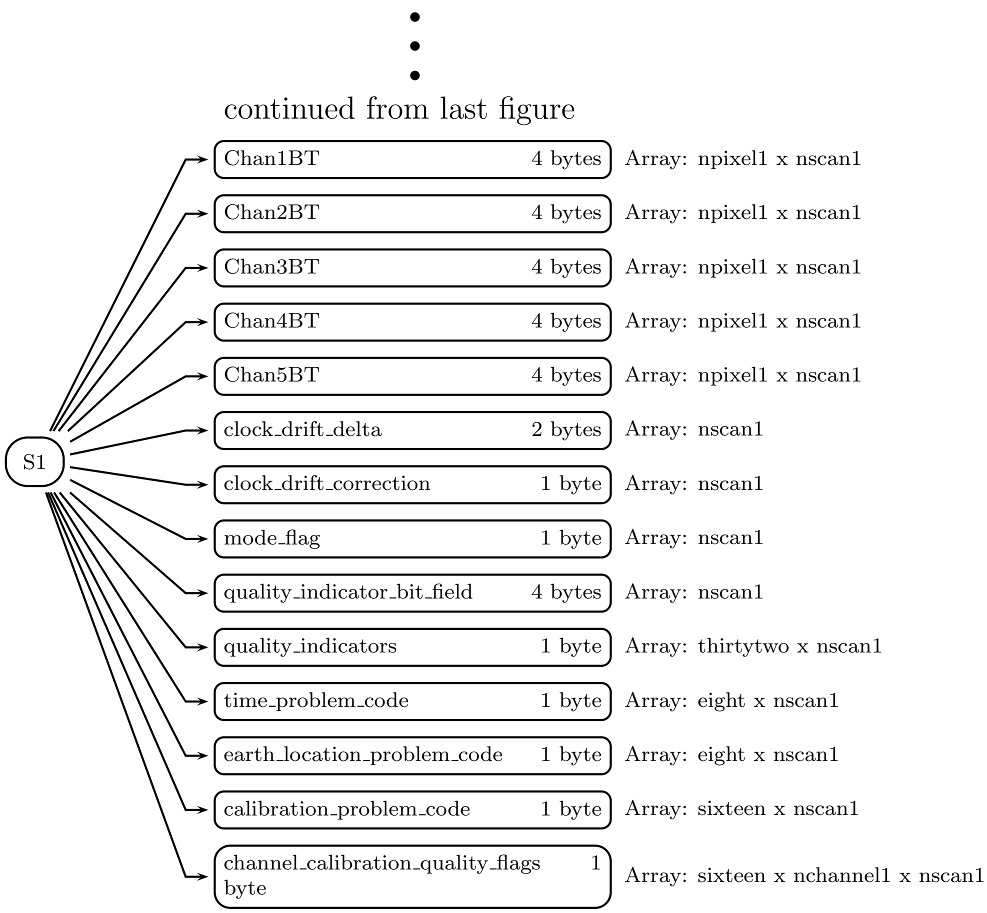


Figure 262: Data Format Structure for 1BASEMHS, MHS base

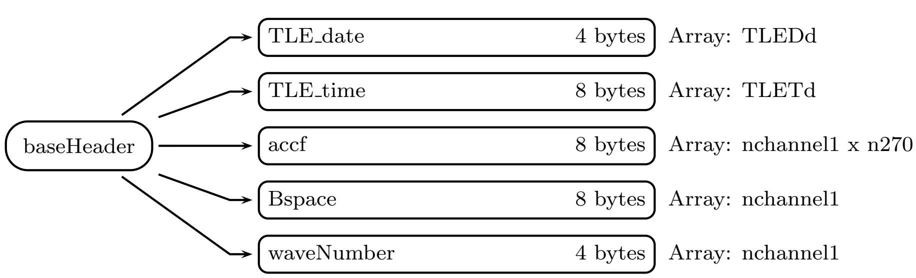


Figure 263: Data Format Structure for 1BASEMHS, baseHeader

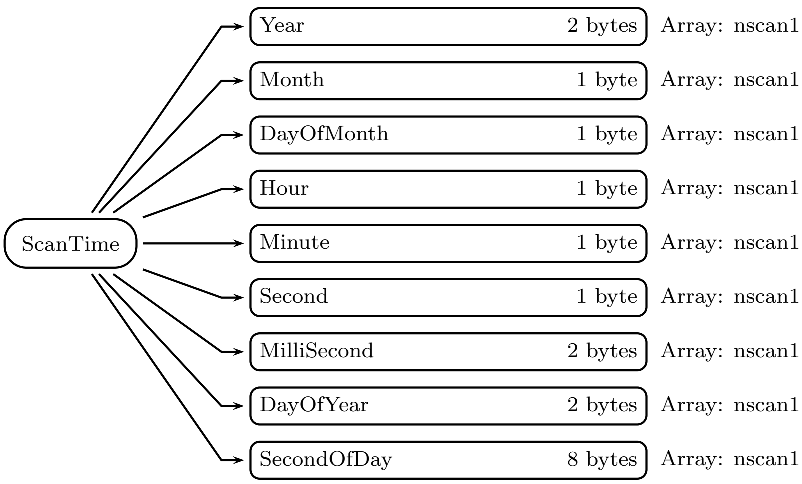


Figure 264: Data Format Structure for 1BASEMHS, ScanTime

baseHeader (Group)

TLE_date (4-byte integer, array size: TLEDd):
TLE date time arrays.

TLE_time (8-byte float, array size: TLETd):
TLE time as in two line element.

accf (8-byte float, array size: nchannel1 x n270):
The correction due to angular dependence of reflectivity.

Bspace (8-byte float, array size: nchannel1):
The channel offset derived from deep space calibration.

waveNumber (4-byte float, array size: nchannel1):
Wave number.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined

as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any

location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan1):
Missing scan flag.

sunGlintAngle (4-byte float, array size: npixel1 x nscan1):
sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection.

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow.

tlePos (4-byte float, array size: three x nscan1):
Spacecraft position at the ScanTime. Values are in m. Special values are defined as:
-9999.9 Missing value

tleVel (4-byte float, array size: three x nscan1):
Spacecraft velocity at the ScanTime. Values are in m/s. Special values are defined as:
-9999.9 Missing value

sclat (4-byte float, array size: nscan1):
Spacecraft latitude at the ScanTime. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan1):
Spacecraft longitude at the ScanTime. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan1):
Spacecraft altitude at the ScanTime. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

TimeTAI93 (8-byte float, array size: nscan1):
Number of seconds since 0000 Jan 1, 1993.

orbitMode (1-byte integer, array size: nscan1):
Orbit direction: 1=ascending 2=descending.

LZangle (4-byte float, array size: npixel1 x nscan1):
Local zenith angle. Values range from -60 to 60 degrees. Special values are defined as:
-9999.9 Missing value

SZangle (4-byte float, array size: npixel1 x nscan1):
Solar zenith angle. Not sure about the range and units.

Chan1BT (4-byte float, array size: npixel1 x nscan1):
Channel 1 brightness Temperature.

Chan2BT (4-byte float, array size: npixel1 x nscan1):
Channel 2 brightness Temperature.

Chan3BT (4-byte float, array size: npixel1 x nscan1):
Channel 3 brightness Temperature.

Chan4BT (4-byte float, array size: npixel1 x nscan1):
Channel 4 brightness Temperature.

Chan5BT (4-byte float, array size: npixel1 x nscan1):
Channel 5 brightness Temperature.

clock_drift_delta (2-byte integer, array size: nscan1):
Satellite clock drift delta (msec).

clock_drift_correction (1-byte integer, array size: nscan1):
Clock drift correction. 0=Not corrected; 1=scan time corrected for clock drift.

mode_flag (1-byte integer, array size: nscan1):

```
Operation mode flag.
value   meaning
0       power-on (empty MHS science data)
1       warm-up (empty MHS science data)
2       standby (empty MHS science data)
3       scan (valid MHS science data)
4       fixed view (valid MHS science data, but instrument is viewing a fixed locatio
5       self test (test data)
6       safeing (empty MHS science data)
7       fault (empty MHS science data)
8-14    undefined (unknow data)
15      memory dump (memory dump dataa)
```

quality_indicator_bit_field (4-byte integer, array size: nscan1):

```
Summary scan quality indicator. Value equal to 0 indicates a good scan.
The value of each bit is stored and described in "quality\_indicators" variable.
```

quality_indicators (1-byte integer, array size: thirtytwo x nscan1):

```
Thirty two scan quality indicators. For each indicator, value of 1 means statement is
index  statement
0      AMSU parity error detected
1      AMSU major frame error detected
2      AMSU minor frame error detected
3      AMSU sync error detected
4      transmitter status change occured
5-24   zero fill
25     instrument status changed with this scan
26     first good time following a clock update
27     earth location data not available
28     insufficient data for calibration
29     data gap precedes this scan
30     time sequence error detected within this scan
31     do not use scan for production generation
```

time_problem_code (1-byte integer, array size: eight x nscan1):

```
Time problem codes. If value equal to 1 then the statement is true.
index  statement
0-3    zero fill
4      start of a sequence that apparently repeats scan times that have been previousl
5      start os a sequency that is inconsistent with previous times
6      time field is bad and can't be inferred from the previous good time
7      time field is bad but can probably be inferred from the previous good time
```

earth_location_problem_code (1-byte integer, array size: eight x nscan1):

```
Earth location problem codes. If value equal to 1 then the statement is true.
index  statement
0-2    zero fill
3      earth location questionable because of antenna position
4      earth location questionable: fails reasonableness check
5      earth location questionable: marginal agreement with reasonableness check
6      earth location questionable: questionable time code
7      not earth located because of bad time; earth location fields zero filled
```

calibration_problem_code (1-byte integer, array size: sixteen x nscan1):

```
Scan Calibration problem codes. If value equal to 1 then the statement is true.
index  statement
0      lunar-contaminated scan line was able to be calibrated
1      scan line contains one or more space viewa that are lunar contaminated
2-7    zero fill
8      questionable calibration because of antenna position error of OBCT view
9      questionable calibration because of antenna position error of space view
10     uncalibrated because of instrument mode
11     some uncalibrated channels on this scan
12     scan line was calibrated but with marginal PRT data
13     scan line was not calibrated because of bad or insufficient PRT data
14     scan line was calibrated useing fewer than the preferred number os scan
15     scan line was not calibrated because of bad time
```

channel_calibration_quality_flags (1-byte integer, array size: sixteen x nchannel1 x nscan1):

```
Calibration quality flags for each channel. A value of 1 means the statement is true.
index  statement
0      marginal PRT temps on this line
1      marginal space view counts for this line
2      marginal OBCT view counts for this line
3      all bad PRTs for this line
4      all bad space view counts for scan line
5      all bad OBCT view counts for scan line
6      this scan line is either the last one before the first one after a sudden, anom
7-15   zero fill
```

C Structure Header file:

```
#ifndef _TK_1BASEMHS_H_
#define _TK_1BASEMHS_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
```

```
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASEMHS_S1_
#define _L1BASEMHS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    float sunLocalTime[90];
    signed char isMissing;
    float sunGlintAngle[90];
    float solarBetaAngle;
    float timeSinceEclipseEntry;
    float tlePos[3];
    float tleVel[3];
    float sclat;
    float sclon;
    float scalt;
    double TimeTAI93;
    signed char orbitMode;
    float LZangle[90];
    float SZangle[90];
    float Chan1BT[90];
    float Chan2BT[90];
    float Chan3BT[90];
    float Chan4BT[90];
    float Chan5BT[90];
    short clock_drift_delta;
    signed char clock_drift_correction;
    signed char mode_flag;
    int quality_indicator_bit_field;
    signed char quality_indicators[32];
    signed char time_problem_code[8];
    signed char earth_location_problem_code[8];
    signed char calibration_problem_code[16];
```

```
    signed char channel_calibration_quality_flags[5][16];
} L1BASEMHS_S1;

#endif

#ifndef _L1BASEMHS_BASEHEADER_
#define _L1BASEMHS_BASEHEADER_

typedef struct {
    int TLE_date[6];
    double TLE_time[1];
    double accf[270][5];
    double Bspace[5];
    float waveNumber[5];
} L1BASEMHS_BASEHEADER;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASEMHS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    REAL*4 sunLocalTime(90)
    BYTE isMissing
    REAL*4 sunGlintAngle(90)
    REAL*4 solarBetaAngle
    REAL*4 timeSinceEclipseEntry
```

```
    REAL*4 tlePos(3)
    REAL*4 tleVel(3)
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*8 TimeTAI93
    BYTE orbitMode
    REAL*4 LZangle(90)
    REAL*4 SZangle(90)
    REAL*4 Chan1BT(90)
    REAL*4 Chan2BT(90)
    REAL*4 Chan3BT(90)
    REAL*4 Chan4BT(90)
    REAL*4 Chan5BT(90)
    INTEGER*2 clock_drift_delta
    BYTE clock_drift_correction
    BYTE mode_flag
    INTEGER*4 quality_indicator_bit_field
    BYTE quality_indicators(32)
    BYTE time_problem_code(8)
    BYTE earth_location_problem_code(8)
    BYTE calibration_problem_code(16)
    BYTE channel_calibration_quality_flags(16,5)
END STRUCTURE

STRUCTURE /L1BASEMHS_BASEHEADER/
    INTEGER*4 TLE_date(6)
    REAL*8 TLE_time(1)
    REAL*8 accf(5,270)
    REAL*8 Bspace(5)
    REAL*4 waveNumber(5)
END STRUCTURE
```

5.15 1BASESAPHIR - SAPHIR base

1BASESAPHIR contains brightness temperature from the SAPHIR passive microwave instrument flown on the Megha-Tropiques satellite. The channels are 183.1 +/- delta GHz, where delta = 0.2, 1.1, 2.8, 4.2, 6.8, 11.0.

Dimension definitions:

nscan	var	Number of Swath 1 scans in the granule.
nchannel	6	Number of channels.
npixel	182	Number of pixels in one scan.
three	3	Number of vectors.
TLEDd	6	Number of TLE_date words.
TLETd	1	Number of TLE_time words.

Figure 265 through Figure 268 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

baseHeader (Group)

TLE_date (4-byte integer, array size: TLEDd):
TLE date time arrays.

TLE_time (8-byte float, array size: TLETd):
TLE time as in two line element.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

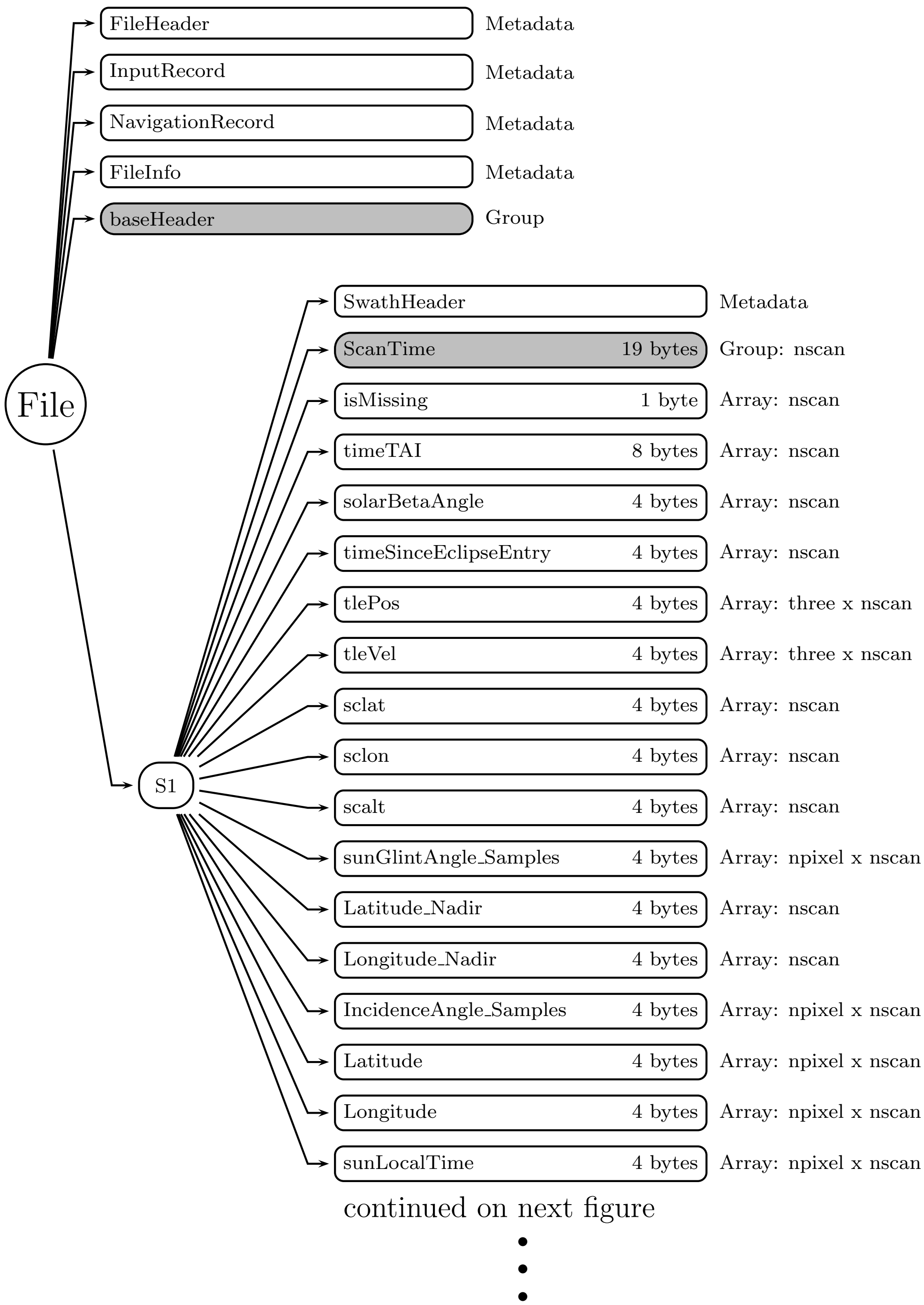


Figure 265: Data Format Structure for 1BASESAPHIR, SAPHIR base

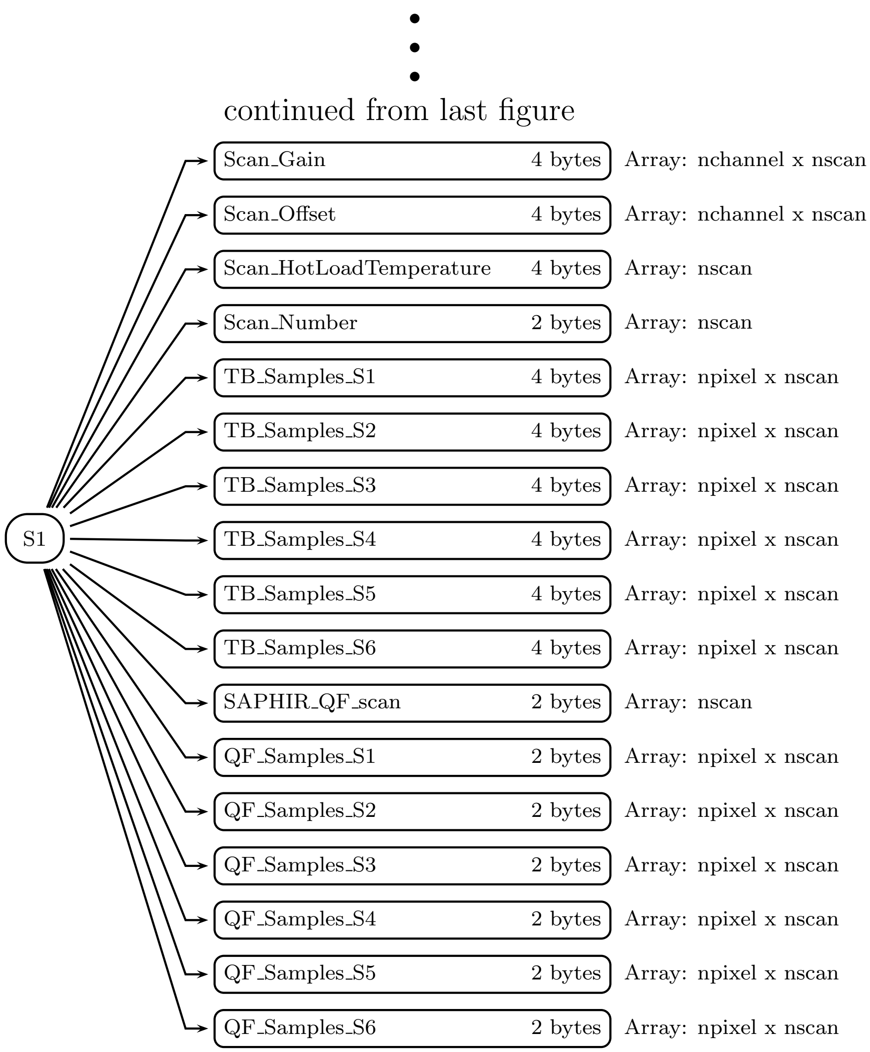


Figure 266: Data Format Structure for 1BASESAPHIR, SAPHIR base

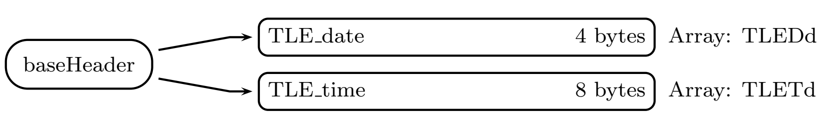


Figure 267: Data Format Structure for 1BASESAPHIR, baseHeader

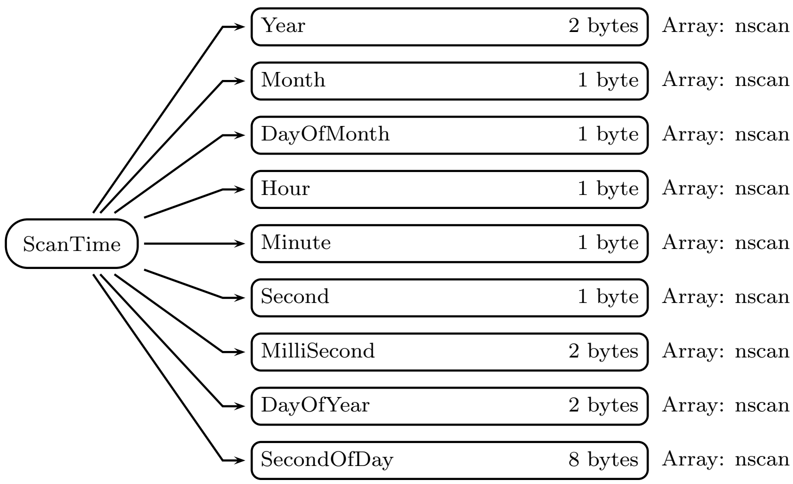


Figure 268: Data Format Structure for 1BASESAPHIR, ScanTime

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

timeTAI (8-byte float, array size: nscan):
Number of seconds since epoch time.

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow.

tlePos (4-byte float, array size: three x nscan):
TLE satellite position. Values are in m. Special values are defined as:
-9999.9 Missing value

tleVel (4-byte float, array size: three x nscan):
TLE satellite velocity. Values are in m/s. Special values are defined as:
-9999.9 Missing value

sclat (4-byte float, array size: nscan):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan):
Spacecraft altitude. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

sunGlintAngle_Samples (4-byte float, array size: npixel x nscan):
sunGlint angle.

Latitude_Nadir (4-byte float, array size: nscan):
Spacecraft latitude. Values range from -90 to 90.0 degree. Special values are defined as:
-9999.9 Missing value

Longitude_Nadir (4-byte float, array size: nscan):
Spacecraft longitude. Values range from -180 to 180.0 degree. Special values are defined as:
-9999.9 Missing value

IncidenceAngle_Samples (4-byte float, array size: npixel x nscan):
Incidence angle.

Latitude (4-byte float, array size: npixel x nscan):
Latitude.

Longitude (4-byte float, array size: npixel x nscan):
Longitude.

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

Scan_Gain (4-byte float, array size: nchannel x nscan):
Gain.

Scan_Offset (4-byte float, array size: nchannel x nscan):
Gain.

Scan_HotLoadTemperature (4-byte float, array size: nscan):
HotLoadTemperature

Scan_Number (2-byte integer, array size: nscan):
Scan number.

TB_Samples_S1 (4-byte float, array size: npixel x nscan):
TB_Samples_S1.

TB_Samples_S2 (4-byte float, array size: npixel x nscan):
TB_Samples_S2.

TB_Samples_S3 (4-byte float, array size: npixel x nscan):
TB_Samples_S3.

TB_Samples_S4 (4-byte float, array size: npixel x nscan):
TB_Samples_S4.

TB_Samples_S5 (4-byte float, array size: npixel x nscan):
TB_Samples_S5.

TB_Samples_S6 (4-byte float, array size: npixel x nscan):
TB_Samples_S6.

SAPHIR_QF_scan (2-byte unsigned integer, array size: nscan):

QF_Samples_S1 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S2 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S3 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S4 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S5 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

QF_Samples_S6 (2-byte unsigned integer, array size: npixel x nscan):
QF_Samples

C Structure Header file:

```
#ifndef _TK_1BASESAPHIR_H_
#define _TK_1BASESAPHIR_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASESAPHIR_S1_
#define _L1BASESAPHIR_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    double timeTAI;
```

```
    float solarBetaAngle;
    float timeSinceEclipseEntry;
    float tlePos[3];
    float tleVel[3];
    float sclat;
    float sclon;
    float scalt;
    float sunGlintAngle_Samples[182];
    float Latitude_Nadir;
    float Longitude_Nadir;
    float IncidenceAngle_Samples[182];
    float Latitude[182];
    float Longitude[182];
    float sunLocalTime[182];
    float Scan_Gain[6];
    float Scan_Offset[6];
    float Scan_HotLoadTemperature;
    short Scan_Number;
    float TB_Samples_S1[182];
    float TB_Samples_S2[182];
    float TB_Samples_S3[182];
    float TB_Samples_S4[182];
    float TB_Samples_S5[182];
    float TB_Samples_S6[182];
    unsigned short SAPHIR_QF_scan;
    unsigned short QF_Samples_S1[182];
    unsigned short QF_Samples_S2[182];
    unsigned short QF_Samples_S3[182];
    unsigned short QF_Samples_S4[182];
    unsigned short QF_Samples_S5[182];
    unsigned short QF_Samples_S6[182];
} L1BASESAPHIR_S1;

#endif

#ifndef _L1BASESAPHIR_BASEHEADER_
#define _L1BASESAPHIR_BASEHEADER_

typedef struct {
    int TLE_date[6];
    double TLE_time[1];
} L1BASESAPHIR_BASEHEADER;
```

```
#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASESAPHIR_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    REAL*8 timeTAI
    REAL*4 solarBetaAngle
    REAL*4 timeSinceEclipseEntry
    REAL*4 tlePos(3)
    REAL*4 tleVel(3)
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*4 sunGlintAngle_Samples(182)
    REAL*4 Latitude_Nadir
    REAL*4 Longitude_Nadir
    REAL*4 IncidenceAngle_Samples(182)
    REAL*4 Latitude(182)
    REAL*4 Longitude(182)
    REAL*4 sunLocalTime(182)
    REAL*4 Scan_Gain(6)
    REAL*4 Scan_Offset(6)
    REAL*4 Scan_HotLoadTemperature
    INTEGER*2 Scan_Number
    REAL*4 TB_Samples_S1(182)
    REAL*4 TB_Samples_S2(182)
    REAL*4 TB_Samples_S3(182)
```

```
    REAL*4 TB_Samples_S4(182)
    REAL*4 TB_Samples_S5(182)
    REAL*4 TB_Samples_S6(182)
    INTEGER*2 SAPHIR_QF_scan
    INTEGER*2 QF_Samples_S1(182)
    INTEGER*2 QF_Samples_S2(182)
    INTEGER*2 QF_Samples_S3(182)
    INTEGER*2 QF_Samples_S4(182)
    INTEGER*2 QF_Samples_S5(182)
    INTEGER*2 QF_Samples_S6(182)
END STRUCTURE

STRUCTURE /L1BASESAPHIR_BASEHEADER/
    INTEGER*4 TLE_date(6)
    REAL*8 TLE_time(1)
END STRUCTURE
```

5.16 1BASEATMS - ATMS base

1BASEATMS contains brightness temperature from the ATMS passive microwave instrument flown on the Suomi NPP satellite and JPSS satellites. ATMS is approximately AMSU-A plus MHS. Rotates 3 scans per 8 seconds. Input is SDR. 1BASEATMS = 1BATMS - PadBytes - BrightnessTemperatureFactors + isMissing + timeSinceEclipseEntry + solarBetaAngle + sunGlintAngle + 6 times + tlePos + tleVel Data that occurs in 1BATMS 1, 2, 4 per ATMS granule appears per scan in 1BASEATMS, i.e., it is repeated. There is 1 swath with the following channels:

Ch	GHz	Pol
1	23.8	QV
2	31.4	QV
3	50.3	QH
4	51.76	QH
5	52.8	QH
6	53.596+-0.115	QH
7	54.4	QH
8	54.94	QH
9	55.5	QH
10	fo = 57.29	QH
11	fo+-0.3222+-0.217	QH
12	fo+-0.3222+-0.048	QH
13	fo+-0.3222+-0.022	QH
14	fo+-0.3222+-0.010	QH

```
15  fo+-0.3222+-0.0045 QH
16  88.2               QV
17  165.5              QH
18  183.31+-7          QH
19  183.31+-4.5        QH
20  183.31+-3          QH
21  183.31+-1.8        QH
22  183.31+-1          QH

Note on geolocation and 1C swaths:
The BeamLatitude and BeamLongitude in 1BASEATMS
have a band dimension of 5.  Lat and lon is for channels
1,2,3,16,17.  Each 1C swath will contain one band:

1C swath   Band   IEEE GHz     Ch geo   Chs in band
1          K      18-26.5      1        1
2          A(Ka)  26.5-40      2        2
3          V      50-75        3        3-15
4          W      75-110       16       16
5          G      110-300      17       17-22
```

More detailed information on some variables may be found in the document JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchannel	22	Number of channels.
nbeam	96	Number of beams in one scan.
nband	5	Number of bands (K,A,V,W,G).
vecsize	3	Vector size.
three	3	Number of vectors.
seven	7	Number of dimensions in time array.

Figure 269 through Figure 272 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the

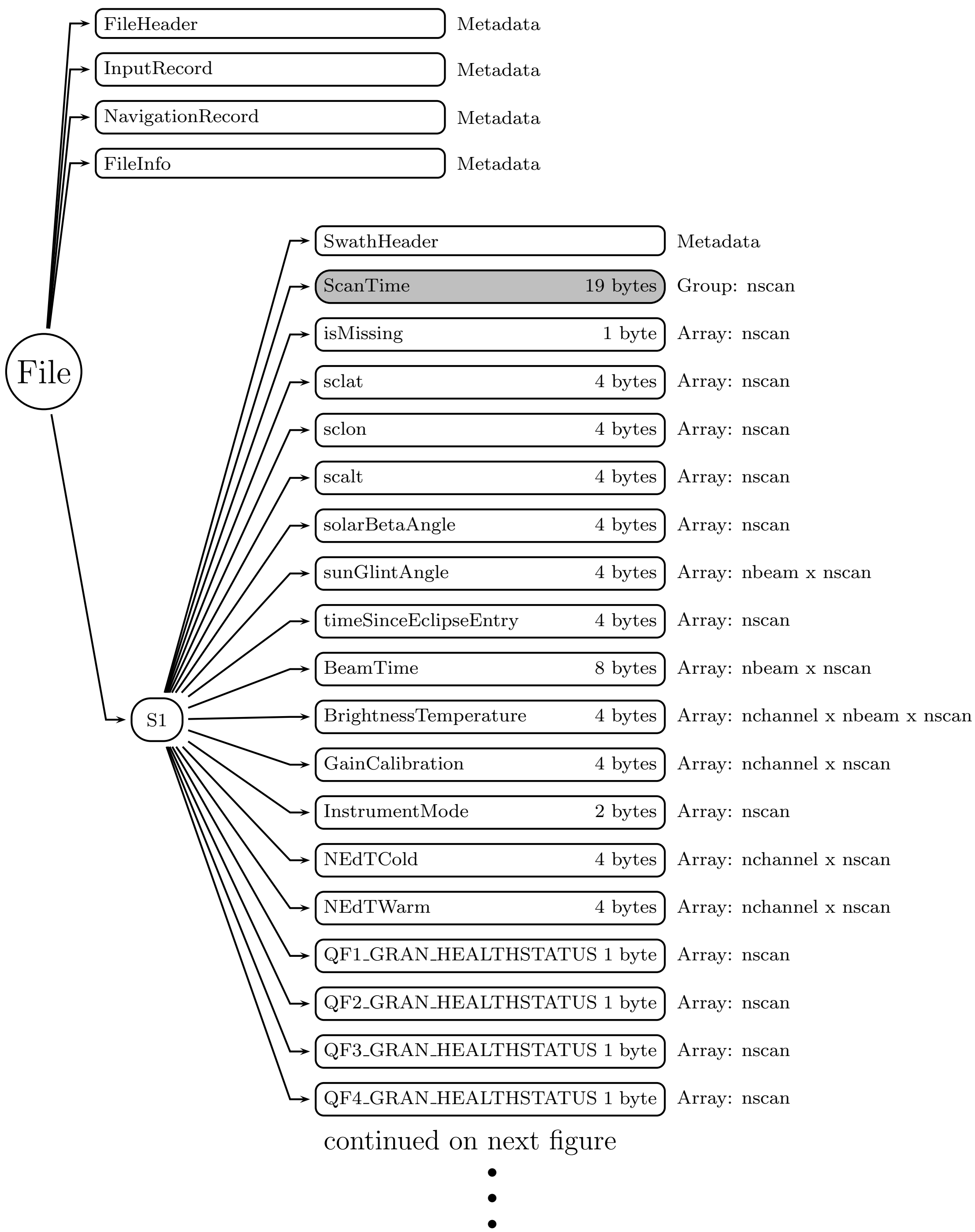


Figure 269: Data Format Structure for 1BASEATMS, ATMS base

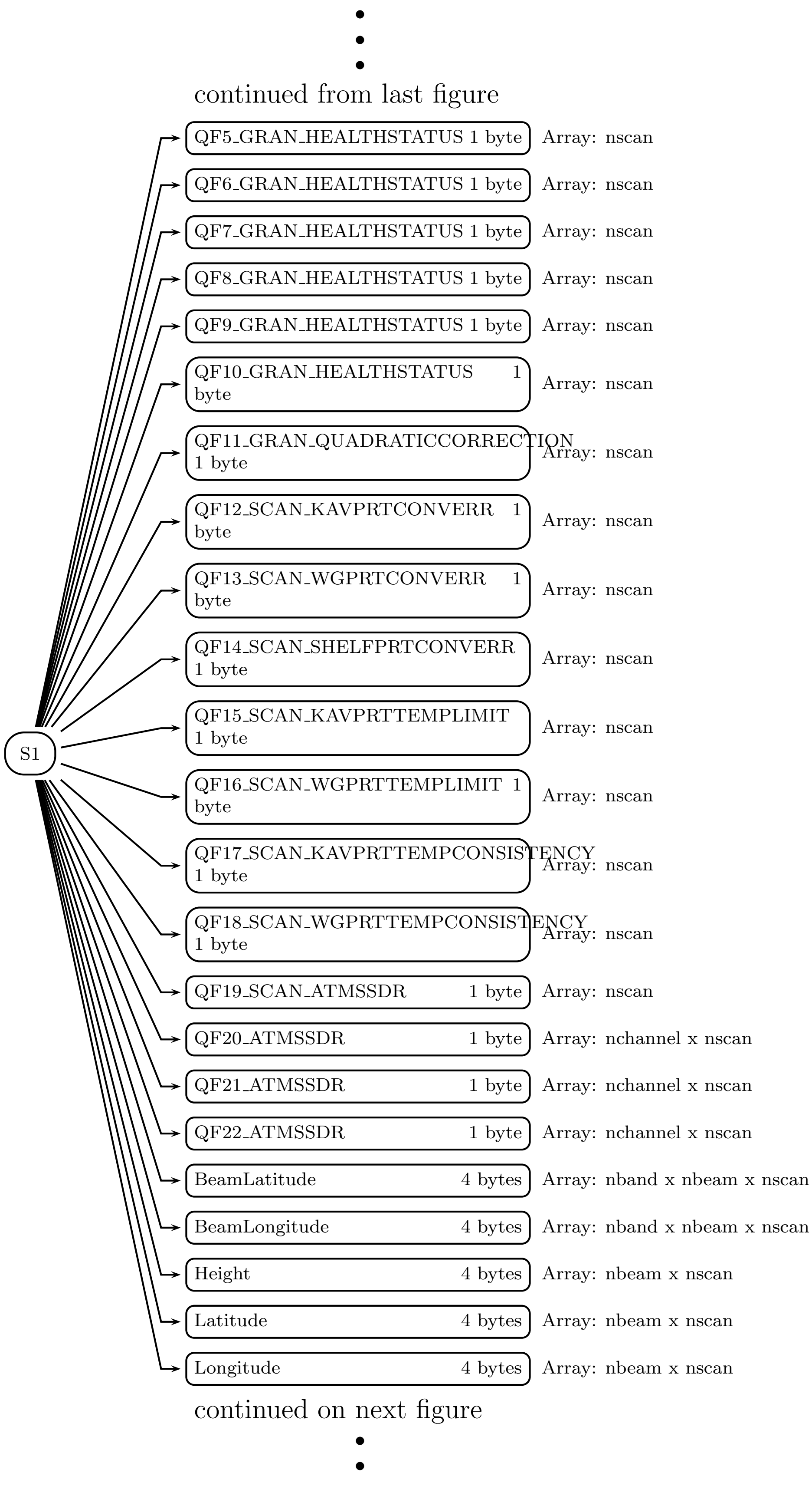


Figure 270: Data Format Structure for 1BASEATMS, ATMS base

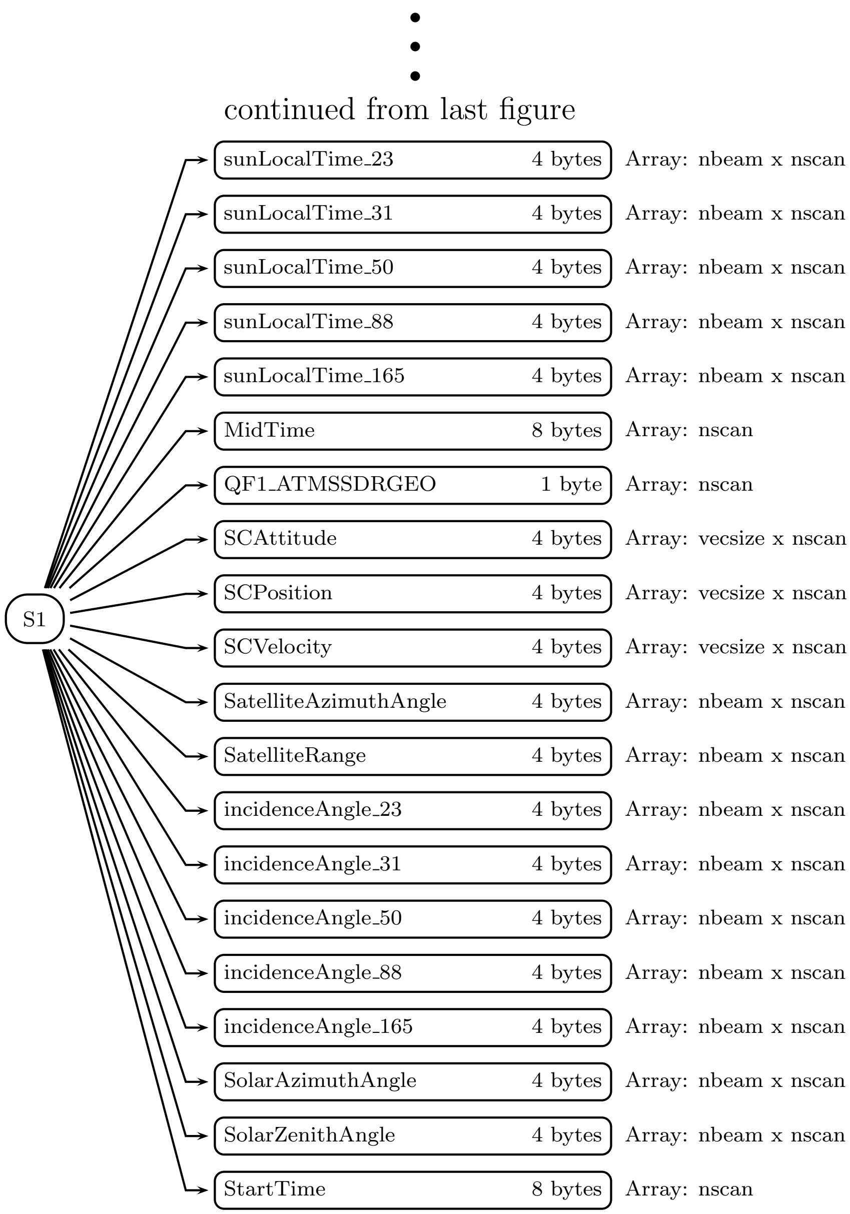


Figure 271: Data Format Structure for 1BASEATMS, ATMS base

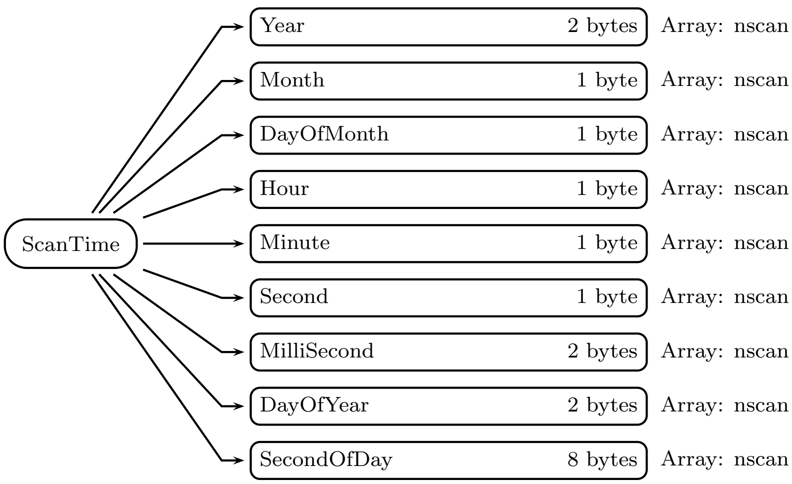


Figure 272: Data Format Structure for 1BASEATMS, ScanTime

same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

isMissing (1-byte integer, array size: nscan):
Missing scan flag.

sclat (4-byte float, array size: nscan):
The geodedic latitude of the spacecraft at the scan mid-time. Values range from -90 to 90.0 degrees. Special values are defined as:
-9999.9 Missing value

sclon (4-byte float, array size: nscan):
The geodedic longitude of the spacecraft at the scan mid-time. Values range from -180 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

scalt (4-byte float, array size: nscan):
The altitude of the spacecraft at the scan mid-time. Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: nbeam x nscan):
sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection.

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow.

BeamTime (8-byte float, array size: nbeam x nscan):
The time in IET (seconds since 1958-01-01 00:00:00) of the end of the view period for this observation.

BrightnessTemperature (4-byte float, array size: nchannel x nbeam x nscan):
Calibrated scene brightness temperature.

GainCalibration (4-byte float, array size: nchannel x nscan):
Gain factor used in calibrating earth scene brightness temperature.

InstrumentMode (2-byte unsigned integer, array size: nscan):
Instrument mode.

NEdTCold (4-byte float, array size: nchannel x nscan):
Noise-equivalent delta temperature while viewing cold space.

NEdTWarm (4-byte float, array size: nchannel x nscan):
Noise-equivalent delta temperature while viewing warm target.

QF1_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF2_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF3_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF4_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF5_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF6_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF7_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF8_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF9_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF10_GRAN_HEALTHSTATUS (1-byte char, array size: nscan):
Out of range quality flag for 8 second health and status packet. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF11_GRAN_QUADRATICCORRECTION (1-byte char, array size: nscan):
Quadratic correction applied to the radiometric transfer function for non-linearity correction. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF12_SCAN_KAVPRTCONVERR (1-byte char, array size: nscan):
If a divide-by-zero condition exists, or if computation loop fails to converge in the temperature computations for the 8 KAV PRTs, the condition is flagged by the corresponding bit in the flag to indicate which PRT has failed.See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF13_SCAN_WGPRTCONVERR (1-byte char, array size: nscan):
If a divide-by-zero condition exists, or if computation loop fails to converge in the temperature computations for the 7 WG PRTs, the condition is flagged by the corresponding bit in the flag to indicate which PRT has failed. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF14_SCAN_SHELFPRTCONVERR (1-byte char, array size: nscan):
If a divide-by-zero condition exists, or if computation loop fails to converge in the temperature computations for the 4 receiver shelf (KKa, V, W and G) PRTs, the condition is flagged by the corresponding bit in the flag to indicate which PRT has failed. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF15_SCAN_KAVPRTTEMPLIMIT (1-byte char, array size: nscan):
Each of the 8 KAV PRT temperatures is checked against a lower limit and an upper limit. Out of range conditions are flagged by the corresponding bit in the flag to indicate which PRT has failed the test. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF16_SCAN_WGPRTTEMPLIMIT (1-byte char, array size: nscan):
Each of the 7 WG PRT temperatures is checked against a lower limit and an upper limit. Out of range conditions are flagged by the corresponding bit in the flag to indicate which PRT has failed the test. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF17_SCAN_KAVPRTTEMPCONSISTENCY (1-byte char, array size: nscan):
The 8 KAV PRT temperatures are checked against each other for consistency. The check failure shall be flagged by the corresponding bit in the flag to indicate which PRT has failed the test. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF18_SCAN_WGPRTTEMPCONSISTENCY (1-byte char, array size: nscan):
The 7 WG PRT temperatures are checked against each other for consistency. The check failure shall be flagged by the corresponding bit in the flag to indicate which PRT has failed the test. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF19_SCAN_ATMSSDR (1-byte char, array size: nscan):
Scan level quality flag. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF20_ATMSSDR (1-byte char, array size: nchannel x nscan):
Scan level quality flag per channel. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF21_ATMSSDR (1-byte char, array size: nchannel x nscan):
Out of range space and blackbody view quality flag. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

QF22_ATMSSDR (1-byte char, array size: nchannel x nscan):
Space and blackbody view quality flag. See JPSS Common Data Format Control Book - Vol III Sensor Data Record (SDR)/TDR Formats for details.

BeamLatitude (4-byte float, array size: nband x nbeam x nscan):
Latitude of individual beam position centers (channels 1, 2, 3, 16, 17).

BeamLongitude (4-byte float, array size: nband x nbeam x nscan):
Longitude of individual beam position centers (channels 1, 2, 3, 16, 17).

Height (4-byte float, array size: nbeam x nscan):
Ellipsoid-Geoid separation,

Latitude (4-byte float, array size: nbeam x nscan):
Latitude of channel 17 beam position center

Longitude (4-byte float, array size: nbeam x nscan):
Longitude of channel 17 beam position center

sunLocalTime_23 (4-byte float, array size: nbeam x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any

location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

sunLocalTime_31 (4-byte float, array size: nbeam x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

sunLocalTime_50 (4-byte float, array size: nbeam x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

sunLocalTime_88 (4-byte float, array size: nbeam x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

sunLocalTime_165 (4-byte float, array size: nbeam x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

MidTime (8-byte float, array size: nscan):
Mid time of scan in IET (seconds since 1958-01-01 00:00:00)

QF1_ATMSSDRGEO (1-byte char, array size: nscan):
Attitude and Ephemeris availability status

value	meaning
0	Nominal
1	missing data less than or equal to small gap
2	missing data larger than small gap, but less tha
3	missing data larger than or equal to granule bou

SCAttitude (4-byte float, array size: vecsize x nscan):
Spacecraft attitude with respect to Geodetic Reference Frame Coordinates (roll, pitch,yaw) at the mid-time of scan.

SCPosition (4-byte float, array size: vecsize x nscan):
Spacecraft position in Earth Centered Rotating (ECR) Coordinates (X, Y, Z) at the mid-time of scan.

SCVelocity (4-byte float, array size: vecsize x nscan):
Spacecraft velocity in Earth Centered Rotating (ECR) Coordinates (dx/dt, dy/dt, dz/dt) at the mid-time of scan.

SatelliteAzimuthAngle (4-byte float, array size: nbeam x nscan):
Azimuth angle (measured clockwise positive from North) to satellite at the geolocated beam position center.

SatelliteRange (4-byte float, array size: nbeam x nscan):
Line of sight distance from the ellipsoid intersection to the satellite.

incidenceAngle_23 (4-byte float, array size: nbeam x nscan):
Earth incidence angle 23 GHz.

incidenceAngle_31 (4-byte float, array size: nbeam x nscan):
Earth incidence angle 31 GHz.

incidenceAngle_50 (4-byte float, array size: nbeam x nscan):
Earth incidence angle 50 GHz.

incidenceAngle_88 (4-byte float, array size: nbeam x nscan):
Earth incidence angle 88 GHz.

incidenceAngle_165 (4-byte float, array size: nbeam x nscan):
Earth incidence angle 165 GHz.

SolarAzimuthAngle (4-byte float, array size: nbeam x nscan):
Azimuth angle (measured clockwise positive from North) of sun at the geolocated beam position center.

SolarZenithAngle (4-byte float, array size: nbeam x nscan):
Zenith angle to sun at the geolocated beam position center.

StartTime (8-byte float, array size: nscan):
Starting time of scan in IET (seconds since 1958-01-01 00:00:00).

C Structure Header file:

```
#ifndef _TK_1BASEATMS_H_
#define _TK_1BASEATMS_H_

#ifndef _SCANTIME_
```

```
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BASEATMS_S1_
#define _L1BASEATMS_S1_

typedef struct {
    SCANTIME ScanTime;
    signed char isMissing;
    float sclat;
    float sclon;
    float scalt;
    float solarBetaAngle;
    float sunGlintAngle[96];
    float timeSinceEclipseEntry;
    double BeamTime[96];
    float BrightnessTemperature[96][22];
    float GainCalibration[22];
    unsigned short InstrumentMode;
    float NEdTCold[22];
    float NEdTWarm[22];
    unsigned char QF1_GRAN_HEALTHSTATUS;
    unsigned char QF2_GRAN_HEALTHSTATUS;
    unsigned char QF3_GRAN_HEALTHSTATUS;
    unsigned char QF4_GRAN_HEALTHSTATUS;
    unsigned char QF5_GRAN_HEALTHSTATUS;
    unsigned char QF6_GRAN_HEALTHSTATUS;
    unsigned char QF7_GRAN_HEALTHSTATUS;
    unsigned char QF8_GRAN_HEALTHSTATUS;
    unsigned char QF9_GRAN_HEALTHSTATUS;
```

```
    unsigned char QF10_GRAN_HEALTHSTATUS;
    unsigned char QF11_GRAN_QUADRATICCORRECTION;
    unsigned char QF12_SCAN_KAVPRTCONVERR;
    unsigned char QF13_SCAN_WGPRTCONVERR;
    unsigned char QF14_SCAN_SHELFPRTCONVERR;
    unsigned char QF15_SCAN_KAVPRTTEMPLIMIT;
    unsigned char QF16_SCAN_WGPRTTEMPLIMIT;
    unsigned char QF17_SCAN_KAVPRTTEMPCONSISTENCY;
    unsigned char QF18_SCAN_WGPRTTEMPCONSISTENCY;
    unsigned char QF19_SCAN_ATMSSDR;
    unsigned char QF20_ATMSSDR[22];
    unsigned char QF21_ATMSSDR[22];
    unsigned char QF22_ATMSSDR[22];
    float BeamLatitude[96][5];
    float BeamLongitude[96][5];
    float Height[96];
    float Latitude[96];
    float Longitude[96];
    float sunLocalTime_23[96];
    float sunLocalTime_31[96];
    float sunLocalTime_50[96];
    float sunLocalTime_88[96];
    float sunLocalTime_165[96];
    double MidTime;
    unsigned char QF1_ATMSSDRGEO;
    float SCAttitude[3];
    float SCPosition[3];
    float SCVelocity[3];
    float SatelliteAzimuthAngle[96];
    float SatelliteRange[96];
    float incidenceAngle_23[96];
    float incidenceAngle_31[96];
    float incidenceAngle_50[96];
    float incidenceAngle_88[96];
    float incidenceAngle_165[96];
    float SolarAzimuthAngle[96];
    float SolarZenithAngle[96];
    double StartTime;
} L1BASEATMS_S1;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BASEATMS_S1/
    RECORD /SCANTIME/ ScanTime
    BYTE isMissing
    REAL*4 sclat
    REAL*4 sclon
    REAL*4 scalt
    REAL*4 solarBetaAngle
    REAL*4 sunGlintAngle(96)
    REAL*4 timeSinceEclipseEntry
    REAL*8 BeamTime(96)
    REAL*4 BrightnessTemperature(22,96)
    REAL*4 GainCalibration(22)
    INTEGER*2 InstrumentMode
    REAL*4 NEdTCold(22)
    REAL*4 NEdTWarm(22)
    CHARACTER QF1_GRAN_HEALTHSTATUS
    CHARACTER QF2_GRAN_HEALTHSTATUS
    CHARACTER QF3_GRAN_HEALTHSTATUS
    CHARACTER QF4_GRAN_HEALTHSTATUS
    CHARACTER QF5_GRAN_HEALTHSTATUS
    CHARACTER QF6_GRAN_HEALTHSTATUS
    CHARACTER QF7_GRAN_HEALTHSTATUS
    CHARACTER QF8_GRAN_HEALTHSTATUS
    CHARACTER QF9_GRAN_HEALTHSTATUS
    CHARACTER QF10_GRAN_HEALTHSTATUS
    CHARACTER QF11_GRAN_QUADRATICCORRECTION
    CHARACTER QF12_SCAN_KAVPRTCONVERR
    CHARACTER QF13_SCAN_WGPRTCONVERR
    CHARACTER QF14_SCAN_SHELFPRTCONVERR
```

```
    CHARACTER QF15_SCAN_KAVPRTTEMPLIMIT
    CHARACTER QF16_SCAN_WGPRTTEMPLIMIT
    CHARACTER QF17_SCAN_KAVPRTTEMPCONSISTENCY
    CHARACTER QF18_SCAN_WGPRTTEMPCONSISTENCY
    CHARACTER QF19_SCAN_ATMSSDR
    CHARACTER QF20_ATMSSDR(22)
    CHARACTER QF21_ATMSSDR(22)
    CHARACTER QF22_ATMSSDR(22)
    REAL*4 BeamLatitude(5,96)
    REAL*4 BeamLongitude(5,96)
    REAL*4 Height(96)
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    REAL*4 sunLocalTime_23(96)
    REAL*4 sunLocalTime_31(96)
    REAL*4 sunLocalTime_50(96)
    REAL*4 sunLocalTime_88(96)
    REAL*4 sunLocalTime_165(96)
    REAL*8 MidTime
    CHARACTER QF1_ATMSSDRGEO
    REAL*4 SCAttitude(3)
    REAL*4 SCPosition(3)
    REAL*4 SCVelocity(3)
    REAL*4 SatelliteAzimuthAngle(96)
    REAL*4 SatelliteRange(96)
    REAL*4 incidenceAngle_23(96)
    REAL*4 incidenceAngle_31(96)
    REAL*4 incidenceAngle_50(96)
    REAL*4 incidenceAngle_88(96)
    REAL*4 incidenceAngle_165(96)
    REAL*4 SolarAzimuthAngle(96)
    REAL*4 SolarZenithAngle(96)
    REAL*8 StartTime
END STRUCTURE
```

5.17 1BGMI - GMI Brightness Temperatures

The Level-1B GMI Product, 1BGMI, "GMI Brightness Temperatures," is written as a multi-Swath Structure. Swath S1 has channels 1-9: 10V 10H 19V 19H 23V 37V 37H 89V 89H. Swath S2 has channels 10-13: 166V 166H 183+/-3V 183+/-8V. The following sections describe the structure and contents of the format.

Dimension definitions:

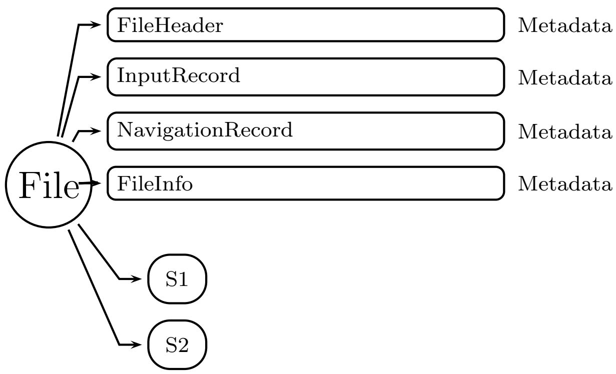


Figure 273: Data Format Structure for 1BGMI, GMI Brightness Temperatures

nscan	var	Number of scans in the granule.
nchan1	9	Number of channels in Swath 1.
nchan2	4	Number of channels in Swath 2.
nfreq1	5	Number of frequencies in Swath 1.
nfreq2	2	Number of frequencies in Swath 2.
npix1	221	Number of pixels in Swath 1.
npix2	221	Number of pixels in Swath 2.
ncolds1	85	Maximum number of cold samples in Swath 1.
ncolds2	85	Maximum number of cold samples in Swath 2.
nhots1	65	Maximum number of hot samples in Swath 1.
nhots2	65	Maximum number of hot samples in Swath 2.
ntherm	11	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nsamt	4	Number of sample types. The types are: total science GSDR, earth-view, hot load, cold sky.
ntach	32	Number of tachometer readings.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.
SVBFd	3	SunVectorinBodyFrame dimension.

Figure 273 through Figure 289 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

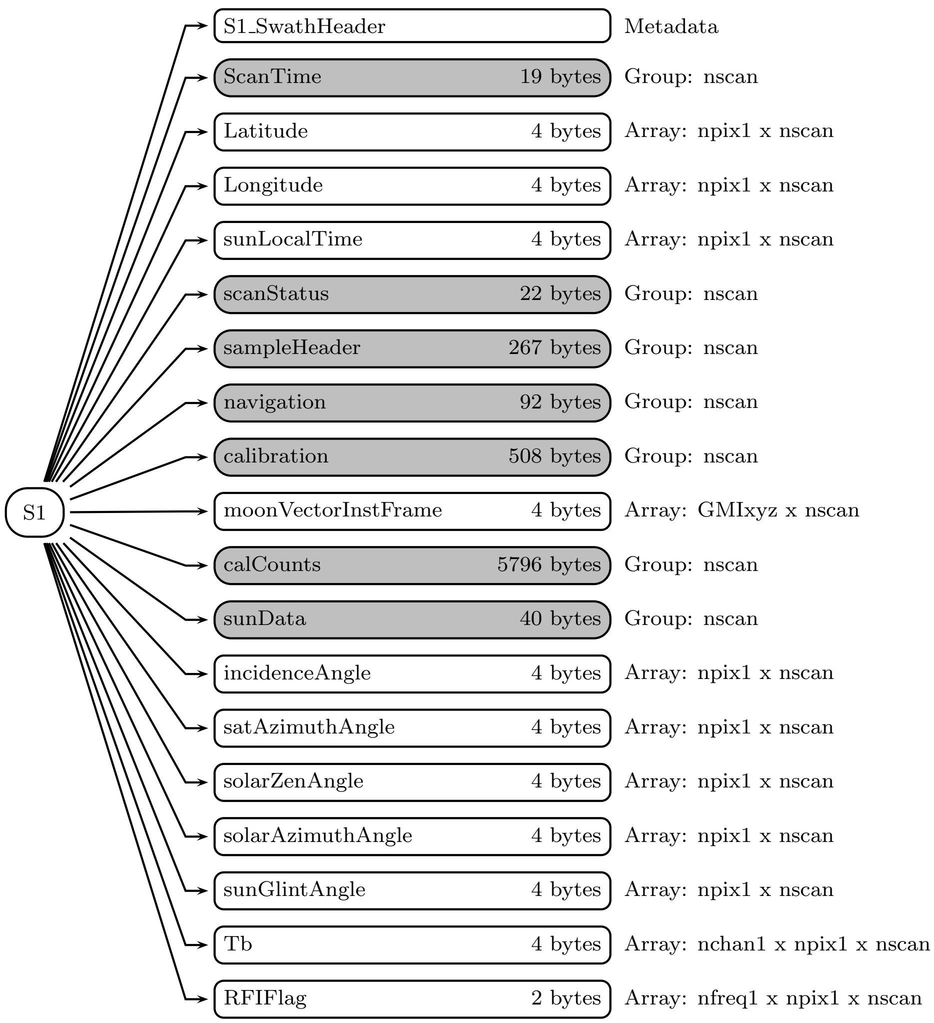


Figure 274: Data Format Structure for 1BGMI, S1

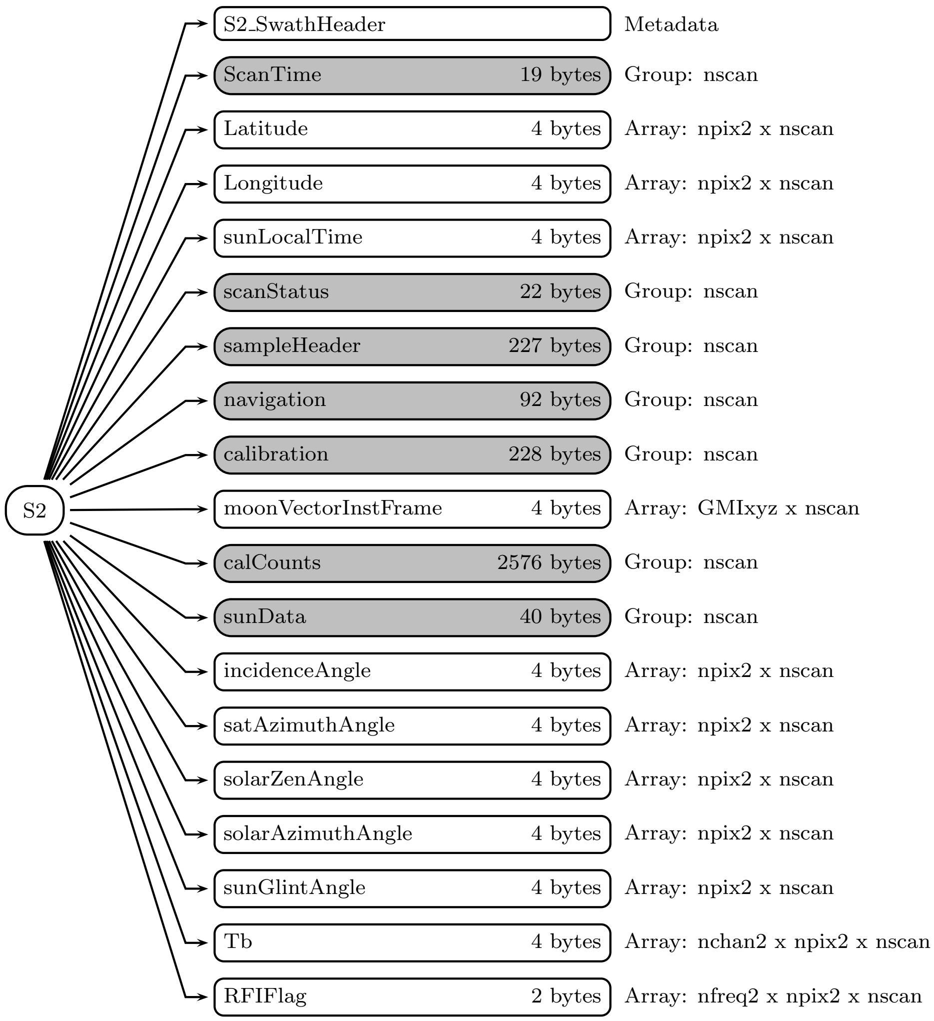


Figure 275: Data Format Structure for 1BGMI, S2

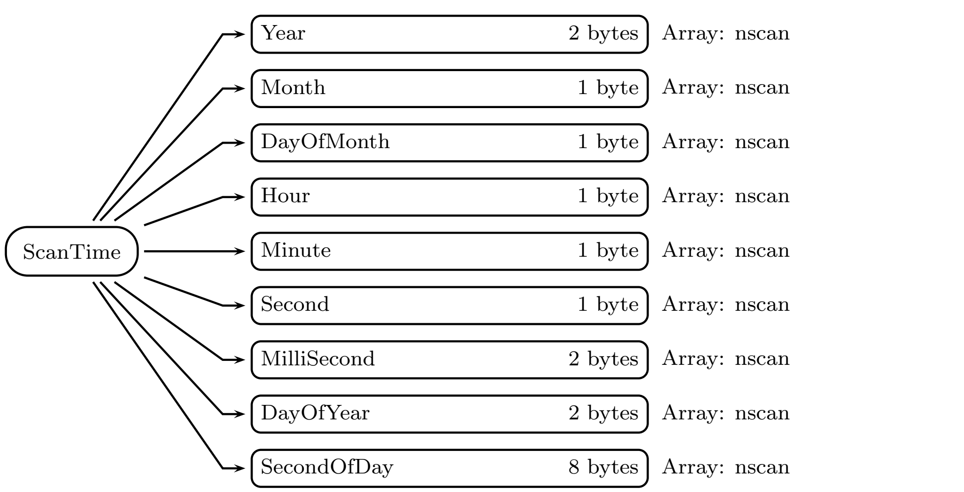


Figure 276: Data Format Structure for 1BGMI, S1, ScanTime

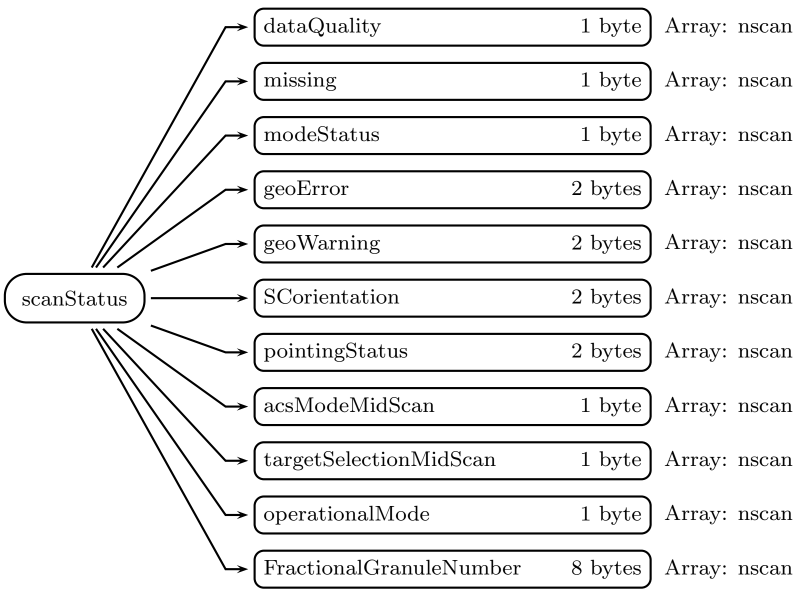


Figure 277: Data Format Structure for 1BGMI, S1, scanStatus

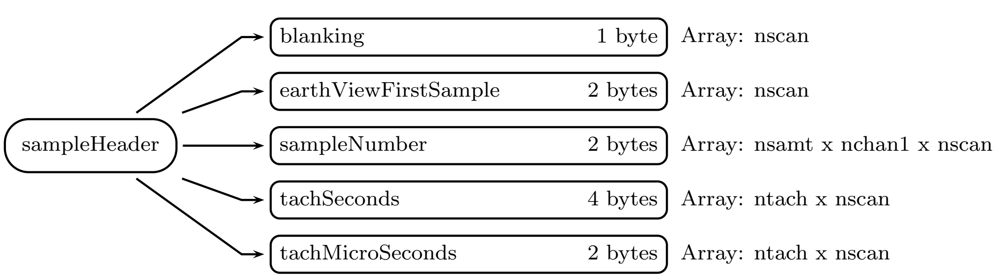


Figure 278: Data Format Structure for 1BGMI, S1, sampleHeader

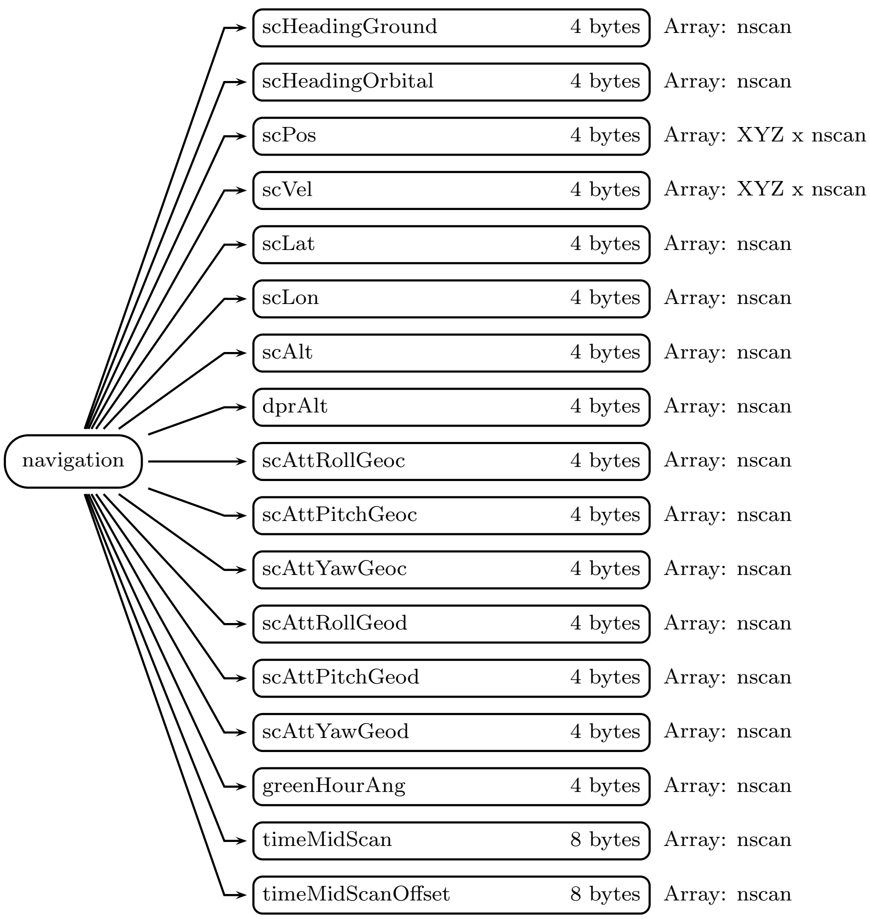


Figure 279: Data Format Structure for 1BGMI, S1, navigation

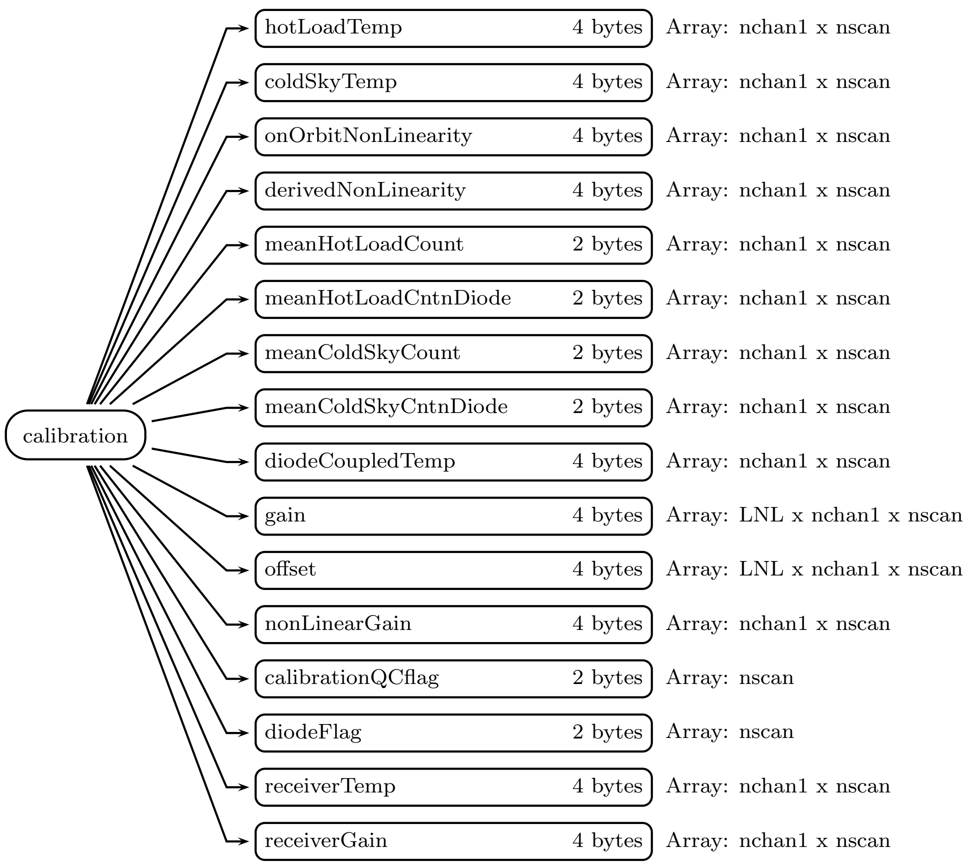


Figure 280: Data Format Structure for 1BGMI, S1, calibration

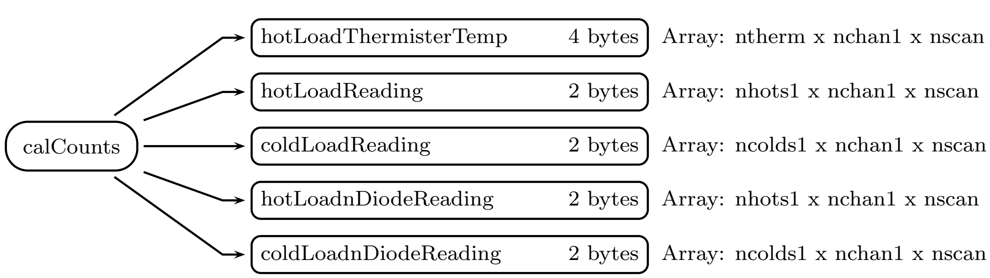


Figure 281: Data Format Structure for 1BGMI, S1, calCounts

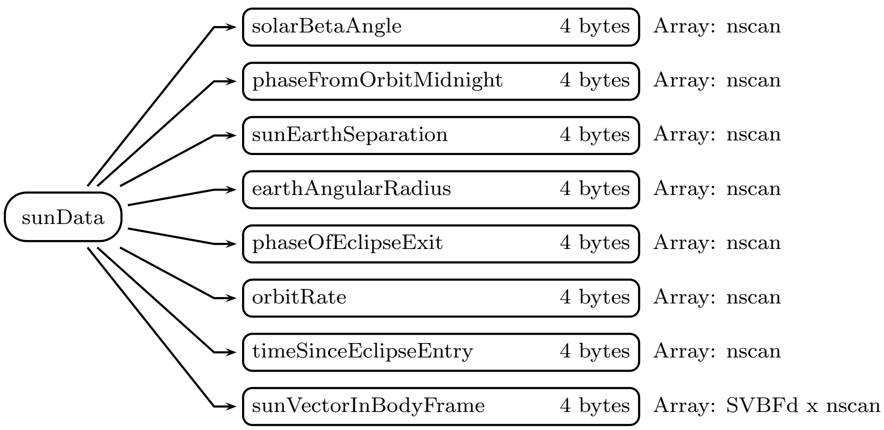


Figure 282: Data Format Structure for 1BGMI, S1, sunData

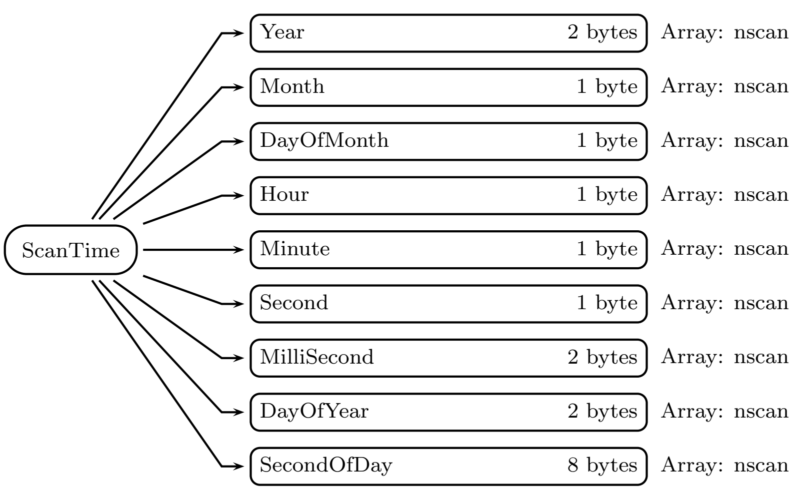


Figure 283: Data Format Structure for 1BGMI, S2, ScanTime

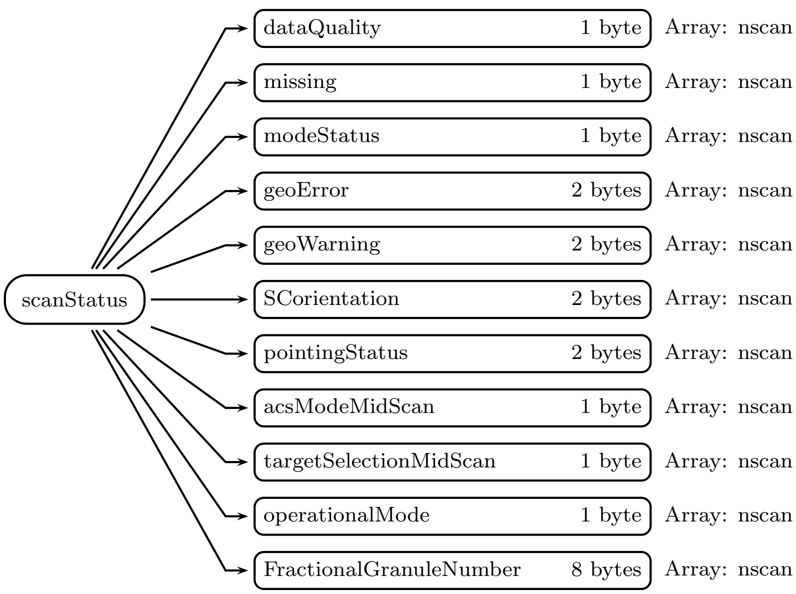


Figure 284: Data Format Structure for 1BGMI, S2, scanStatus

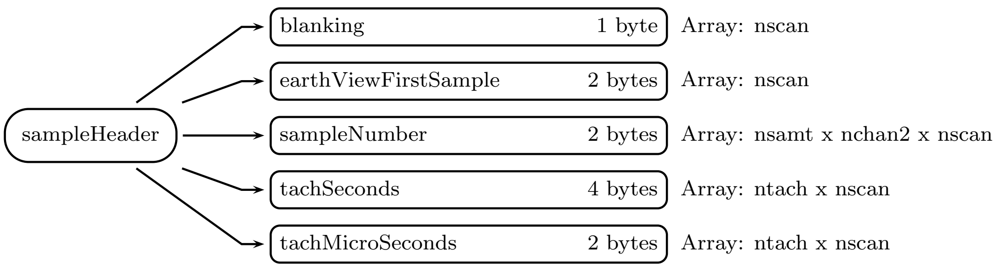


Figure 285: Data Format Structure for 1BGMI, S2, sampleHeader

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999	Missing value

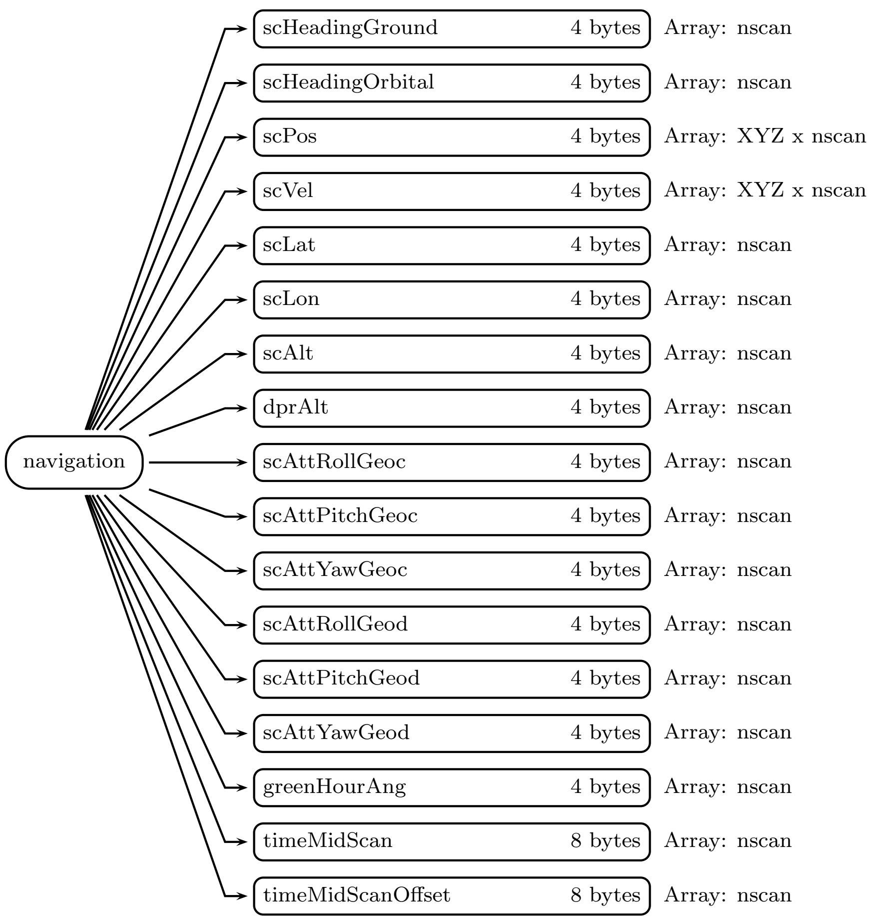


Figure 286: Data Format Structure for 1BGMI, S2, navigation

calibration

hotLoadTemp	4 bytes	Array: nchan2 x nscan
coldSkyTemp	4 bytes	Array: nchan2 x nscan
onOrbitNonLinearity	4 bytes	Array: nchan2 x nscan
derivedNonLinearity	4 bytes	Array: nchan2 x nscan
meanHotLoadCount	2 bytes	Array: nchan2 x nscan
meanHotLoadCntnDiode	2 bytes	Array: nchan2 x nscan
meanColdSkyCount	2 bytes	Array: nchan2 x nscan
meanColdSkyCntnDiode	2 bytes	Array: nchan2 x nscan
diodeCoupledTemp	4 bytes	Array: nchan2 x nscan
gain	4 bytes	Array: LNL x nchan2 x nscan
offset	4 bytes	Array: LNL x nchan2 x nscan
nonLinearGain	4 bytes	Array: nchan2 x nscan
calibrationQCflag	2 bytes	Array: nscan
diodeFlag	2 bytes	Array: nscan
receiverTemp	4 bytes	Array: nchan2 x nscan
receiverGain	4 bytes	Array: nchan2 x nscan

Figure 287: Data Format Structure for 1BGMI, S2, calibration

calCounts

hotLoadThermisterTemp	4 bytes	Array: ntherm x nchan2 x nscan
hotLoadReading	2 bytes	Array: nhots2 x nchan2 x nscan
coldLoadReading	2 bytes	Array: ncolds2 x nchan2 x nscan
hotLoadnDiodeReading	2 bytes	Array: nhots2 x nchan2 x nscan
coldLoadnDiodeReading	2 bytes	Array: ncolds2 x nchan2 x nscan

Figure 288: Data Format Structure for 1BGMI, S2, calCounts

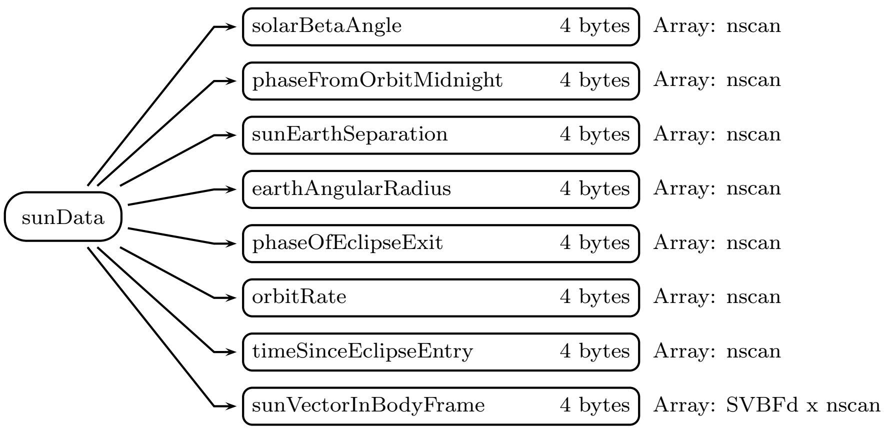


Figure 289: Data Format Structure for 1BGMI, S2, sunData

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix1 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude

is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix1 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix1 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
```

```
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is

good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

sampleHeader (Group in S1)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Table 0 used for hot and cold samples,
                     No blanking
Value of 1 = Table 1 used for hot and cold samples,
                     Blanking on both sides
Value of 2 = Table 2 used for hot and cold samples,
                     Blanking on begin side
Value of 3 = Table 3 used for hot and cold samples,
                     Blanking on end side
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:

-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan1 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:

-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Special values are defined as:

0 Missing value

tachMicroSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer microseconds. Special values are defined as:

0 Missing value

navigation (Group in S1)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to

North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital

Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):
The derived Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanHotLoadCntnDiode (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Hot Load Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCntnDiode (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Cold Sky Count Plus Noise Diode. Values range from 0 to 15. Special values

are defined as:
65535 Missing value

diodeCoupledTemp (4-byte float, array size: nchan1 x nscan):
The diode Coupled Temp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):
Diode flag. If diodeFlag = 1, use LoadPlusDiodeReading If diodeFlag = 0, use LoadReading Values range from 0 to 1 counts. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan1 x nscan):
Hot Load Thermister Temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotLoadReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix1 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix1 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix1 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix1 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle

is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan1 x npix1 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npix1 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix2 x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix2 x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npix2 x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine operationalMode
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken

down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
```

```
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
```

```
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):
Status of the GMI instrument.

```
Bit Meaning if bit = 1
0   Receiver status (0=ON, 1=OFF)
1   Spinup Status (0=ON, 1=OFF)
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

sampleHeader (Group in S2)

blanking (1-byte integer, array size: nscan):

```
Value of 0 = Table 0 used for hot and cold samples,
                     No blanking
Value of 1 = Table 1 used for hot and cold samples,
                     Blanking on both sides
Value of 2 = Table 2 used for hot and cold samples,
                     Blanking on begin side
```

```
Value of 3 = Table 3 used for hot and cold samples,
                      Blanking on end side
```

earthViewFirstSample (2-byte integer, array size: nscan):
Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan2 x nscan):
Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:
-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):
Tachometer seconds. Special values are defined as:
0 Missing value

tachMicroSeconds (2-byte unsigned integer, array size: ntach x nscan):
Tachometer microseconds. Special values are defined as:
0 Missing value

navigation (Group in S2)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time.

Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values

range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):
The mean physical temperature for the temperature sensors attached to the hot load.

Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):
The derived Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchan2 x nscan):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanHotLoadCntnDiode (2-byte unsigned integer, array size: nchan2 x nscan):
The mean Hot Load Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchan2 x nscan):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCntnDiode (2-byte unsigned integer, array size: nchan2 x nscan):
The mean Cold Sky Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:
65535 Missing value

diodeCoupledTemp (4-byte float, array size: nchan2 x nscan):
The diode Coupled Temp. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchan2 x nscan):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):
Diode flag. If diodeFlag = 1, use LoadPlusDiodeReading If diodeFlag = 0, use LoadReading Values range from 0 to 1 counts. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchan2 x nscan):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):
The receiver gain. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan2 x nscan):
Hot Load Thermister Temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotLoadReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):
Hot Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):
Cold Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such

that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix2 x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix2 x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix2 x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix2 x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchan2 x npix2 x nscan):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq2 x npix2 x nscan):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0:     Not affected by RFI.
```

```
1:     Affected by RFI with X-cal filter.
2:     Affected by RFI with RSS filter.
3-7:   Spare
-9999: Missing
```

C Structure Header file:

```
#ifndef _TK_1BGMI_H_
#define _TK_1BGMI_H_

#ifndef _L1BGMI_S2_SUNDATA_
#define _L1BGMI_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BGMI_S2_SUNDATA;

#endif

#ifndef _L1BGMI_S2_CALCOUNTS_
#define _L1BGMI_S2_CALCOUNTS_

typedef struct {
    float hotLoadThermisterTemp[4][11];
    unsigned short hotLoadReading[4][65];
    unsigned short coldLoadReading[4][85];
    unsigned short hotLoadnDiodeReading[4][65];
    unsigned short coldLoadnDiodeReading[4][85];
} L1BGMI_S2_CALCOUNTS;

#endif

#ifndef _L1BGMI_S2_CALIBRATION_
#define _L1BGMI_S2_CALIBRATION_

typedef struct {
```

```
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    unsigned short meanHotLoadCount[4];
    unsigned short meanHotLoadCntnDiode[4];
    unsigned short meanColdSkyCount[4];
    unsigned short meanColdSkyCntnDiode[4];
    float diodeCoupledTemp[4];
    float gain[4][2];
    float offset[4][2];
    float nonLinearGain[4];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[4];
    float receiverGain[4];
} L1BGMI_S2_CALIBRATION;

#endif

#ifndef _L1BGMI_S2_SAMPLEHEADER_
#define _L1BGMI_S2_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[4][4];
    unsigned int tachSeconds[32];
    unsigned short tachMicroSeconds[32];
} L1BGMI_S2_SAMPLEHEADER;

#endif

#ifndef _L1BGMI_S2_SCANSTATUS_
#define _L1BGMI_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
```

```
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BGMI_S2_SCANSTATUS;

#endif

#ifndef _L1BGMI_S2_
#define _L1BGMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    L1BGMI_S2_SCANSTATUS scanStatus;
    L1BGMI_S2_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    L1BGMI_S2_CALIBRATION calibration;
    float moonVectorInstFrame[3];
    L1BGMI_S2_CALCOUNTS calCounts;
    L1BGMI_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float Tb[221][4];
    short RFIFlag[221][2];
} L1BGMI_S2;

#endif

#ifndef _L1BGMI_S1_SUNDATA_
#define _L1BGMI_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
```

```
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BGMI_S1_SUNDATA;

#endif

#ifndef _L1BGMI_S1_CALCOUNTS_
#define _L1BGMI_S1_CALCOUNTS_

typedef struct {
    float hotLoadThermisterTemp[9][11];
    unsigned short hotLoadReading[9][65];
    unsigned short coldLoadReading[9][85];
    unsigned short hotLoadnDiodeReading[9][65];
    unsigned short coldLoadnDiodeReading[9][85];
} L1BGMI_S1_CALCOUNTS;

#endif

#ifndef _L1BGMI_S1_CALIBRATION_
#define _L1BGMI_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    unsigned short meanHotLoadCount[9];
    unsigned short meanHotLoadCntnDiode[9];
    unsigned short meanColdSkyCount[9];
    unsigned short meanColdSkyCntnDiode[9];
    float diodeCoupledTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} L1BGMI_S1_CALIBRATION;
```

```
#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1BGMI_S1_SAMPLEHEADER_
#define _L1BGMI_S1_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[9][4];
    unsigned int tachSeconds[32];
    unsigned short tachMicroSeconds[32];
} L1BGMI_S1_SAMPLEHEADER;

#endif

#ifndef _L1BGMI_S1_SCANSTATUS_
#define _L1BGMI_S1_SCANSTATUS_
```

```
typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BGMI_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BGMI_S1_
#define _L1BGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    L1BGMI_S1_SCANSTATUS scanStatus;
    L1BGMI_S1_SAMPLEHEADER sampleHeader;
```

```
    NAVIGATION navigation;
    L1BGMI_S1_CALIBRATION calibration;
    float moonVectorInstFrame[3];
    L1BGMI_S1_CALCOUNTS calCounts;
    L1BGMI_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float Tb[221][9];
    short RFIFlag[221][5];
} L1BGMI_S1;

#endif

#ifndef _L1BGMI_SWATHS_
#define _L1BGMI_SWATHS_

typedef struct {
    L1BGMI_S1 S1;
    L1BGMI_S2 S2;
} L1BGMI_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BGMI_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BGMI_S2_CALCOUNTS/
    REAL*4 hotLoadThermisterTemp(11,4)
```

```
    INTEGER*2 hotLoadReading(65,4)
    INTEGER*2 coldLoadReading(85,4)
    INTEGER*2 hotLoadnDiodeReading(65,4)
    INTEGER*2 coldLoadnDiodeReading(85,4)
END STRUCTURE

STRUCTURE /L1BGMI_S2_CALIBRATION/
    REAL*4 hotLoadTemp(4)
    REAL*4 coldSkyTemp(4)
    REAL*4 onOrbitNonLinearity(4)
    REAL*4 derivedNonLinearity(4)
    INTEGER*2 meanHotLoadCount(4)
    INTEGER*2 meanHotLoadCntnDiode(4)
    INTEGER*2 meanColdSkyCount(4)
    INTEGER*2 meanColdSkyCntnDiode(4)
    REAL*4 diodeCoupledTemp(4)
    REAL*4 gain(2,4)
    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /L1BGMI_S2_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,4)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachMicroSeconds(32)
END STRUCTURE

STRUCTURE /L1BGMI_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
```

```
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BGMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /L1BGMI_S2_SCANSTATUS/ scanStatus
    RECORD /L1BGMI_S2_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1BGMI_S2_CALIBRATION/ calibration
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BGMI_S2_CALCOUNTS/ calCounts
    RECORD /L1BGMI_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 Tb(4,221)
    INTEGER*2 RFIFlag(2,221)
END STRUCTURE

STRUCTURE /L1BGMI_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BGMI_S1_CALCOUNTS/
    REAL*4 hotLoadThermisterTemp(11,9)
    INTEGER*2 hotLoadReading(65,9)
    INTEGER*2 coldLoadReading(85,9)
    INTEGER*2 hotLoadnDiodeReading(65,9)
    INTEGER*2 coldLoadnDiodeReading(85,9)
END STRUCTURE
```

```
STRUCTURE /L1BGMI_S1_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    INTEGER*2 meanHotLoadCount(9)
    INTEGER*2 meanHotLoadCntnDiode(9)
    INTEGER*2 meanColdSkyCount(9)
    INTEGER*2 meanColdSkyCntnDiode(9)
    REAL*4 diodeCoupledTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BGMI_S1_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
```

```
    INTEGER*2 sampleNumber(4,9)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachMicroSeconds(32)
END STRUCTURE

STRUCTURE /L1BGMI_S1_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /L1BGMI_S1_SCANSTATUS/ scanStatus
    RECORD /L1BGMI_S1_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1BGMI_S1_CALIBRATION/ calibration
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BGMI_S1_CALCOUNTS/ calCounts
    RECORD /L1BGMI_S1_SUNDATA/ sunData
```

```
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 Tb(9,221)
    INTEGER*2 RFIFlag(5,221)
END STRUCTURE

STRUCTURE /L1BGMI_SWATHS/
    RECORD /L1BGMI_S1/ S1;
    RECORD /L1BGMI_S2/ S2;
END STRUCTURE
```

5.18 1BTMI - TMI unpacked packet data

1BTMI contains TMI science data from the TMI passive microwave instrument flown on the TRMM satellite. There are 3 swaths. Swath S1 has 10V 10H; Swath S2 has 19V, 19H, 21V, 37V, 37H; Swath S3 has 85V, 85H;

```
        The S1 channels are:
10.7  GHz vertically-polarized
10.7  GHz horizontally-polarized


        The S2 channels are:
18.7  GHz vertically-polarized
18.7  GHz horizontally-polarized
23.8  GHz vertically-polarized
36.5  GHz vertically-polarized
36.5  GHz horizontally-polarized


        The S3 channels are:
85.0  GHz vertically-polarized
85.0  GHz horizontally-polarized
```

Earth observations are taken during a segment of the rotation when TMI is looking in the +x direction of the TRMM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

Before Aug 7, 2001 31.6rpm * 1min/60s * 5490s/orbit = 2891 scans / orbit.

After Aug 24, 2001 31.6rpm * 1min/60s * 5550s/orbit = 2923 scans / orbit.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and the same number of pixels as Swath S1. Swath S3 has the same number of scans and twice as many pixels as Swath S1. Each S1 scan contains 2 channels sampled 104 times along the scan. Each S2 scan contains 5 channels sampled 104 times along the scan. Each S3 scan contains 2 channels sampled 208 times along the scan.

Dimension definitions:

VH	2	Number of polarizations.
nscan1	var	Typical number of Swath S1 scans in the granule.
nchannel1	2	Number of Swath S1 channels (10V).
nfreq1	1	Number of frequencies in Swath 1.
npixelev1	104	Number of earth view pixels in one scan.
npixelht1	8	Number of hot load pixels in one scan.
npixelcs1	8	Number of cold sky pixels in one scan.
nscan2	var	Typical number of Swath S2 scans in the granule.
nchannel2	5	Number of Swath S2 channels (19V 19H 21V 37V 37H).
nfreq2	3	Number of frequencies in Swath 2.
npixelev2	104	Number of earth view pixels in one scan.
npixelht2	8	Number of hot load pixels in one scan.
npixelcs2	8	Number of cold sky pixels in one scan.
nscan3	var	Typical number of Swath S3 scans in the granule.
nchannel3	2	Number of Swath S3 channels (85V 85H).
nfreq3	1	Number of frequencies in Swath 3.
npixelev3	208	Number of earth view pixels in one scan.
npixelht3	16	Number of hot load pixels in one scan.
npixelcs3	16	Number of cold sky pixels in one scan.
nchannelall	9	Number of all channels.
ntherm	3	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nndiode	6	Number of noise diodes.
dim2	2	Number.
dim3	3	Number.
dim4	4	Number.
dim5	5	Number.
dim6	6	Number.
dim7	7	Number.
dim8	8	Number.
dim9	9	Number.
dim10	10	Number.
dim11	11	Number.
dim12	12	Number.
TMIxyz	3	x, y, z components in TMI instrument coordinate system.
SVBFd	3	SunVectorinBodyFrame dimension.

Figure 290 through Figure 311 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

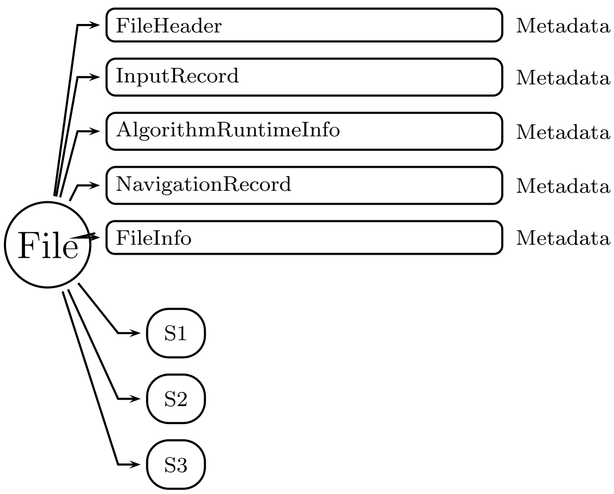


Figure 290: Data Format Structure for 1BTMI, TMI unpacked packet data

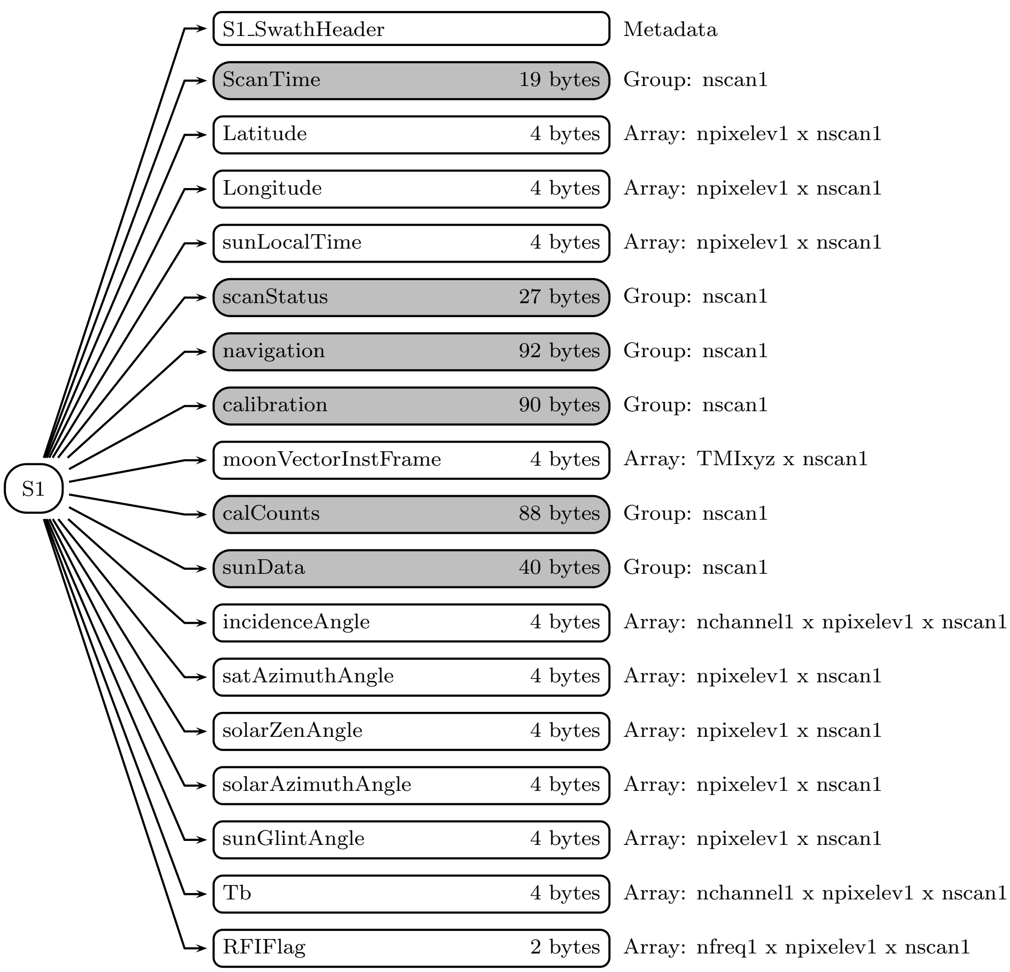


Figure 291: Data Format Structure for 1BTMI, S1

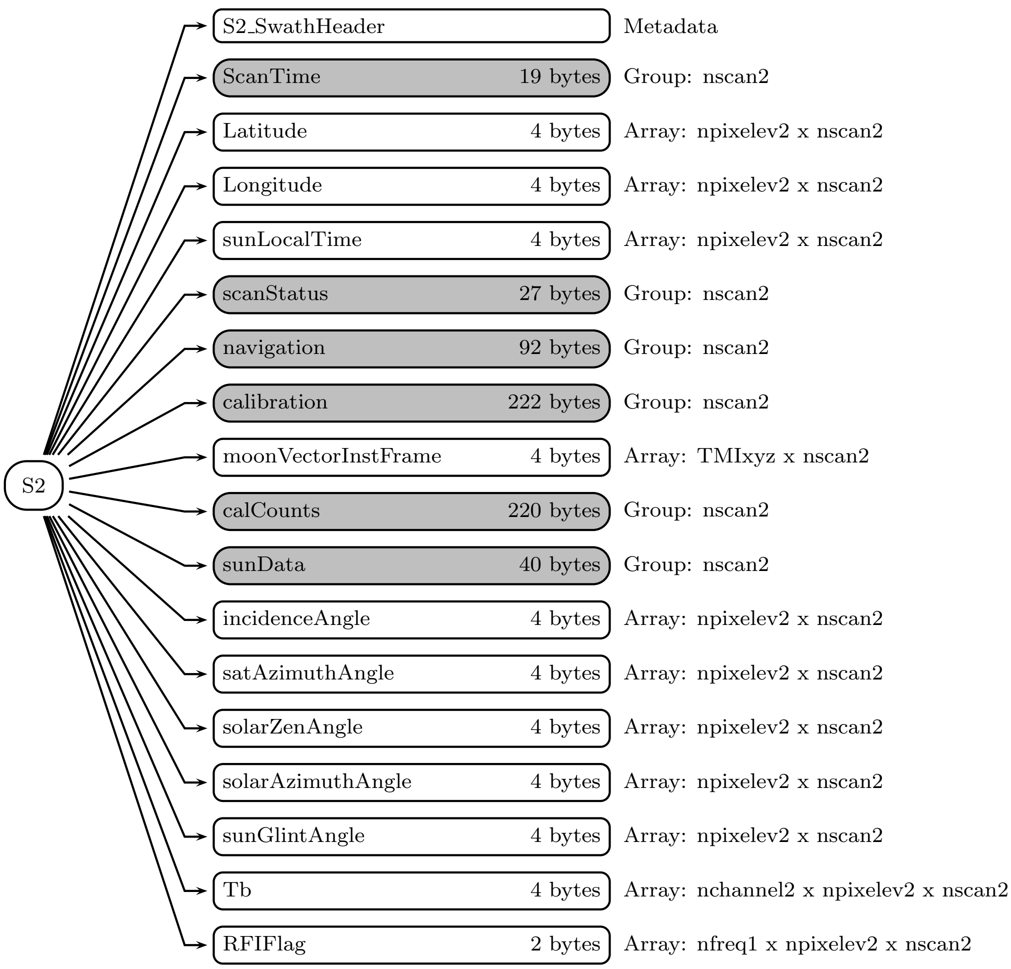


Figure 292: Data Format Structure for 1BTMI, S2

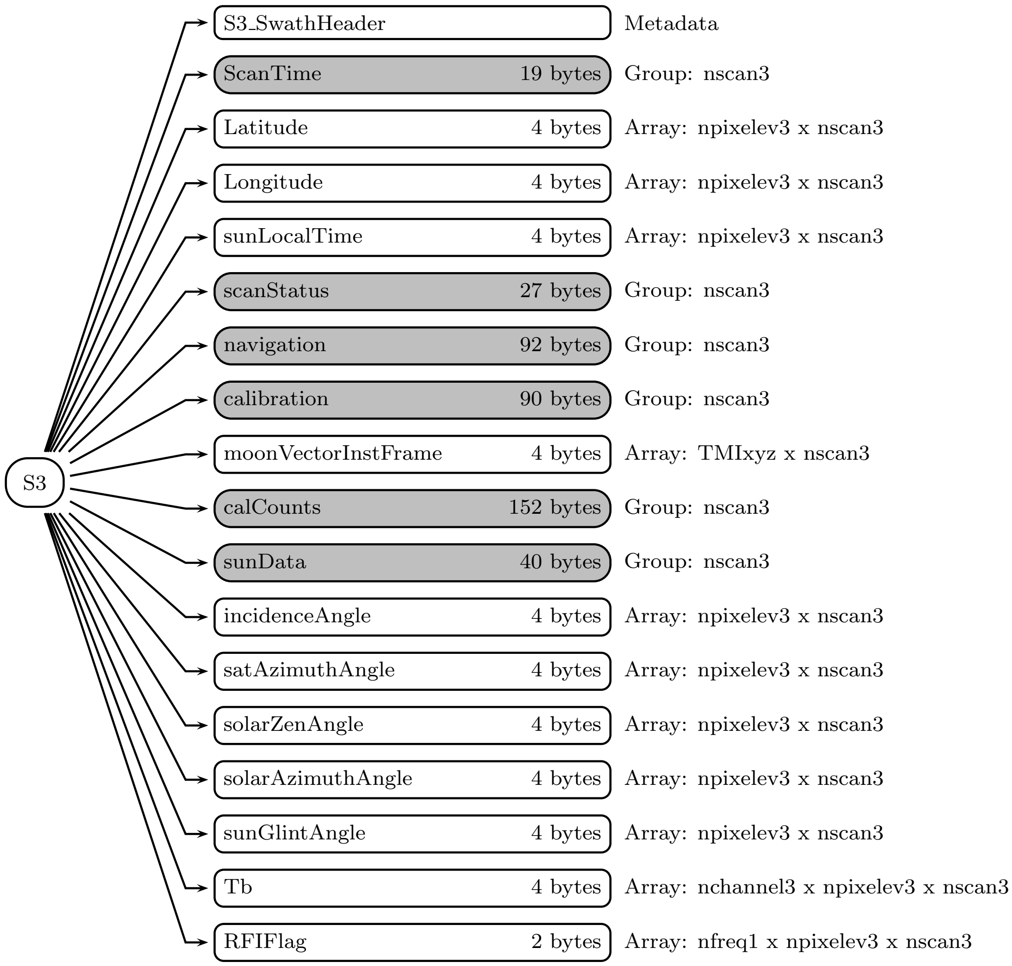


Figure 293: Data Format Structure for 1BTMI, S3

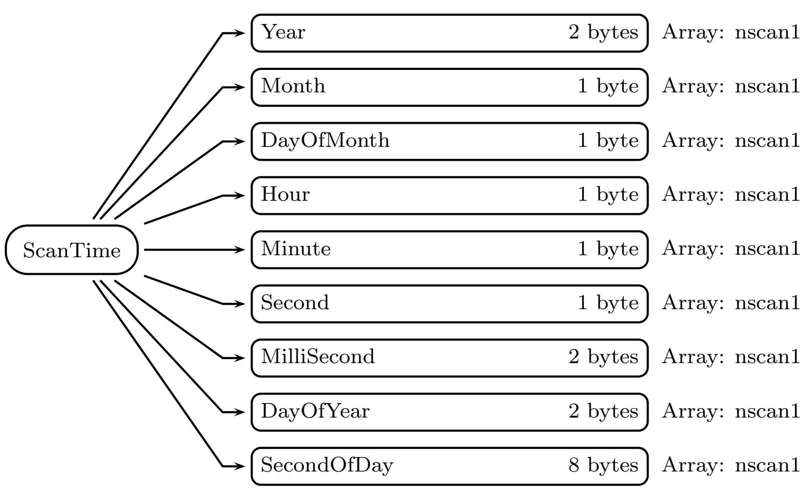


Figure 294: Data Format Structure for 1BTMI, S1, ScanTime

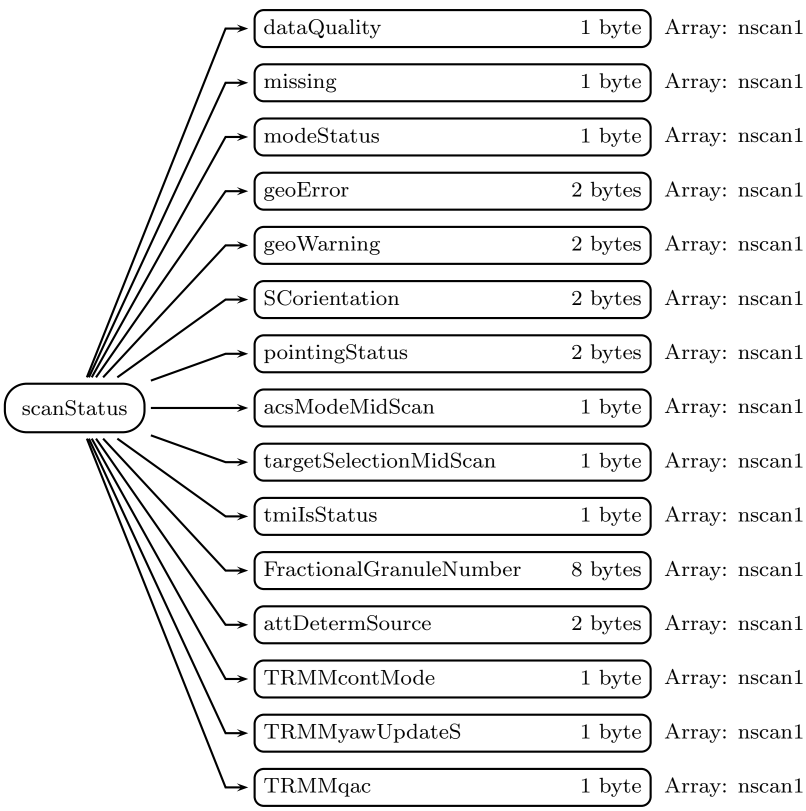


Figure 295: Data Format Structure for 1BTMI, S1, scanStatus

navigation

scHeadingGround	4 bytes	Array: nscan1
scHeadingOrbital	4 bytes	Array: nscan1
scPos	4 bytes	Array: XYZ x nscan1
scVel	4 bytes	Array: XYZ x nscan1
scLat	4 bytes	Array: nscan1
scLon	4 bytes	Array: nscan1
scAlt	4 bytes	Array: nscan1
dprAlt	4 bytes	Array: nscan1
scAttRollGeoc	4 bytes	Array: nscan1
scAttPitchGeoc	4 bytes	Array: nscan1
scAttYawGeoc	4 bytes	Array: nscan1
scAttRollGeod	4 bytes	Array: nscan1
scAttPitchGeod	4 bytes	Array: nscan1
scAttYawGeod	4 bytes	Array: nscan1
greenHourAng	4 bytes	Array: nscan1
timeMidScan	8 bytes	Array: nscan1
timeMidScanOffset	8 bytes	Array: nscan1

Figure 296: Data Format Structure for 1BTMI, S1, navigation

calibration

hotLoadTemp	4 bytes	Array: nchannel1 x nscan1
coldSkyTemp	4 bytes	Array: nchannel1 x nscan1
onOrbitNonLinearity	4 bytes	Array: nchannel1 x nscan1
meanHotLoadCount	2 bytes	Array: nchannel1 x nscan1
meanColdSkyCount	2 bytes	Array: nchannel1 x nscan1
gain	4 bytes	Array: LNL x nchannel1 x nscan1
offset	4 bytes	Array: LNL x nchannel1 x nscan1
nonLinearGain	4 bytes	Array: nchannel1 x nscan1
calibrationQCflag	2 bytes	Array: nscan1
receiverTemp	4 bytes	Array: nchannel1 x nscan1
receiverGain	4 bytes	Array: nchannel1 x nscan1

Figure 297: Data Format Structure for 1BTMI, S1, calibration

calCounts	hotLoadThermisterTemp	4 bytes	Array: ntherm x nchannel1 x nscan1
	hotLoadReading	2 bytes	Array: npixelht1 x nchannel1 x nscan1
	coldLoadReading	2 bytes	Array: npixelcs1 x nchannel1 x nscan1

Figure 298: Data Format Structure for 1BTMI, S1, calCounts

sunData	solarBetaAngle	4 bytes	Array: nscan1
	phaseFromOrbitMidnight	4 bytes	Array: nscan1
	sunEarthSeparation	4 bytes	Array: nscan1
	earthAngularRadius	4 bytes	Array: nscan1
	phaseOfEclipseExit	4 bytes	Array: nscan1
	orbitRate	4 bytes	Array: nscan1
	timeSinceEclipseEntry	4 bytes	Array: nscan1
	sunVectorInBodyFrame	4 bytes	Array: SVBFd x nscan1

Figure 299: Data Format Structure for 1BTMI, S1, sunData

ScanTime	Year	2 bytes	Array: nscan2
	Month	1 byte	Array: nscan2
	DayOfMonth	1 byte	Array: nscan2
	Hour	1 byte	Array: nscan2
	Minute	1 byte	Array: nscan2
	Second	1 byte	Array: nscan2
	MilliSecond	2 bytes	Array: nscan2
	DayOfYear	2 bytes	Array: nscan2
	SecondOfDay	8 bytes	Array: nscan2

Figure 300: Data Format Structure for 1BTMI, S2, ScanTime

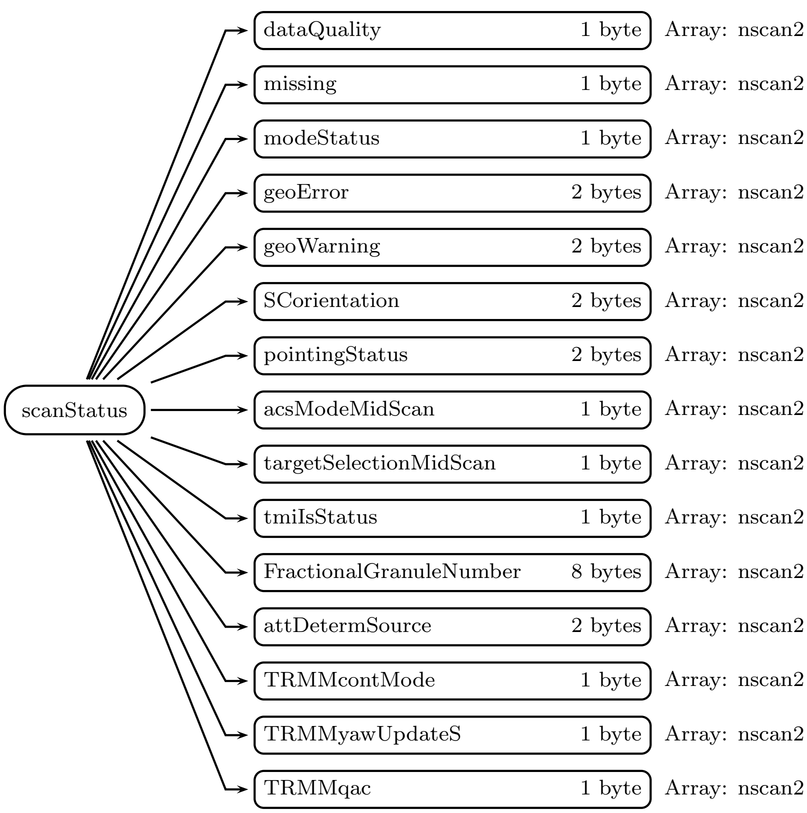


Figure 301: Data Format Structure for 1BTMI, S2, scanStatus

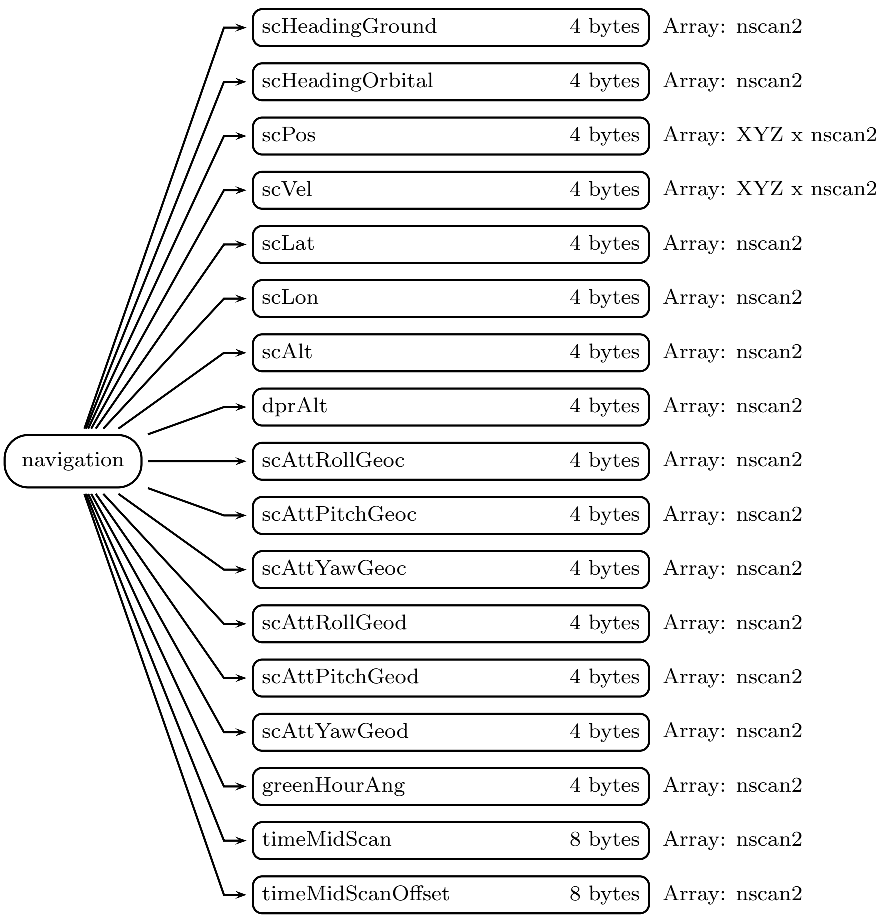


Figure 302: Data Format Structure for 1BTMI, S2, navigation

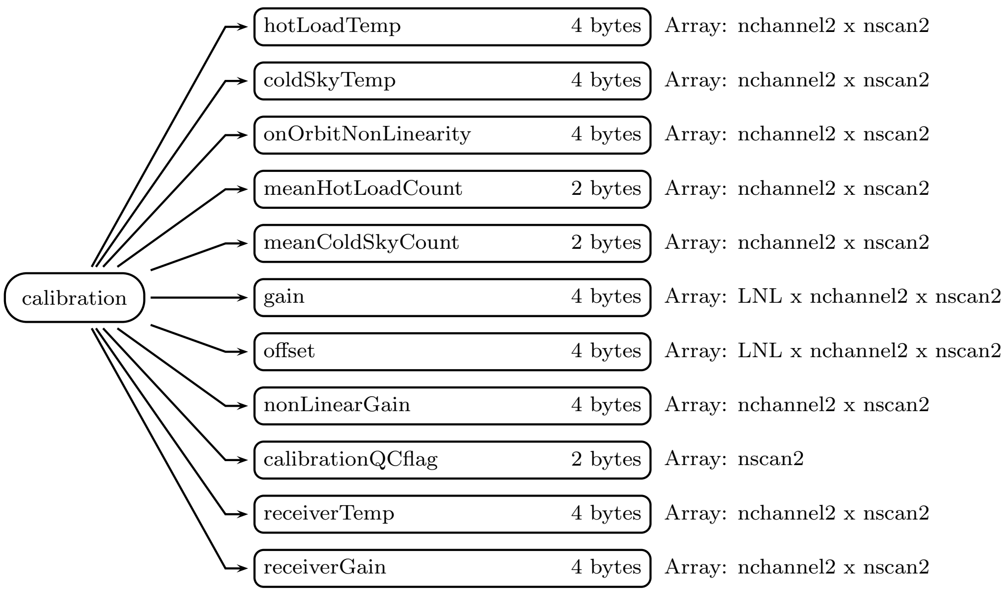


Figure 303: Data Format Structure for 1BTMI, S2, calibration

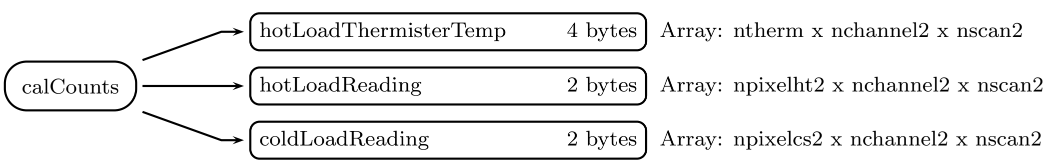


Figure 304: Data Format Structure for 1BTMI, S2, calCounts

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

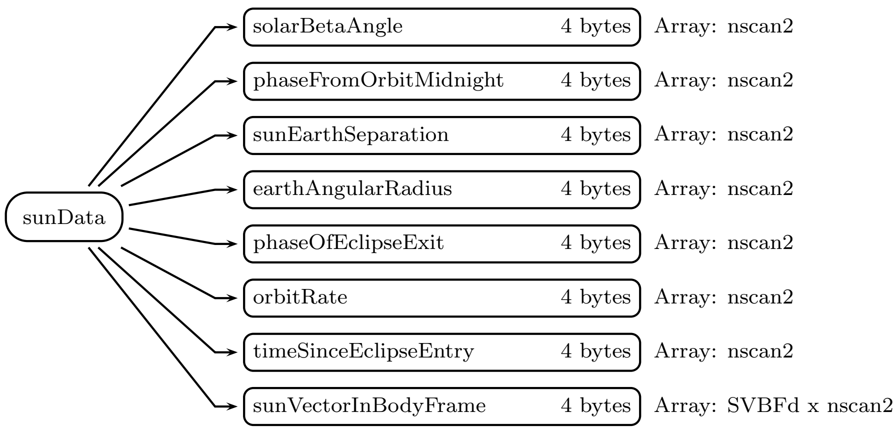


Figure 305: Data Format Structure for 1BTMI, S2, sunData

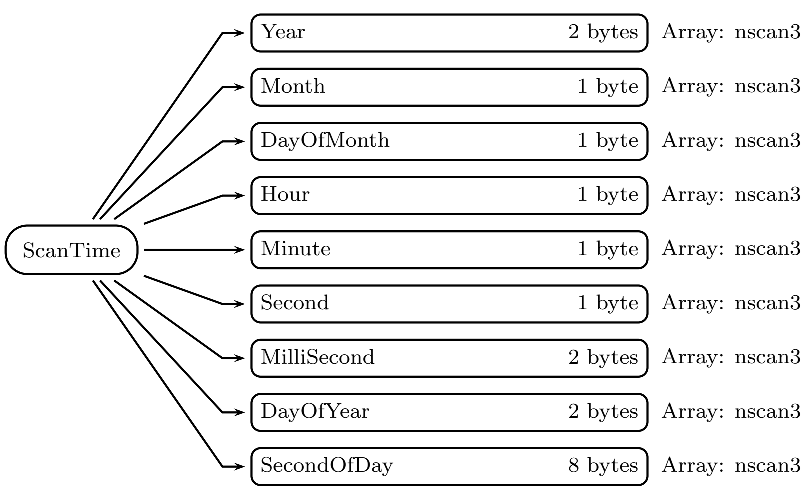


Figure 306: Data Format Structure for 1BTMI, S3, ScanTime

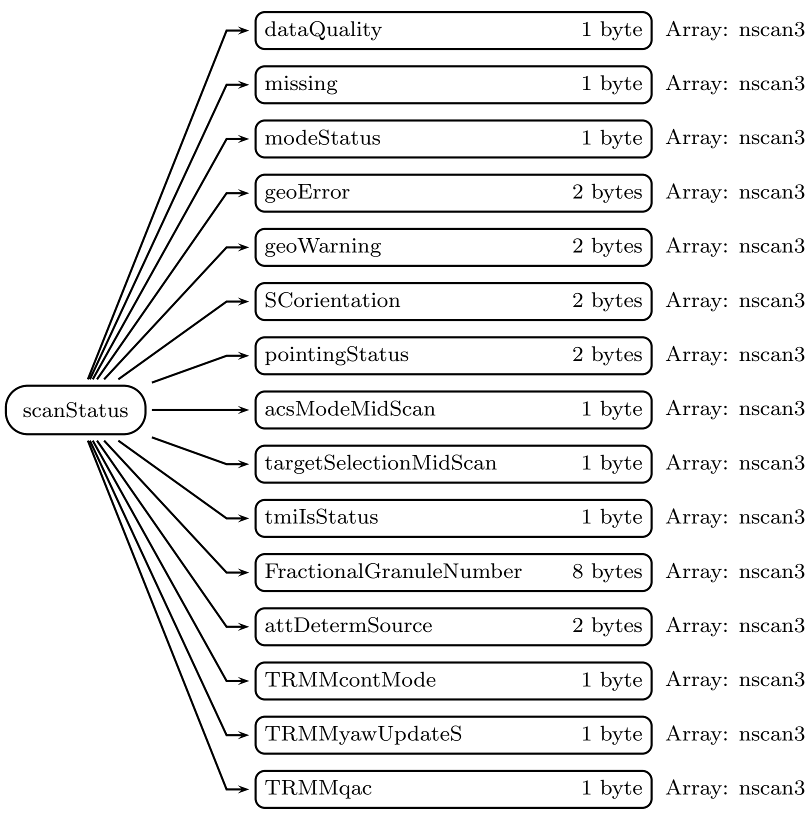


Figure 307: Data Format Structure for 1BTMI, S3, scanStatus

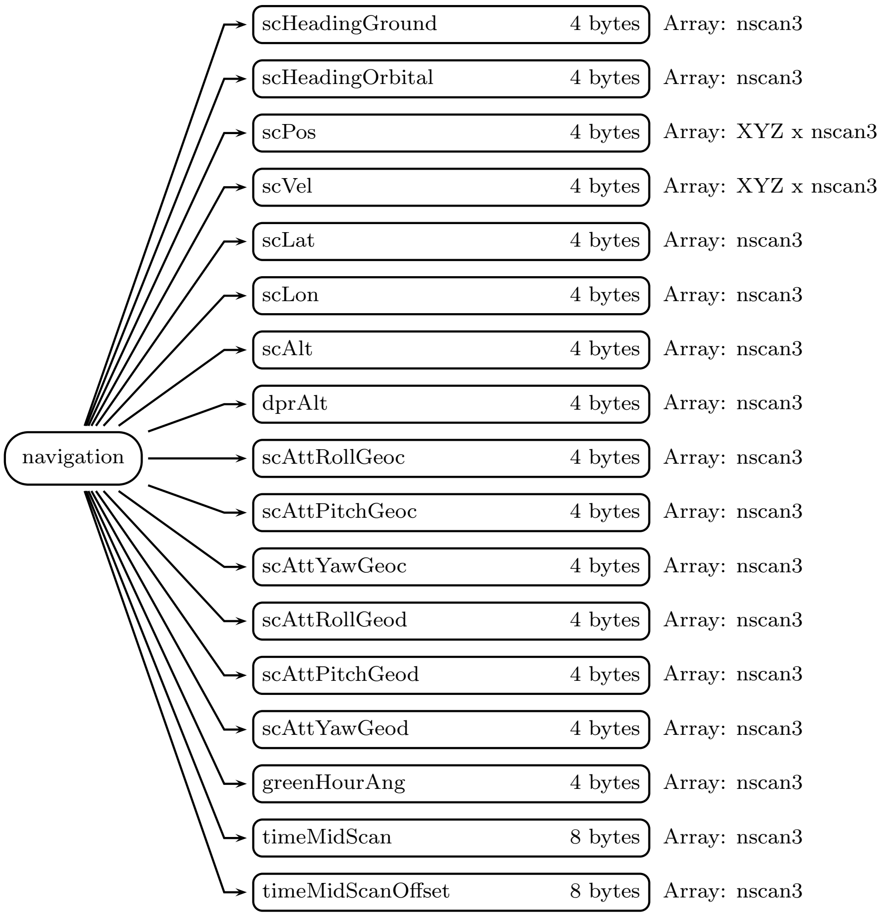


Figure 308: Data Format Structure for 1BTMI, S3, navigation

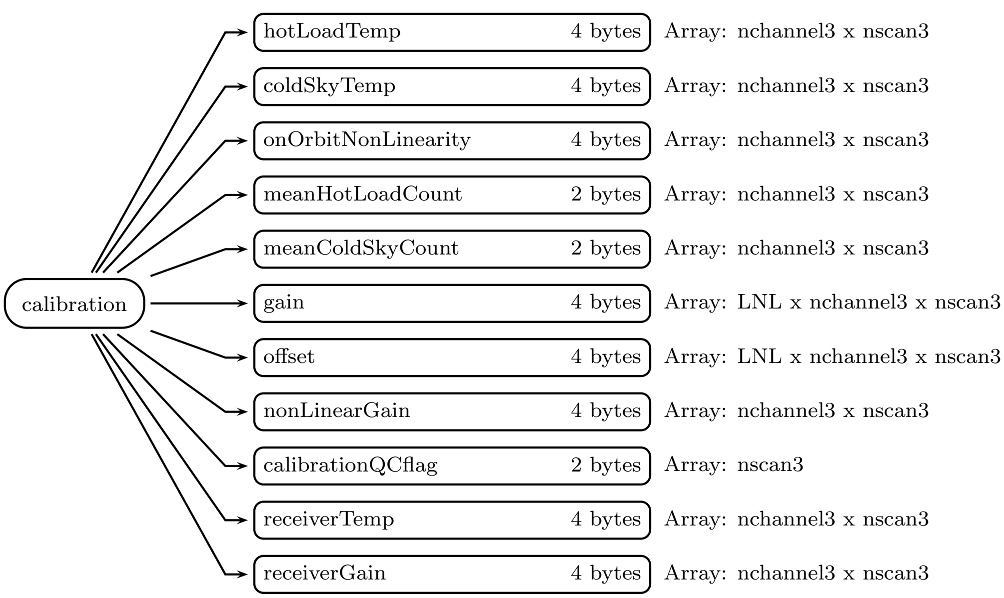


Figure 309: Data Format Structure for 1BTMI, S3, calibration

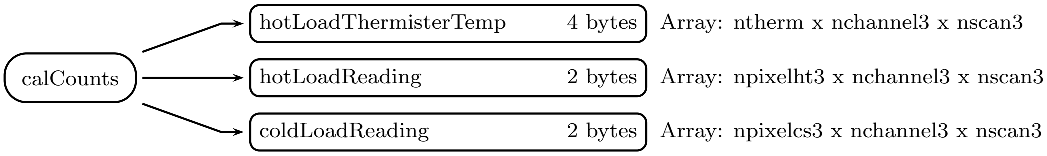


Figure 310: Data Format Structure for 1BTMI, S3, calCounts

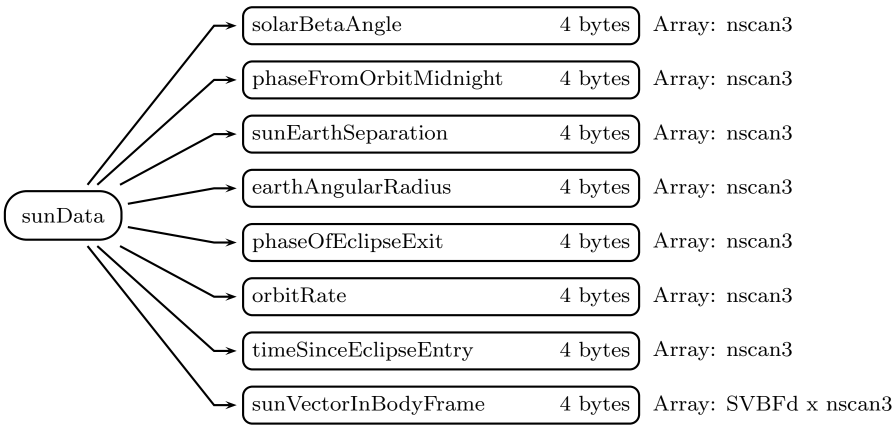


Figure 311: Data Format Structure for 1BTMI, S3, sunData

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte char, array size: nscan1):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan1):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan1):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine tmiIsStatus
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan1):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan1):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
```

```
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan1):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan1):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan1):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan1):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

tmiIsStatus (1-byte char, array size: nscan1):
Status of the instrument from Housekeeping packets. Bit 0 is the most significant bit (I.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00   Receiver status (0=ON, 1=OFF)
01   Spinup Status (0=ON, 1=OFF)
02   Spare command 1 Status
03   Spare command 2 Status
04   1 Hz Clock Select (1=A, 0=B)
05   Spare
06   Spare Command 4 Status
07   Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan1):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value             Meaning
    430 and higher    Best accuracy, good data for this orbit
    421               Reduced accuracy, PR roll data not available
                      (affecting roll/yaw estimates)
    413               Reduced accuracy, sun data not available (affecting pitch)
    411               Reduced accuracy, PR roll and sun sensor not available
    300-399           Reduced accuracy due to various special conditions
    200-299           Fallback to using the onboard attitude estimates
                      with TRMM V7 corrections
    -91               Spacecraft in safehold mode, no science data
    -99               No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan1):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
```

```
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan1):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan1):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

navigation (Group in S1)

scHeadingGround (4-byte float, array size: nscan1):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan1):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan1):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan1):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan1):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan1):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan1):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan1):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan1):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan1):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan1):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan1):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan1):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchannel1 x nscan1):
The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchannel1 x nscan1):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchannel1 x nscan1):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchannel1 x nscan1):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchannel1 x nscan1):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

gain (4-byte float, array size: LNL x nchannel1 x nscan1):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchannel1 x nscan1):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchannel1 x nscan1):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan1):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchannel1 x nscan1):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchannel1 x nscan1):
The receiver gain. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: TMIxyz x nscan1):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S1)

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchannel1 x nscan1):
Hot Load Thermister Temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotLoadReading (2-byte unsigned integer, array size: npixelht1 x nchannel1 x nscan1):
Hot Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: npixelcs1 x nchannel1 x nscan1):
Cold Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan1):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan1):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan1):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan1):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan1):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan1):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan1):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan1):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: nchannel1 x npixelev1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev1 x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev1 x nscan1):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev1 x nscan1):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev1 x nscan1):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchannel1 x npixelev1 x nscan1):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npixelev1 x nscan1):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0: No RFI on earth view samples and all Tb values of this swath are lower
than or equal to 320 K.
1: Earth view Tb values from one or more channels of this swath are greater
than 320 K.
2: RFI on earth view samples is detected by spectral differential method (10
GHz and 19 GHz channels only).
3: (combination of 1 and 2). Earth view Tb values from one or more channels
of this swath are greater than 320 K and RFI is detected by spectral
differential method (10 GHz and 19 GHz channels only)
-9999: Missing
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte char, array size: nscan2):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan2):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan2):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine tmiIsStatus
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan2):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan2):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate

bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan2):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan2):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
```

```
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan2):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan2):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

tmiIsStatus (1-byte char, array size: nscan2):
Status of the instrument from Housekeeping packets. Bit 0 is the most significant bit (I.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00   Receiver status (0=ON, 1=OFF)
01   Spinup Status (0=ON, 1=OFF)
02   Spare command 1 Status
03   Spare command 2 Status
04   1 Hz Clock Select (1=A, 0=B)
05   Spare
06   Spare Command 4 Status
07   Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan2):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value             Meaning
    430 and higher    Best accuracy, good data for this orbit
    421               Reduced accuracy, PR roll data not available
                      (affecting roll/yaw estimates)
    413               Reduced accuracy, sun data not available (affecting pitch)
    411               Reduced accuracy, PR roll and sun sensor not available
    300-399           Reduced accuracy due to various special conditions
    200-299           Fallback to using the onboard attitude estimates
                      with TRMM V7 corrections
    -91               Spacecraft in safehold mode, no science data
    -99               No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan2):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
```

```
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan2):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan2):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

navigation (Group in S2)

scHeadingGround (4-byte float, array size: nscan2):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over

the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan2):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan2):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan2):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan2):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan2):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan2):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the

Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan2):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan2):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan2):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan2):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan2):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan2):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchannel2 x nscan2):
The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchannel2 x nscan2):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchannel2 x nscan2):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchannel2 x nscan2):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchannel2 x nscan2):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

gain (4-byte float, array size: LNL x nchannel2 x nscan2):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchannel2 x nscan2):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchannel2 x nscan2):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan2):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchannel2 x nscan2):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchannel2 x nscan2):
The receiver gain. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: TMIxyz x nscan2):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S2)

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchannel2 x nscan2):
Hot Load Thermister Temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotLoadReading (2-byte unsigned integer, array size: npixelht2 x nchannel2 x nscan2):
Hot Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: npixelcs2 x nchannel2 x nscan2):
Cold Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan2):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan2):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees

occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan2):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan2):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan2):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan2):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan2):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan2):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev2 x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev2 x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev2 x nscan2):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev2 x nscan2):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev2 x nscan2):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchannel2 x npixelev2 x nscan2):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npixelev2 x nscan2):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0: No RFI on earth view samples and all Tb values of this swath are lower
than or equal to 320 K.
1: Earth view Tb values from one or more channels of this swath are greater
than 320 K.
2: RFI on earth view samples is detected by spectral differential method (10
GHz and 19 GHz channels only).
3: (combination of 1 and 2). Earth view Tb values from one or more channels
of this swath are greater than 320 K and RFI is detected by spectral
differential method (10 GHz and 19 GHz channels only)
-9999: Missing
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixelev3 x nscan3):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude

is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixelev3 x nscan3):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixelev3 x nscan3):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S3)

dataQuality (1-byte char, array size: nscan3):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan3):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan3):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
3   Spare (always 0)
4   Non-routine tmiIsStatus
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan3):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
```

```
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan3):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan3):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan3):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan3):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan3):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

tmiIsStatus (1-byte char, array size: nscan3):
Status of the instrument from Housekeeping packets. Bit 0 is the most significant bit (I.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Meaning
00   Receiver status (0=ON, 1=OFF)
```

```
    01   Spinup Status (0=ON, 1=OFF)
    02   Spare command 1 Status
    03   Spare command 2 Status
    04   1 Hz Clock Select (1=A, 0=B)
    05   Spare
    06   Spare Command 4 Status
    07   Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

attDetermSource (2-byte integer, array size: nscan3):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value             Meaning
    430 and higher    Best accuracy, good data for this orbit
    421               Reduced accuracy, PR roll data not available
                      (affecting roll/yaw estimates)
    413               Reduced accuracy, sun data not available (affecting pitch)
    411               Reduced accuracy, PR roll and sun sensor not available
    300-399           Reduced accuracy due to various special conditions
    200-299           Fallback to using the onboard attitude estimates
                      with TRMM V7 corrections
    -91               Spacecraft in safehold mode, no science data
    -99               No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan3):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
```

```
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan3):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan3):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

navigation (Group in S3)

scHeadingGround (4-byte float, array size: nscan3):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan3):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan3):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan3):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan3):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan3):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan3):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan3):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000

to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan3):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan3):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan3):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan3):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan3):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan3):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values

range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan3):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan3):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan3):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

calibration (Group in S3)

hotLoadTemp (4-byte float, array size: nchannel3 x nscan3):
The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchannel3 x nscan3):
The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchannel3 x nscan3):
The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchannel3 x nscan3):
The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchannel3 x nscan3):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:
65535 Missing value

gain (4-byte float, array size: LNL x nchannel3 x nscan3):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

offset (4-byte float, array size: LNL x nchannel3 x nscan3):
Offset. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchannel3 x nscan3):
The nonlinear gain. Special values are defined as:
-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan3):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:
-9999 Missing value

receiverTemp (4-byte float, array size: nchannel3 x nscan3):
The receiver temperature. Special values are defined as:
-9999.9 Missing value

receiverGain (4-byte float, array size: nchannel3 x nscan3):
The receiver gain. Special values are defined as:
-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: TMIxyz x nscan3):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:
-9999.9 Missing value

calCounts (Group in S3)

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchannel3 x nscan3):
Hot Load Thermister Temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotLoadReading (2-byte unsigned integer, array size: npixelht3 x nchannel3 x nscan3):
Hot Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

coldLoadReading (2-byte unsigned integer, array size: npixelcs3 x nchannel3 x nscan3):
Cold Load Reading. Values range from 0 to 15 counts. Special values are defined as:
0 Missing value

sunData (Group in S3)

solarBetaAngle (4-byte float, array size: nscan3):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from

-89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan3):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan3):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan3):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan3):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan3):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan3):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan3):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixelev3 x nscan3):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel

location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixelev3 x nscan3):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixelev3 x nscan3):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixelev3 x nscan3):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixelev3 x nscan3):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

Tb (4-byte float, array size: nchannel3 x npixelev3 x nscan3):
Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

RFIFlag (2-byte integer, array size: nfreq1 x npixelev3 x nscan3):

```
Radio Frequency Interference (RFI) Flag.  The flag is set
to non-zero if the pixel is contaminated by RFI according
to certain filters.  Current values are:

0: No RFI on earth view samples and all Tb values of this swath are lower
than or equal to 320 K.
1: Earth view Tb values from one or more channels of this swath are greater
than 320 K.
-9999: Missing
```

C Structure Header file:

```
#ifndef _TK_1BTMI_H_
#define _TK_1BTMI_H_

#ifndef _L1BTMI_S3_SUNDATA_
#define _L1BTMI_S3_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BTMI_S3_SUNDATA;

#endif

#ifndef _L1BTMI_S3_CALCOUNTS_
#define _L1BTMI_S3_CALCOUNTS_

typedef struct {
    float hotLoadThermisterTemp[2][3];
    unsigned short hotLoadReading[2][16];
    unsigned short coldLoadReading[2][16];
} L1BTMI_S3_CALCOUNTS;

#endif

#ifndef _L1BTMI_S3_CALIBRATION_
#define _L1BTMI_S3_CALIBRATION_

typedef struct {
    float hotLoadTemp[2];
    float coldSkyTemp[2];
    float onOrbitNonLinearity[2];
    unsigned short meanHotLoadCount[2];
    unsigned short meanColdSkyCount[2];
    float gain[2][2];
    float offset[2][2];
    float nonLinearGain[2];
```

```
    short calibrationQCflag;
    float receiverTemp[2];
    float receiverGain[2];
} L1BTMI_S3_CALIBRATION;

#endif

#ifndef _L1BTMI_S3_SCANSTATUS_
#define _L1BTMI_S3_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    unsigned char tmiIsStatus;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1BTMI_S3_SCANSTATUS;

#endif

#ifndef _L1BTMI_S3_
#define _L1BTMI_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    float sunLocalTime[208];
    L1BTMI_S3_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L1BTMI_S3_CALIBRATION calibration;
    float moonVectorInstFrame[3];
    L1BTMI_S3_CALCOUNTS calCounts;
```

```
    L1BTMI_S3_SUNDATA sunData;
    float incidenceAngle[208];
    float satAzimuthAngle[208];
    float solarZenAngle[208];
    float solarAzimuthAngle[208];
    float sunGlintAngle[208];
    float Tb[208][2];
    short RFIFlag[208][1];
} L1BTMI_S3;

#endif

#ifndef _L1BTMI_S2_SUNDATA_
#define _L1BTMI_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BTMI_S2_SUNDATA;

#endif

#ifndef _L1BTMI_S2_CALCOUNTS_
#define _L1BTMI_S2_CALCOUNTS_

typedef struct {
    float hotLoadThermisterTemp[5][3];
    unsigned short hotLoadReading[5][8];
    unsigned short coldLoadReading[5][8];
} L1BTMI_S2_CALCOUNTS;

#endif

#ifndef _L1BTMI_S2_CALIBRATION_
#define _L1BTMI_S2_CALIBRATION_

typedef struct {
```

```
    float hotLoadTemp[5];
    float coldSkyTemp[5];
    float onOrbitNonLinearity[5];
    unsigned short meanHotLoadCount[5];
    unsigned short meanColdSkyCount[5];
    float gain[5][2];
    float offset[5][2];
    float nonLinearGain[5];
    short calibrationQCflag;
    float receiverTemp[5];
    float receiverGain[5];
} L1BTMI_S2_CALIBRATION;

#endif

#ifndef _L1BTMI_S2_SCANSTATUS_
#define _L1BTMI_S2_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    unsigned char tmiIsStatus;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1BTMI_S2_SCANSTATUS;

#endif

#ifndef _L1BTMI_S2_
#define _L1BTMI_S2_

typedef struct {
    SCANTIME ScanTime;
```

```
    float Latitude[104];
    float Longitude[104];
    float sunLocalTime[104];
    L1BTMI_S2_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L1BTMI_S2_CALIBRATION calibration;
    float moonVectorInstFrame[3];
    L1BTMI_S2_CALCOUNTS calCounts;
    L1BTMI_S2_SUNDATA sunData;
    float incidenceAngle[104];
    float satAzimuthAngle[104];
    float solarZenAngle[104];
    float solarAzimuthAngle[104];
    float sunGlintAngle[104];
    float Tb[104][5];
    short RFIFlag[104][1];
} L1BTMI_S2;

#endif

#ifndef _L1BTMI_S1_SUNDATA_
#define _L1BTMI_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BTMI_S1_SUNDATA;

#endif

#ifndef _L1BTMI_S1_CALCOUNTS_
#define _L1BTMI_S1_CALCOUNTS_

typedef struct {
    float hotLoadThermisterTemp[2][3];
    unsigned short hotLoadReading[2][8];
    unsigned short coldLoadReading[2][8];
```

```
} L1BTMI_S1_CALCOUNTS;

#endif

#ifndef _L1BTMI_S1_CALIBRATION_
#define _L1BTMI_S1_CALIBRATION_

typedef struct {
    float hotLoadTemp[2];
    float coldSkyTemp[2];
    float onOrbitNonLinearity[2];
    unsigned short meanHotLoadCount[2];
    unsigned short meanColdSkyCount[2];
    float gain[2][2];
    float offset[2][2];
    float nonLinearGain[2];
    short calibrationQCflag;
    float receiverTemp[2];
    float receiverGain[2];
} L1BTMI_S1_CALIBRATION;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
```

```
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1BTMI_S1_SCANSTATUS_
#define _L1BTMI_S1_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    unsigned char tmiIsStatus;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1BTMI_S1_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;
```

```
#endif

#ifndef _L1BTMI_S1_
#define _L1BTMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[104];
    float Longitude[104];
    float sunLocalTime[104];
    L1BTMI_S1_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L1BTMI_S1_CALIBRATION calibration;
    float moonVectorInstFrame[3];
    L1BTMI_S1_CALCOUNTS calCounts;
    L1BTMI_S1_SUNDATA sunData;
    float incidenceAngle[104][2];
    float satAzimuthAngle[104];
    float solarZenAngle[104];
    float solarAzimuthAngle[104];
    float sunGlintAngle[104];
    float Tb[104][2];
    short RFIFlag[104][1];
} L1BTMI_S1;

#endif

#ifndef _L1BTMI_SWATHS_
#define _L1BTMI_SWATHS_

typedef struct {
    L1BTMI_S1 S1;
    L1BTMI_S2 S2;
    L1BTMI_S3 S3;
} L1BTMI_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BTMI_S3_SUNDATA/
```

```
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BTMI_S3_CALCOUNTS/
    REAL*4 hotLoadThermisterTemp(3,2)
    INTEGER*2 hotLoadReading(16,2)
    INTEGER*2 coldLoadReading(16,2)
END STRUCTURE

STRUCTURE /L1BTMI_S3_CALIBRATION/
    REAL*4 hotLoadTemp(2)
    REAL*4 coldSkyTemp(2)
    REAL*4 onOrbitNonLinearity(2)
    INTEGER*2 meanHotLoadCount(2)
    INTEGER*2 meanColdSkyCount(2)
    REAL*4 gain(2,2)
    REAL*4 offset(2,2)
    REAL*4 nonLinearGain(2)
    INTEGER*2 calibrationQCflag
    REAL*4 receiverTemp(2)
    REAL*4 receiverGain(2)
END STRUCTURE

STRUCTURE /L1BTMI_S3_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    CHARACTER tmiIsStatus
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
```

```
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE

STRUCTURE /L1BTMI_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    REAL*4 sunLocalTime(208)
    RECORD /L1BTMI_S3_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BTMI_S3_CALIBRATION/ calibration
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BTMI_S3_CALCOUNTS/ calCounts
    RECORD /L1BTMI_S3_SUNDATA/ sunData
    REAL*4 incidenceAngle(208)
    REAL*4 satAzimuthAngle(208)
    REAL*4 solarZenAngle(208)
    REAL*4 solarAzimuthAngle(208)
    REAL*4 sunGlintAngle(208)
    REAL*4 Tb(2,208)
    INTEGER*2 RFIFlag(1,208)
END STRUCTURE

STRUCTURE /L1BTMI_S2_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BTMI_S2_CALCOUNTS/
    REAL*4 hotLoadThermisterTemp(3,5)
    INTEGER*2 hotLoadReading(8,5)
    INTEGER*2 coldLoadReading(8,5)
END STRUCTURE

STRUCTURE /L1BTMI_S2_CALIBRATION/
```

```
    REAL*4 hotLoadTemp(5)
    REAL*4 coldSkyTemp(5)
    REAL*4 onOrbitNonLinearity(5)
    INTEGER*2 meanHotLoadCount(5)
    INTEGER*2 meanColdSkyCount(5)
    REAL*4 gain(2,5)
    REAL*4 offset(2,5)
    REAL*4 nonLinearGain(5)
    INTEGER*2 calibrationQCflag
    REAL*4 receiverTemp(5)
    REAL*4 receiverGain(5)
END STRUCTURE

STRUCTURE /L1BTMI_S2_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    CHARACTER tmiIsStatus
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE

STRUCTURE /L1BTMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(104)
    REAL*4 Longitude(104)
    REAL*4 sunLocalTime(104)
    RECORD /L1BTMI_S2_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BTMI_S2_CALIBRATION/ calibration
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BTMI_S2_CALCOUNTS/ calCounts
    RECORD /L1BTMI_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(104)
```

```
    REAL*4 satAzimuthAngle(104)
    REAL*4 solarZenAngle(104)
    REAL*4 solarAzimuthAngle(104)
    REAL*4 sunGlintAngle(104)
    REAL*4 Tb(5,104)
    INTEGER*2 RFIFlag(1,104)
END STRUCTURE

STRUCTURE /L1BTMI_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BTMI_S1_CALCOUNTS/
    REAL*4 hotLoadThermisterTemp(3,2)
    INTEGER*2 hotLoadReading(8,2)
    INTEGER*2 coldLoadReading(8,2)
END STRUCTURE

STRUCTURE /L1BTMI_S1_CALIBRATION/
    REAL*4 hotLoadTemp(2)
    REAL*4 coldSkyTemp(2)
    REAL*4 onOrbitNonLinearity(2)
    INTEGER*2 meanHotLoadCount(2)
    INTEGER*2 meanColdSkyCount(2)
    REAL*4 gain(2,2)
    REAL*4 offset(2,2)
    REAL*4 nonLinearGain(2)
    INTEGER*2 calibrationQCflag
    REAL*4 receiverTemp(2)
    REAL*4 receiverGain(2)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
```

```
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BTMI_S1_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    CHARACTER tmiIsStatus
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
```

```
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BTMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(104)
    REAL*4 Longitude(104)
    REAL*4 sunLocalTime(104)
    RECORD /L1BTMI_S1_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BTMI_S1_CALIBRATION/ calibration
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BTMI_S1_CALCOUNTS/ calCounts
    RECORD /L1BTMI_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(2,104)
    REAL*4 satAzimuthAngle(104)
    REAL*4 solarZenAngle(104)
    REAL*4 solarAzimuthAngle(104)
    REAL*4 sunGlintAngle(104)
    REAL*4 Tb(2,104)
    INTEGER*2 RFIFlag(1,104)
END STRUCTURE

STRUCTURE /L1BTMI_SWATHS/
    RECORD /L1BTMI_S1/ S1;
    RECORD /L1BTMI_S2/ S2;
    RECORD /L1BTMI_S3/ S3;
END STRUCTURE
```

5.19 1BVIRS - VIRS Radiance

The VIRS Level-1B Product, 1BVIRS, "VIRS Radiance," is written in HDF. The following sizing parameter is used in describing these formats:

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	261	Number of pixels in each scan.
nchan	5	Number of channels.
nchanvis	2	Number of visible channels.
nchanir	3	Number of channels with infrared.
CCd5	5	calCounts dimension of 5.
CCd2	2	calCounts dimension of 2.
CCd3	3	calCounts dimension of 3.
TCd6	6	tempCounts dimension of 6.
SVBFd	3	SunVectorinBodyFrame dimension.

Figure 312 through Figure 318 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Swath (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

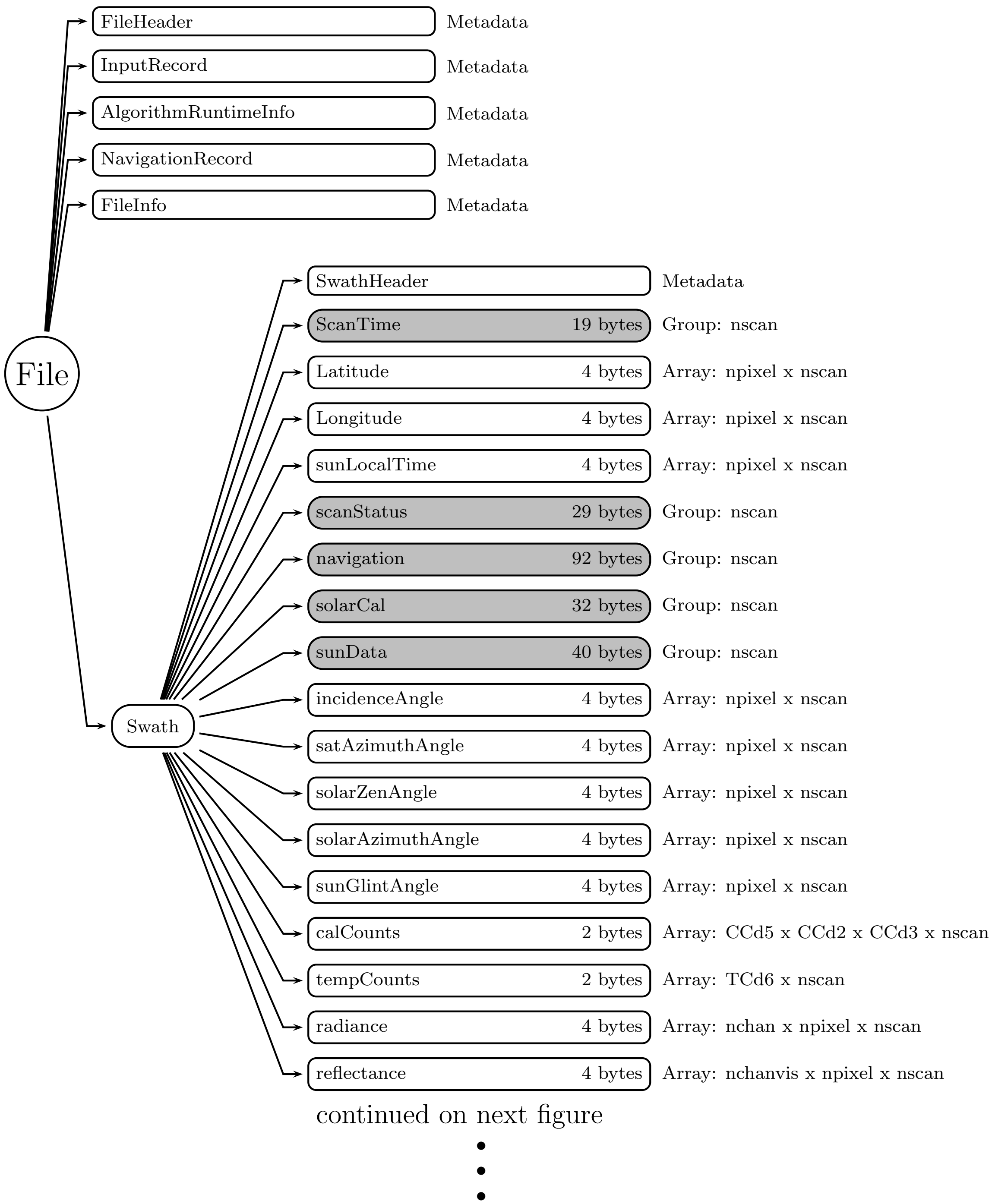


Figure 312: Data Format Structure for 1BVIRS, VIRS Radiance

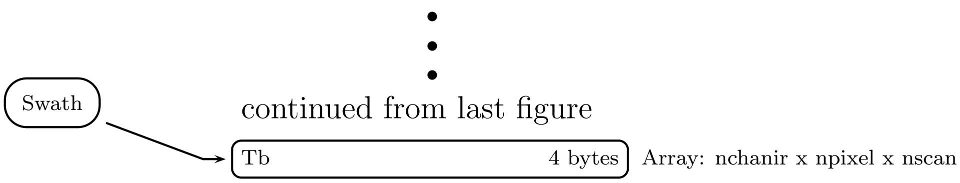


Figure 313: Data Format Structure for 1BVIRS, VIRS Radiance

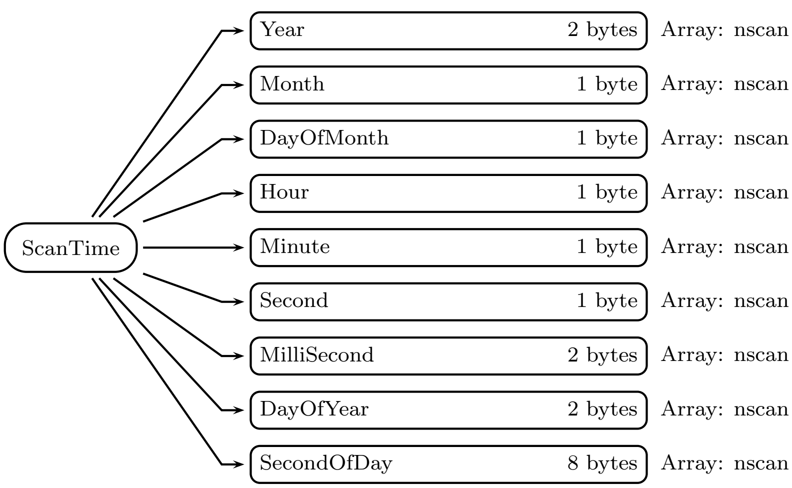


Figure 314: Data Format Structure for 1BVIRS, ScanTime

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):

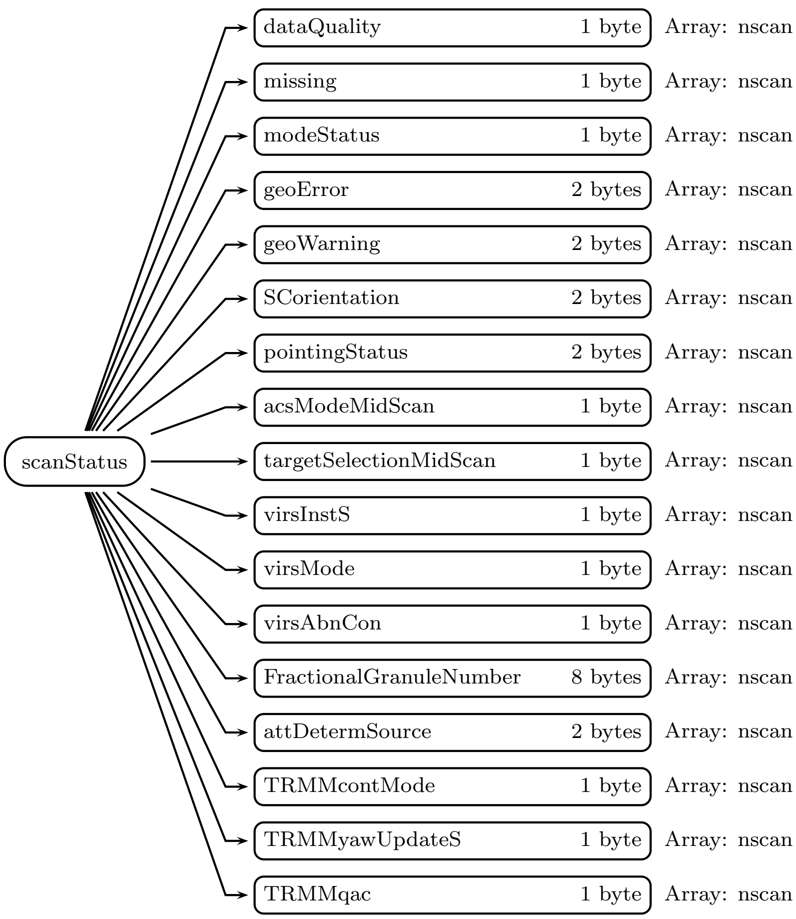


Figure 315: Data Format Structure for 1BVIRS, scanStatus

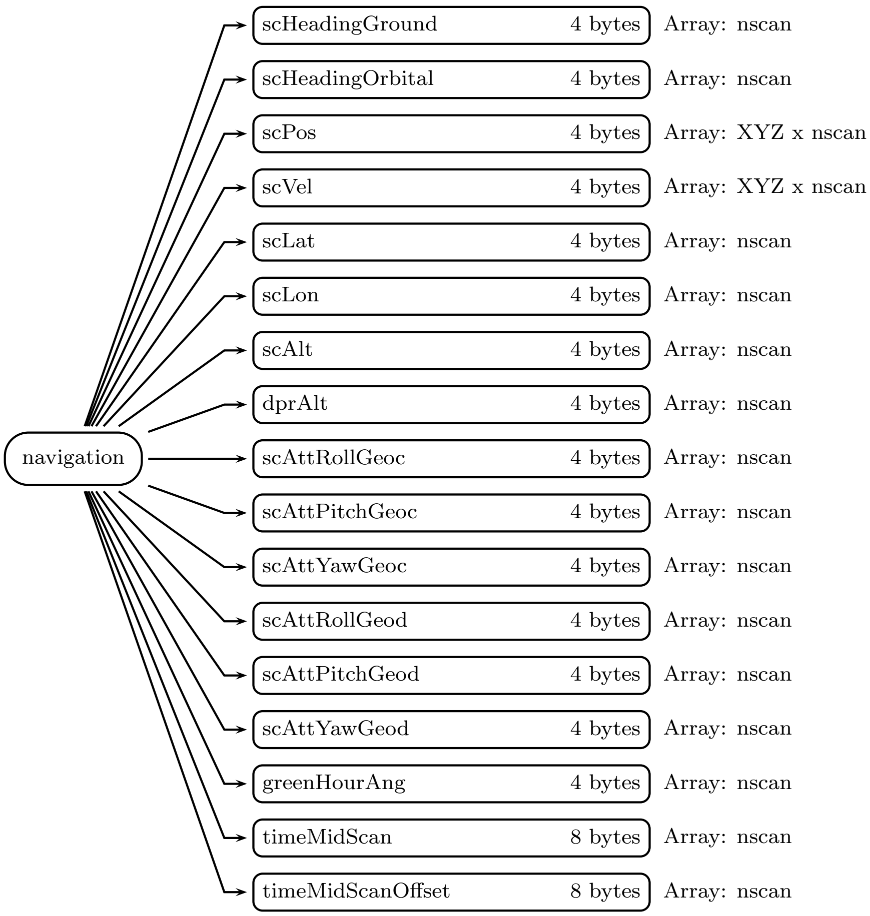


Figure 316: Data Format Structure for 1BVIRS, navigation

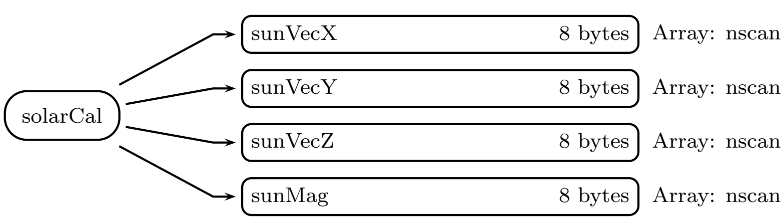


Figure 317: Data Format Structure for 1BVIRS, solarCal

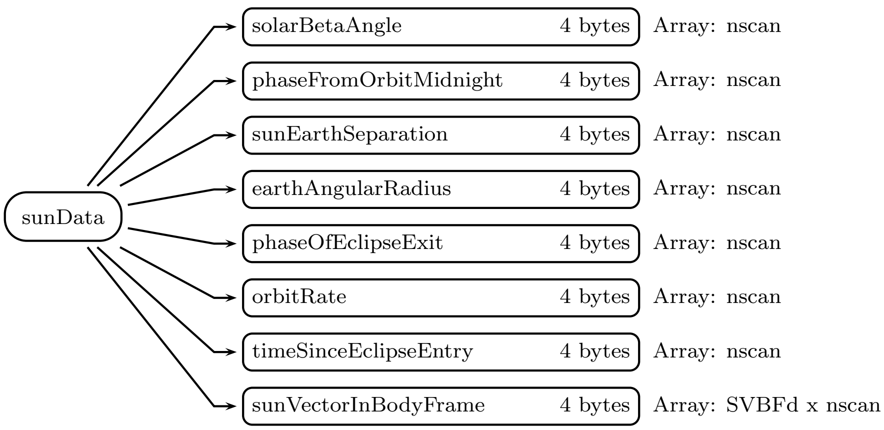


Figure 318: Data Format Structure for 1BVIRS, sunData

Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined

as:
-9999.9 Missing value

scanStatus (Group)

dataQuality (1-byte char, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError indicates bad or missing values
6   modeStatus is not normal
7   QAC errors associated with this scan
```

missing (1-byte char, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte char, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation is not 0 or 180
2   pointingStatus not 0
```

```
3   Spare (always 0)
4   Non-routine instrument status
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8002 Yaw turn in progress
-8003 Deep Space Calibration in progress
-8004 Non-nominal pointing other than above
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0      Nominal ACS mode (4) for mission science
-8000  Non-nominal ACS mode
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Standby
1     Sun Acquire
2     Earth Acquire
3     Yaw Acquire
4     Nominal
5     Yaw Maneuver
6     Delta-H (Thruster)
7     Delta-V (Thruster)
8     CERES Calibration
-99   Unknown -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     Yaw = 0 or maneuver in progress to yaw = 0
1     Yaw = 180 or maneuver in progress to yaw = 180
2     Yaw = 90 or maneuver in progress to yaw = 90
-99   Missing
```

virsInstS (1-byte integer, array size: nscan):

```
Value Meaning
0     Day (no calibration occurring)
1     Night
2     Monitor Scan Stability
3     Day with Calibration
```

virsMode (1-byte integer, array size: nscan):

```
Value Meaning
0     mission mode
1     safehold mode
2     outgas mode
3     activation mode
```

virsAbnCon (1-byte char, array size: nscan):
Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

```
Bit Value Meaning
0   0     normal
    1     scan phase error
1   0     normal
    1     selftest error
2   0     normal
    1     thermal data missing
3   0     normal
    1     moon in space view
4   0     normal
    1     H/K data drop-out suspected
5   0     normal
    1     SV counts for channel 4 or 5 greater than
          L1B01\_MIN\_DNSV
6   0     not used
7   0     not used
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9	Missing value

attDetermSource (2-byte integer, array size: nscan):

```
Attitude determination source.
A flag explaining how the attitude value was calculated.
Improved estimates make use of ground processing of PR
science-instrument-measured roll values, Gyroscope data,
and Sun Sensor 1 data.  Earlier products (TRMM V7 and before)
used the onboard attitudes with various corrections.
Values were determined for each granule based on the data
available and conditions for each orbit.  Flag values follow.

    Value           Meaning
    430 and higher  Best accuracy, good data for this orbit
    421             Reduced accuracy, PR roll data not available
                    (affecting roll/yaw estimates)
    413             Reduced accuracy, sun data not available (affecting pitch)
```

```
411            Reduced accuracy, PR roll and sun sensor not available
300-399        Reduced accuracy due to various special conditions
200-299        Fallback to using the onboard attitude estimates
               with TRMM V7 corrections
-91            Spacecraft in safehold mode, no science data
-99            No data due to telemetry data gap
```

TRMMcontMode (1-byte integer, array size: nscan):

```
The Contingency Mode Flag from telemetry indicates
alternate attitude control of the spacecraft.
The nominal at-launch Attitude Control System (ACS)
for TRMM used Earth horizon sensors for pitch and
roll control, and the yaw was updated twice each orbit
using the Sun Sensors and propagated using gyro data.
However, due to possible problems identified with
the Earth Sensor Assembly (ESA) lifetime on-orbit,
a contingency ACS mode was developed late in the
development cycle.  This mode used the Sun Sensors,
magnetometers, and gyroscope data.  It proved very
valuable when the horizon sensors had problems with
TRMM moving to the higher operating altitude (from
350 to 402.5 km) to extend the mission lifetime.
Thus the contingency mode was used throughout the
post-boost period.  It was also tested early in
the mission on 1998-01-13.

    Value Meaning
    0     Nominal control of spacecraft used in the pre-boost period
    1     Contingency mode control used in the post-boost period
    -99   Missing
```

TRMMyawUpdateS (1-byte integer, array size: nscan):

```
The Yaw Update Status flag in telemetry gives the status
of the Yaw accuracy for the nominal pre-boost Attitude Contral
System (ACS) operation.  The yaw is considered "indeterminate"
in various non-nominal control modes, and after the return
to the nominal Earth pointing (using the Earth sensor
for pitch and roll), the yaw is considered "inaccurate" until
the time when an "update" is done using a Sun sensor (at certain
positions in the orbit).  Before the update "the yaw attitude
```

```
knowledge is acceptable for ACS use, but might not be acceptable
for science use" according to ACS Software User's Guide.

    Value Meaning
    0     Inaccurate
    1     Indeterminate
    2     Accurate
    -99   Missing
```

TRMMqac (1-byte integer, array size: nscan):
The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

navigation (Group)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the

Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

solarCal (Group)

sunVecX (8-byte float, array size: nscan):
Solar Position (X-component) (Geocentric Inertial Coord).

sunVecY (8-byte float, array size: nscan):
Solar Position (Y-component) (Geocentric Inertial Coord).

sunVecZ (8-byte float, array size: nscan):
Solar Position (Z-component) (Geocentric Inertial Coord).

sunMag (8-byte float, array size: nscan):
Sun-Earth Distance (m).

sunData (Group)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special

values are defined as:
-9999.9 Missing value

incidenceAngle (4-byte float, array size: npixel x nscan):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npixel x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarZenAngle (4-byte float, array size: npixel x nscan):
The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npixel x nscan):
The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsiod-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:
-9999.9 Missing value

calCounts (2-byte integer, array size: CCd5 x CCd2 x CCd3 x nscan):
Raw calibration counts are given in four dimensions. The first dimension is the channel number, the second dimension is the data word, the third dimension is blackbody, space view and solar diffuser, in that order, and the fourth dimension is the number of scans.

tempCounts (2-byte integer, array size: TCd6 x nscan):
Temperatures of the black body, primary and redundant, the radiant cooler temperatures, primary and redundant, the mirror temperature, and the electronics module temperature. All quantities have units of counts, and have minimum values of 0, and maximum values of 4095.

radiance (4-byte float, array size: nchan x npixel x nscan):
Scene data for the channels, measured in Radiance ($mW cm^{-2} \mu m^{-1} sr^{-1}$). sr means steradian. The three dimensions are channel, pixel, and scan. The range, accuracy and wavelength for each channel are as follows:

Channel	Minimum	Maximum	Accuracy	Wavelength (micrometers)
1	0	65.5	10%	0.63
2	0	32.7	10%	1.6
3	0	0.111	2%	3.75
4	0	1.371	2%	10.8
5	0	1.15	2%	12.0

reflectance (4-byte float, array size: nchanvis x npixel x nscan):
Scene data for channels 1 and 2, measured in reflectance. The three dimensions are channel, pixel, and scan.

Tb (4-byte float, array size: nchanir x npixel x nscan):
Scene data for channels 3, 4 and 5, measured in brighness temperature (K). The three dimensions are channel, pixel, and scan.

C Structure Header file:

```
#ifndef _TK_1BVIRS_H_
#define _TK_1BVIRS_H_

#ifndef _L1BVIRS_SUNDATA_
#define _L1BVIRS_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BVIRS_SUNDATA;

#endif

#ifndef _L1BVIRS_SOLARCAL_
#define _L1BVIRS_SOLARCAL_

typedef struct {
    double sunVecX;
    double sunVecY;
    double sunVecZ;
    double sunMag;
```

```
} L1BVIRS_SOLARCAL;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1BVIRS_SCANSTATUS_
#define _L1BVIRS_SCANSTATUS_

typedef struct {
    unsigned char dataQuality;
    unsigned char missing;
    unsigned char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char virsInstS;
```

```
    signed char virsMode;
    unsigned char virsAbnCon;
    double FractionalGranuleNumber;
    short attDetermSource;
    signed char TRMMcontMode;
    signed char TRMMyawUpdateS;
    signed char TRMMqac;
} L1BVIRS_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BVIRS_SWATH_
#define _L1BVIRS_SWATH_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[261];
    float Longitude[261];
    float sunLocalTime[261];
    L1BVIRS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L1BVIRS_SOLARCAL solarCal;
    L1BVIRS_SUNDATA sunData;
    float incidenceAngle[261];
    float satAzimuthAngle[261];
    float solarZenAngle[261];
```

```
    float solarAzimuthAngle[261];
    float sunGlintAngle[261];
    short calCounts[3][2][5];
    short tempCounts[6];
    float radiance[261][5];
    float reflectance[261][2];
    float Tb[261][3];
} L1BVIRS_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BVIRS_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BVIRS_SOLARCAL/
    REAL*8 sunVecX
    REAL*8 sunVecY
    REAL*8 sunVecZ
    REAL*8 sunMag
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
```

```
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BVIRS_SCANSTATUS/
    CHARACTER dataQuality
    CHARACTER missing
    CHARACTER modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE virsInstS
    BYTE virsMode
    CHARACTER virsAbnCon
    REAL*8 FractionalGranuleNumber
    INTEGER*2 attDetermSource
    BYTE TRMMcontMode
    BYTE TRMMyawUpdateS
    BYTE TRMMqac
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BVIRS_SWATH/
```

```
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(261)
    REAL*4 Longitude(261)
    REAL*4 sunLocalTime(261)
    RECORD /L1BVIRS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BVIRS_SOLARCAL/ solarCal
    RECORD /L1BVIRS_SUNDATA/ sunData
    REAL*4 incidenceAngle(261)
    REAL*4 satAzimuthAngle(261)
    REAL*4 solarZenAngle(261)
    REAL*4 solarAzimuthAngle(261)
    REAL*4 sunGlintAngle(261)
    INTEGER*2 calCounts(5,2,3)
    INTEGER*2 tempCounts(6)
    REAL*4 radiance(5,261)
    REAL*4 reflectance(2,261)
    REAL*4 Tb(3,261)
END STRUCTURE
```

5.20 1CTMI - GPM Common Calibrated Brightness Temperature

1CTMI contains common calibrated brightness temperatures from the TMI passive microwave instrument flown on the TRMM satellite. There are 3 swaths. Swath S1 has 2 low resolution channels (10V 10H). Swath S2 has 5 low resolution channels (19V 19H 21V 37V 37H). Swath S3 has 2 high resolution channels (85V 85H). Data for all swaths is observed in the same revolution of the instrument.

Earth observations are taken during a segment of the rotation when TMI is looking in the +x direction of the TRMM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and pixels as Swath S1. Swath S3 has the same number of scans but twice as many pixels as Swath S1. Each S1 and S2 scan contains low frequency channels sampled 104 times along the scan. Each S3 scan contains high frequency channels sampled 208 times along the scan. S1 S2 and S3 scans are repeated every 1.9s. Along an S1 scan every other center of an S3 pixel coincides with the center of an S1 pixel.

The Figure below shows the locations of the pixels of scans 1 and 2 for Swath 1 and Swath 3. Each "+" represents centers of pixels from one or more swaths. For example, the label "S1:1,2 S3:1,3" means that both Swath S1, Scan 1, Pixel 2 and Swath S3, Scan 1, Pixel 3 are located at the "+".

```
S1:1,1 S3:1,1    S3:1,2   S1:1,2 S3:1,3         S1:1,104 S3:1,207  S3:1,208
      +              +              +      .......      +              +




S1:2,1 S3:2,1    S3:2,2   S1:2,2 S3:2,3         S1:2,104 S3:2,207  S3:2,208
      +              +              +      .......      +              +
```

Dimension definitions:

nscan1	var	Number of Swath S1 scans in the granule.
nchannel1	2	Number of Swath S1 channels (10V 10H).
npixel1	104	Number of Swath S1 pixels in one scan.
nchUIA1	2	Number of Swath S1 unique incidence angles.
nscan2	var	Number of Swath S3 scans in the granule.
nchannel2	5	Number of Swath S2 channels (19V 19H 21V 37V 37H).
npixel2	104	Number of Swath S2 pixels in one scan.
nchUIA2	1	Number of Swath S2 unique incidence angles.
nscan3	var	Number of Swath S3 scans in the granule.
nchannel3	2	Number of Swath S3 channels (85V 85H).
npixel3	208	Number of Swath S3 pixels in one scan.
nchUIA3	1	Number of Swath S3 unique incidence angles.

Figure 319 through Figure 328 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

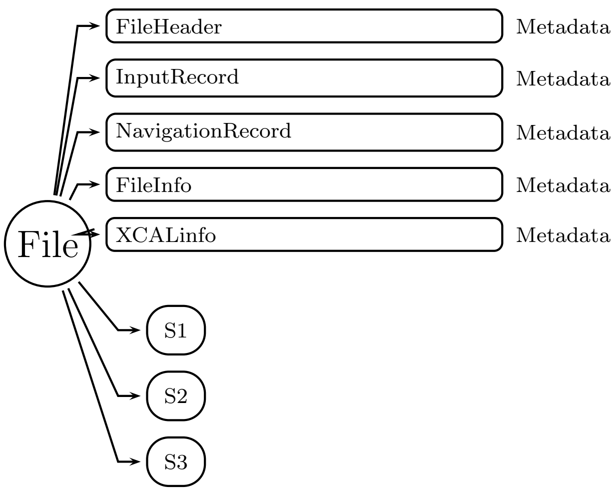


Figure 319: Data Format Structure for 1CTMI, GPM Common Calibrated Brightness Temperature

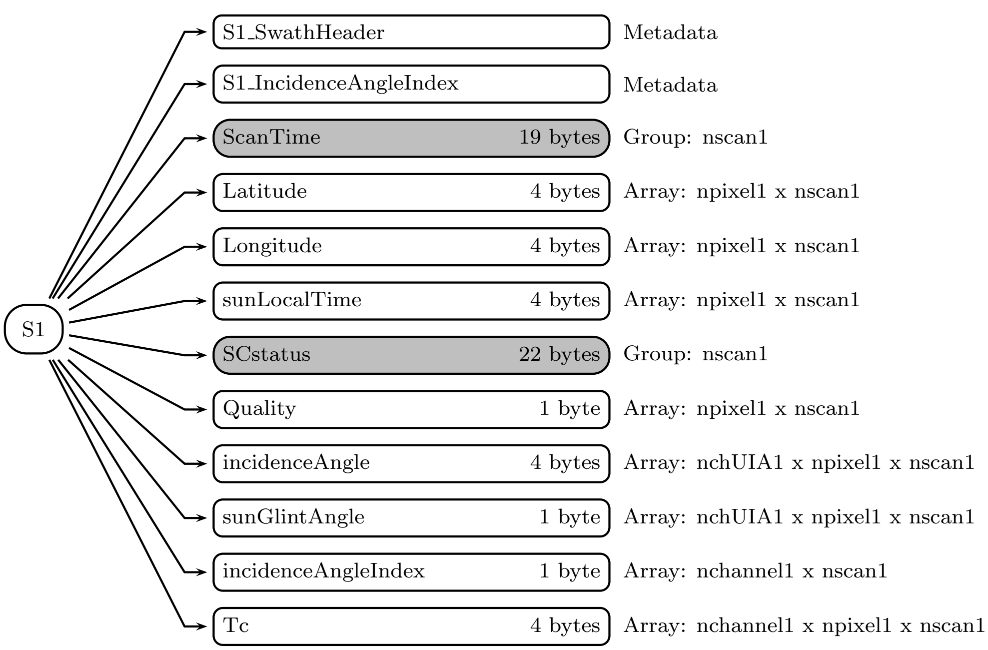


Figure 320: Data Format Structure for 1CTMI, S1

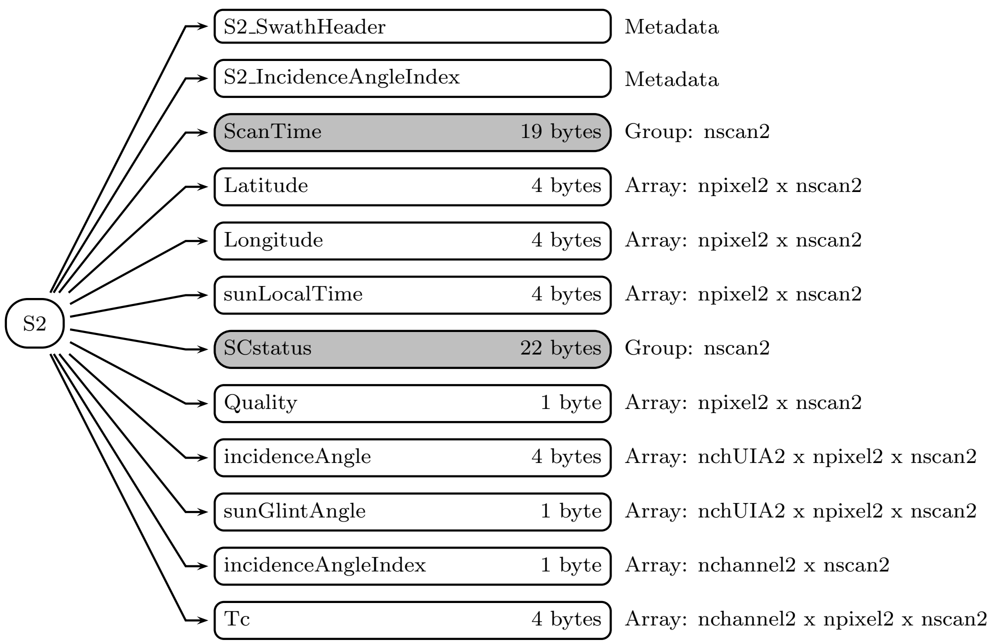


Figure 321: Data Format Structure for 1CTMI, S2

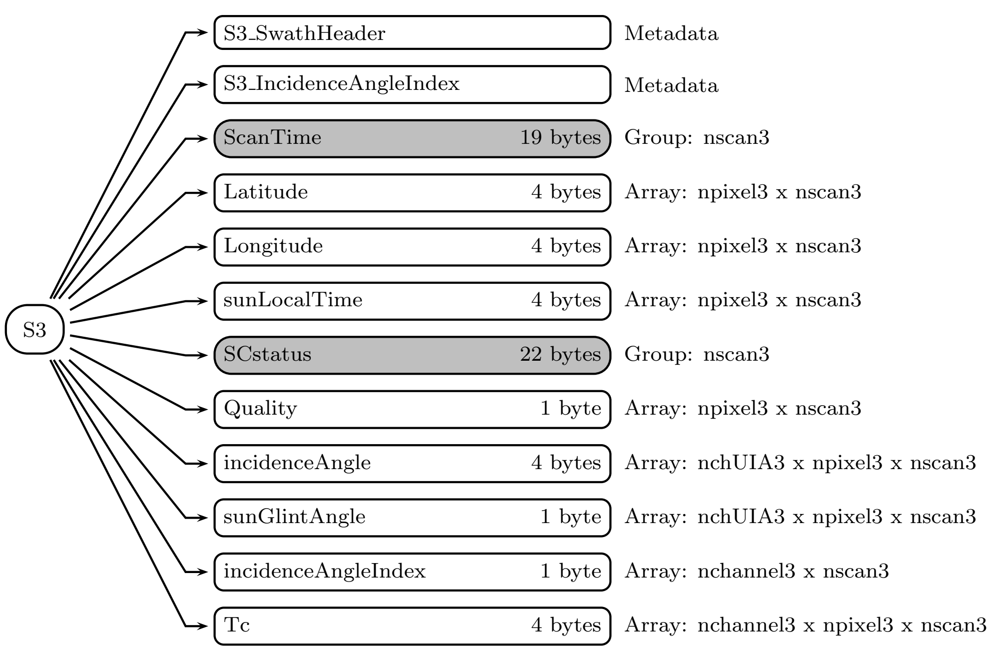


Figure 322: Data Format Structure for 1CTMI, S3

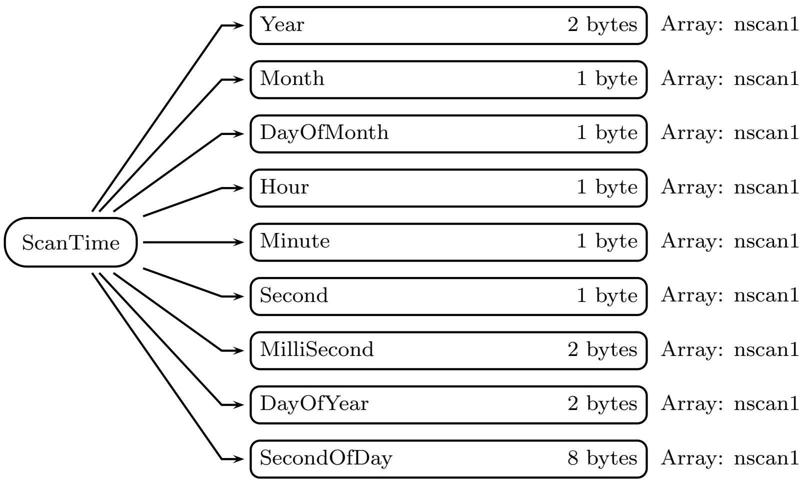


Figure 323: Data Format Structure for 1CTMI, S1, ScanTime

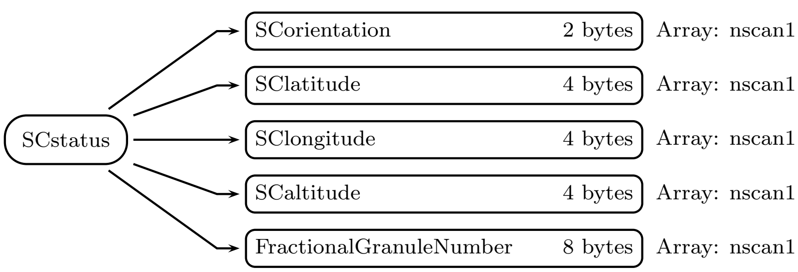


Figure 324: Data Format Structure for 1CTMI, S1, SCstatus

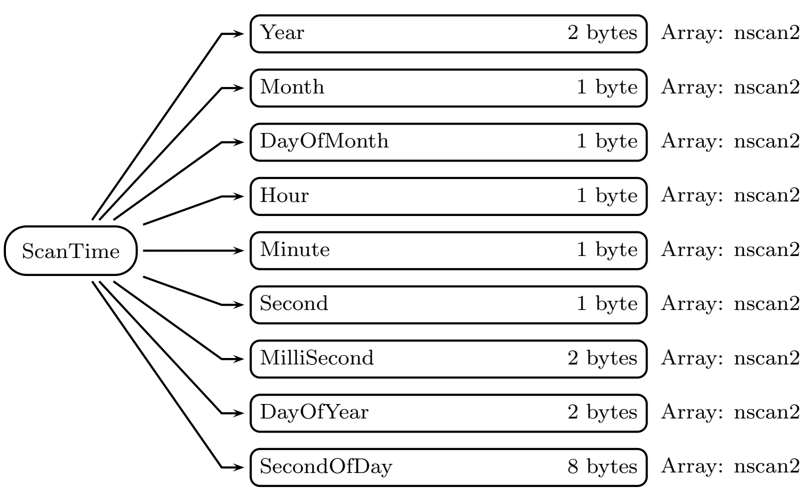


Figure 325: Data Format Structure for 1CTMI, S2, ScanTime

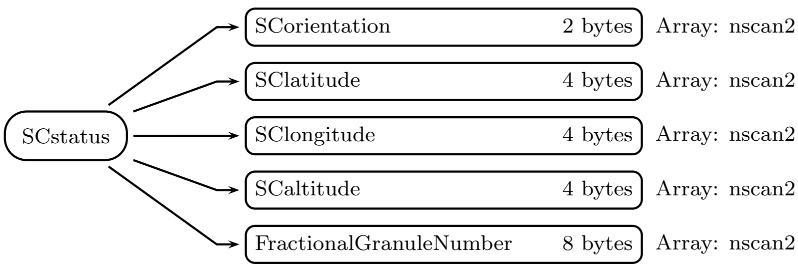


Figure 326: Data Format Structure for 1CTMI, S2, SCstatus

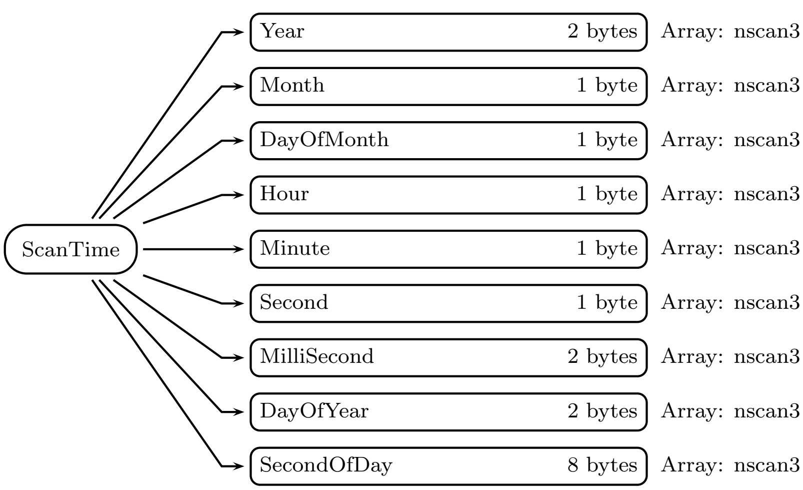


Figure 327: Data Format Structure for 1CTMI, S3, ScanTime

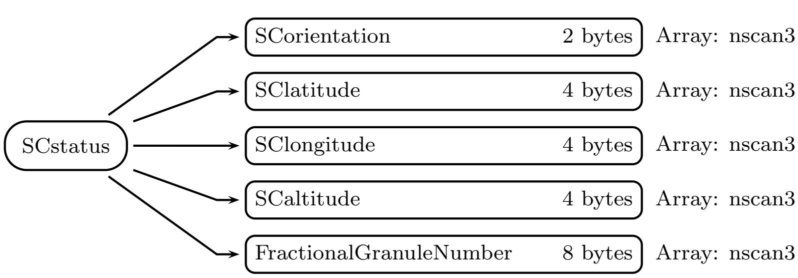


Figure 328: Data Format Structure for 1CTMI, S3, SCstatus

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)

  -100  =     Quality and Accounting Capsule errors this scan
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):

```
GPM Common Calibrated Brightness Temperature. The channels are:
```

```
10.65 GHz vertically-polarized TBs
10.65  GHz horizontally-polarized TBs
```

Values range from 0 to 10000 K. Special values are defined as:
-9999.9 Missing value

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
      -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

```
-100  =     Quality and Accounting Capsule errors this scan
```

incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):

```
GPM Common Calibrated Brightness Temperature. The channels are:
19.35  GHz vertically-polarized   TBs
19.35  GHz horizontally-polarized TBs
21.3  GHz vertically-polarized   TBs
37.0   GHz vertically-polarized   TBs
37.0   GHz horizontally-polarized TBs
```

Values range from 0 to 10000 K. Special values are defined as:
-9999.9 Missing value

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S3_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S3)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel3 x nscan3):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel3 x nscan3):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel3 x nscan3):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan3):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel3 x nscan3):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
           1-99 = Generic flags (all sensors)
        100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
        -(1-98) = Generic flags (all sensors)
            -99 = Missing value (no quality information available)
      -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
```

```
  -10  =  Distance to its corresponding LF pixel exceeds 7Km
          threshold.   used in L1C-R product only
  -99  =        Missing value (no quality information available)

 -100  =     Quality and Accounting Capsule errors this scan
```

incidenceAngle (4-byte float, array size: nchUIA3 x npixel3 x nscan3):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA3 x npixel3 x nscan3):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3):

```
GPM Common Calibrated Brightness Temperature. The channels are:
85.5  GHz vertically-polarized   TBs
85.5  GHz horizontally-polarized TBs
```

Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_1CTMI_H_
#define _TK_1CTMI_H_

#ifndef _L1CTMI_S3_
#define _L1CTMI_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    float sunLocalTime[208];
    SCSTATUS SCstatus;
    signed char Quality[208];
    float incidenceAngle[208][1];
    signed char sunGlintAngle[208][1];
    signed char incidenceAngleIndex[2];
    float Tc[208][2];
} L1CTMI_S3;

#endif

#ifndef _L1CTMI_S2_
#define _L1CTMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[104];
    float Longitude[104];
    float sunLocalTime[104];
```

```
    SCSTATUS SCstatus;
    signed char Quality[104];
    float incidenceAngle[104][1];
    signed char sunGlintAngle[104][1];
    signed char incidenceAngleIndex[5];
    float Tc[104][5];
} L1CTMI_S2;

#endif

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CTMI_S1_
#define _L1CTMI_S1_
```

```
typedef struct {
    SCANTIME ScanTime;
    float Latitude[104];
    float Longitude[104];
    float sunLocalTime[104];
    SCSTATUS SCstatus;
    signed char Quality[104];
    float incidenceAngle[104][2];
    signed char sunGlintAngle[104][2];
    signed char incidenceAngleIndex[2];
    float Tc[104][2];
} L1CTMI_S1;

#endif

#ifndef _L1CTMI_SWATHS_
#define _L1CTMI_SWATHS_

typedef struct {
    L1CTMI_S1 S1;
    L1CTMI_S2 S2;
    L1CTMI_S3 S3;
} L1CTMI_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CTMI_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    REAL*4 sunLocalTime(208)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(208)
    REAL*4 incidenceAngle(1,208)
    BYTE sunGlintAngle(1,208)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,208)
END STRUCTURE
```

```
STRUCTURE /L1CTMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(104)
    REAL*4 Longitude(104)
    REAL*4 sunLocalTime(104)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(104)
    REAL*4 incidenceAngle(1,104)
    BYTE sunGlintAngle(1,104)
    BYTE incidenceAngleIndex(5)
    REAL*4 Tc(5,104)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CTMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(104)
    REAL*4 Longitude(104)
    REAL*4 sunLocalTime(104)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(104)
    REAL*4 incidenceAngle(2,104)
    BYTE sunGlintAngle(2,104)
    BYTE incidenceAngleIndex(2)
```

```
    REAL*4 Tc(2,104)
END STRUCTURE

STRUCTURE /L1CTMI_SWATHS/
    RECORD /L1CTMI_S1/ S1;
    RECORD /L1CTMI_S2/ S2;
    RECORD /L1CTMI_S3/ S3;
END STRUCTURE
```

5.21 1CGMI - GPM Common Calibrated Brightness Temperature

1CGMI contains common calibrated brightness temperatures from the GMI passive microwave instrument flown on the GPM satellite. 1C-R GMI is a remapped version of 1CGMI which is explained at the end of this section. Both 1CGMI and 1C-R GMI have the same format. Swath S1 has 9 channels which are similar to TRMM TMI (10V 10H 19V 19H 23V 37V 37H 89V 89H). Swath S2 has 4 channels similar to AMSU-B (166V 166H 183+/-3V 183+/-7V). Data for both swaths is observed in the same revolution of the instrument.

Earth observations are taken during a segment of the rotation when GMI is looking in the +x direction of the GPM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

32rpm * 1min/60s * 5538s/orbit = 2954 scans / orbit.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and the same number of pixels as Swath S1. Each S1 scan contains 9 channels sampled 221 times along the scan. Each S2 scan contains 4 channels sampled 221 times along the scan. Since the incidence angle of Swath S1 is different than Swath S2, the geolocations of the pixel centers are different.

1C-R GMI is a remapped version of 1CGMI. 1C-R is the input for Gprof. The 1C-R Swath S1 is the same as the 1C Swath S1. However, the 1C-R Swath S2 consists of pixels selected from 1C Swath S2 to be as close as possible to the S1 pixels. The 1C-R S2 pixels will often be observed at a different scantime and sometimes from a different granule than the corresponding S1 pixel. Since 1C S2 is narrower than 1C S1, 1C-R S2 has missing pixels on both edges of the swath.

Dimension definitions:

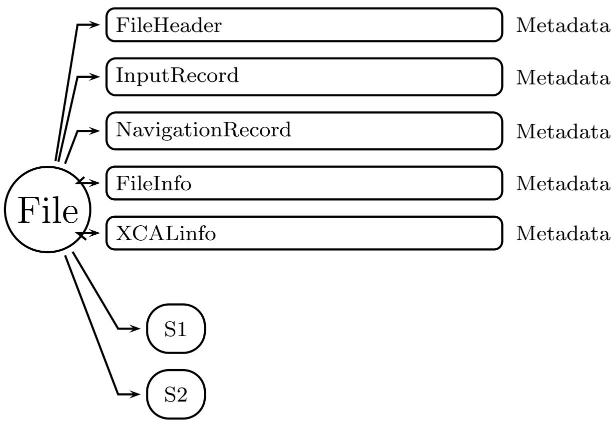


Figure 329: Data Format Structure for 1CGMI, GPM Common Calibrated Brightness Temperature

nscan1	var	Typical number of Swath S1 scans in the granule.
nchannel1	9	Number of Swath S1 channels (10V 10H 19V 19H 23V 37V 37H 89V 89H).
npixel1	221	Number of Swath S1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nscan2	var	Typical number of Swath S2 scans in the granule.
nchannel2	4	Number of Swath S2 channels (165V 165H 183+/-3V 183+/-7V).
npixel2	221	Number of Swath S2 pixels in one scan.
nchUIA2	1	Number of Swath S2 unique incidence angles.

Figure 329 through Figure 335 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM

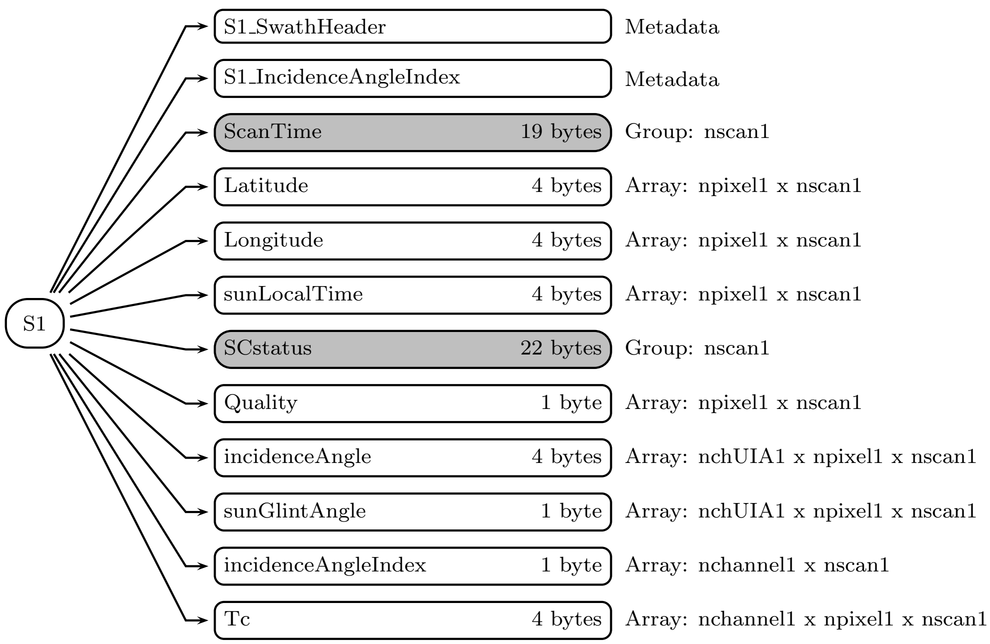


Figure 330: Data Format Structure for 1CGMI, S1

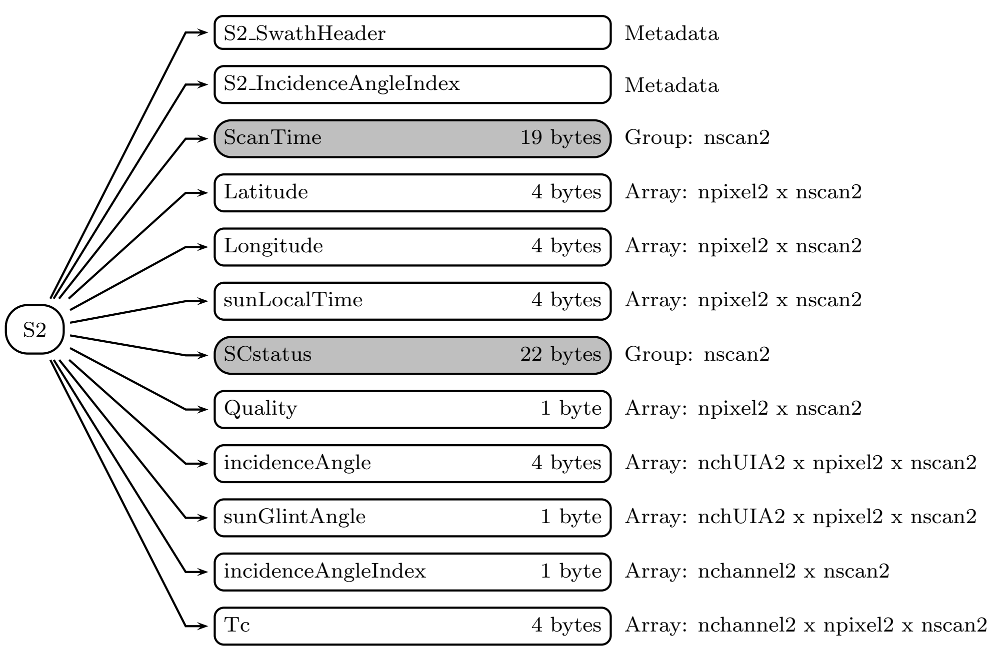


Figure 331: Data Format Structure for 1CGMI, S2

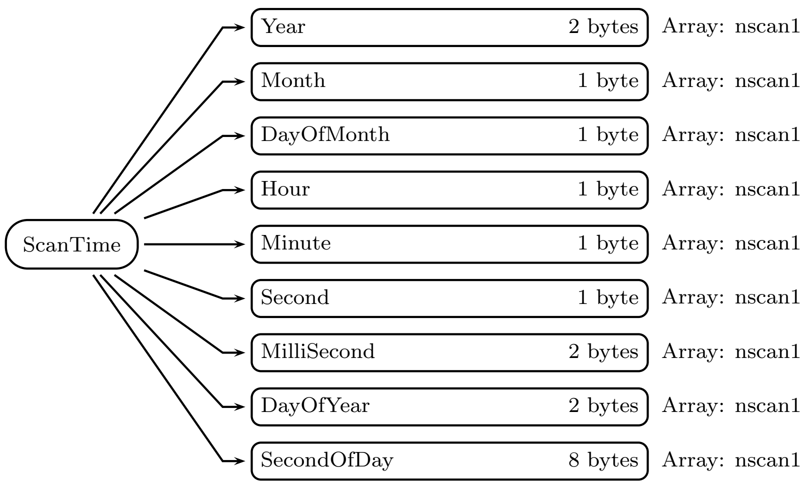


Figure 332: Data Format Structure for 1CGMI, S1, ScanTime

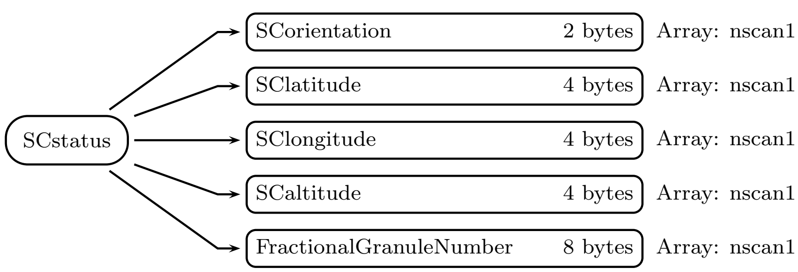


Figure 333: Data Format Structure for 1CGMI, S1, SCstatus

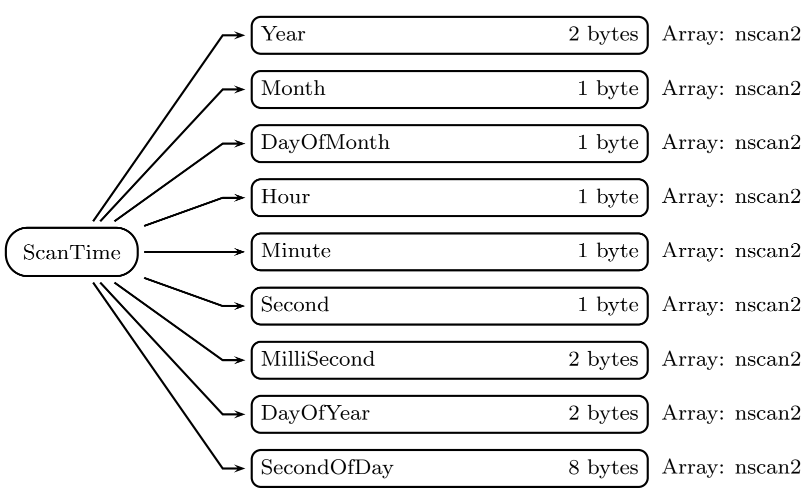


Figure 334: Data Format Structure for 1CGMI, S2, ScanTime

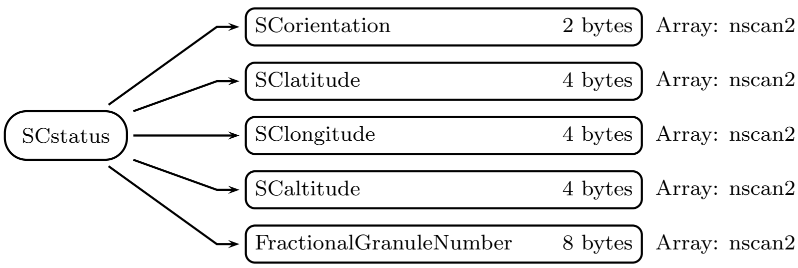


Figure 335: Data Format Structure for 1CGMI, S2, SCstatus

Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

 100 = Scan blanking on

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
```

```
 -6  =  Lat/Lon values are out of range
 -7  =  Non-normal status modes
-10  =  Distance to its corresponding LF pixel exceeds 7Km
        threshold.   used in L1C-R product only
-99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):

```
GPM Common Calibrated Brightness Temperature.
The channels are:

10.65  GHz vertically-polarized   TBs
10.65  GHz horizontally-polarized TBs
18.7  GHz vertically-polarized   TBs
18.7  GHz horizontally-polarized TBs
23.8  GHz vertically-polarized   TBs
36.64  GHz vertically-polarized   TBs
36.64  GHz horizontally-polarized TBs
89.0  GHz vertically-polarized   TBs
89.0  GHz horizontally-polarized TBs
```

Values range from 0 to 10000 K. Special values are defined as:
-9999.9 Missing value

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion
```

```
 100 = Scan blanking on

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)
```

```
The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):

```
GPM Common Calibrated Brightness Temperature.
The channels are:

166.0  GHz vertically-polarized        TBs
166.0  GHz horizontally-polarized      TBs
183.31+/-3  GHz vertically-polarized   TBs
183.31+/-7  GHz vertically-polarized   TBs
```

Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_1CGMI_H_
#define _TK_1CGMI_H_

#ifndef _L1CGMI_S2_
#define _L1CGMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    SCSTATUS SCstatus;
    signed char Quality[221];
    float incidenceAngle[221][1];
    signed char sunGlintAngle[221][1];
    signed char incidenceAngleIndex[4];
```

```
    float Tc[221][4];
} L1CGMI_S2;

#endif

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CGMI_S1_
#define _L1CGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
```

```
    SCSTATUS SCstatus;
    signed char Quality[221];
    float incidenceAngle[221][1];
    signed char sunGlintAngle[221][1];
    signed char incidenceAngleIndex[9];
    float Tc[221][9];
} L1CGMI_S1;

#endif

#ifndef _L1CGMI_SWATHS_
#define _L1CGMI_SWATHS_

typedef struct {
    L1CGMI_S1 S1;
    L1CGMI_S2 S2;
} L1CGMI_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CGMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(221)
    REAL*4 incidenceAngle(1,221)
    BYTE sunGlintAngle(1,221)
    BYTE incidenceAngleIndex(4)
    REAL*4 Tc(4,221)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
```

```
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(221)
    REAL*4 incidenceAngle(1,221)
    BYTE sunGlintAngle(1,221)
    BYTE incidenceAngleIndex(9)
    REAL*4 Tc(9,221)
END STRUCTURE

STRUCTURE /L1CGMI_SWATHS/
    RECORD /L1CGMI_S1/ S1;
    RECORD /L1CGMI_S2/ S2;
END STRUCTURE
```

5.22 1CSSMI - Common Calibrated Brightness Temperature

1CSSMI contains common calibrated brightness temperature from the SSM/I passive microwave instruments flown on the DMSP satellites. Swath S1 has 5 low frequency channels (19V 19H 22V 37V 37H). Swath S2 has 2 high frequency channels (85V 85H).

Earth observations for both swaths are taken during a 102.4^o segment of the instrument rotation when SSM/I is looking in the aft direction from satellite F8 or the foreward direction from satellites F10 - F15. We define the spacecraft vector (v) at the center of this segment. "v" is used in the definition of the variable SCorientation.

RELATION BETWEEN THE SWATHS: Each S1 scan contains low frequency channels sampled 64 times along the scan. Each S2 scan contains high frequency channels sampled 128 times along the scan. Swath S2 has exactly twice as many scans as Swath S1. S1 scans 1, 2, 3, ... coincide with S2 scans 1, 3, 5, ... S1 scans are repeated every 3.8s; S2 scans are repeated every 1.9s. Along an S1 scan every other center of an S2 sample coincides with the center of an S1 sample.

The Figure below shows the locations of the samples of Swath S1 scan 1 and Swath S2 scans 1 and 2. Each "+" represents centers of samples from one or both swaths. For example, the label "S1:1,2 S2:1,3" means that both Swath S1, scan 1, sample 2, and Swath S2, scan 1, sample 3 are located at the "+".

```
S1:1,1 S2:1,1    S2:1,2   S1:1,2 S2:1,3         S1:1,64 S2:1,127   S2:1,128
      +             +            +       .......       +              +

   S2:2,1        S2:2,2       S2:2,3                 S2:2,127      S2:2,128
      +             +            +       .......       +              +
```

KNOWN PROBLEMS OR ISSUES WITH DATA:

1. F15 data: On August 14, 2006 two radar calibration (i.e. RADCAL) beacons operating at 150 and 400 MHz were activated on board the DMSP F15 spacecraft. These beacons were found to interfere with the 22.235 GHz vertically polarized channel and the 85.5 GHz horizontally polarized channel on the SSM/I sensor. The interference to these two channels was found to vary across the scan, but it appears to very stable and correctable. A correction to the Level 1C brightness temperatures was implemented based on a comparison of mean brightness temperatures over a four month period (Sep-Dec, 2006) with data from Sep-Dec 2005. The correction to the 22V channel varies between 5 and 13 K while the correction to the 85.5H varies from 0.5 to 1.0 K. Rainfall estimates from the corrected brightness temperatures appear very consistent with those from F13 and F14, however, caution is warranted in using the RADCAL corrected data. For additional updated information on this issue please refer to the Level 1C web site (http://mrain.atmos.colostate.edu/LEVEL1C).

Dimension definitions:

nscan1	var	Number of Swath S1 scans in the granule.
nchannel1	5	Number of Swath S1 channels (19V 19H 22V 37V 37H).
npixel1	64	Number of Swath S1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nscan2	var	Number of Swath S2 scans in the granule.
nchannel2	2	Number of Swath S2 channels (85V 85H).
npixel2	128	Number of Swath S2 pixels in one scan.
nchUIA2	1	Number of Swath S2 unique incidence angles.

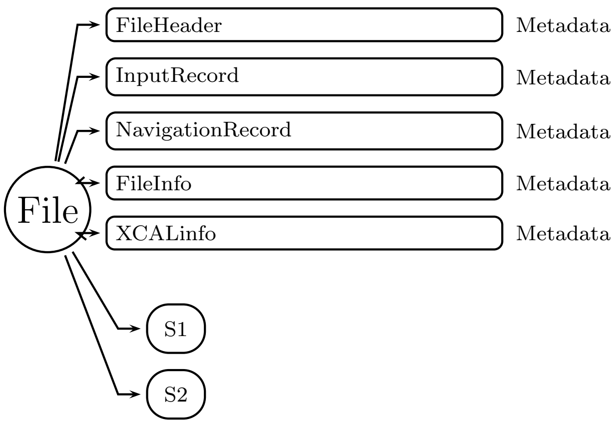


Figure 336: Data Format Structure for 1CSSMI, Common Calibrated Brightness Temperature

Figure 336 through Figure 342 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

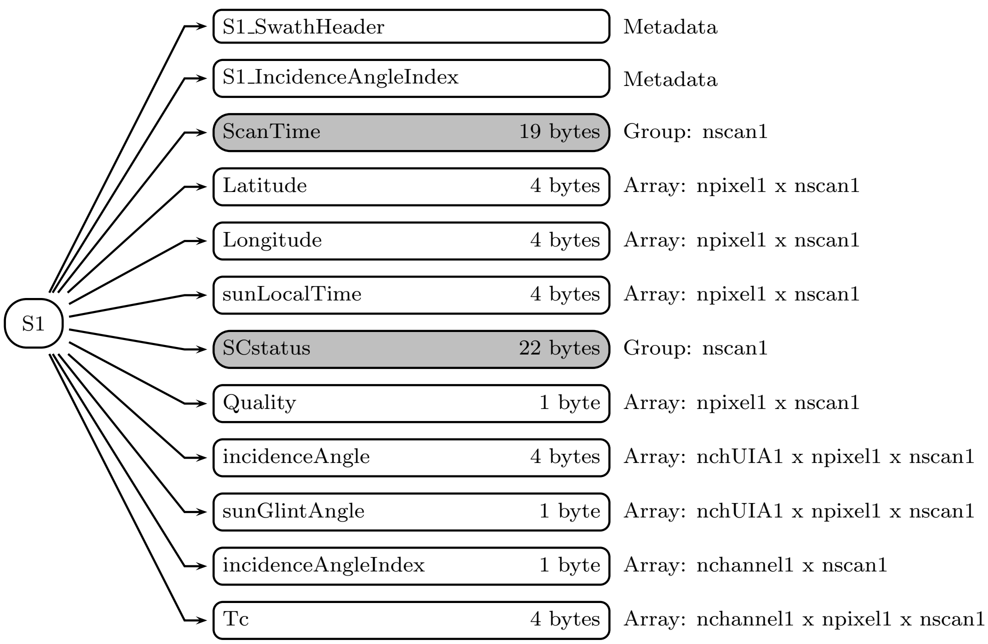


Figure 337: Data Format Structure for 1CSSMI, S1

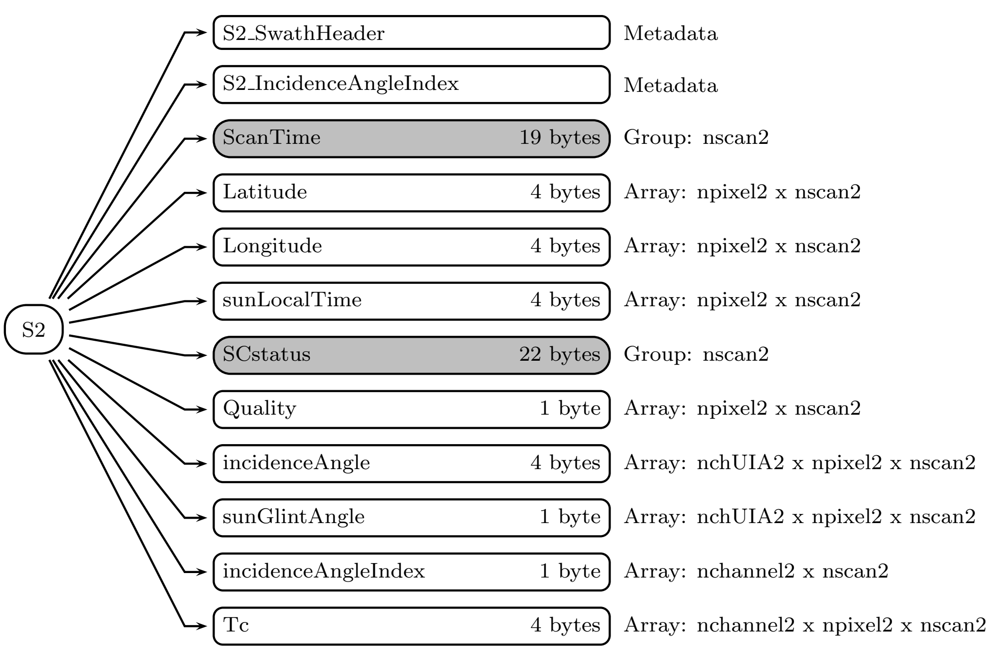


Figure 338: Data Format Structure for 1CSSMI, S2

ScanTime		
Year	2 bytes	Array: nscan1
Month	1 byte	Array: nscan1
DayOfMonth	1 byte	Array: nscan1
Hour	1 byte	Array: nscan1
Minute	1 byte	Array: nscan1
Second	1 byte	Array: nscan1
MilliSecond	2 bytes	Array: nscan1
DayOfYear	2 bytes	Array: nscan1
SecondOfDay	8 bytes	Array: nscan1

Figure 339: Data Format Structure for 1CSSMI, S1, ScanTime

SCstatus		
SCorientation	2 bytes	Array: nscan1
SClatitude	4 bytes	Array: nscan1
SClongitude	4 bytes	Array: nscan1
SCaltitude	4 bytes	Array: nscan1
FractionalGranuleNumber	8 bytes	Array: nscan1

Figure 340: Data Format Structure for 1CSSMI, S1, SCstatus

ScanTime		
Year	2 bytes	Array: nscan2
Month	1 byte	Array: nscan2
DayOfMonth	1 byte	Array: nscan2
Hour	1 byte	Array: nscan2
Minute	1 byte	Array: nscan2
Second	1 byte	Array: nscan2
MilliSecond	2 bytes	Array: nscan2
DayOfYear	2 bytes	Array: nscan2
SecondOfDay	8 bytes	Array: nscan2

Figure 341: Data Format Structure for 1CSSMI, S2, ScanTime

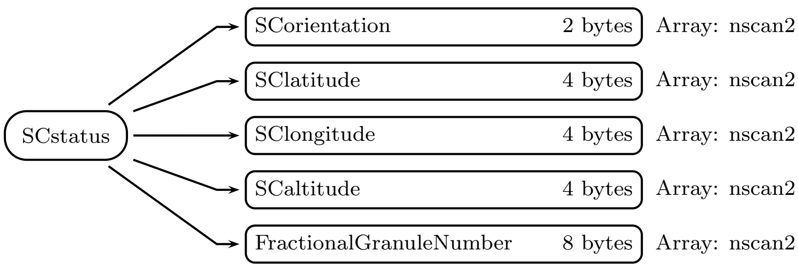


Figure 342: Data Format Structure for 1CSSMI, S2, SCstatus

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

   102  =   Climatology check warning (19V Channel)
   103  =   Climatology check warning (19H Channel)
   104  =   Climatology check warning (22V Channel)
   105  =   Climatology check warning (37V Channel)
   106  =   Climatology check warning (37H Channel)
   107  =   Climatology check warning (19V Channel)
   108  =   Climatology check warning (19V Channel)
   109  =   Climatology check warning (Multiple low-res channels)
   110  =   Climatology check warning (Multiple high-res channels)
   111  =   Warning adjacent/cross-pol pixel flagged as bad
   112  =   Warning of increased noise in 85V channel on DMSP F08
   113  =   RADCAL correction applied to Tb22v (do not use for climate)
   114  =   Ta correction made by eliminating spikes in scan cal data
```

```
    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)

  -102  =     Climatology check flagged in input BASE file
  -103  =     Climatology check failed (19V Channel)
  -104  =     Climatology check failed (19H Channel)
  -105  =     Climatology check failed (22V Channel)
  -106  =     Climatology check failed (37V Channel)
  -107  =     Climatology check failed (37H Channel)
  -108  =     Climatology check failed (85V Channel)
  -109  =     Climatology check failed (85H Channel)
  -110  =     Climatology check failed (Multiple low-res channels)
  -111  =     Climatology check failed (Multiple high-res channels)
  -112  =     Distance between pixels is nonphysical
  -115  =     Failure of 85V channel on DMSP F08
  -116  =     Failure of 85V and increased noise in 85H on DMSP F08
  -117  =     Failure of both 85V and 85H channels on DMSP F08
  -118  =     Invalid scan time
  -119  =     Ta set to missing due to bad cal data
  -120  =     All data set to missing
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
```

```
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
19.35  GHz vertically-polarized   TBs
19.35  GHz horizontally-polarized TBs
22.235 GHz vertically-polarized   TBs
37.0   GHz vertically-polarized   TBs
37.0   GHz horizontally-polarized TBs
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

   102  =   Climatology check warning (19V Channel)
   103  =   Climatology check warning (19H Channel)
   104  =   Climatology check warning (22V Channel)
   105  =   Climatology check warning (37V Channel)
   106  =   Climatology check warning (37H Channel)
   107  =   Climatology check warning (19V Channel)
   108  =   Climatology check warning (19V Channel)
   109  =   Climatology check warning (Multiple low-res channels)
   110  =   Climatology check warning (Multiple high-res channels)
   111  =   Warning adjacent/cross-pol pixel flagged as bad
   112  =   Warning of increased noise in 85V channel on DMSP F08
   113  =   RADCAL correction applied to Tb22v (do not use for climate)
   114  =   Ta correction made by eliminating spikes in scan cal data

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)

  -102  =     Climatology check flagged in input BASE file
```

```
-103  =     Climatology check failed (19V Channel)
-104  =     Climatology check failed (19H Channel)
-105  =     Climatology check failed (22V Channel)
-106  =     Climatology check failed (37V Channel)
-107  =     Climatology check failed (37H Channel)
-108  =     Climatology check failed (85V Channel)
-109  =     Climatology check failed (85H Channel)
-110  =     Climatology check failed (Multiple low-res channels)
-111  =     Climatology check failed (Multiple high-res channels)
-112  =     Distance between pixels is nonphysical
-115  =     Failure of 85V channel on DMSP F08
-116  =     Failure of 85V and increased noise in 85H on DMSP F08
-117  =     Failure of both 85V and 85H channels on DMSP F08
-118  =     Invalid scan time
-119  =     Ta set to missing due to bad cal data
-120  =     All data set to missing
```

incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
```

```
        ia = incidenceAngle(i,pixel,scan)
        sga = sunGlintAngle(i,pixel,scan)

      The incidenceAngleIndex is the same for every scan,
      but is repeated each scan for the convenience of users
      reading the data scan by scan.  In addition,
      incidenceAngleIndex is located in metadata for the
      convenience of users wishing to read this information
      from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):
GPM Common Calibrated Brightness Temperature. The channels are:

```
85.5 GHz vertically-polarized TBs
85.5 GHz horizontally-polarized TBs
```

C Structure Header file:

```
#ifndef _TK_1CSSMI_H_
#define _TK_1CSSMI_H_

#ifndef _L1CSSMI_S2_
#define _L1CSSMI_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[128];
    float Longitude[128];
    float sunLocalTime[128];
    SCSTATUS SCstatus;
    signed char Quality[128];
    float incidenceAngle[128][1];
    signed char sunGlintAngle[128][1];
    signed char incidenceAngleIndex[2];
    float Tc[128][2];
} L1CSSMI_S2;

#endif
```

```
#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CSSMI_S1_
#define _L1CSSMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[64];
    float Longitude[64];
    float sunLocalTime[64];
    SCSTATUS SCstatus;
    signed char Quality[64];
    float incidenceAngle[64][1];
    signed char sunGlintAngle[64][1];
    signed char incidenceAngleIndex[5];
```

```
    float Tc[64][5];
} L1CSSMI_S1;

#endif

#ifndef _L1CSSMI_SWATHS_
#define _L1CSSMI_SWATHS_

typedef struct {
    L1CSSMI_S1 S1;
    L1CSSMI_S2 S2[2];
} L1CSSMI_SWATHS;

#endif

#endif

NOTE:  S2[0] contains A-scan data
   and S2[1] contains B-scan data.
```

Fortran Structure Header file:

```
STRUCTURE /L1CSSMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(128)
    REAL*4 Longitude(128)
    REAL*4 sunLocalTime(128)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(128)
    REAL*4 incidenceAngle(1,128)
    BYTE sunGlintAngle(1,128)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,128)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE
```

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CSSMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(64)
    REAL*4 Longitude(64)
    REAL*4 sunLocalTime(64)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(64)
    REAL*4 incidenceAngle(1,64)
    BYTE sunGlintAngle(1,64)
    BYTE incidenceAngleIndex(5)
    REAL*4 Tc(5,64)
END STRUCTURE

STRUCTURE /L1CSSMI_SWATHS/
    RECORD /L1CSSMI_S1/ S1;
    RECORD /L1CSSMI_S2/ S2(2);
END STRUCTURE


NOTE:  S2(1) contains A-scan data
   and S2(2) contains B-scan data.
```

5.23 1CSSMIS - Common Calibrated Brightness Temperature

1CSSMIS contains common calibrated brightness temperature from the SSMIS passive microwave instruments flown on the DMSP satellites. Swath S1 has 3 low frequency channels (19V 19H 22V). Swath S2 has 2 low frequency channels (37V 37H). Swath S3 has 4 high frequency channels (150H 183+/-1H 183+/-3H 183+/-7H). S4 has 2 high frequency channels (91V 91H). All the above frequencies are in GHz.

Earth observations for all four swaths are taken during a 144^o segment of the instrument rotation when SSMIS scans in the direction of foreward satellite motion. We define the spacecraft vector (v) at the center of this segment. "v" is used in the definition of the variable SCorientation.

RELATION BETWEEN THE SWATHS: Each S1 and S2 scan contains low frequency channels sampled 90 times along the scan. Each S3 and S4 scan contains high frequency channels sampled 180 times along the scan. All four swaths have exactly the same number of scans. All four swaths repeat scans every 1.9s. The earth positions of S1 are very close to those of S2. The earth positions of S3 are very close to those of S4. The earth positions of S1 and S2 alternate with those of S3 and S4 along the satellite track. The positions of the S1 and S2 pixels do not match the positions of the S3 and S4 pixels.

The Figure below shows the locations of the samples of Swath S1 and Swath S2 scan 1 and Swath S3 and Swath S4 scan 1. Each "+" represents centers of samples from two swaths. For example, the label "S1S2:1,2" means that Swath S1 and Swath S2, scan 1, sample 2 is located approximately at the "+". The positions of S1 and S2 are slightly different from each other but close enough to be represented by the same "+" in the Figure. The positions of S3 and S4 are slightly different from each other but close enough to be represented by the same "+" in the Figure.

```
S1S2:1,1                  S1S2:1,2                                S1S2:1,90
    +                         +       .......                          +

 S3S4:1,1     S3S4:1,2     S3S4:1,3              S3S4:1,179    S3S4:1,180
     +            +            +      .......         +             +
```

KNOWN PROBLEMS OR ISSUES: L1C data was flagged and Tc was set to Missing due to channel failure: F18 150GHz starting Feb 14, 2012. F16 183GHz starting Dec 1, 2013 F16 150GHz starting May 1, 2015.

Dimension definitions:

nscan1	var	Number of Swath S1 scans in the granule.
nchannel1	3	Number of Swath S1 channels.
npixel1	90	Number of Swath S1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nscan2	var	Number of Swath S2 scans in the granule.
nchannel2	2	Number of Swath S2 channels.
npixel2	90	Number of Swath S2 pixels in one scan.
nchUIA2	1	Number of Swath S2 unique incidence angles.
nscan3	var	Number of Swath S3 scans in the granule.
nchannel3	4	Number of Swath S3 channels.
npixel3	180	Number of Swath S3 pixels in one scan.
nchUIA3	1	Number of Swath S3 unique incidence angles.
nscan4	var	Number of Swath S4 scans in the granule.
nchannel4	2	Number of Swath S4 channels.
npixel4	180	Number of Swath S4 pixels in one scan.
nchUIA4	1	Number of Swath S4 unique incidence angles.

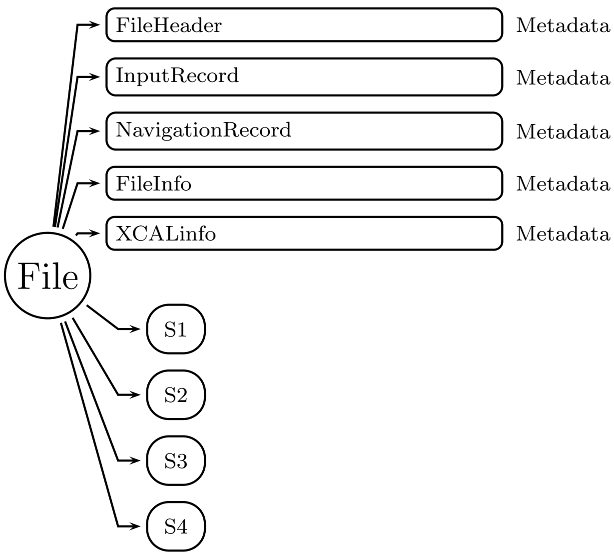


Figure 343: Data Format Structure for 1CSSMIS, Common Calibrated Brightness Temperature

Figure 343 through Figure 355 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

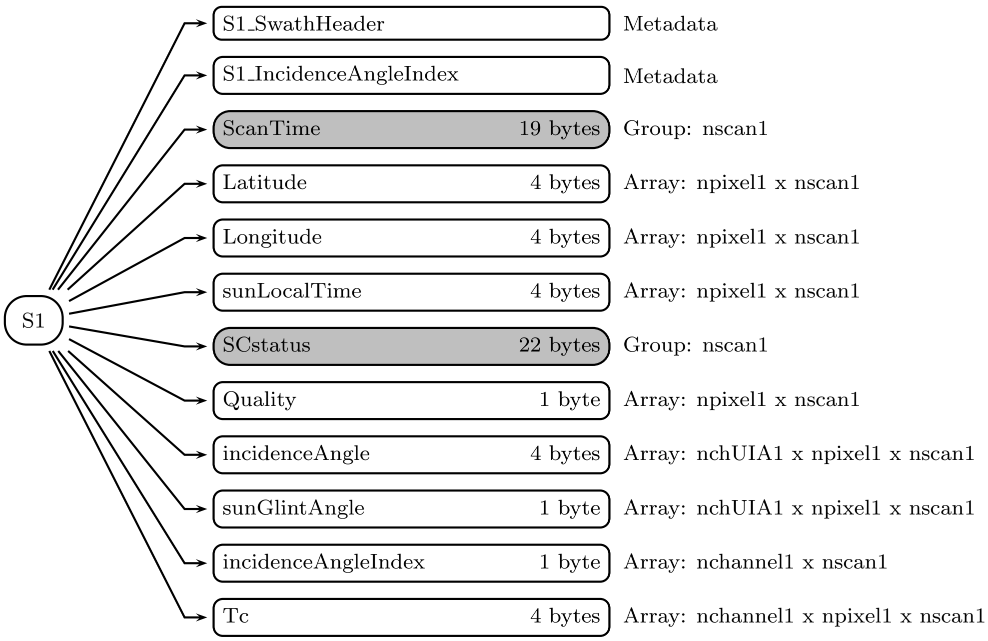


Figure 344: Data Format Structure for 1CSSMIS, S1

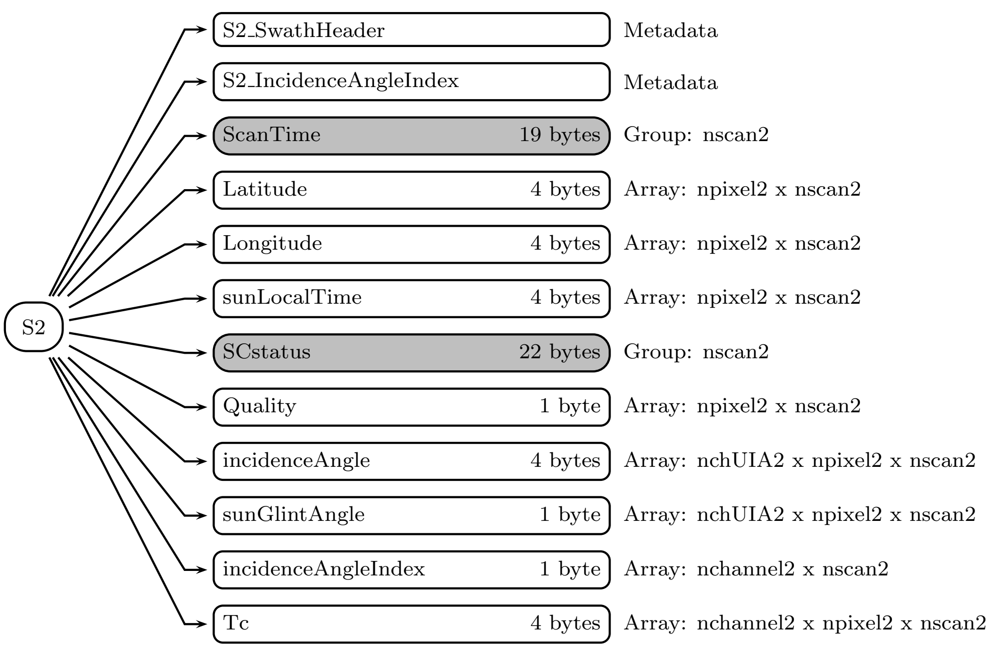


Figure 345: Data Format Structure for 1CSSMIS, S2

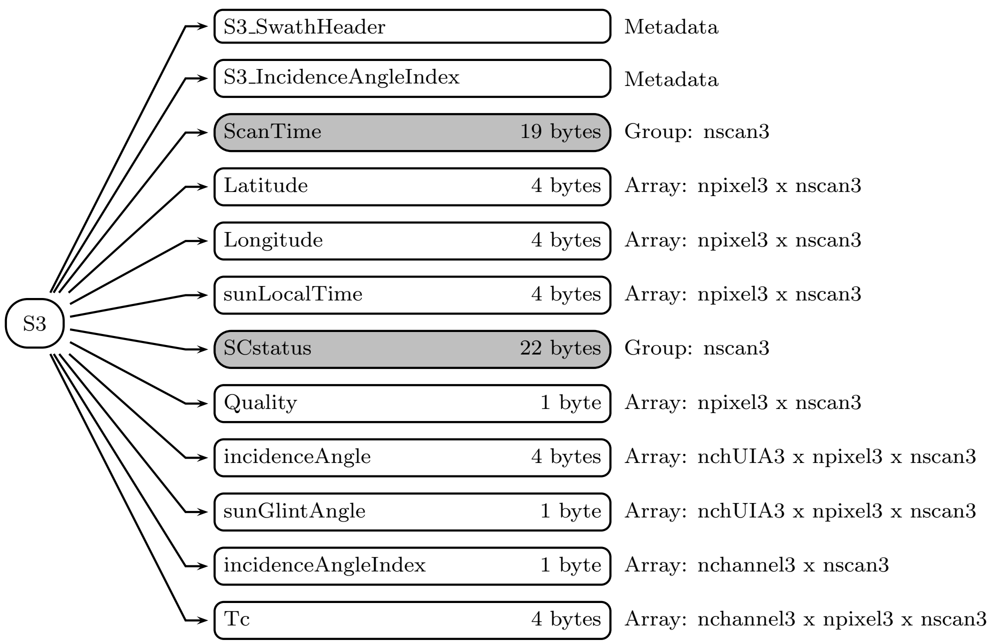


Figure 346: Data Format Structure for 1CSSMIS, S3

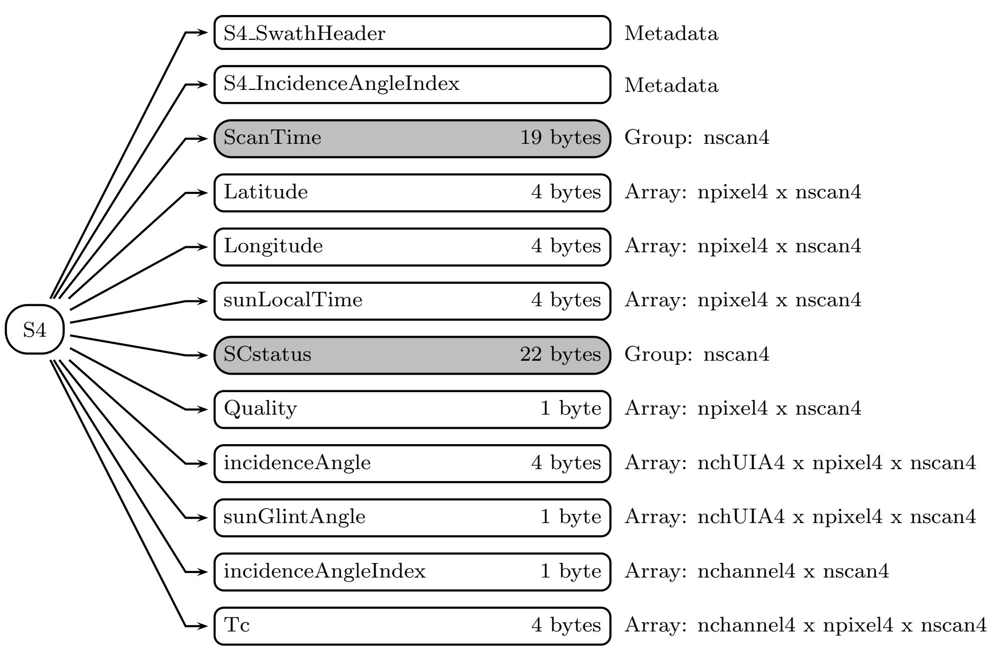


Figure 347: Data Format Structure for 1CSSMIS, S4

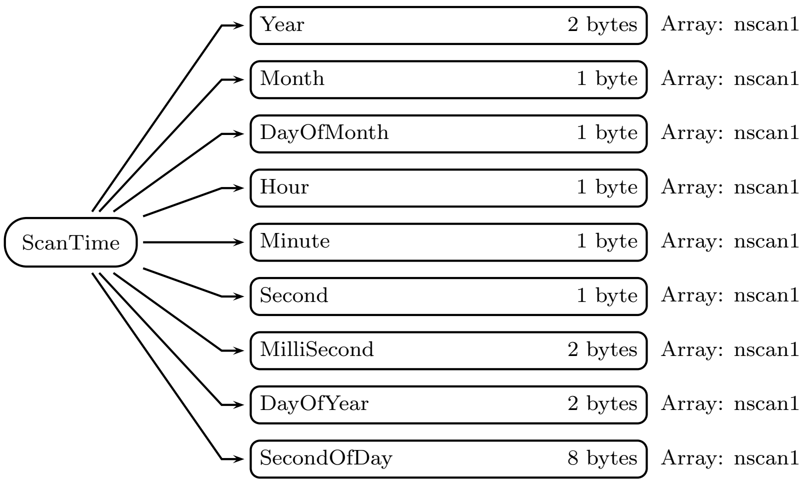


Figure 348: Data Format Structure for 1CSSMIS, S1, ScanTime

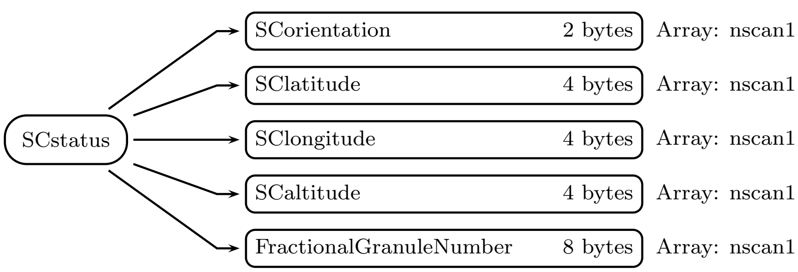


Figure 349: Data Format Structure for 1CSSMIS, S1, SCstatus

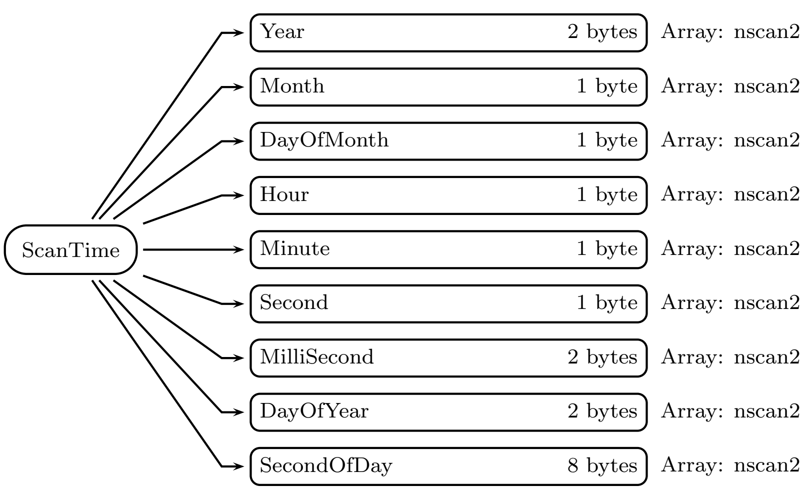


Figure 350: Data Format Structure for 1CSSMIS, S2, ScanTime

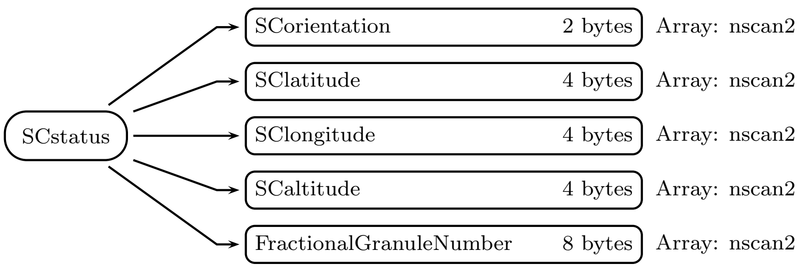


Figure 351: Data Format Structure for 1CSSMIS, S2, SCstatus

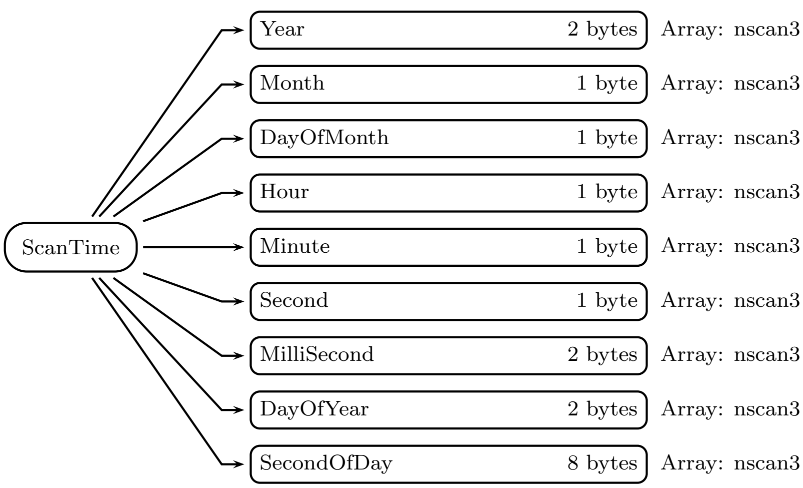


Figure 352: Data Format Structure for 1CSSMIS, S3, ScanTime

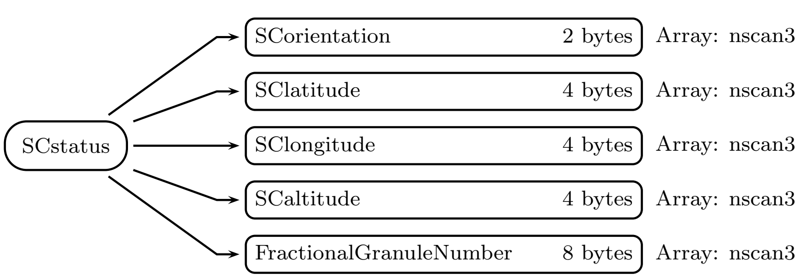


Figure 353: Data Format Structure for 1CSSMIS, S3, SCstatus

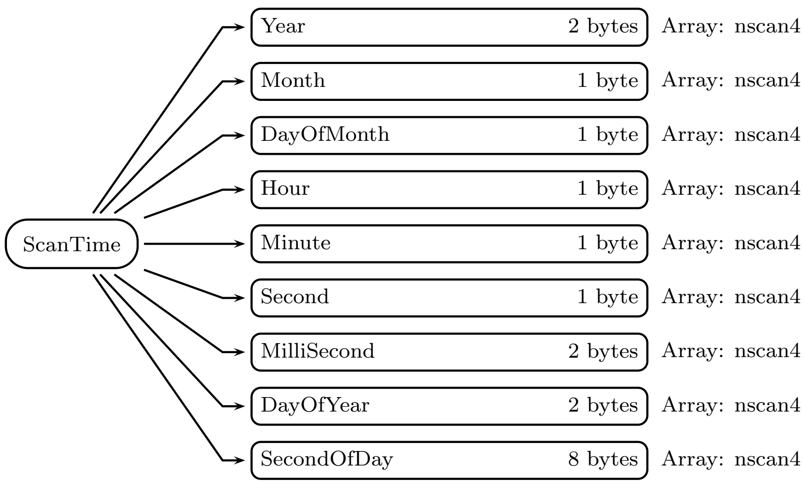


Figure 354: Data Format Structure for 1CSSMIS, S4, ScanTime

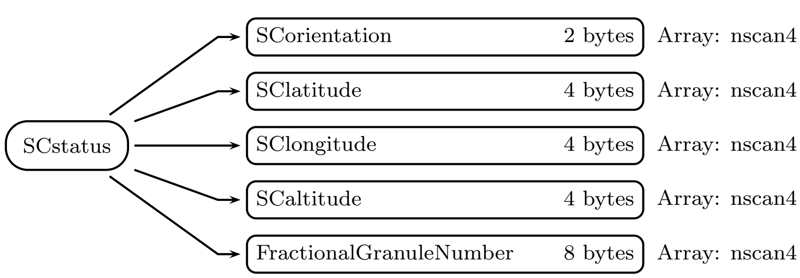


Figure 355: Data Format Structure for 1CSSMIS, S4, SCstatus

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    102 = Climatology check warning 19V channel
    103 = Climatology check warning 19H channel
    104 = Climatology check warning 22V channel
    105 = Climatology check warning 37V channel
    106 = Climatology check warning 37H channel
    107 = Climatology check warning 91V channel
    108 = Climatology check warning 91H channel
    109 = Climatology check warning 150H channel
    110 = Climatology check warning 183+/-1 channel
    111 = Climatology check warning 183+/-3 channel
    112 = Climatology check warning 183+/-7 channel
    113 = Climatology check warning Multiple enviro sensor channels
    114 = Climatology check warning Multiple imager sensor channels
    115 = Climatology check warning One or more LAS sensor channels
    116 = Climatology check warning One or more UAS sensor channels
    117 = Climatology check warning Correction for lunar intrusion into warm load
    118 = Climatology check warning Correction for solar intrusion into warm load
    119 = No sun angle correction warning in multiple channels
    120 = Sensor data issue warning in multiple imager sensor channels
    121 = Sensor data issue warning in multiple enviro sensor channels
    122 = Sensor data issue warning in 91H channel
```

```
 -1  =  Data is missing from file or unreadable, missing scan
 -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
 -3  =  Error in geolocation
 -4  =  Data is missing in 1 channel
 -5  =  Data is missing in multiple channels
 -6  =  Lat/Lon values are out of range
 -7  =  Non-normal status modes
-10  =  Distance to its corresponding LF pixel exceeds 7Km
        threshold.   used in L1C-R product only
-99  =        Missing value (no quality information available)

-102 = Climatology check flagged in input BASE file
-104 = Bad gain value in intrusion correction
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels
-125 = Failure of 150H channel
-126 = Failure of multiple imager sensor channels
-127 = Failure of 37V channel
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
19.35  GHz vertically-polarized   TBs
19.35  GHz horizontally-polarized TBs
22.235 GHz vertically-polarized   TBs
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    102 = Climatology check warning 19V channel
    103 = Climatology check warning 19H channel
    104 = Climatology check warning 22V channel
    105 = Climatology check warning 37V channel
    106 = Climatology check warning 37H channel
    107 = Climatology check warning 91V channel
    108 = Climatology check warning 91H channel
    109 = Climatology check warning 150H channel
    110 = Climatology check warning 183+/-1 channel
    111 = Climatology check warning 183+/-3 channel
    112 = Climatology check warning 183+/-7 channel
    113 = Climatology check warning Multiple enviro sensor channels
    114 = Climatology check warning Multiple imager sensor channels
    115 = Climatology check warning One or more LAS sensor channels
    116 = Climatology check warning One or more UAS sensor channels
    117 = Climatology check warning Correction for lunar intrusion into warm load
    118 = Climatology check warning Correction for solar intrusion into warm load
    119 = No sun angle correction warning in multiple channels
    120 = Sensor data issue warning in multiple imager sensor channels
    121 = Sensor data issue warning in multiple enviro sensor channels
    122 = Sensor data issue warning in 91H channel
```

```
 -1  =  Data is missing from file or unreadable, missing scan
 -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
 -3  =  Error in geolocation
 -4  =  Data is missing in 1 channel
 -5  =  Data is missing in multiple channels
 -6  =  Lat/Lon values are out of range
 -7  =  Non-normal status modes
-10  =  Distance to its corresponding LF pixel exceeds 7Km
        threshold.   used in L1C-R product only
-99  =        Missing value (no quality information available)

-102 = Climatology check flagged in input BASE file
-104 = Bad gain value in intrusion correction
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels
-125 = Failure of 150H channel
-126 = Failure of multiple imager sensor channels
-127 = Failure of 37V channel
```

incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):
GPM Common Calibrated Brightness Temperature. The channels are:

```
37.0   GHz vertically-polarized   TBs
37.0   GHz horizontally-polarized TBs
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S3_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel3 x nscan3):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel3 x nscan3):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel3 x nscan3):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan3):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel3 x nscan3):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    102 = Climatology check warning 19V channel
    103 = Climatology check warning 19H channel
    104 = Climatology check warning 22V channel
    105 = Climatology check warning 37V channel
    106 = Climatology check warning 37H channel
    107 = Climatology check warning 91V channel
    108 = Climatology check warning 91H channel
    109 = Climatology check warning 150H channel
    110 = Climatology check warning 183+/-1 channel
    111 = Climatology check warning 183+/-3 channel
    112 = Climatology check warning 183+/-7 channel
    113 = Climatology check warning Multiple enviro sensor channels
    114 = Climatology check warning Multiple imager sensor channels
    115 = Climatology check warning One or more LAS sensor channels
    116 = Climatology check warning One or more UAS sensor channels
    117 = Climatology check warning Correction for lunar intrusion into warm load
    118 = Climatology check warning Correction for solar intrusion into warm load
    119 = No sun angle correction warning in multiple channels
    120 = Sensor data issue warning in multiple imager sensor channels
    121 = Sensor data issue warning in multiple enviro sensor channels
    122 = Sensor data issue warning in 91H channel


    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
```

```
  -4  =  Data is missing in 1 channel
  -5  =  Data is missing in multiple channels
  -6  =  Lat/Lon values are out of range
  -7  =  Non-normal status modes
 -10  =  Distance to its corresponding LF pixel exceeds 7Km
         threshold.   used in L1C-R product only
 -99  =        Missing value (no quality information available)

 -102 = Climatology check flagged in input BASE file
 -104 = Bad gain value in intrusion correction
 -110 = Climatology check failure 19V channel
 -111 = Climatology check failure 19H channel
 -112 = Climatology check failure 22V channel
 -113 = Climatology check failure 37V channel
 -114 = Climatology check failure 37H channel
 -115 = Climatology check failure 91V channel
 -116 = Climatology check failure 91H channel
 -117 = Climatology check failure 150H channel
 -118 = Climatology check failure 183+/-1 channel
 -119 = Climatology check failure 183+/-3 channel
 -120 = Climatology check failure 183+/-7 channel
 -121 = Climatology check failure Multiple enviro sensor channels
 -122 = Climatology check failure Multiple imager sensor channels
 -123 = Climatology check failure One or more LAS sensor channels
 -124 = Climatology check failure One or more UAS sensor channels
 -125 = Failure of 150H channel
 -126 = Failure of multiple imager sensor channels
 -127 = Failure of 37V channel
```

incidenceAngle (4-byte float, array size: nchUIA3 x npixel3 x nscan3):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA3 x npixel3 x nscan3):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
```

```
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3):
GPM Common Calibrated Brightness Temperature. The channels are:

```
150 GHz horizontally-polarized TBs
183.31 +/- 1 GHz horizontally-polarized TBs
183.31 +/- 3 GHz horizontally-polarized TBs
183.31 +/- 6.6 GHz horizontally-polarized TBs
```

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S4_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan4):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan4):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan4):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan4):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan4):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan4):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan4):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan4):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan4):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel4 x nscan4):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel4 x nscan4):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel4 x nscan4):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan4):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan4):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan4):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan4):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan4):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel4 x nscan4):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    102 = Climatology check warning 19V channel
    103 = Climatology check warning 19H channel
    104 = Climatology check warning 22V channel
    105 = Climatology check warning 37V channel
    106 = Climatology check warning 37H channel
    107 = Climatology check warning 91V channel
    108 = Climatology check warning 91H channel
    109 = Climatology check warning 150H channel
    110 = Climatology check warning 183+/-1 channel
    111 = Climatology check warning 183+/-3 channel
    112 = Climatology check warning 183+/-7 channel
    113 = Climatology check warning Multiple enviro sensor channels
    114 = Climatology check warning Multiple imager sensor channels
    115 = Climatology check warning One or more LAS sensor channels
    116 = Climatology check warning One or more UAS sensor channels
    117 = Climatology check warning Correction for lunar intrusion into warm load
    118 = Climatology check warning Correction for solar intrusion into warm load
    119 = No sun angle correction warning in multiple channels
    120 = Sensor data issue warning in multiple imager sensor channels
    121 = Sensor data issue warning in multiple enviro sensor channels
    122 = Sensor data issue warning in 91H channel


    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
```

```
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)

   -102 = Climatology check flagged in input BASE file
   -104 = Bad gain value in intrusion correction
   -110 = Climatology check failure 19V channel
   -111 = Climatology check failure 19H channel
   -112 = Climatology check failure 22V channel
   -113 = Climatology check failure 37V channel
   -114 = Climatology check failure 37H channel
   -115 = Climatology check failure 91V channel
   -116 = Climatology check failure 91H channel
   -117 = Climatology check failure 150H channel
   -118 = Climatology check failure 183+/-1 channel
   -119 = Climatology check failure 183+/-3 channel
   -120 = Climatology check failure 183+/-7 channel
   -121 = Climatology check failure Multiple enviro sensor channels
   -122 = Climatology check failure Multiple imager sensor channels
   -123 = Climatology check failure One or more LAS sensor channels
   -124 = Climatology check failure One or more UAS sensor channels
   -125 = Failure of 150H channel
   -126 = Failure of multiple imager sensor channels
   -127 = Failure of 37V channel
```

incidenceAngle (4-byte float, array size: nchUIA4 x npixel4 x nscan4):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA4 x npixel4 x nscan4):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel4 x nscan4):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
```

```
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel4 x npixel4 x nscan4):
GPM Common Calibrated Brightness Temperature. The channels are:

```
91.665 GHz vertically-polarized   TBs
91.665 GHz horizontally-polarized TBs
```

C Structure Header file:

```
#ifndef _TK_1CSSMIS_H_
#define _TK_1CSSMIS_H_

#ifndef _L1CSSMIS_S4_
#define _L1CSSMIS_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[180];
```

```
    float Longitude[180];
    float sunLocalTime[180];
    SCSTATUS SCstatus;
    signed char Quality[180];
    float incidenceAngle[180][1];
    signed char sunGlintAngle[180][1];
    signed char incidenceAngleIndex[2];
    float Tc[180][2];
} L1CSSMIS_S4;

#endif

#ifndef _L1CSSMIS_S3_
#define _L1CSSMIS_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[180];
    float Longitude[180];
    float sunLocalTime[180];
    SCSTATUS SCstatus;
    signed char Quality[180];
    float incidenceAngle[180][1];
    signed char sunGlintAngle[180][1];
    signed char incidenceAngleIndex[4];
    float Tc[180][4];
} L1CSSMIS_S3;

#endif

#ifndef _L1CSSMIS_S2_
#define _L1CSSMIS_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    float sunLocalTime[90];
    SCSTATUS SCstatus;
    signed char Quality[90];
    float incidenceAngle[90][1];
    signed char sunGlintAngle[90][1];
    signed char incidenceAngleIndex[2];
```

```
    float Tc[90][2];
} L1CSSMIS_S2;

#endif

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CSSMIS_S1_
#define _L1CSSMIS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    float sunLocalTime[90];
```

```
    SCSTATUS SCstatus;
    signed char Quality[90];
    float incidenceAngle[90][1];
    signed char sunGlintAngle[90][1];
    signed char incidenceAngleIndex[3];
    float Tc[90][3];
} L1CSSMIS_S1;

#endif

#ifndef _L1CSSMIS_SWATHS_
#define _L1CSSMIS_SWATHS_

typedef struct {
    L1CSSMIS_S1 S1;
    L1CSSMIS_S2 S2;
    L1CSSMIS_S3 S3;
    L1CSSMIS_S4 S4;
} L1CSSMIS_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CSSMIS_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(180)
    REAL*4 Longitude(180)
    REAL*4 sunLocalTime(180)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(180)
    REAL*4 incidenceAngle(1,180)
    BYTE sunGlintAngle(1,180)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,180)
END STRUCTURE

STRUCTURE /L1CSSMIS_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(180)
    REAL*4 Longitude(180)
```

```
    REAL*4 sunLocalTime(180)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(180)
    REAL*4 incidenceAngle(1,180)
    BYTE sunGlintAngle(1,180)
    BYTE incidenceAngleIndex(4)
    REAL*4 Tc(4,180)
END STRUCTURE

STRUCTURE /L1CSSMIS_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    REAL*4 sunLocalTime(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(90)
    REAL*4 incidenceAngle(1,90)
    BYTE sunGlintAngle(1,90)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,90)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CSSMIS_S1/
```

```
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    REAL*4 sunLocalTime(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(90)
    REAL*4 incidenceAngle(1,90)
    BYTE sunGlintAngle(1,90)
    BYTE incidenceAngleIndex(3)
    REAL*4 Tc(3,90)
END STRUCTURE

STRUCTURE /L1CSSMIS_SWATHS/
    RECORD /L1CSSMIS_S1/ S1;
    RECORD /L1CSSMIS_S2/ S2;
    RECORD /L1CSSMIS_S3/ S3;
    RECORD /L1CSSMIS_S4/ S4;
END STRUCTURE
```

5.24 1CAMSRE - Common Calibrated Brightness Temperature

1CAMSRE contains common calibrated brightness temperature from the AMSR-E passive microwave instrument flown on the AQUA satellite. This products contains 6 swaths. Swath 1 has channels 10.65V 10.65H. Swath 2 has channels 18.7V 18.7H. Swath 3 has channels 23.8V 23.8H. Swath 4 has channels 36.5V 36.5H. Swath S5 has 2 high frequency A-Scan channels (89V 89H). Swath S6 has 2 high frequency B-Scan channels (89V 89H). Data for all six swaths is observed in the same revolution of the instrument. High frequency A-Scan and high frequency B-Scan data are observed in separate feedhorns.

Earth observations for all three swaths are taken during a 122^o segment of the instrument rotation when AMSR-E is looking in the foreward direction. We define the spacecraft vector (v) at the center of this segment. "v" is used in the definition of the variable SCorientation.

RELATION BETWEEN THE SWATHS: Each S1 scan contains 10 GHz channels sampled 243 times along the scan. S2, S3, and S4 are sampled nominally at the same position as the S1 samples, but differ by small distances. Each S5 scan contains high frequency A channels sampled 486 times along the scan. Each S6 scan contains high frequency B channels sampled 486 times along the scan. Both Swath S5 and Swath S6 have exactly twice as many pixels as Swath S1. S1 pixels 1, 2, 3, ... coincide with S5 pixels 1, 3, 5, ... Scans of all swaths are repeated every 1.5s and the scans of one swath are about 10km apart along the direction of the satellite track. Along an S1 scan every other center of an S5 pixel coincides with the center of an S1 pixel, but the S6 pixels are offset from S1 and S5 pixels by nominally 15km in the direction normal to the scan direction on the aft side, in other words S6 pixels are nominally 15km "behind" the S1 and S5 pixels for the same scan.

The Figure below shows the locations of the pixels of scans 1 and 2 for swaths S1, S5, and S6. Since swaths S2, S3 and S4 are close to S1, they are omitted from the figure. Each "+" represents centers of pixels from one or more swaths. For example, the label "S1:1,2 S5:1,3" means that both Swath S1, Scan 1, Pixel 2 and Swath S5, Scan 1, Pixel 3 are located at the "+".

```
   S6:1,1        S6:1,2       S6:1,3                S6:1,485       S6:1,486
     +             +            +       .......        +              +



   S6:2,1        S6:2,2       S6:2,3                S6:2,485       S6:2,486
     +             +            +       .......        +              +
S1:1,1 S5:1,1    S5:1,2    S1:1,2 S5:1,3        S1:1,243 S5:1,485  S5:1,486
     +             +            +       .......        +              +



S1:2,1 S5:2,1    S5:2,2    S1:2,2 S5:2,3        S1:2,243 S5:2,485  S5:2,486
     +             +            +       .......        +              +
```

KNOWN PROBLEMS OR ISSUES:

1. Swath S5 (89A) V and H data is missing due to channel failure starting Nov. 4, 2004

Dimension definitions:

nscan1	var	Number of scans in Swath S1 in the granule.
nscan2	var	Number of scans in Swath S2 in the granule.
nscan3	var	Number of scans in Swath S3 in the granule.
nscan4	var	Number of scans in Swath S4 in the granule.
nscan5	var	Number of scans in Swath S5 in the granule.
nscan6	var	Number of scans in Swath S6 in the granule.
npixel1	243	Number of Swath S1 pixels in one scan.
npixel2	243	Number of Swath S2 pixels in one scan.
npixel3	243	Number of Swath S3 pixels in one scan.
npixel4	243	Number of Swath S4 pixels in one scan.
npixel5	486	Number of Swath S5 pixels in one scan.
npixel6	486	Number of Swath S6 pixels in one scan.
nchannel1	2	Number of Swath S1 channels.
nchannel2	2	Number of Swath S2 channels.
nchannel3	2	Number of Swath S3 channels.
nchannel4	2	Number of Swath S4 channels.
nchannel5	2	Number of Swath S5 channels.
nchannel6	2	Number of Swath S6 channels.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nchUIA2	1	Number of Swath S2 unique incidence angles.
nchUIA3	1	Number of Swath S3 unique incidence angles.
nchUIA4	1	Number of Swath S4 unique incidence angles.
nchUIA5	1	Number of Swath S5 unique incidence angles.
nchUIA6	1	Number of Swath S6 unique incidence angles.

Figure 356 through Figure 374 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

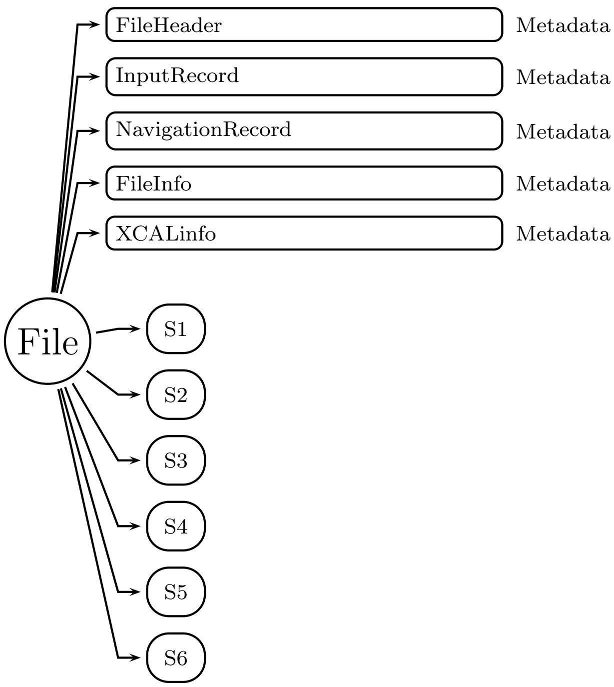


Figure 356: Data Format Structure for 1CAMSRE, Common Calibrated Brightness Temperature

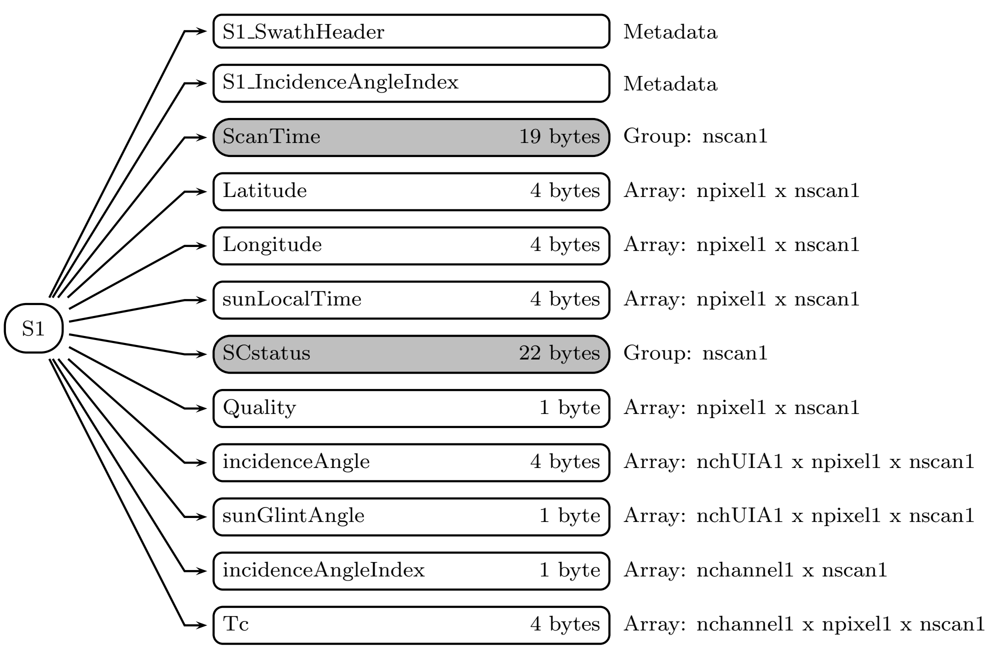


Figure 357: Data Format Structure for 1CAMSRE, S1

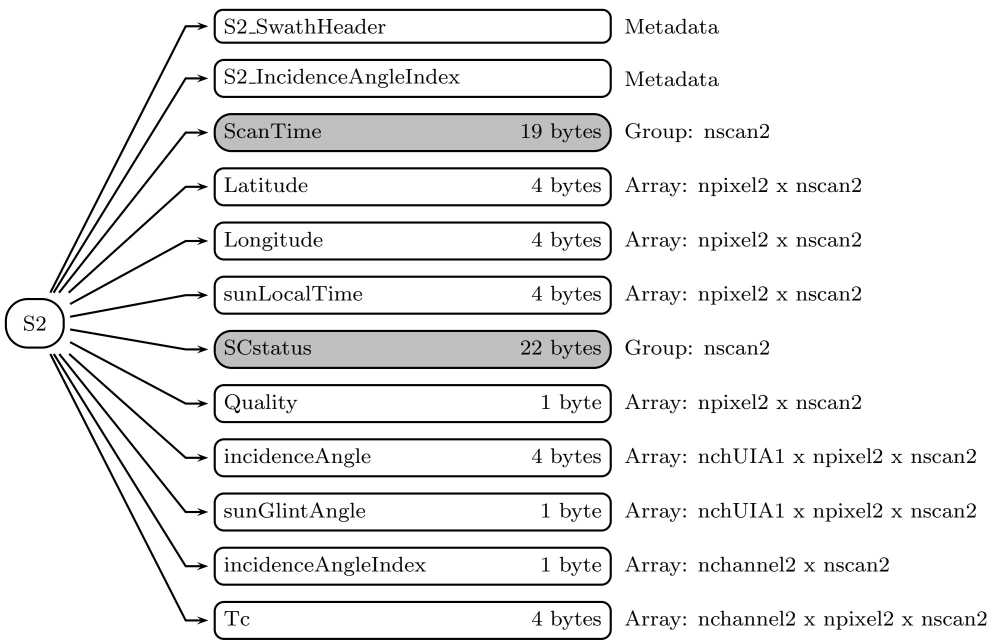


Figure 358: Data Format Structure for 1CAMSRE, S2

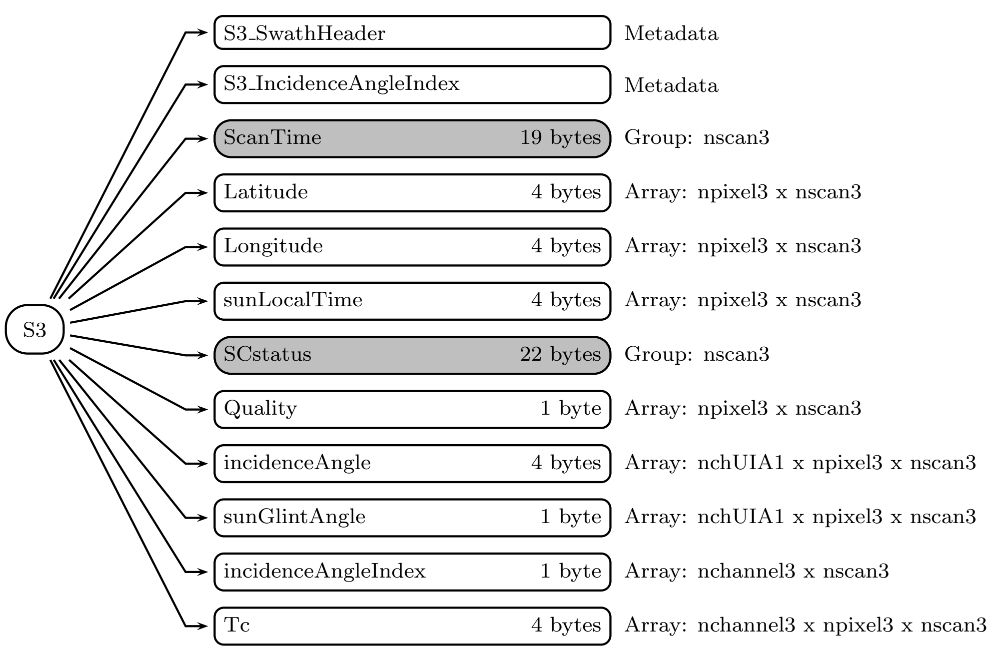


Figure 359: Data Format Structure for 1CAMSRE, S3

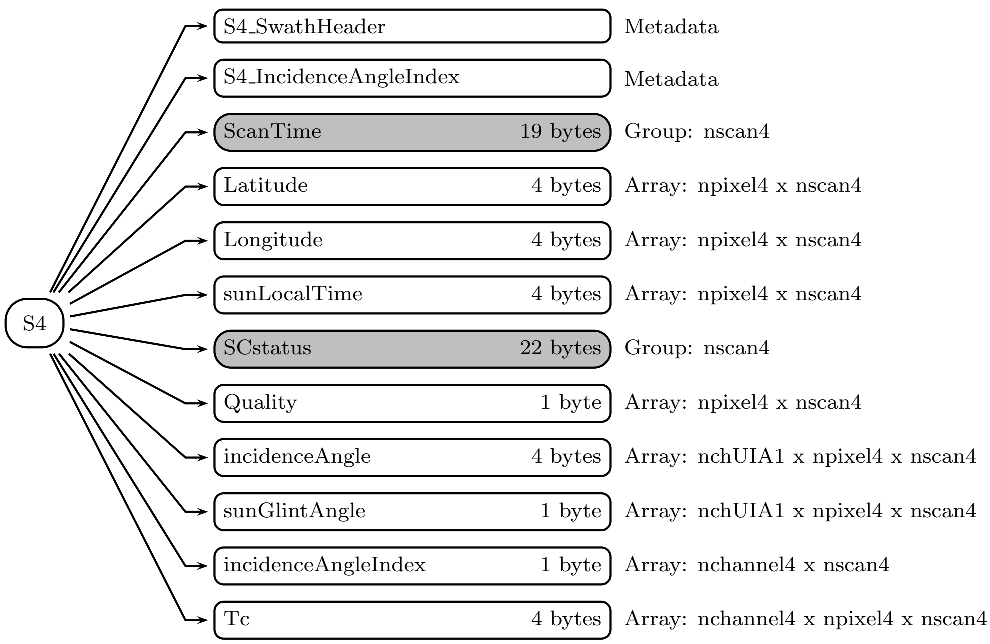


Figure 360: Data Format Structure for 1CAMSRE, S4

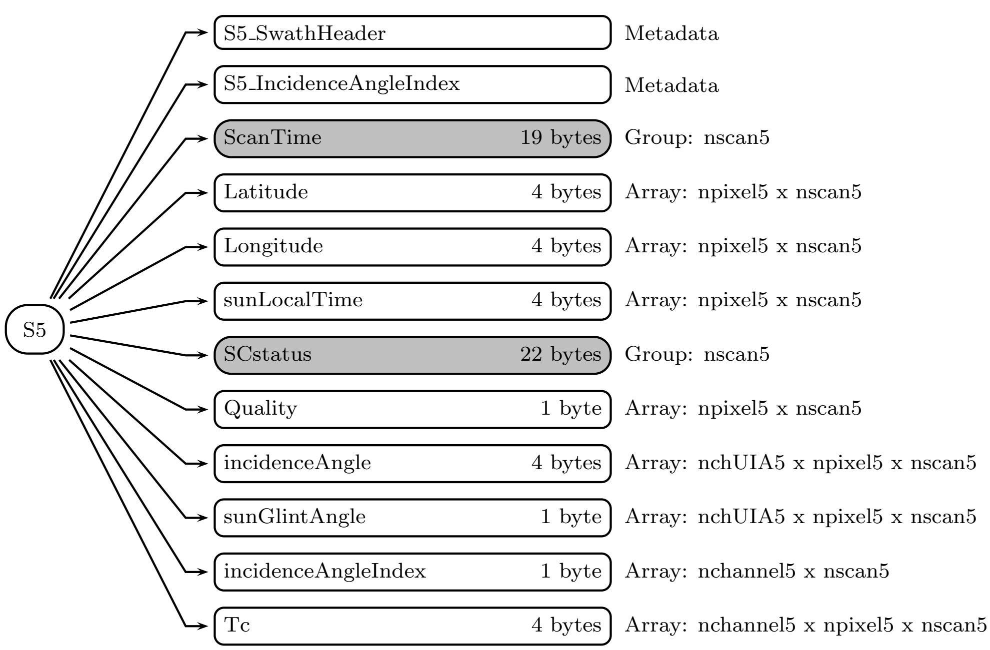


Figure 361: Data Format Structure for 1CAMSRE, S5

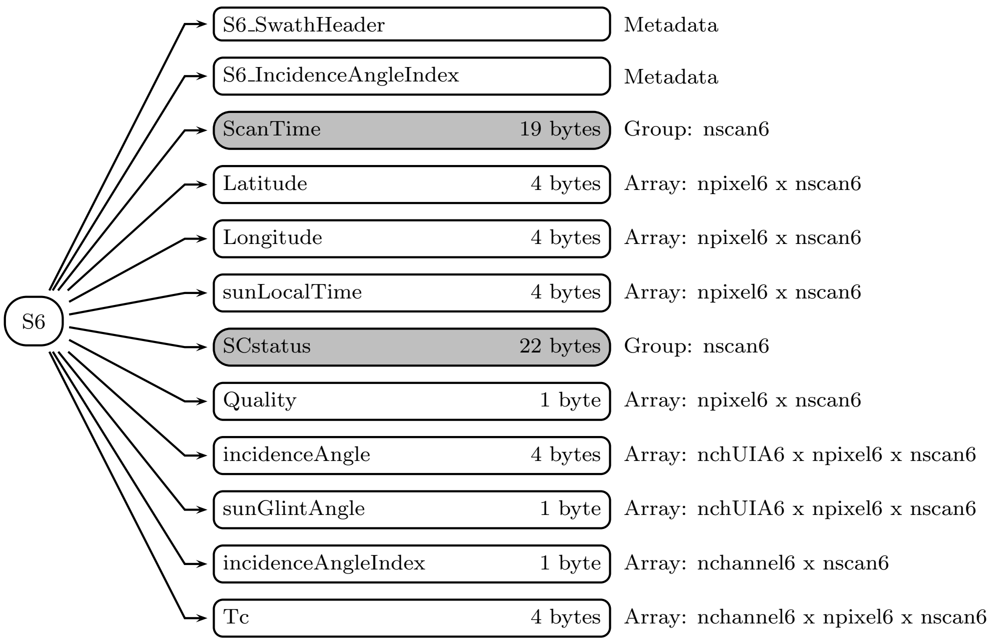


Figure 362: Data Format Structure for 1CAMSRE, S6

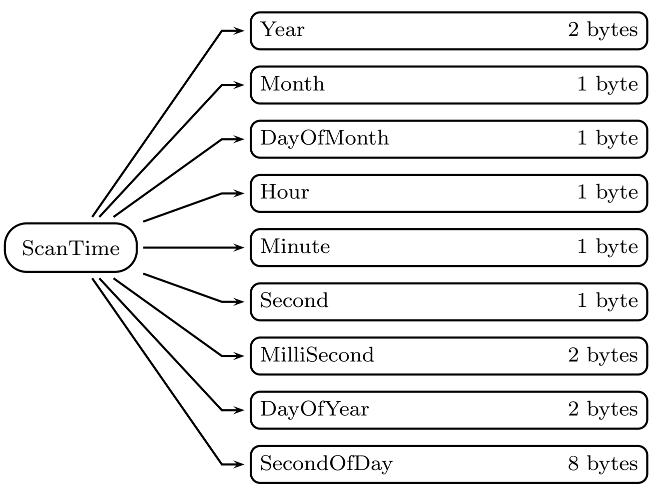


Figure 363: Data Format Structure for 1CAMSRE, S1, ScanTime

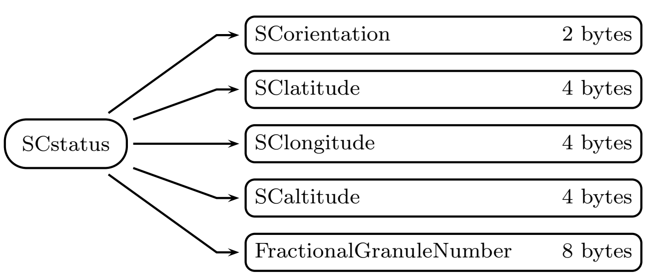


Figure 364: Data Format Structure for 1CAMSRE, S1, SCstatus

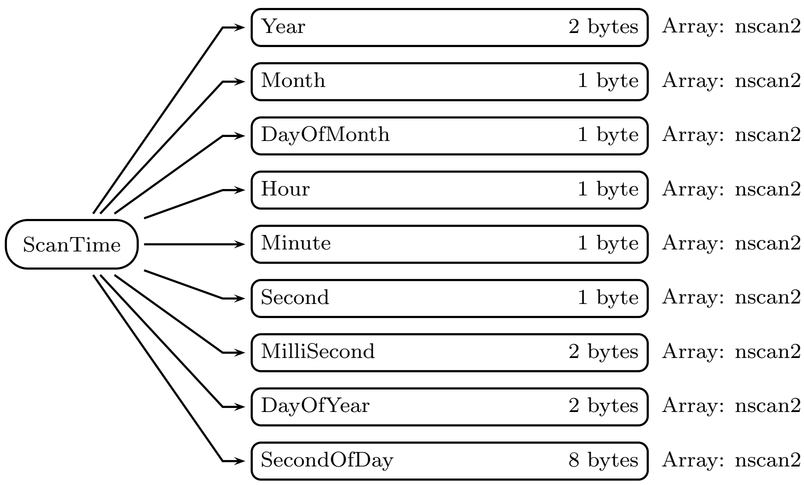


Figure 365: Data Format Structure for 1CAMSRE, S2, ScanTime

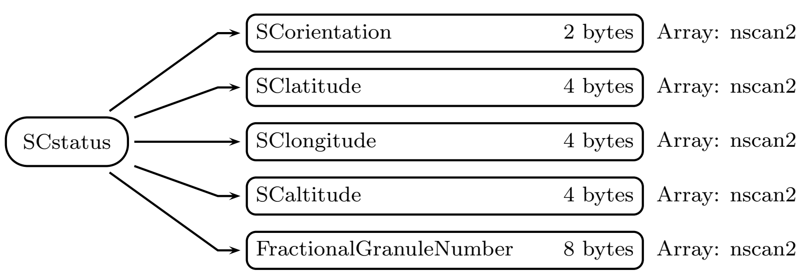


Figure 366: Data Format Structure for 1CAMSRE, S2, SCstatus

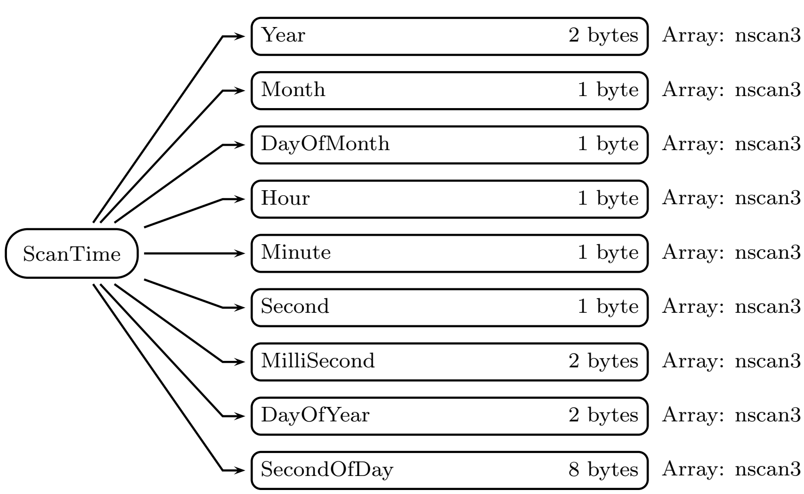


Figure 367: Data Format Structure for 1CAMSRE, S3, ScanTime

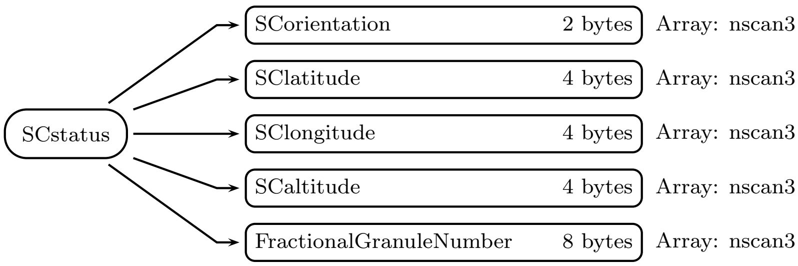


Figure 368: Data Format Structure for 1CAMSRE, S3, SCstatus

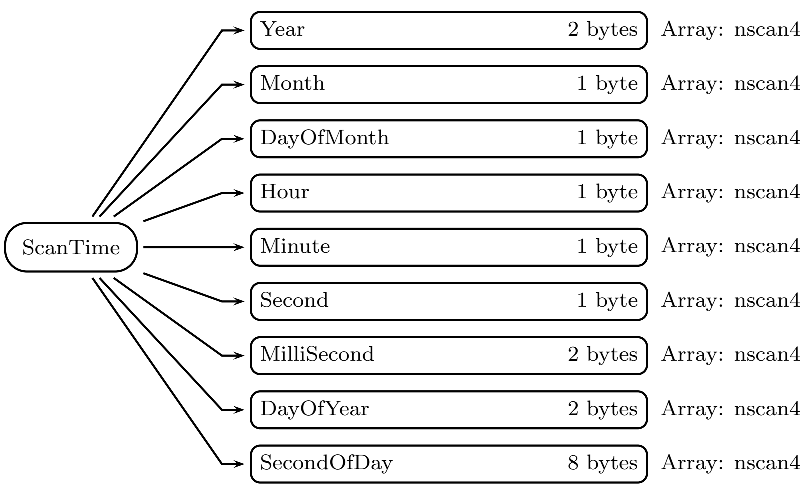


Figure 369: Data Format Structure for 1CAMSRE, S4, ScanTime

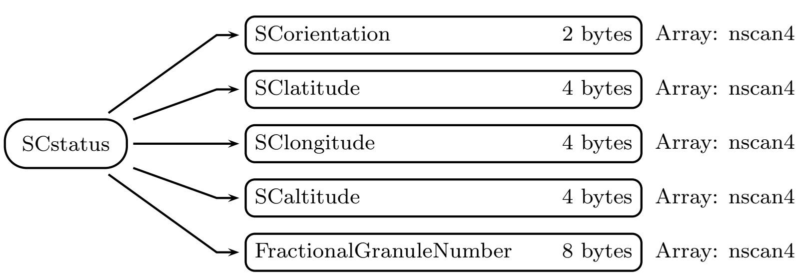


Figure 370: Data Format Structure for 1CAMSRE, S4, SCstatus

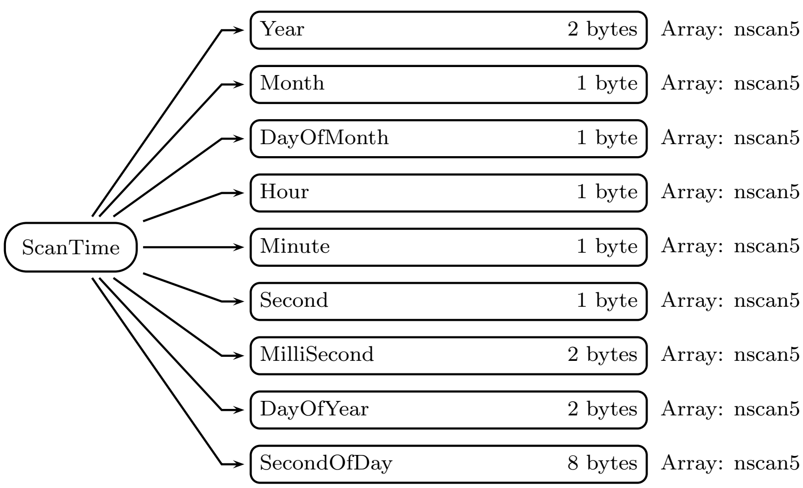


Figure 371: Data Format Structure for 1CAMSRE, S5, ScanTime

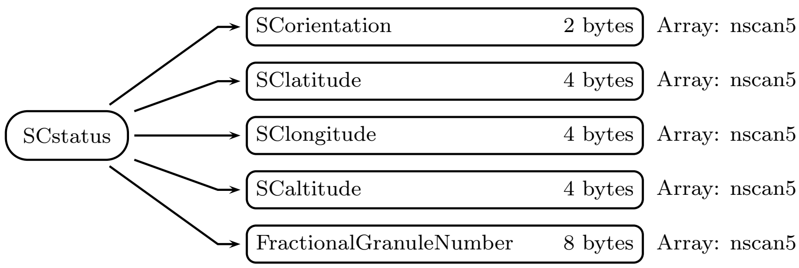


Figure 372: Data Format Structure for 1CAMSRE, S5, SCstatus

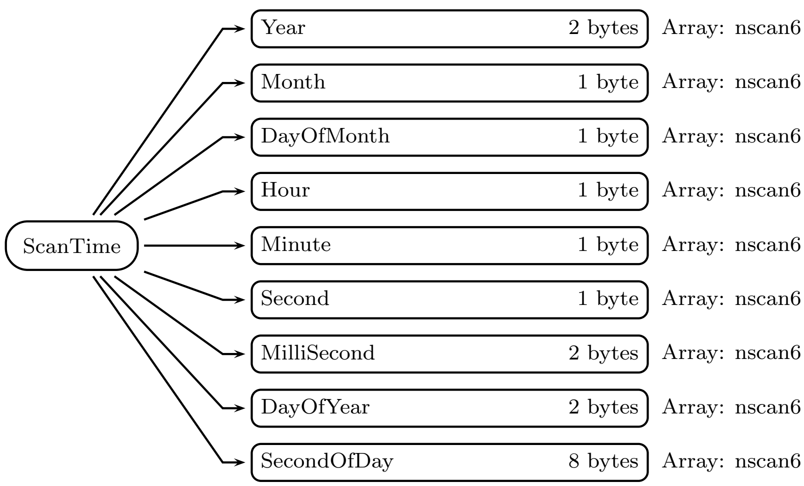


Figure 373: Data Format Structure for 1CAMSRE, S6, ScanTime

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

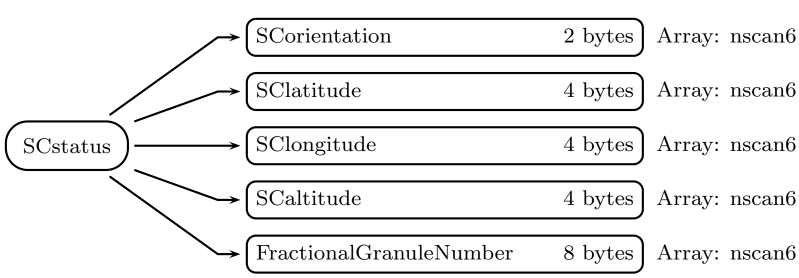


Figure 374: Data Format Structure for 1CAMSRE, S6, SCstatus

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel1 x nscan1):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
            1-99 = Generic flags (all sensors)
         100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
         -(1-98) = Generic flags (all sensors)
             -99 = Missing value (no quality information available)
      -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

   100  = 10V/H GHz channels blockage issue


    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
```

```
          threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)

  -100  =     Failure of 89A V/H channel on AMSRE Nov 04, 2004
  -101  =     Scan failed quality checks in L1B
  -102  =     SPC and/or SPS anomaly
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
10.65    GHz vertically-polarized   TBs
10.65    GHz horizontally-polarized TBs
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel2 x nscan2):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

sunLocalTime (4-byte float, array size: npixel2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
            1-99 = Generic flags (all sensors)
         100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
         -(1-98) = Generic flags (all sensors)
             -99 = Missing value (no quality information available)
      -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel2 x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):
GPM Common Calibrated Brightness Temperature. The channels are:

```
18.7     GHz vertically-polarized   TBs
18.7     GHz horizontally-polarized TBs
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S3_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel3 x nscan3):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel3 x nscan3):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

sunLocalTime (4-byte float, array size: npixel3 x nscan3):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan3):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel3 x nscan3):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel3 x nscan3):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel3 x nscan3):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3):
GPM Common Calibrated Brightness Temperature. The channels are:

```
23.8     GHz vertically-polarized   TBs
23.8     GHz horizontally-polarized TBs
```

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S4_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan4):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan4):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan4):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan4):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan4):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan4):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan4):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan4):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan4):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel4 x nscan4):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel4 x nscan4):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

sunLocalTime (4-byte float, array size: npixel4 x nscan4):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan4):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan4):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan4):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan4):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan4):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel4 x nscan4):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
```

```
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =       Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel4 x nscan4):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel4 x nscan4):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel4 x nscan4):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
```

```
    sunGlintAngle(2,npixel,nscan)
    incidenceAngleIndex(10,nscan)
    Tc(10,npixel,nscan)

  The user would do the following to retreive the angles
  for a given channel, pixel, and scan:

    i = incidenceAngleIndex(channel,scan)
    ia = incidenceAngle(i,pixel,scan)
    sga = sunGlintAngle(i,pixel,scan)

  The incidenceAngleIndex is the same for every scan,
  but is repeated each scan for the convenience of users
  reading the data scan by scan.  In addition,
  incidenceAngleIndex is located in metadata for the
  convenience of users wishing to read this information
  from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel4 x npixel4 x nscan4):
GPM Common Calibrated Brightness Temperature. The channels are:

```
36.5     GHz vertically-polarized   TBs
36.5     GHz horizontally-polarized TBs
```

S5 (Swath)

S5_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S5_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S5)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan5):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan5):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan5):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan5):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan5):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan5):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan5):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan5):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan5):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel5 x nscan5):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel5 x nscan5):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel5 x nscan5):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S5)

SCorientation (2-byte integer, array size: nscan5):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan5):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan5):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan5):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan5):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel5 x nscan5):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
```

```
lt 0 = Major errors resulting in missing data
         -(1-98) = Generic flags (all sensors)
             -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA5 x npixel5 x nscan5):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA5 x npixel5 x nscan5):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel5 x nscan5):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)
```

```
The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel5 x npixel5 x nscan5):
GPM Common Calibrated Brightness Temperature. The channels are:

```
89 GHz vertically-polarized   TBs
89 GHz horizontally-polarized TBs
```

S6 (Swath)

S6_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S6_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S6)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan6):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined

as:
-9999 Missing value

Month (1-byte integer, array size: nscan6):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan6):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan6):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan6):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan6):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan6):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan6):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan6):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel6 x nscan6):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel6 x nscan6):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel6 x nscan6):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any

location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S6)

SCorientation (2-byte integer, array size: nscan6):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan6):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan6):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan6):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan6):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel6 x nscan6):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
            1-99 = Generic flags (all sensors)
         100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
             -99 = Missing value (no quality information available)
```

```
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA6 x npixel6 x nscan6):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA6 x npixel6 x nscan6):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel6 x nscan6):

```
      Index (1 based as in Fortran) of
      the incidence angle array corresponding to the channel.
      For example, if the swath has 10 channels and
      2 unique incidence angles, then the dimensions
      in Fortran would be:

        incidenceAngle(2,npixel,nscan)
        sunGlintAngle(2,npixel,nscan)
        incidenceAngleIndex(10,nscan)
        Tc(10,npixel,nscan)

      The user would do the following to retreive the angles
      for a given channel, pixel, and scan:
```

```
  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel6 x npixel6 x nscan6):
GPM Common Calibrated Brightness Temperature. The channels are:

```
89 GHz vertically-polarized TBs
89 GHz horizontally-polarized TBs
```

C Structure Header file:

```
#ifndef _TK_1CAMSRE_H_
#define _TK_1CAMSRE_H_

#ifndef _L1CAMSRE_S6_
#define _L1CAMSRE_S6_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[486];
    float Longitude[486];
    float sunLocalTime[486];
    SCSTATUS SCstatus;
    signed char Quality[486];
    float incidenceAngle[486][1];
    signed char sunGlintAngle[486][1];
    signed char incidenceAngleIndex[2];
    float Tc[486][2];
} L1CAMSRE_S6;
```

```
#endif

#ifndef _L1CAMSRE_S5_
#define _L1CAMSRE_S5_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[486];
    float Longitude[486];
    float sunLocalTime[486];
    SCSTATUS SCstatus;
    signed char Quality[486];
    float incidenceAngle[486][1];
    signed char sunGlintAngle[486][1];
    signed char incidenceAngleIndex[2];
    float Tc[486][2];
} L1CAMSRE_S5;

#endif

#ifndef _L1CAMSRE_S4_
#define _L1CAMSRE_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    float sunLocalTime[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSRE_S4;

#endif

#ifndef _L1CAMSRE_S3_
#define _L1CAMSRE_S3_

typedef struct {
    SCANTIME ScanTime;
```

```
    float Latitude[243];
    float Longitude[243];
    float sunLocalTime[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSRE_S3;

#endif

#ifndef _L1CAMSRE_S2_
#define _L1CAMSRE_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    float sunLocalTime[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSRE_S2;

#endif

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif
```

```
#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CAMSRE_S1_
#define _L1CAMSRE_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    float sunLocalTime[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSRE_S1;

#endif

#ifndef _L1CAMSRE_SWATHS_
#define _L1CAMSRE_SWATHS_

typedef struct {
    L1CAMSRE_S1 S1;
    L1CAMSRE_S2 S2;
    L1CAMSRE_S3 S3;
```

```
    L1CAMSRE_S4 S4;
    L1CAMSRE_S5 S5;
    L1CAMSRE_S6 S6;
} L1CAMSRE_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CAMSRE_S6/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(486)
    REAL*4 Longitude(486)
    REAL*4 sunLocalTime(486)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(486)
    REAL*4 incidenceAngle(1,486)
    BYTE sunGlintAngle(1,486)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,486)
END STRUCTURE

STRUCTURE /L1CAMSRE_S5/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(486)
    REAL*4 Longitude(486)
    REAL*4 sunLocalTime(486)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(486)
    REAL*4 incidenceAngle(1,486)
    BYTE sunGlintAngle(1,486)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,486)
END STRUCTURE

STRUCTURE /L1CAMSRE_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    REAL*4 sunLocalTime(243)
    RECORD /SCSTATUS/ SCstatus
```

```
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /L1CAMSRE_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    REAL*4 sunLocalTime(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /L1CAMSRE_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    REAL*4 sunLocalTime(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
```

```
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CAMSRE_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    REAL*4 sunLocalTime(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /L1CAMSRE_SWATHS/
    RECORD /L1CAMSRE_S1/ S1;
    RECORD /L1CAMSRE_S2/ S2;
    RECORD /L1CAMSRE_S3/ S3;
    RECORD /L1CAMSRE_S4/ S4;
    RECORD /L1CAMSRE_S5/ S5;
    RECORD /L1CAMSRE_S6/ S6;
END STRUCTURE
```

5.25 1CAMSR2 - Common Calibrated Brightness Temperature

1CAMSR2 contains common calibrated brightness temperature from the AMSR2 passive microwave instrument flown on the GCOMW1 satellite. This products contains 6 swaths. Swath 1 has channels 10.65V 10.65H. Swath 2 has channels 18.7V 18.7H. Swath 3 has channels 23.8V 23.8H. Swath 4 has channels 36.5V 36.5H. Swath S5 has 2 high frequency A-Scan channels (89V 89H). Swath S6 has 2 high frequency B-Scan channels (89V 89H). Data for all six swaths is observed in the same revolution of the instrument. High frequency A and high frequency B data are observed in separate feedhorns.

RELATION BETWEEN THE SWATHS: Each S1 scan contains 10 GHz channels sampled

243 times along the scan. S2, S3, and S4 are sampled nominally at the same position as the S1 samples, but differ by small distances. Each S5 scan contains high frequency A channels sampled 486 times along the scan. Each S6 scan contains high frequency B channels sampled 486 times along the scan. Both Swath S5 and Swath S6 have exactly twice as many pixels as Swath S1. S1 pixels 1, 2, 3, ... coincide with S5 pixels 1, 3, 5, ... Scans of all swaths are repeated every 1.5s and the scans of one swath are about 10km apart along the direction of the satellite track. Along an S1 scan every other center of an S5 pixel coincides with the center of an S1 pixel, but the S6 pixels are offset from S1 and S5 pixels by nominally 15km in the direction normal to the scan direction on the aft side, in other words S6 pixels are nominally 15km "behind" the S1 and S5 pixels for the same scan.

The Figure below shows the locations of the pixels of scans 1 and 2 for swaths S1, S5, and S6. Since swaths S2, S3 and S4 are close to S1, they are omitted from the figure. Each "+" represents centers of pixels from one or more swaths. For example, the label "S1:1,2 S5:1,3" means that both Swath S1, Scan 1, Pixel 2 and Swath S5, Scan 1, Pixel 3 are located at the "+".

```
S6:1,1      S6:1,2      S6:1,3                 S6:1,485      S6:1,486
  +           +           +        .......        +             +


S6:2,1      S6:2,2      S6:2,3                 S6:2,485      S6:2,486
  +           +           +        .......        +             +
```

```
S1:1,1 S5:1,1    S5:1,2   S1:1,2 S5:1,3         S1:1,243 S5:1,485  S5:1,486
      +            +            +       .......        +              +



S1:2,1 S5:2,1    S5:2,2   S1:2,2 S5:2,3         S1:2,243 S5:2,485  S5:2,486
      +            +            +       .......        +              +
```

KNOWN PROBLEMS OR ISSUES :

None

Dimension definitions:

nscan1	var	Number of scans in Swath S1 in the granule.
nscan2	var	Number of scans in Swath S2 in the granule.
nscan3	var	Number of scans in Swath S3 in the granule.
nscan4	var	Number of scans in Swath S4 in the granule.
nscan5	var	Number of scans in Swath S5 in the granule.
nscan6	var	Number of scans in Swath S6 in the granule.
npixel1	243	Number of Swath S1 pixels in one scan.
npixel2	243	Number of Swath S2 pixels in one scan.
npixel3	243	Number of Swath S3 pixels in one scan.
npixel4	243	Number of Swath S4 pixels in one scan.
npixel5	486	Number of Swath S5 pixels in one scan.
npixel6	486	Number of Swath S6 pixels in one scan.
nchannel1	2	Number of Swath S1 channels.
nchannel2	2	Number of Swath S2 channels.
nchannel3	2	Number of Swath S3 channels.
nchannel4	2	Number of Swath S4 channels.
nchannel5	2	Number of Swath S5 channels.
nchannel6	2	Number of Swath S6 channels.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nchUIA2	1	Number of Swath S2 unique incidence angles.
nchUIA3	1	Number of Swath S3 unique incidence angles.
nchUIA4	1	Number of Swath S4 unique incidence angles.
nchUIA5	1	Number of Swath S5 unique incidence angles.
nchUIA6	1	Number of Swath S6 unique incidence angles.

Figure 375 through Figure 393 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

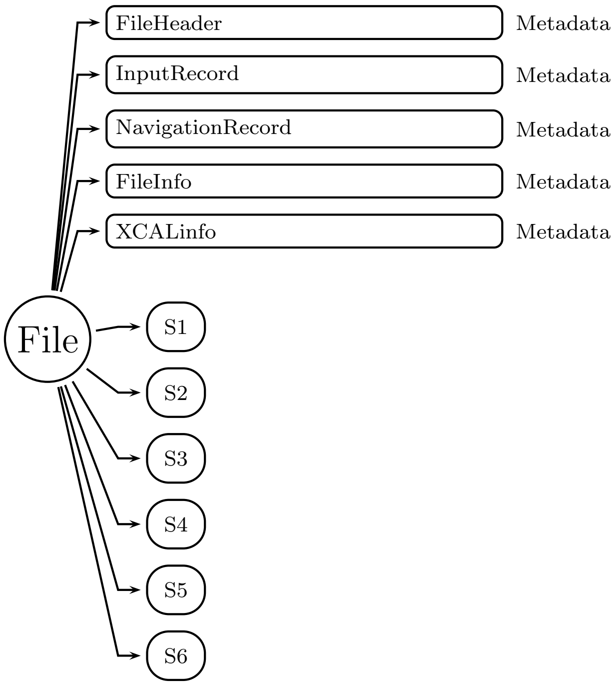


Figure 375: Data Format Structure for 1CAMSR2, Common Calibrated Brightness Temperature

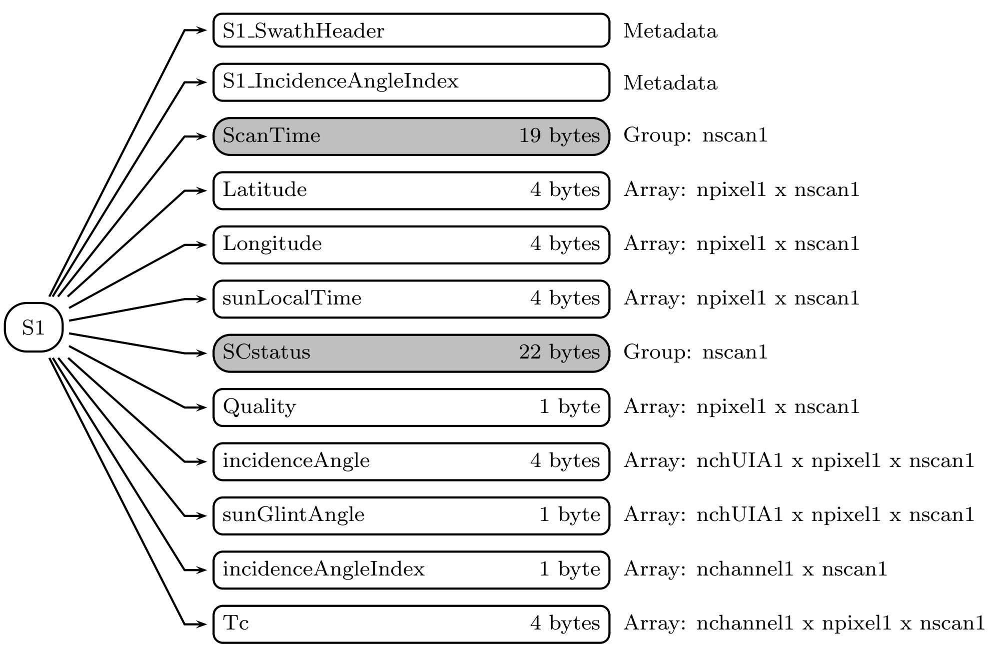


Figure 376: Data Format Structure for 1CAMSR2, S1

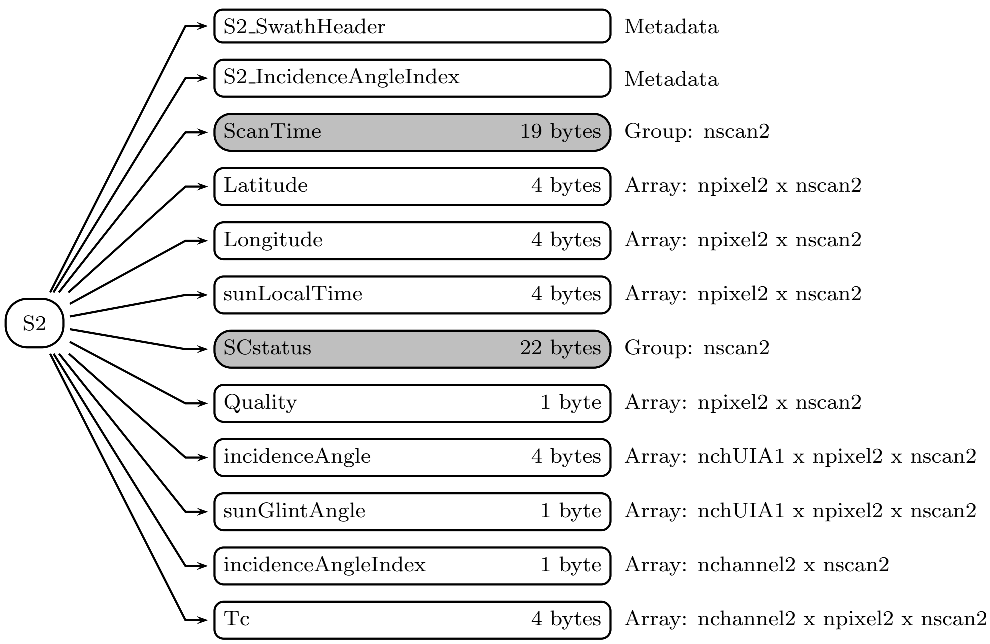


Figure 377: Data Format Structure for 1CAMSR2, S2

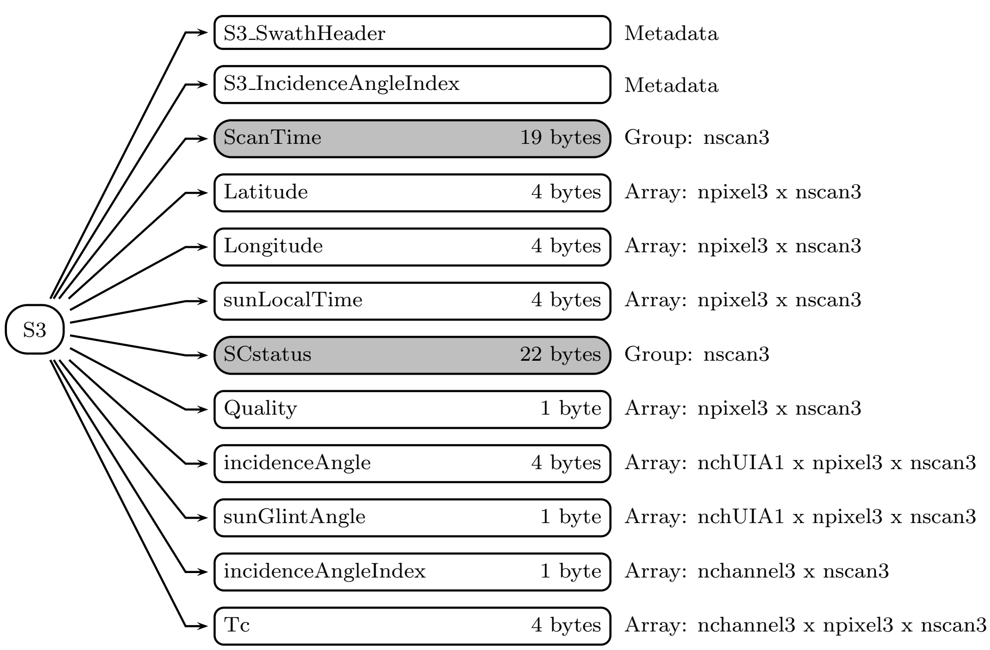


Figure 378: Data Format Structure for 1CAMSR2, S3

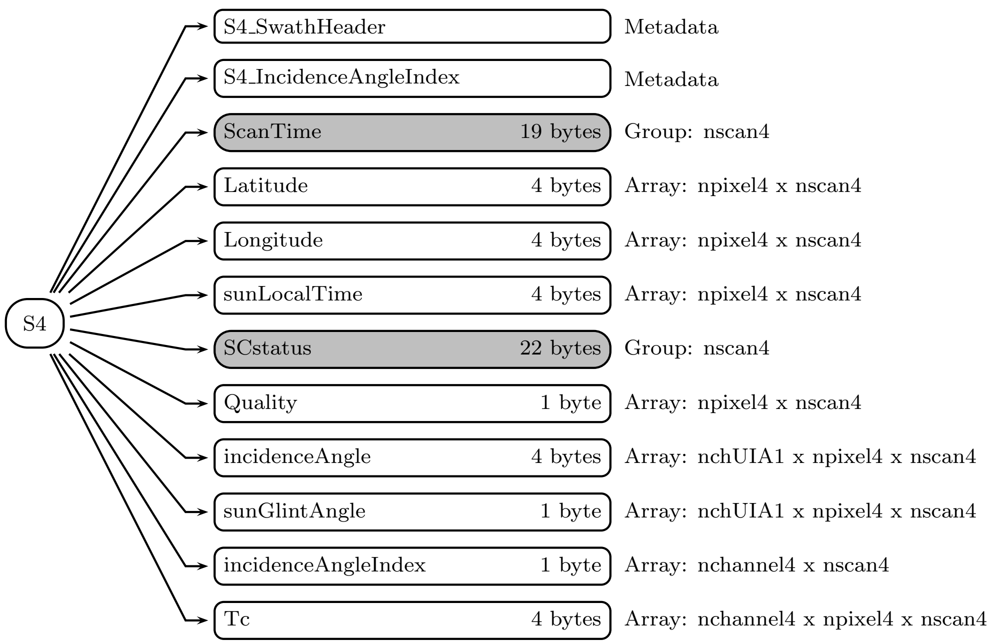


Figure 379: Data Format Structure for 1CAMSR2, S4

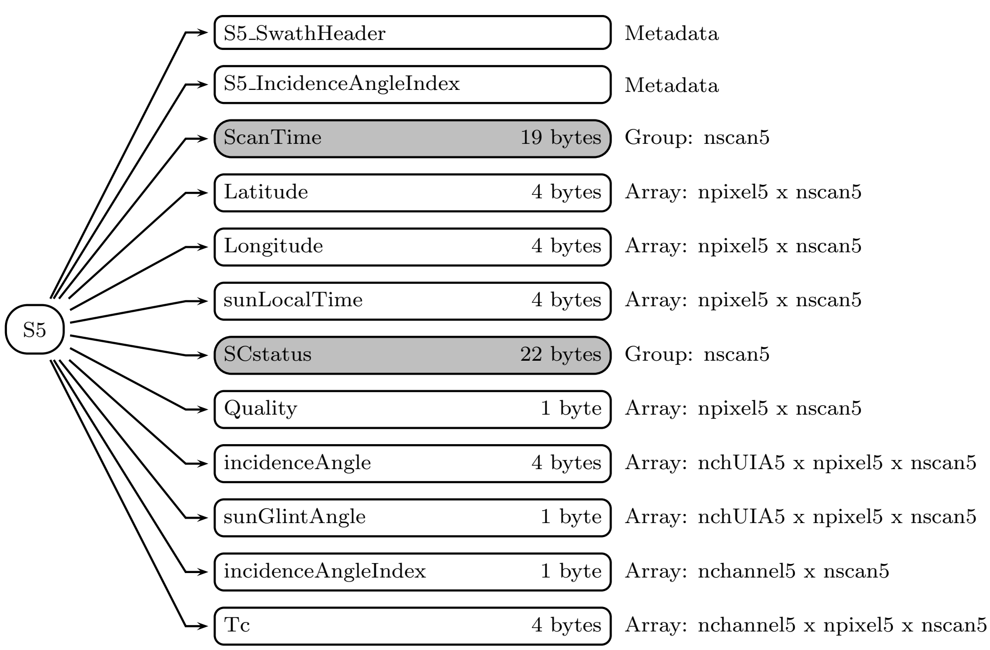


Figure 380: Data Format Structure for 1CAMSR2, S5

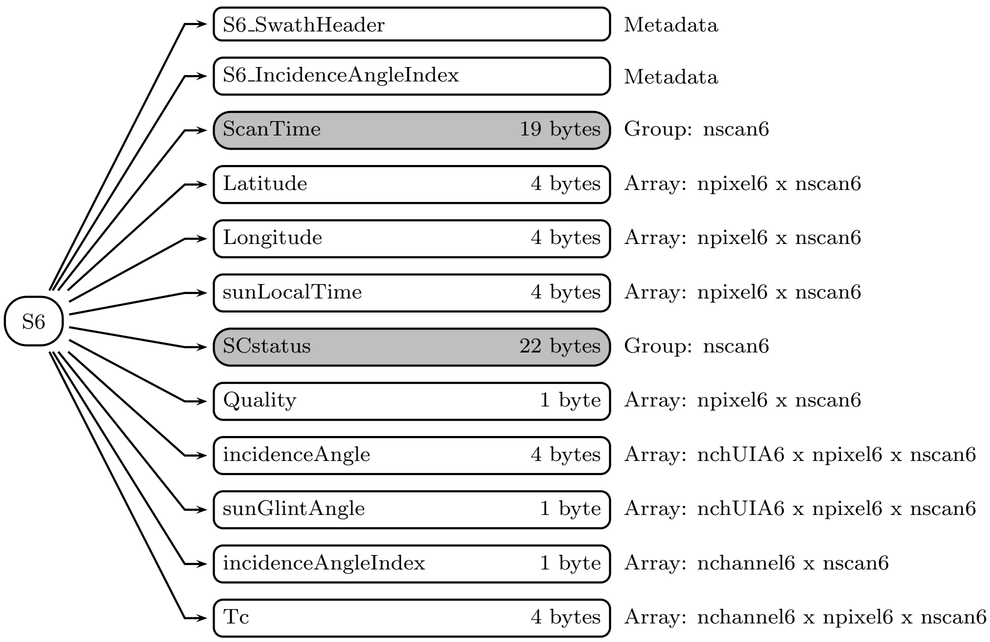


Figure 381: Data Format Structure for 1CAMSR2, S6

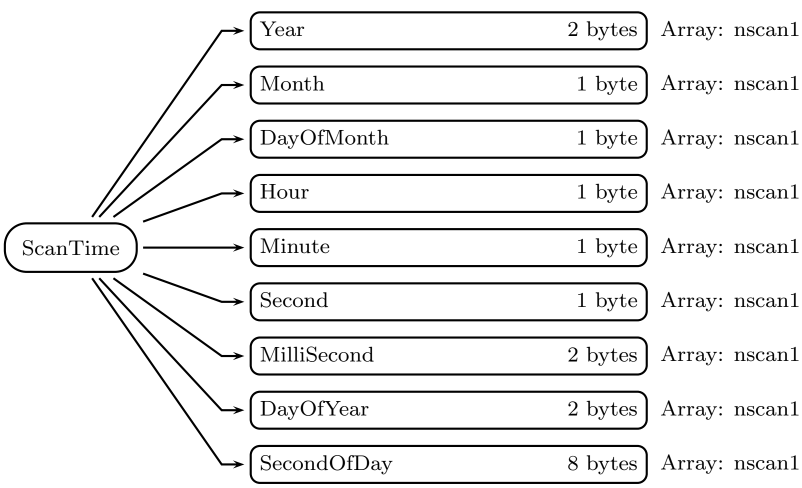


Figure 382: Data Format Structure for 1CAMSR2, S1, ScanTime

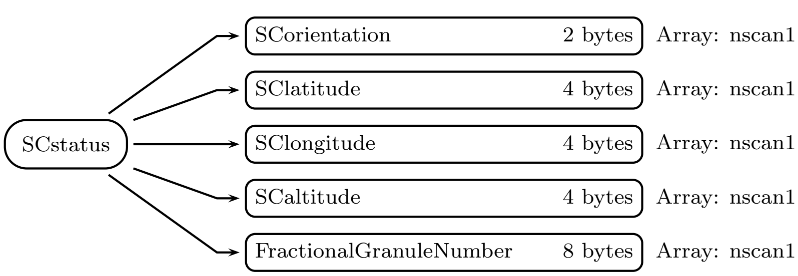


Figure 383: Data Format Structure for 1CAMSR2, S1, SCstatus

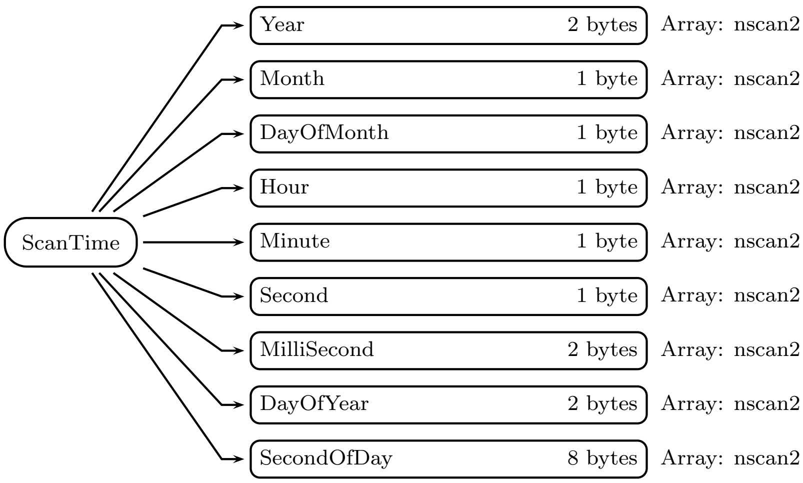


Figure 384: Data Format Structure for 1CAMSR2, S2, ScanTime

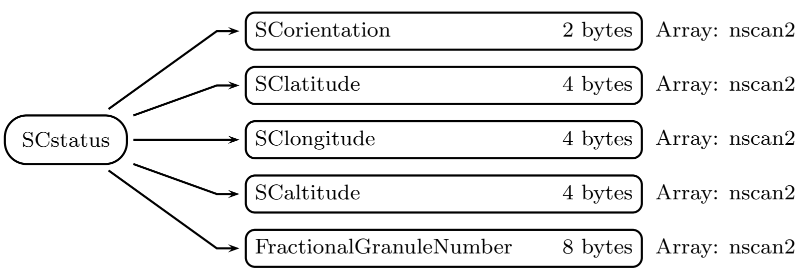


Figure 385: Data Format Structure for 1CAMSR2, S2, SCstatus

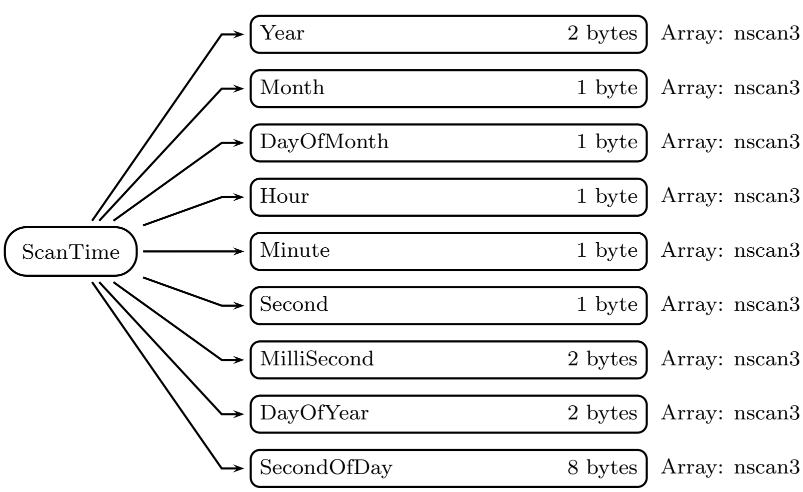


Figure 386: Data Format Structure for 1CAMSR2, S3, ScanTime

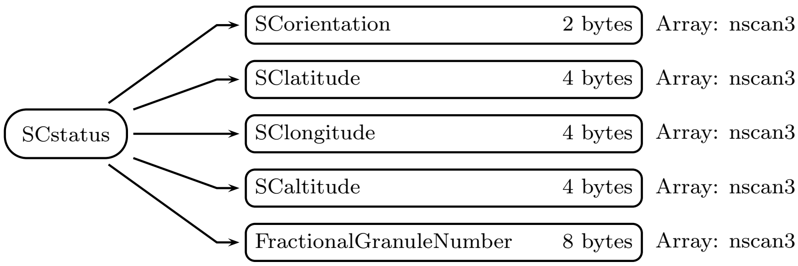


Figure 387: Data Format Structure for 1CAMSR2, S3, SCstatus

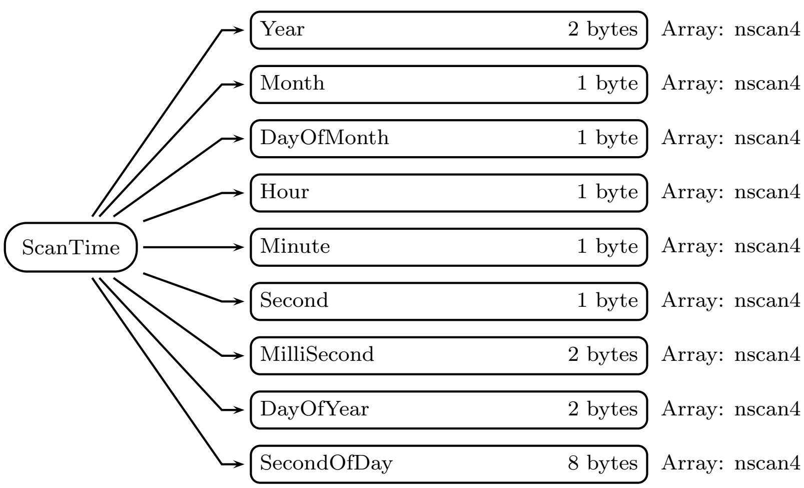


Figure 388: Data Format Structure for 1CAMSR2, S4, ScanTime

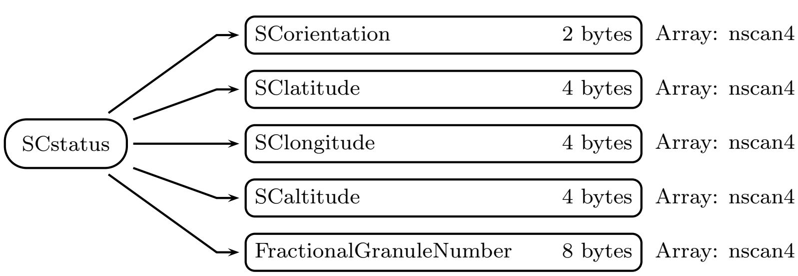


Figure 389: Data Format Structure for 1CAMSR2, S4, SCstatus

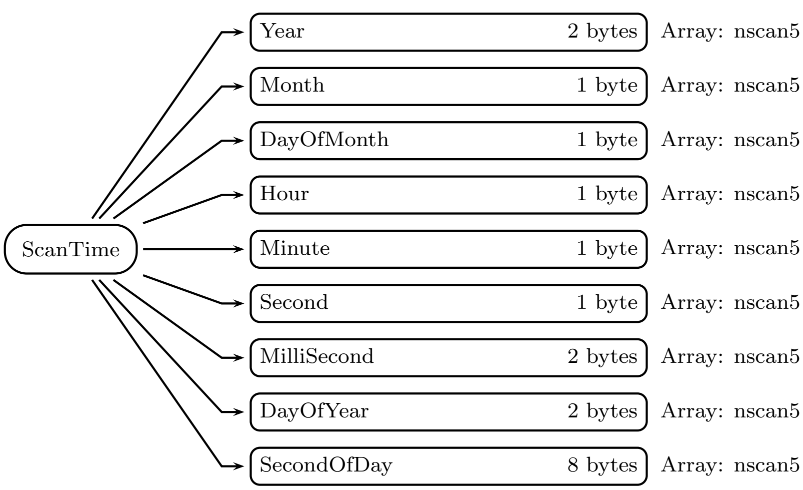


Figure 390: Data Format Structure for 1CAMSR2, S5, ScanTime

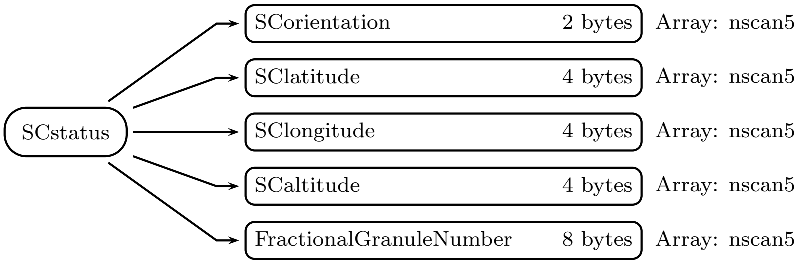


Figure 391: Data Format Structure for 1CAMSR2, S5, SCstatus

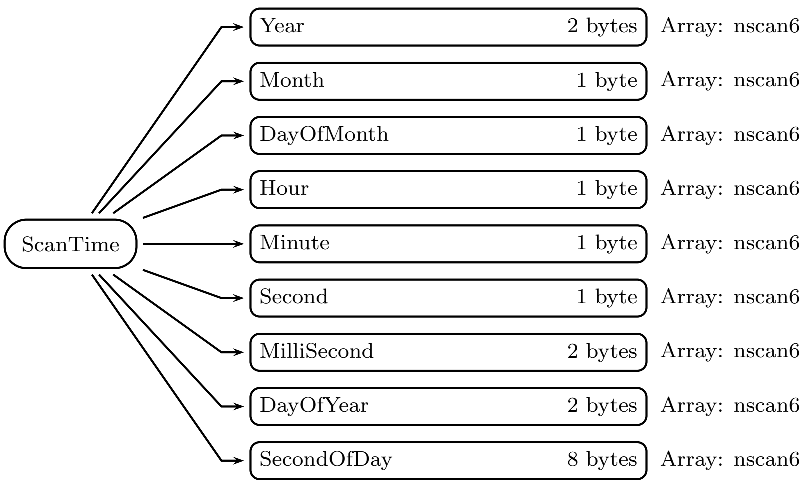


Figure 392: Data Format Structure for 1CAMSR2, S6, ScanTime

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

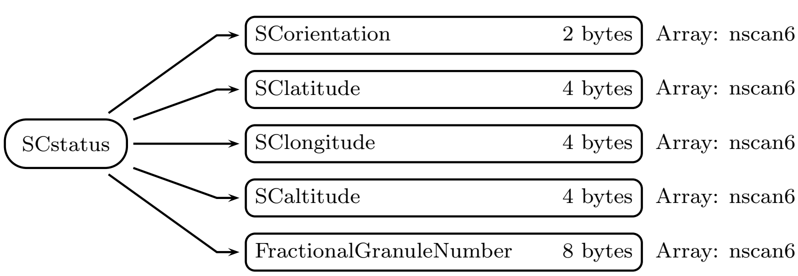


Figure 393: Data Format Structure for 1CAMSR2, S6, SCstatus

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel1 x nscan1):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
10.65    GHz vertically-polarized   TBs
10.65    GHz horizontally-polarized TBs
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel2 x nscan2):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

sunLocalTime (4-byte float, array size: npixel2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel2 x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):
GPM Common Calibrated Brightness Temperature. The channels are:

```
18.7     GHz vertically-polarized   TBs
18.7     GHz horizontally-polarized TBs
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S3_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel3 x nscan3):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel3 x nscan3):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

sunLocalTime (4-byte float, array size: npixel3 x nscan3):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan3):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel3 x nscan3):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
```

```
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel3 x nscan3):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel3 x nscan3):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
```

```
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3):
GPM Common Calibrated Brightness Temperature. The channels are:

```
23.8     GHz vertically-polarized   TBs
23.8     GHz horizontally-polarized TBs
```

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S4_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan4):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan4):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan4):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan4):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan4):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan4):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan4):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan4):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan4):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel4 x nscan4):
Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Longitude (4-byte float, array size: npixel4 x nscan4):
Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

sunLocalTime (4-byte float, array size: npixel4 x nscan4):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined

as:
-9999.9 Missing value

SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan4):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan4):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan4):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan4):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan4):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel4 x nscan4):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags
```

```
DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel4 x nscan4):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel4 x nscan4):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel4 x nscan4):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
```

```
    ia = incidenceAngle(i,pixel,scan)
    sga = sunGlintAngle(i,pixel,scan)

  The incidenceAngleIndex is the same for every scan,
  but is repeated each scan for the convenience of users
  reading the data scan by scan.  In addition,
  incidenceAngleIndex is located in metadata for the
  convenience of users wishing to read this information
  from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel4 x npixel4 x nscan4):
GPM Common Calibrated Brightness Temperature. The channels are:

```
36.5     GHz vertically-polarized   TBs
36.5     GHz horizontally-polarized TBs
```

S5 (Swath)

S5_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S5_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S5)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan5):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan5):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan5):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan5):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan5):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan5):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan5):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan5):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan5):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel5 x nscan5):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel5 x nscan5):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel5 x nscan5):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S5)

SCorientation (2-byte integer, array size: nscan5):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan5):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan5):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan5):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan5):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel5 x nscan5):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion
```

```
  -1  =  Data is missing from file or unreadable, missing scan
  -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
  -3  =  Error in geolocation
  -4  =  Data is missing in 1 channel
  -5  =  Data is missing in multiple channels
  -6  =  Lat/Lon values are out of range
  -7  =  Non-normal status modes
 -10  =  Distance to its corresponding LF pixel exceeds 7Km
         threshold.   used in L1C-R product only
 -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA5 x npixel5 x nscan5):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA5 x npixel5 x nscan5):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel5 x nscan5):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
```

```
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel5 x npixel5 x nscan5):
GPM Common Calibrated Brightness Temperature. The channels are:

```
89 GHz vertically-polarized   TBs
89 GHz horizontally-polarized TBs
```

S6 (Swath)

S6_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S6_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S6)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan6):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan6):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan6):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan6):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan6):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan6):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan6):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan6):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan6):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel6 x nscan6):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel6 x nscan6):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel6 x nscan6):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S6)

SCorientation (2-byte integer, array size: nscan6):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan6):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan6):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan6):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan6):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel6 x nscan6):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
```

```
  -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
  -3  =  Error in geolocation
  -4  =  Data is missing in 1 channel
  -5  =  Data is missing in multiple channels
  -6  =  Lat/Lon values are out of range
  -7  =  Non-normal status modes
 -10  =  Distance to its corresponding LF pixel exceeds 7Km
         threshold.   used in L1C-R product only
 -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA6 x npixel6 x nscan6):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA6 x npixel6 x nscan6):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel6 x nscan6):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
```

```
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel6 x npixel6 x nscan6):
GPM Common Calibrated Brightness Temperature. The channels are:

```
89 GHz vertically-polarized TBs
89 GHz horizontally-polarized TBs
```

C Structure Header file:

```
#ifndef _TK_1CAMSR2_H_
#define _TK_1CAMSR2_H_

#ifndef _L1CAMSR2_S6_
#define _L1CAMSR2_S6_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[486];
    float Longitude[486];
    float sunLocalTime[486];
    SCSTATUS SCstatus;
    signed char Quality[486];
    float incidenceAngle[486][1];
    signed char sunGlintAngle[486][1];
    signed char incidenceAngleIndex[2];
    float Tc[486][2];
} L1CAMSR2_S6;

#endif

#ifndef _L1CAMSR2_S5_
#define _L1CAMSR2_S5_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[486];
    float Longitude[486];
```

```
    float sunLocalTime[486];
    SCSTATUS SCstatus;
    signed char Quality[486];
    float incidenceAngle[486][1];
    signed char sunGlintAngle[486][1];
    signed char incidenceAngleIndex[2];
    float Tc[486][2];
} L1CAMSR2_S5;

#endif

#ifndef _L1CAMSR2_S4_
#define _L1CAMSR2_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    float sunLocalTime[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSR2_S4;

#endif

#ifndef _L1CAMSR2_S3_
#define _L1CAMSR2_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    float sunLocalTime[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
```

```
} L1CAMSR2_S3;

#endif

#ifndef _L1CAMSR2_S2_
#define _L1CAMSR2_S2_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    float sunLocalTime[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSR2_S2;

#endif

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
```

```
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CAMSR2_S1_
#define _L1CAMSR2_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[243];
    float Longitude[243];
    float sunLocalTime[243];
    SCSTATUS SCstatus;
    signed char Quality[243];
    float incidenceAngle[243][1];
    signed char sunGlintAngle[243][1];
    signed char incidenceAngleIndex[2];
    float Tc[243][2];
} L1CAMSR2_S1;

#endif

#ifndef _L1CAMSR2_SWATHS_
#define _L1CAMSR2_SWATHS_

typedef struct {
    L1CAMSR2_S1 S1;
    L1CAMSR2_S2 S2;
    L1CAMSR2_S3 S3;
    L1CAMSR2_S4 S4;
    L1CAMSR2_S5 S5;
    L1CAMSR2_S6 S6;
} L1CAMSR2_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CAMSR2_S6/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(486)
    REAL*4 Longitude(486)
    REAL*4 sunLocalTime(486)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(486)
    REAL*4 incidenceAngle(1,486)
    BYTE sunGlintAngle(1,486)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,486)
END STRUCTURE

STRUCTURE /L1CAMSR2_S5/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(486)
    REAL*4 Longitude(486)
    REAL*4 sunLocalTime(486)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(486)
    REAL*4 incidenceAngle(1,486)
    BYTE sunGlintAngle(1,486)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,486)
END STRUCTURE

STRUCTURE /L1CAMSR2_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    REAL*4 sunLocalTime(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /L1CAMSR2_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
```

```
    REAL*4 Longitude(243)
    REAL*4 sunLocalTime(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /L1CAMSR2_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    REAL*4 sunLocalTime(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE
```

```
STRUCTURE /L1CAMSR2_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(243)
    REAL*4 Longitude(243)
    REAL*4 sunLocalTime(243)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(243)
    REAL*4 incidenceAngle(1,243)
    BYTE sunGlintAngle(1,243)
    BYTE incidenceAngleIndex(2)
    REAL*4 Tc(2,243)
END STRUCTURE

STRUCTURE /L1CAMSR2_SWATHS/
    RECORD /L1CAMSR2_S1/ S1;
    RECORD /L1CAMSR2_S2/ S2;
    RECORD /L1CAMSR2_S3/ S3;
    RECORD /L1CAMSR2_S4/ S4;
    RECORD /L1CAMSR2_S5/ S5;
    RECORD /L1CAMSR2_S6/ S6;
END STRUCTURE
```

5.26 1CMHS - Common Calibrated Brightness Temperature

1CMHS contains common calibrated brightness temperature from the MHS passive microwave instrument flown on the NOAA and METOPS satellites. Swath S1 is the only swath and has 5 channels (89.0GHzV, 157.0GHzV, 183.31GHz+/-1GHzH, 183.31GHz+/-3GHzH, and 190.31GHzV). MHS is very similar to AMSU-B. The scan period is 2.667s.

RELATION BETWEEN THE SWATHS: S1 is the only swath, containing observations sampled 90 times along the scan.

KNOWN PROBLEMS OR ISSUES WITH REVISION 1 DATA: None.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	5	Number of Swath 1 channels.
npixel1	90	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.

Figure 394 through Figure 397 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

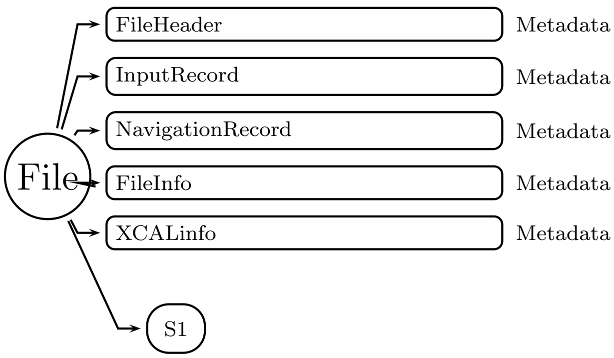


Figure 394: Data Format Structure for 1CMHS, Common Calibrated Brightness Temperature

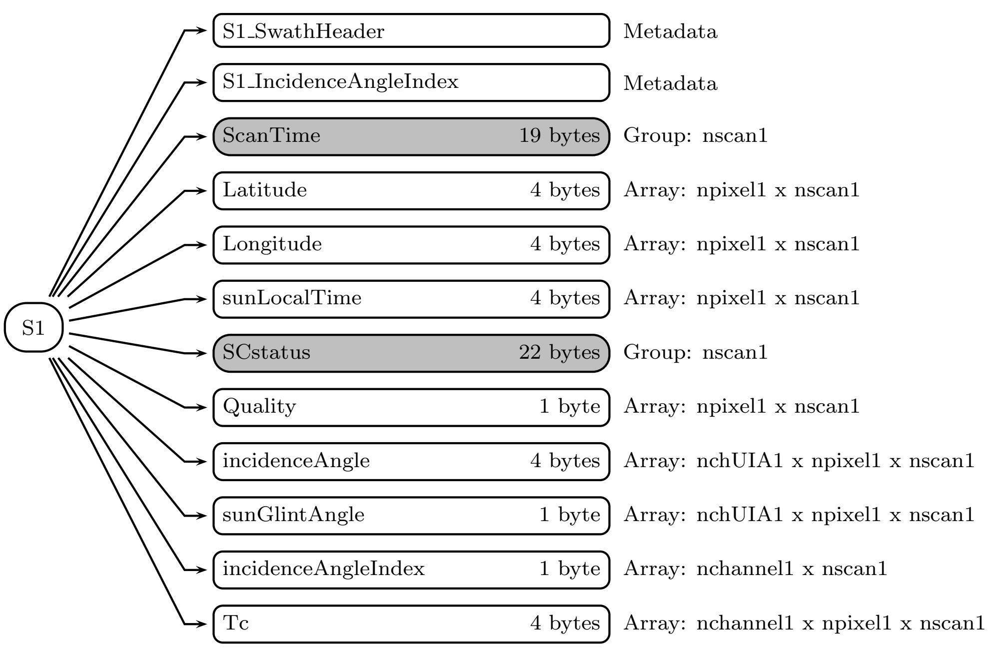


Figure 395: Data Format Structure for 1CMHS, S1

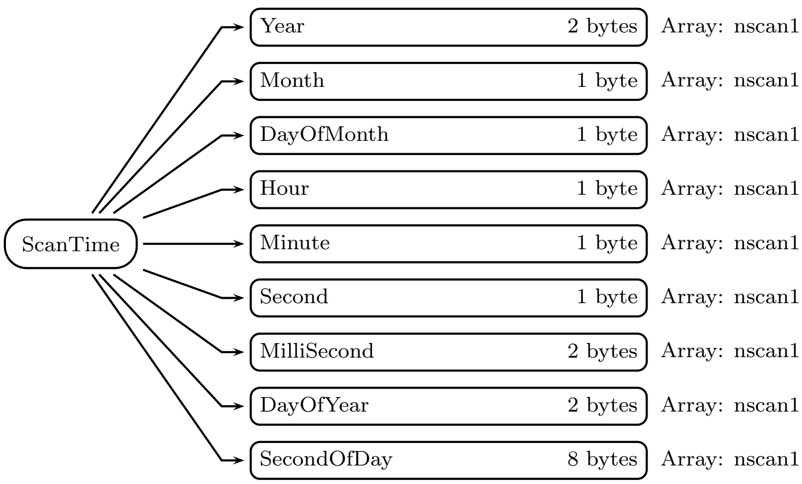


Figure 396: Data Format Structure for 1CMHS, ScanTime

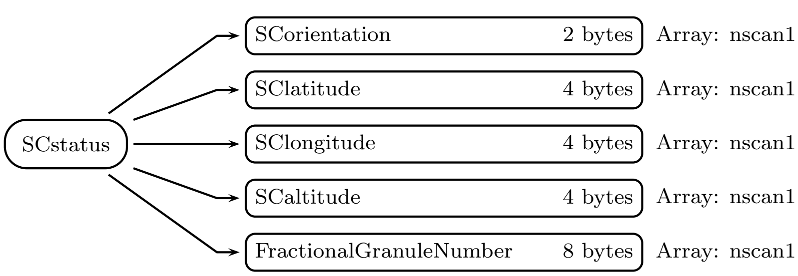


Figure 397: Data Format Structure for 1CMHS, SCstatus

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion
```

```
    100 = Possible calibration issue

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)

-100 =  parity error detected
-101 =  major frame error detected
-102 =  minor frame error detected
-103 =  sync error detected
-104 =  transmitter status change occurred
-105 =  instrument status changed with this scan
-106 =  insufficient data for calibration
-107 =  time sequence error detected within this scan
-108 =  do not use this scan for production generation
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
```

```
    sunGlintAngle(2,npixel,nscan)
    incidenceAngleIndex(10,nscan)
    Tc(10,npixel,nscan)

  The user would do the following to retreive the angles
  for a given channel, pixel, and scan:

    i = incidenceAngleIndex(channel,scan)
    ia = incidenceAngle(i,pixel,scan)
    sga = sunGlintAngle(i,pixel,scan)

  The incidenceAngleIndex is the same for every scan,
  but is repeated each scan for the convenience of users
  reading the data scan by scan.  In addition,
  incidenceAngleIndex is located in metadata for the
  convenience of users wishing to read this information
  from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
 89.0   GHz vertically-polarized   TBs
157.0   GHz vertically-polarized   TBs
183.31   GHz +/-1GzH  horizontally-polarized   TBs
183.31   GHz +/-3GzH  horizontally-polarized   TBs
190.31   GHz vertically-polarized   TBs
```

C Structure Header file:

```
#ifndef _TK_1CMHS_H_
#define _TK_1CMHS_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
```

```
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CMHS_S1_
#define _L1CMHS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    float sunLocalTime[90];
    SCSTATUS SCstatus;
    signed char Quality[90];
    float incidenceAngle[90][1];
    signed char sunGlintAngle[90][1];
    signed char incidenceAngleIndex[5];
    float Tc[90][5];
} L1CMHS_S1;

#endif

#ifndef _L1CMHS_SWATHS_
#define _L1CMHS_SWATHS_
```

```
typedef struct {
    L1CMHS_S1 S1;
} L1CMHS_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CMHS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    REAL*4 sunLocalTime(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(90)
    REAL*4 incidenceAngle(1,90)
    BYTE sunGlintAngle(1,90)
    BYTE incidenceAngleIndex(5)
    REAL*4 Tc(5,90)
END STRUCTURE
```

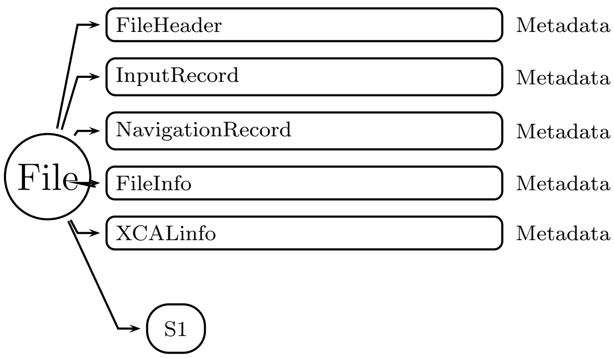


Figure 398: Data Format Structure for 1CSAPHIR, Common Calibrated Brightness Temperature

```
STRUCTURE /L1CMHS_SWATHS/
    RECORD /L1CMHS_S1/ S1;
END STRUCTURE
```

5.27 1CSAPHIR - Common Calibrated Brightness Temperature

1CSAPHIR contains common calibrated brightness temperature from the SAPHIR passive microwave instrument flown on the Megha-Tropiques satellite. Swath S1 is the only swath and has 6 channels (S1 S2 S3 S4 S5 S6) The channels are 183.31 +/- delta GHz, where delta = 0.2, 1.1, 2.8, 4.2, 6.8, 11.0.

RELATION BETWEEN THE SWATHS: S1 is the only swath, containing observations sampled 182 times along the scan.

KNOWN PROBLEMS OR ISSUES WITH REVISION 1 DATA: None.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	6	Number of Swath 1 channels.
npixel1	182	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.

Figure 398 through Figure 401 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information

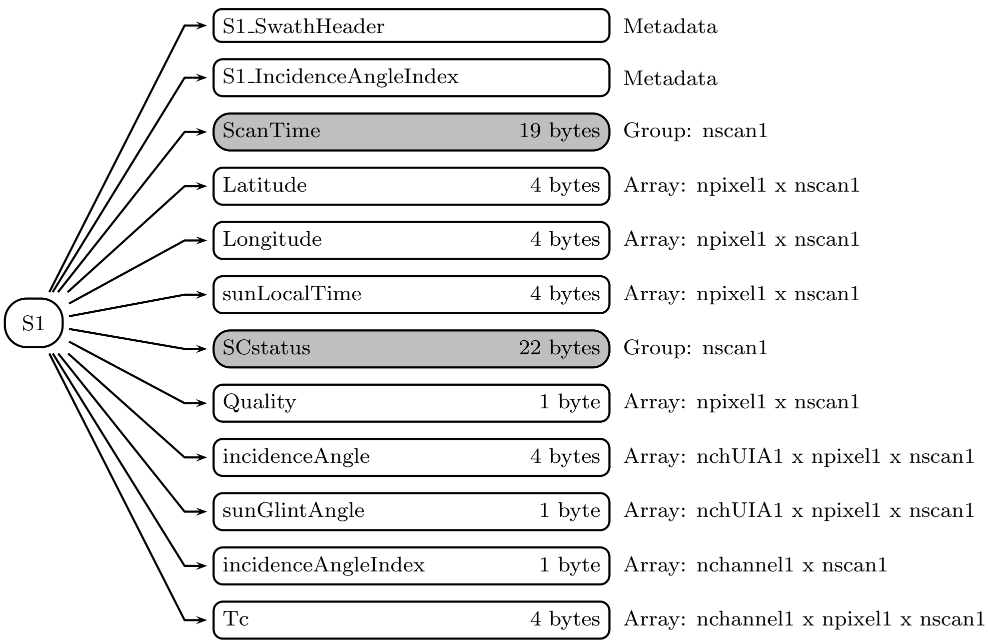


Figure 399: Data Format Structure for 1CSAPHIR, S1

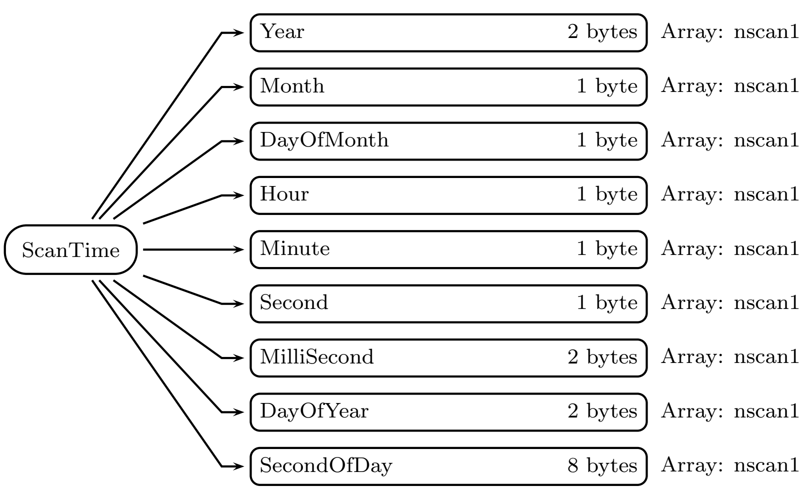


Figure 400: Data Format Structure for 1CSAPHIR, ScanTime

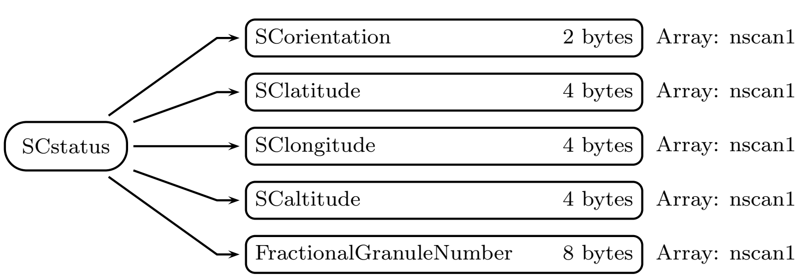


Figure 401: Data Format Structure for 1CSAPHIR, SCstatus

separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values

are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
          1-99 = Generic flags (all sensors)
       100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
        -(1-98) = Generic flags (all sensors)
            -99 = Missing value (no quality information available)
     -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

 101 = Backward scanning

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
```

```
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)

-100 = Invalid scan
-101 = Scan error
-102 = date/time error
-103 = PRT error
-104 = CRC error
-105 = Payload not nominal
-110 = Channel is off
-111 = L0 count saturated or has poor value
-112 = Hot/cold count not available
-113 = Calibration issue
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:
```

```
    i = incidenceAngleIndex(channel,scan)
    ia = incidenceAngle(i,pixel,scan)
    sga = sunGlintAngle(i,pixel,scan)

  The incidenceAngleIndex is the same for every scan,
  but is repeated each scan for the convenience of users
  reading the data scan by scan.  In addition,
  incidenceAngleIndex is located in metadata for the
  convenience of users wishing to read this information
  from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
(S1 S2 S3 S4 S5 S6)
      183.31 +/- delta GHz, where
      delta = 0.2, 1.1, 2.8, 4.2, 6.8, 11.0.
```

C Structure Header file:

```
#ifndef _TK_1CSAPHIR_H_
#define _TK_1CSAPHIR_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_
```

```
typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CSAPHIR_S1_
#define _L1CSAPHIR_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[182];
    float Longitude[182];
    float sunLocalTime[182];
    SCSTATUS SCstatus;
    signed char Quality[182];
    float incidenceAngle[182][1];
    signed char sunGlintAngle[182][1];
    signed char incidenceAngleIndex[6];
    float Tc[182][6];
} L1CSAPHIR_S1;

#endif

#ifndef _L1CSAPHIR_SWATHS_
#define _L1CSAPHIR_SWATHS_

typedef struct {
    L1CSAPHIR_S1 S1;
} L1CSAPHIR_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CSAPHIR_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(182)
    REAL*4 Longitude(182)
    REAL*4 sunLocalTime(182)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(182)
    REAL*4 incidenceAngle(1,182)
    BYTE sunGlintAngle(1,182)
    BYTE incidenceAngleIndex(6)
    REAL*4 Tc(6,182)
END STRUCTURE

STRUCTURE /L1CSAPHIR_SWATHS/
    RECORD /L1CSAPHIR_S1/ S1;
END STRUCTURE
```

5.28 1CATMS - Common Calibrated Brightness Temperature

1CATMS contains common calibrated brightness temperature from the ATMS passive microwave instrument flown on the Suomi NPP satellite and JPSS satellites. ATMS is approximatly a combination of the AMSU-A channels and the MHS channels. ATMS rotates 3 scans per 8 seconds. ATMS has the following 22 channels:

```
Ch  GHz                 Pol
1   23.8                QV
2   31.4                QV
3   50.3                QH
4   51.76               QH
5   52.8                QH
6   53.596+-0.115       QH
7   54.4                QH
8   54.94               QH
9   55.5                QH
10  fo = 57.29          QH
11  fo+-0.3222+-0.217   QH
12  fo+-0.3222+-0.048   QH
13  fo+-0.3222+-0.022   QH
14  fo+-0.3222+-0.010   QH
15  fo+-0.3222+-0.0045  QH
16  88.2                QV
17  165.5               QH
18  183.31+-7           QH
19  183.31+-4.5         QH
20  183.31+-3           QH
21  183.31+-1.8         QH
22  183.31+-1           QH

QV means quasi-vertical;
the polarization vector is parallel
to the scan plane at nadir.
QH meansquasi-horizontal polarization.


Note on geolocation and 1C swaths:
The BeamLatitude and BeamLongitude in 1BASEATMS
have a band dimension of 5.  Lat and lon is for channels
1,2,3,16,17.  Each 1C swath will contain one band:

1C swath    Band    IEEE GHz       Ch geo    Chs in band
1           K       18-26.5        1         1
```

```
                  2           A(Ka)  26.5-40        2         2
                  3           W      75-110         16        16
                  4           G      110-300        17        17-22

Note that channels 3-15 are NOT included
in the 1C product.
```

1CATMS contains 4 swaths, one for each band K, A(Ka), W, and G.

RELATION BETWEEN THE SWATHS: All 4 swaths contain observations sampled 96 times along the scan.

KNOWN PROBLEMS OR ISSUES WITH REVISION 1 DATA: None.

Dimension definitions:

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	1	Number of Swath 1 channels.
npixel1	96	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.
nscan2	var	Number of Swath 2 scans in the granule.
nchannel2	1	Number of Swath 2 channels.
npixel2	96	Number of Swath 2 pixels in one scan.
nchUIA2	1	Number of Swath S2 unique incidence angles.
nscan3	var	Number of Swath 3 scans in the granule.
nchannel3	1	Number of Swath 3 channels.
npixel3	96	Number of Swath 3 pixels in one scan.
nchUIA3	1	Number of Swath S3 unique incidence angles.
nscan4	var	Number of Swath 4 scans in the granule.
nchannel4	6	Number of Swath 4 channels.
npixel4	96	Number of Swath 4 pixels in one scan.
nchUIA4	1	Number of Swath S4 unique incidence angles.

Figure 402 through Figure 414 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

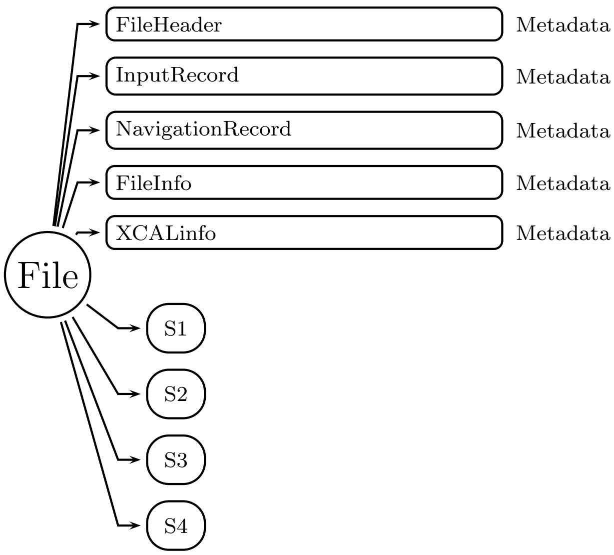


Figure 402: Data Format Structure for 1CATMS, Common Calibrated Brightness Temperature

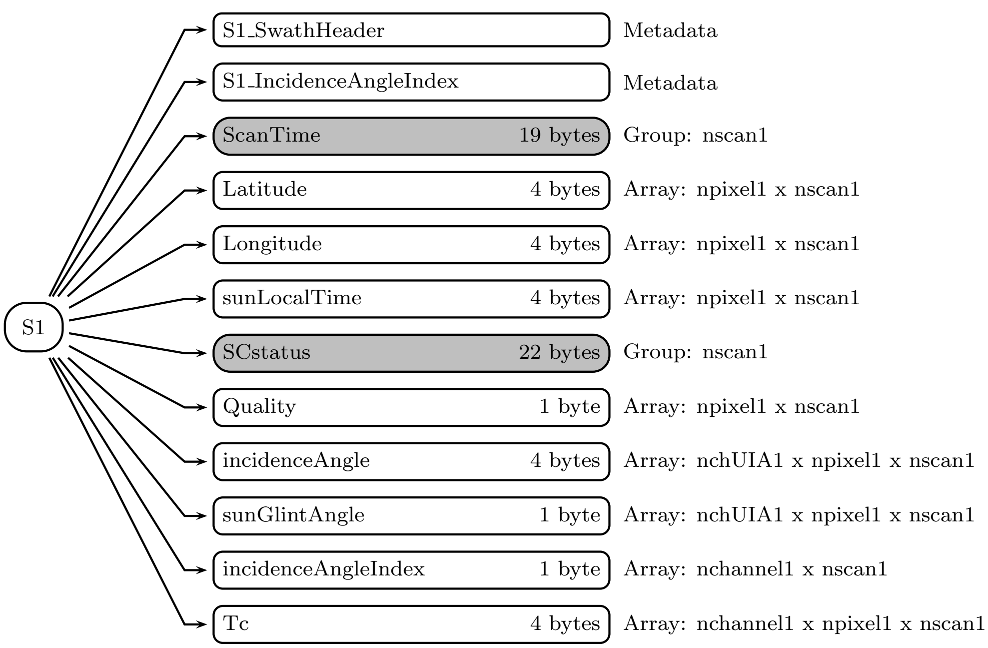


Figure 403: Data Format Structure for 1CATMS, S1

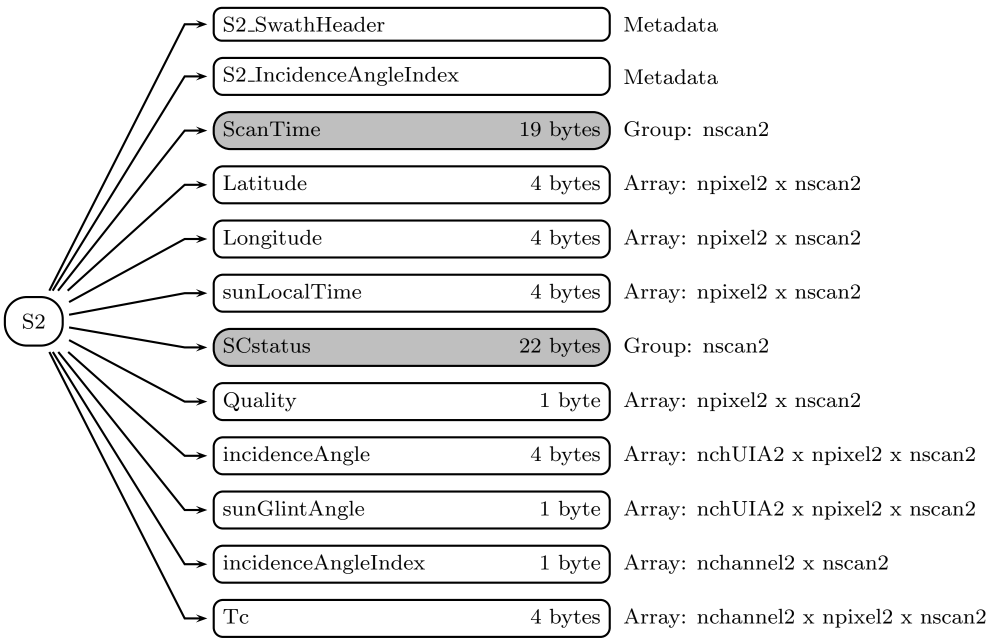


Figure 404: Data Format Structure for 1CATMS, S2

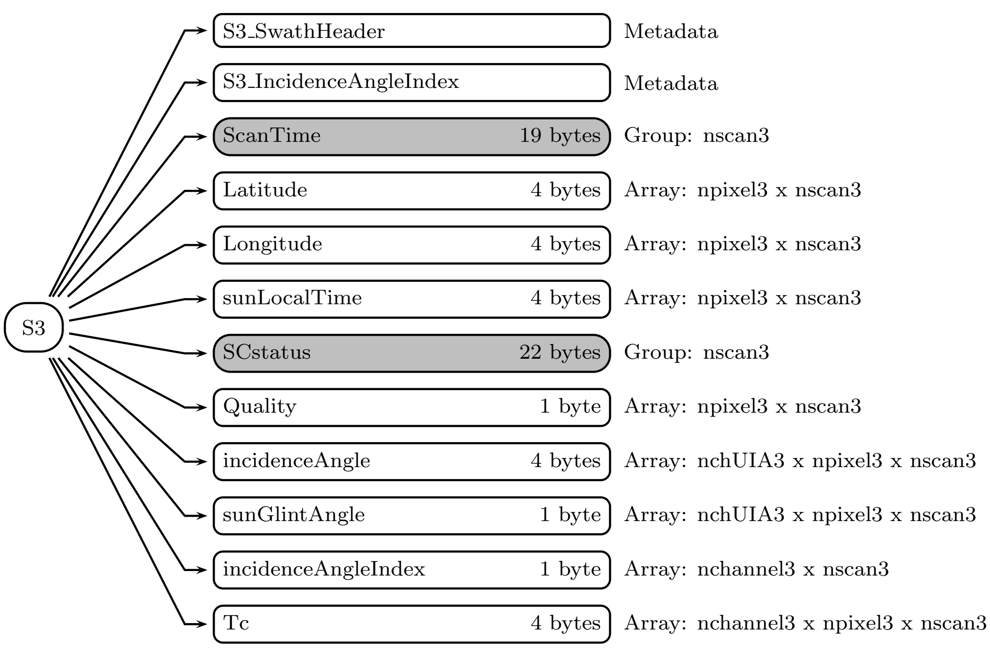


Figure 405: Data Format Structure for 1CATMS, S3

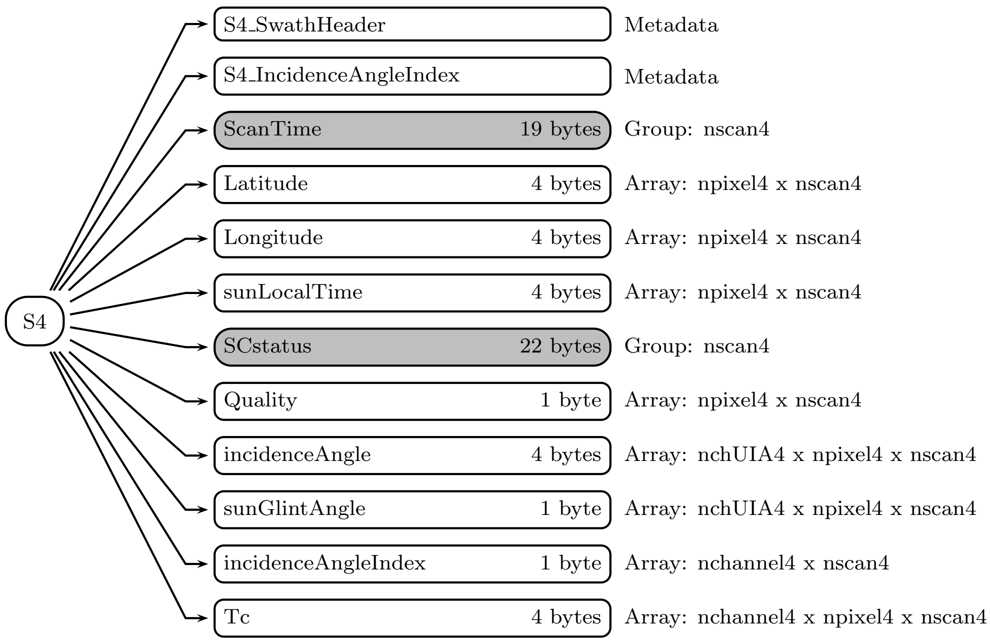


Figure 406: Data Format Structure for 1CATMS, S4

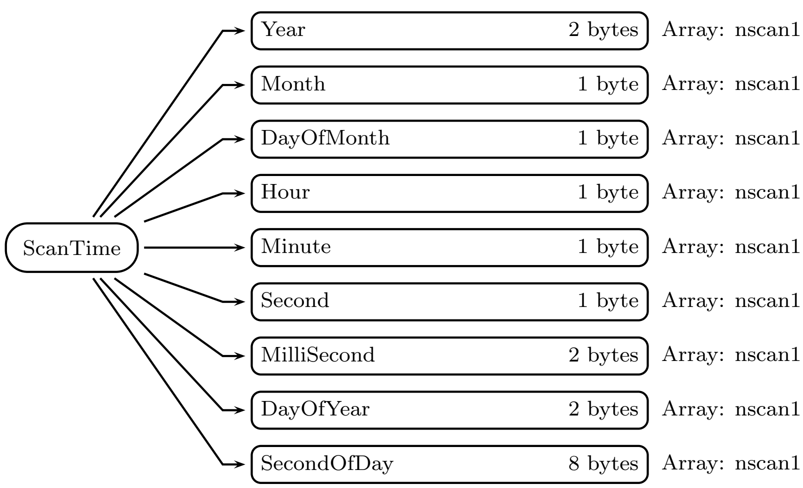


Figure 407: Data Format Structure for 1CATMS, S1, ScanTime

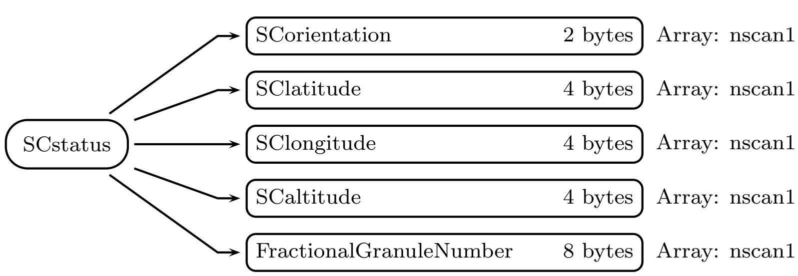


Figure 408: Data Format Structure for 1CATMS, S1, SCstatus

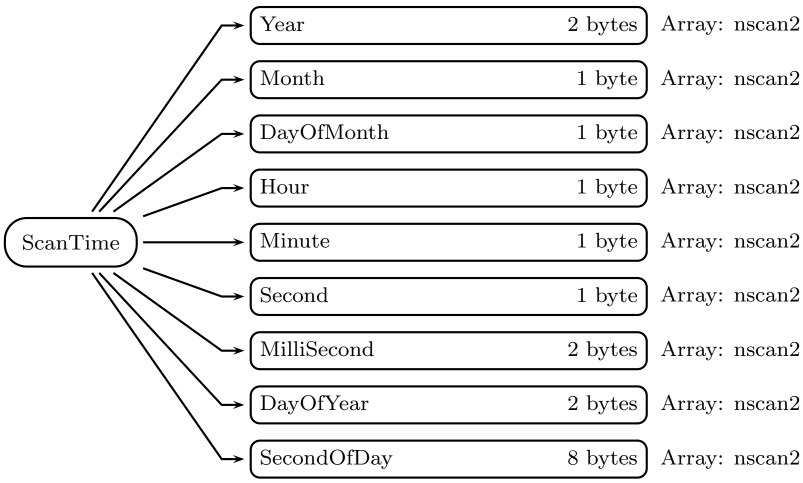


Figure 409: Data Format Structure for 1CATMS, S2, ScanTime

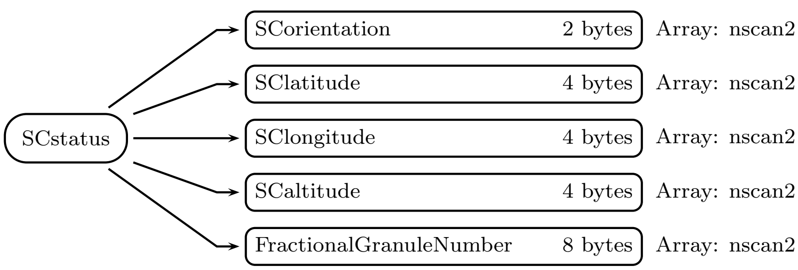


Figure 410: Data Format Structure for 1CATMS, S2, SCstatus

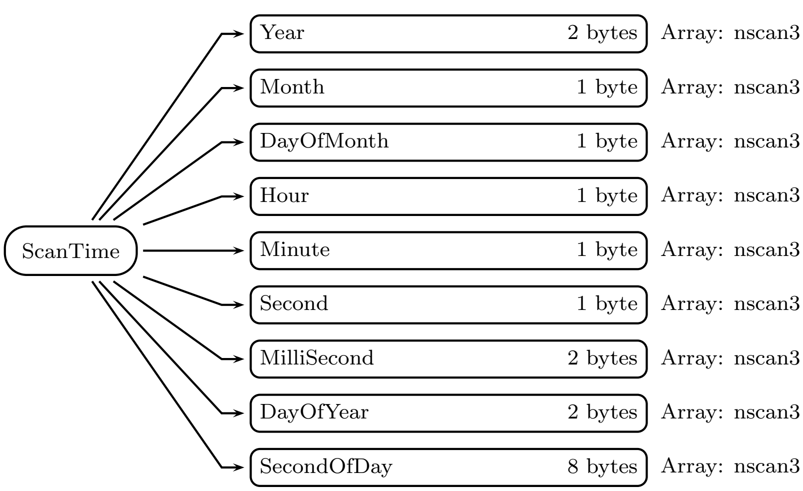


Figure 411: Data Format Structure for 1CATMS, S3, ScanTime

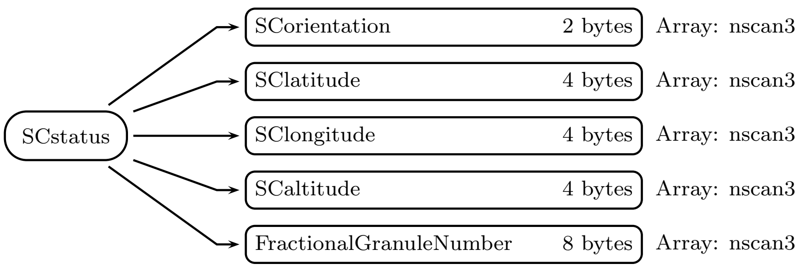


Figure 412: Data Format Structure for 1CATMS, S3, SCstatus

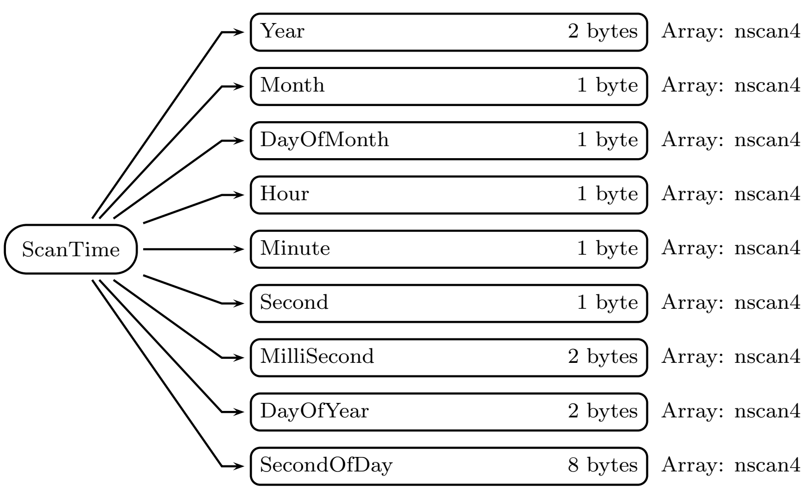


Figure 413: Data Format Structure for 1CATMS, S4, ScanTime

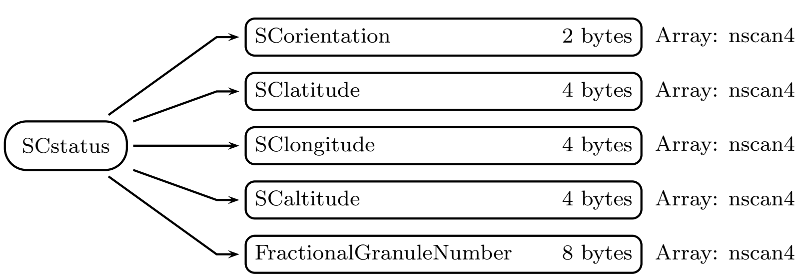


Figure 414: Data Format Structure for 1CATMS, S4, SCstatus

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
```

```
  -10  =  Distance to its corresponding LF pixel exceeds 7Km
          threshold.   used in L1C-R product only
  -99  =        Missing value (no quality information available)

-100 = Missing scan indicated by QF19\_SCAN\_ATMSSDR
-101 = Time sequence error
-102 = Insufficient KAV PRT data
-103 = Insufficient WG PRT data
-104 = Space view antenna position error
-105 = Blackbody view antenna position error
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
```

```
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
23.8   GHz quasi vertically-polarized   TBs
```

S2 (Swath)

S2_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S2_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan2):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan2):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan2):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan2):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan2):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel2 x nscan2):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel2 x nscan2):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel2 x nscan2):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values

are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan2):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel2 x nscan2):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
```

```
  -6  =  Lat/Lon values are out of range
  -7  =  Non-normal status modes
 -10  =  Distance to its corresponding LF pixel exceeds 7Km
         threshold.   used in L1C-R product only
 -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2):
GPM Common Calibrated Brightness Temperature. The channels are:

```
31.4   GHz quasi-vertically-polarized   TBs
```

S3 (Swath)

S3_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S3_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan3):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan3):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan3):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan3):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel3 x nscan3):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel3 x nscan3):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel3 x nscan3):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan3):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel3 x nscan3):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA3 x npixel3 x nscan3):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA3 x npixel3 x nscan3):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3):
GPM Common Calibrated Brightness Temperature. The channels are:

```
 88.2   GHz quasi-vertically-polarized   TBs
```

S4 (Swath)

S4_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S4_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan4):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan4):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan4):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan4):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan4):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan4):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan4):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan4):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan4):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel4 x nscan4):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel4 x nscan4):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel4 x nscan4):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan4):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan4):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan4):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan4):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan4):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel4 x nscan4):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)
```

incidenceAngle (4-byte float, array size: nchUIA4 x npixel4 x nscan4):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA4 x npixel4 x nscan4):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel4 x nscan4):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel4 x npixel4 x nscan4):
GPM Common Calibrated Brightness Temperature. The channels are:

```
165.5         GHz   quasi-horizontally-polarized   TBs
183.31+-7     GHz   quasi-horizontally-polarized   TBs
183.31+-4.5   GHz   quasi-horizontally-polarized   TBs
183.31+-3     GHz   quasi-horizontally-polarized   TBs
183.31+-1.8   GHz   quasi-horizontally-polarized   TBs
183.31+-1     GHz   quasi-horizontally-polarized   TBs
```

C Structure Header file:

```
#ifndef _TK_1CATMS_H_
#define _TK_1CATMS_H_

#ifndef _L1CATMS_S4_
#define _L1CATMS_S4_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    float sunLocalTime[96];
    SCSTATUS SCstatus;
    signed char Quality[96];
    float incidenceAngle[96][1];
    signed char sunGlintAngle[96][1];
    signed char incidenceAngleIndex[6];
    float Tc[96][6];
} L1CATMS_S4;

#endif

#ifndef _L1CATMS_S3_
#define _L1CATMS_S3_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    float sunLocalTime[96];
    SCSTATUS SCstatus;
    signed char Quality[96];
    float incidenceAngle[96][1];
    signed char sunGlintAngle[96][1];
    signed char incidenceAngleIndex[1];
    float Tc[96][1];
} L1CATMS_S3;

#endif

#ifndef _L1CATMS_S2_
#define _L1CATMS_S2_
```

```
typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    float sunLocalTime[96];
    SCSTATUS SCstatus;
    signed char Quality[96];
    float incidenceAngle[96][1];
    signed char sunGlintAngle[96][1];
    signed char incidenceAngleIndex[1];
    float Tc[96][1];
} L1CATMS_S2;

#endif

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;
```

```
#endif

#ifndef _L1CATMS_S1_
#define _L1CATMS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    float sunLocalTime[96];
    SCSTATUS SCstatus;
    signed char Quality[96];
    float incidenceAngle[96][1];
    signed char sunGlintAngle[96][1];
    signed char incidenceAngleIndex[1];
    float Tc[96][1];
} L1CATMS_S1;

#endif

#ifndef _L1CATMS_SWATHS_
#define _L1CATMS_SWATHS_

typedef struct {
    L1CATMS_S1 S1;
    L1CATMS_S2 S2;
    L1CATMS_S3 S3;
    L1CATMS_S4 S4;
} L1CATMS_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1CATMS_S4/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    REAL*4 sunLocalTime(96)
    RECORD /SCSTATUS/ SCstatus
```

```
    BYTE Quality(96)
    REAL*4 incidenceAngle(1,96)
    BYTE sunGlintAngle(1,96)
    BYTE incidenceAngleIndex(6)
    REAL*4 Tc(6,96)
END STRUCTURE

STRUCTURE /L1CATMS_S3/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    REAL*4 sunLocalTime(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(96)
    REAL*4 incidenceAngle(1,96)
    BYTE sunGlintAngle(1,96)
    BYTE incidenceAngleIndex(1)
    REAL*4 Tc(1,96)
END STRUCTURE

STRUCTURE /L1CATMS_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    REAL*4 sunLocalTime(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(96)
    REAL*4 incidenceAngle(1,96)
    BYTE sunGlintAngle(1,96)
    BYTE incidenceAngleIndex(1)
    REAL*4 Tc(1,96)
END STRUCTURE

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
```

```
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CATMS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    REAL*4 sunLocalTime(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(96)
    REAL*4 incidenceAngle(1,96)
    BYTE sunGlintAngle(1,96)
    BYTE incidenceAngleIndex(1)
    REAL*4 Tc(1,96)
END STRUCTURE

STRUCTURE /L1CATMS_SWATHS/
    RECORD /L1CATMS_S1/ S1;
    RECORD /L1CATMS_S2/ S2;
    RECORD /L1CATMS_S3/ S3;
    RECORD /L1CATMS_S4/ S4;
END STRUCTURE
```

5.29 1CAMSUB - Common Calibrated Brightness Temperature

1CAMSUB contains common calibrated brightness temperature from the AMSU-B passive microwave instrument flown on the NOAA satellites. Swath S1 is the only swath and has 5 channels (89.0 +/- 0.9 GHz, 150.0 +/- 0.9 GHz, 183.31 +/- 1 GHz, 183.31 +/- 3 GHz, and 183.31 +/- 7 GHz) AMSU-B is very similar to MHS. The scan period is 2.667s.

RELATION BETWEEN THE SWATHS: S1 is the only swath, containing observations sampled 90 times along the scan.

KNOWN PROBLEMS OR ISSUES WITH REVISION 1 DATA: None.

Dimension definitions:

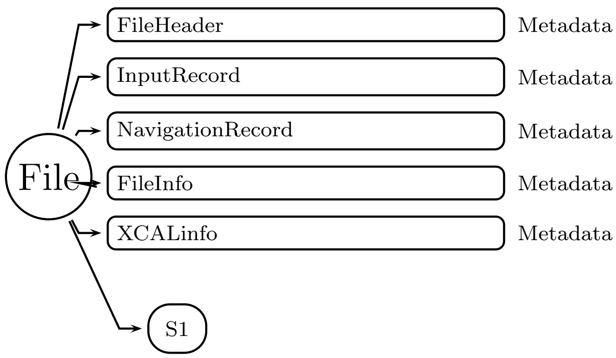


Figure 415: Data Format Structure for 1CAMSUB, Common Calibrated Brightness Temperature

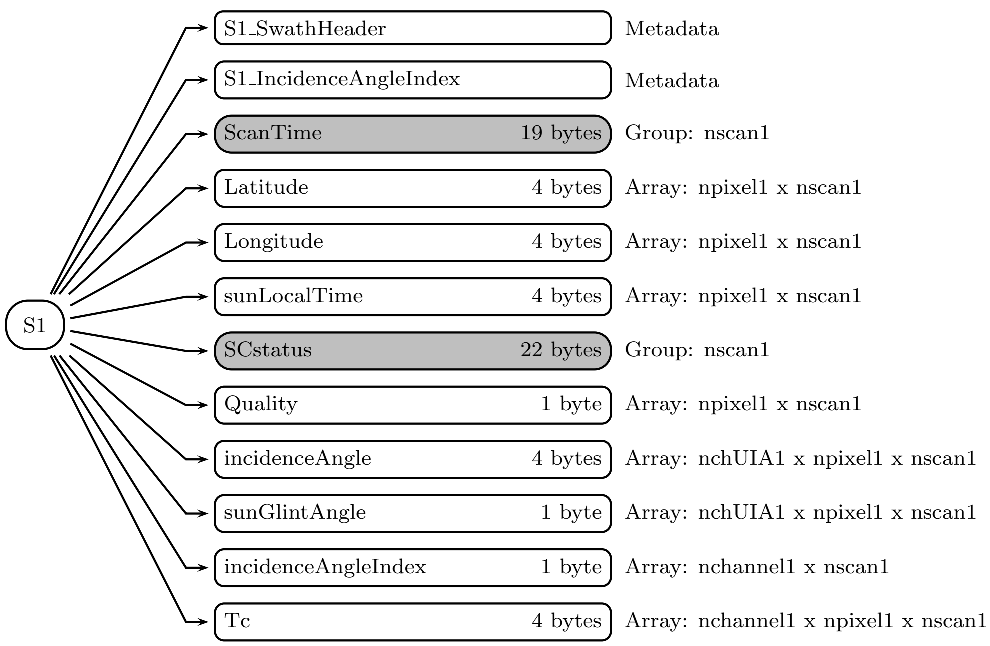


Figure 416: Data Format Structure for 1CAMSUB, S1

nscan1	var	Number of Swath 1 scans in the granule.
nchannel1	5	Number of Swath 1 channels.
npixel1	90	Number of Swath 1 pixels in one scan.
nchUIA1	1	Number of Swath S1 unique incidence angles.

Figure 415 through Figure 418 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):

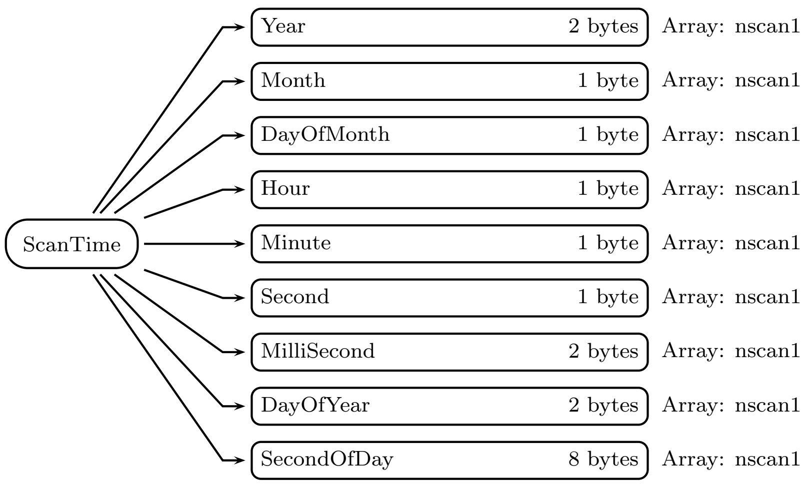


Figure 417: Data Format Structure for 1CAMSUB, ScanTime

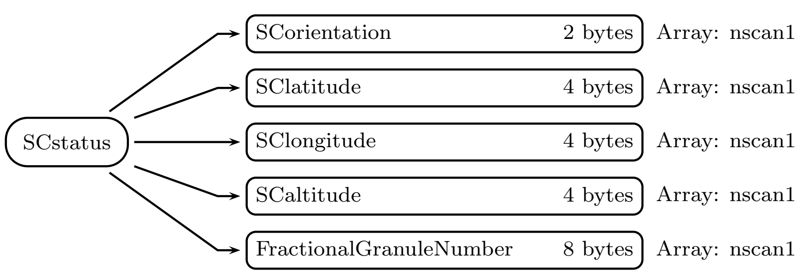


Figure 418: Data Format Structure for 1CAMSUB, SCstatus

InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

XCALinfo (Metadata):
XCALinfo contains metadata required by 1C intercalibrated files. See Metadata for GPM Products for details.

S1 (Swath)

S1_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

S1_IncidenceAngleIndex (Metadata):
IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan1):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan1):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan1):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan1):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan1):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel1 x nscan1):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel1 x nscan1):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel1 x nscan1):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan1):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values

are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan1):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

Quality (1-byte integer, array size: npixel1 x nscan1):
Quality of Tc in the swath.

```
GENERAL SPECIFICATIONS:
   0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
             1-99 = Generic flags (all sensors)
          100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
          -(1-98) = Generic flags (all sensors)
              -99 = Missing value (no quality information available)
       -(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:
     1  =  Possible sunGlint,  0 le sunGlintAngle lt 20
     2  =  Possible radio frequency interference
     3  =  Degraded geolocation data
     4  =  Data corrected for warm load instrusion

    -1  =  Data is missing from file or unreadable, missing scan
    -2  =  Invalid Tb or unphysical brightness temperature Tb lt 50 or Tb gt 350
    -3  =  Error in geolocation
    -4  =  Data is missing in 1 channel
    -5  =  Data is missing in multiple channels
```

```
    -6  =  Lat/Lon values are out of range
    -7  =  Non-normal status modes
   -10  =  Distance to its corresponding LF pixel exceeds 7Km
           threshold.   used in L1C-R product only
   -99  =        Missing value (no quality information available)

-100 =  data not useable in 89 GHz channel
-101 =  data not useable in 150 GHz channel
-102 =  data not useable in 183+/-1 GHz channel
-103 =  data not useable in 183+/-3 GHz channel
-104 =  data not useable in 183+/-7 GHz channel
-105 =  data not useable in multiple channels
```

incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1):
Earth incidence angle, the angle of the satellite from the local zenith as seen at the pixel location on the earth. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1):
Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1):

```
Index (1 based as in Fortran) of
the incidence angle array corresponding to the channel.
For example, if the swath has 10 channels and
2 unique incidence angles, then the dimensions
in Fortran would be:

  incidenceAngle(2,npixel,nscan)
  sunGlintAngle(2,npixel,nscan)
  incidenceAngleIndex(10,nscan)
  Tc(10,npixel,nscan)

The user would do the following to retreive the angles
for a given channel, pixel, and scan:

  i = incidenceAngleIndex(channel,scan)
  ia = incidenceAngle(i,pixel,scan)
  sga = sunGlintAngle(i,pixel,scan)
```

```
The incidenceAngleIndex is the same for every scan,
but is repeated each scan for the convenience of users
reading the data scan by scan.  In addition,
incidenceAngleIndex is located in metadata for the
convenience of users wishing to read this information
from metadata.
```

Values range from 0 to 100. Special values are defined as:
-99 Missing value

Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1):
GPM Common Calibrated Brightness Temperature. The channels are:

```
 89.0 +/- 0.9 GHz TBs
150.0 +/- 0.9 GHz TBs
183.31 +/- 1 GHz TBs
183.31 +/- 3 GHz TBs
183.31 +/- 7 GHz TBs
```

C Structure Header file:

```
#ifndef _TK_1CAMSUB_H_
#define _TK_1CAMSUB_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
```

```
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1CAMSUB_S1_
#define _L1CAMSUB_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    float sunLocalTime[90];
    SCSTATUS SCstatus;
    signed char Quality[90];
    float incidenceAngle[90][1];
    signed char sunGlintAngle[90][1];
    signed char incidenceAngleIndex[5];
    float Tc[90][5];
} L1CAMSUB_S1;

#endif

#ifndef _L1CAMSUB_SWATHS_
#define _L1CAMSUB_SWATHS_

typedef struct {
    L1CAMSUB_S1 S1;
} L1CAMSUB_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1CAMSUB_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    REAL*4 sunLocalTime(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE Quality(90)
    REAL*4 incidenceAngle(1,90)
    BYTE sunGlintAngle(1,90)
    BYTE incidenceAngleIndex(5)
    REAL*4 Tc(5,90)
END STRUCTURE

STRUCTURE /L1CAMSUB_SWATHS/
    RECORD /L1CAMSUB_S1/ S1;
END STRUCTURE
```

5.30 2AGPROFGMI - Radiometer Profiling

2AGPROFGMI, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 80 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use the 2AGPROFGMI format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	221	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 419 through Figure 423 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

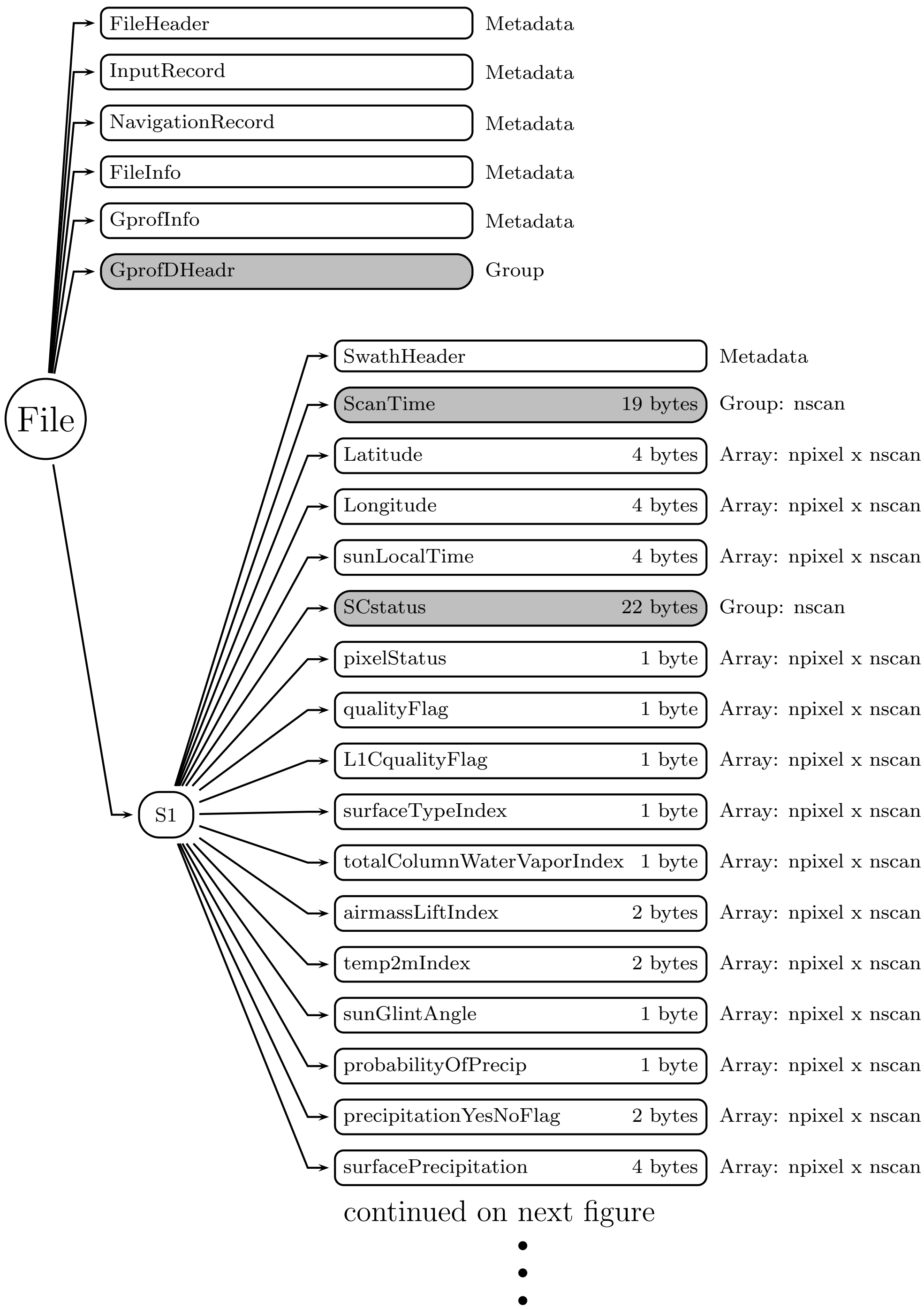


Figure 419: Data Format Structure for 2AGPROFGMI, Radiometer Profiling

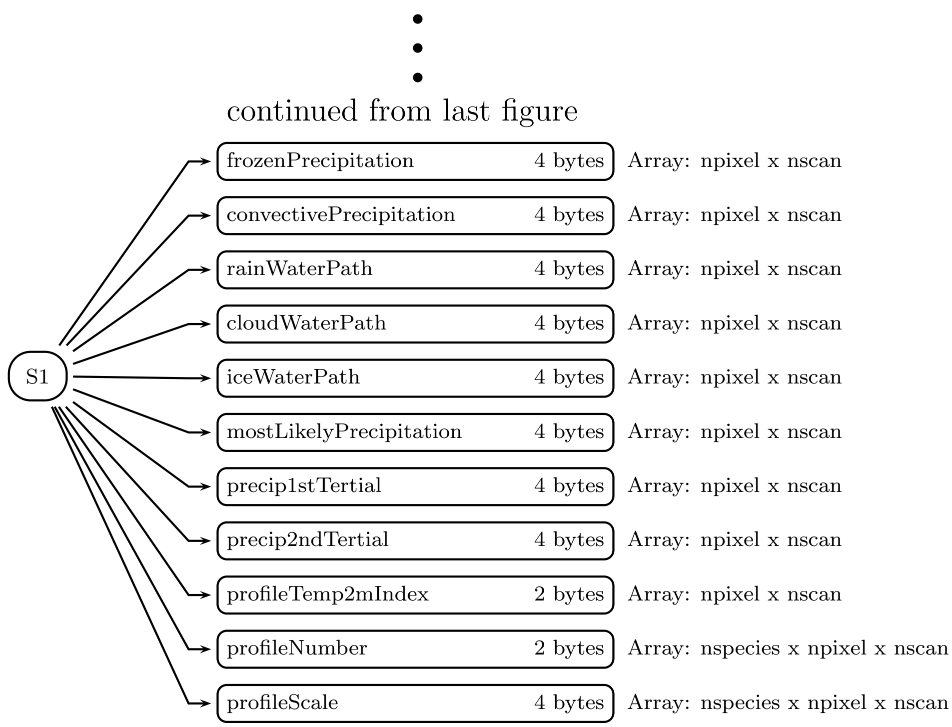


Figure 420: Data Format Structure for 2AGPROFGMI, Radiometer Profiling

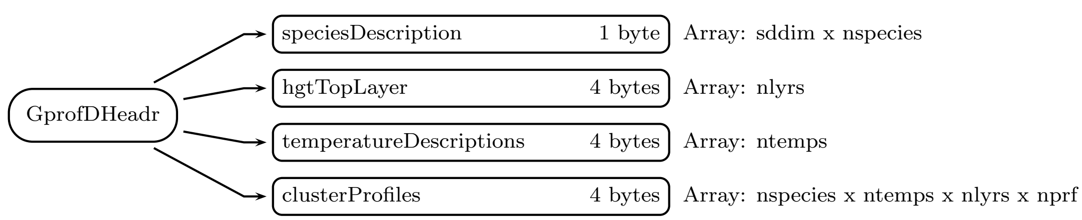


Figure 421: Data Format Structure for 2AGPROFGMI, GprofDHeadr

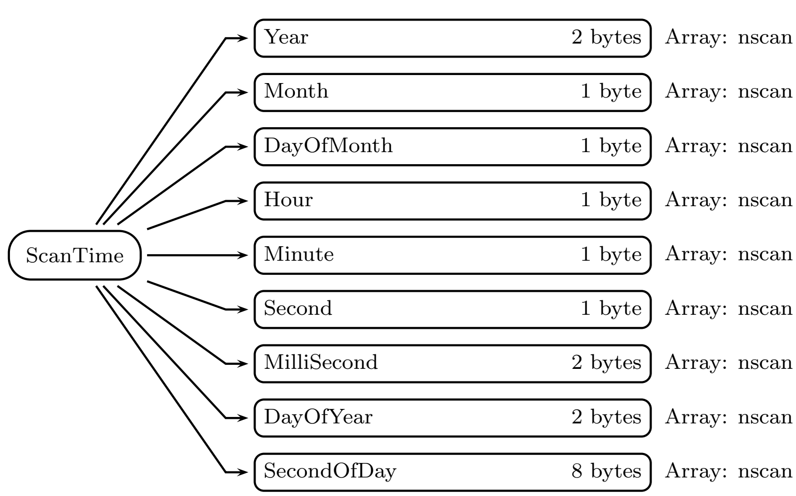


Figure 422: Data Format Structure for 2AGPROFGMI, ScanTime

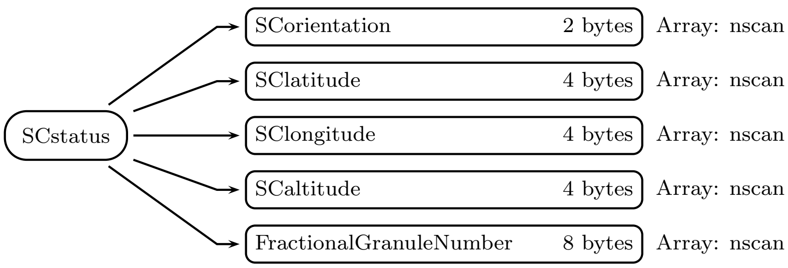


Figure 423: Data Format Structure for 2AGPROFGMI, SCstatus

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value

Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
```

```
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:
-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFGMI_H_
#define _TK_2AGPROFGMI_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif
```

```
#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFGMI_S1_
#define _L2AGPROFGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    float sunLocalTime[221];
    SCSTATUS SCstatus;
    signed char pixelStatus[221];
    signed char qualityFlag[221];
    signed char L1CqualityFlag[221];
    signed char surfaceTypeIndex[221];
    signed char totalColumnWaterVaporIndex[221];
    short airmassLiftIndex[221];
    short temp2mIndex[221];
    signed char sunGlintAngle[221];
    signed char probabilityOfPrecip[221];
    short precipitationYesNoFlag[221];
    float surfacePrecipitation[221];
    float frozenPrecipitation[221];
    float convectivePrecipitation[221];
    float rainWaterPath[221];
    float cloudWaterPath[221];
    float iceWaterPath[221];
    float mostLikelyPrecipitation[221];
```

```
    float precip1stTertial[221];
    float precip2ndTertial[221];
    short profileTemp2mIndex[221];
    short profileNumber[221][5];
    float profileScale[221][5];
} L2AGPROFGMI_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
```

```
END STRUCTURE

STRUCTURE /L2AGPROFGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    REAL*4 sunLocalTime(221)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(221)
    BYTE qualityFlag(221)
    BYTE L1CqualityFlag(221)
    BYTE surfaceTypeIndex(221)
    BYTE totalColumnWaterVaporIndex(221)
    INTEGER*2 airmassLiftIndex(221)
    INTEGER*2 temp2mIndex(221)
    BYTE sunGlintAngle(221)
    BYTE probabilityOfPrecip(221)
    INTEGER*2 precipitationYesNoFlag(221)
    REAL*4 surfacePrecipitation(221)
    REAL*4 frozenPrecipitation(221)
    REAL*4 convectivePrecipitation(221)
    REAL*4 rainWaterPath(221)
    REAL*4 cloudWaterPath(221)
    REAL*4 iceWaterPath(221)
    REAL*4 mostLikelyPrecipitation(221)
    REAL*4 precip1stTertial(221)
    REAL*4 precip2ndTertial(221)
    INTEGER*2 profileTemp2mIndex(221)
    INTEGER*2 profileNumber(5,221)
    REAL*4 profileScale(5,221)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

5.31 2AGPROFTMI - Radiometer Profiling

2AGPROFTMI, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use this format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	208	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 424 through Figure 428 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

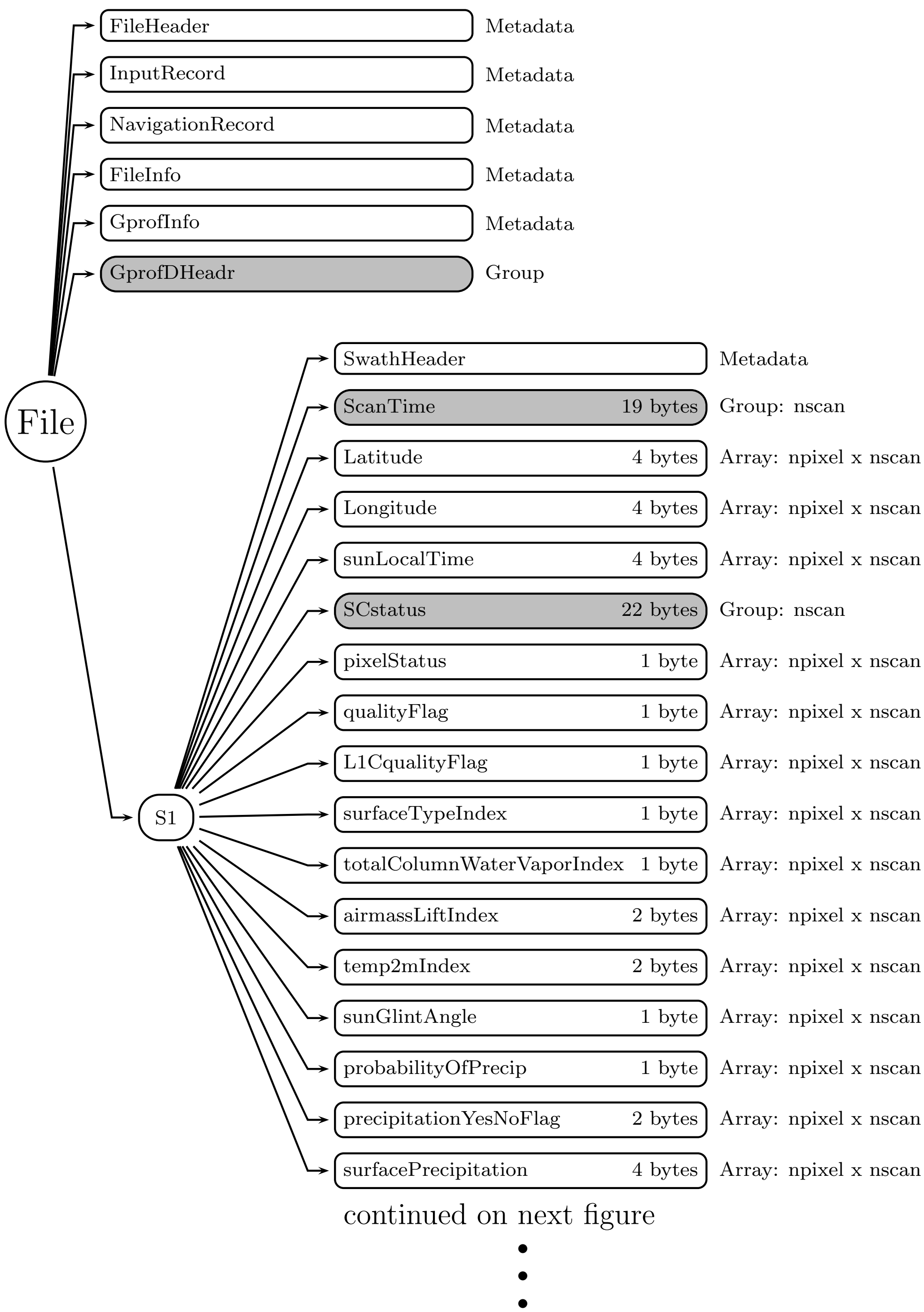


Figure 424: Data Format Structure for 2AGPROFTMI, Radiometer Profiling

continued from last figure

S1

frozenPrecipitation	4 bytes	Array: npixel x nscan
convectivePrecipitation	4 bytes	Array: npixel x nscan
rainWaterPath	4 bytes	Array: npixel x nscan
cloudWaterPath	4 bytes	Array: npixel x nscan
iceWaterPath	4 bytes	Array: npixel x nscan
mostLikelyPrecipitation	4 bytes	Array: npixel x nscan
precip1stTertial	4 bytes	Array: npixel x nscan
precip2ndTertial	4 bytes	Array: npixel x nscan
profileTemp2mIndex	2 bytes	Array: npixel x nscan
profileNumber	2 bytes	Array: nspecies x npixel x nscan
profileScale	4 bytes	Array: nspecies x npixel x nscan

Figure 425: Data Format Structure for 2AGPROFTMI, Radiometer Profiling

GprofDHeadr

speciesDescription	1 byte	Array: sddim x nspecies
hgtTopLayer	4 bytes	Array: nlyrs
temperatureDescriptions	4 bytes	Array: ntemps
clusterProfiles	4 bytes	Array: nspecies x ntemps x nlyrs x nprf

Figure 426: Data Format Structure for 2AGPROFTMI, GprofDHeadr

ScanTime

Year	2 bytes	Array: nscan
Month	1 byte	Array: nscan
DayOfMonth	1 byte	Array: nscan
Hour	1 byte	Array: nscan
Minute	1 byte	Array: nscan
Second	1 byte	Array: nscan
MilliSecond	2 bytes	Array: nscan
DayOfYear	2 bytes	Array: nscan
SecondOfDay	8 bytes	Array: nscan

Figure 427: Data Format Structure for 2AGPROFTMI, ScanTime

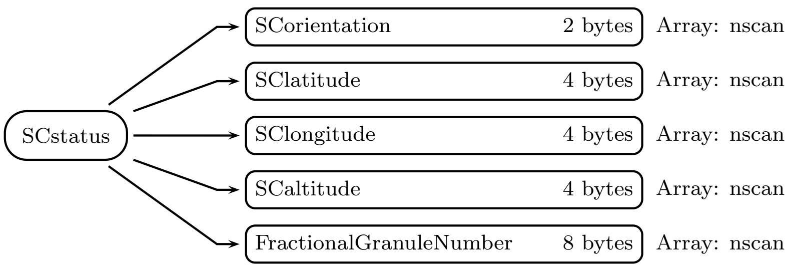


Figure 428: Data Format Structure for 2AGPROFTMI, SCstatus

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value
```

```
Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to

frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:
-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description

below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFTMI_H_
#define _TK_2AGPROFTMI_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;
```

```
#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFTMI_S1_
#define _L2AGPROFTMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    float sunLocalTime[208];
    SCSTATUS SCstatus;
    signed char pixelStatus[208];
    signed char qualityFlag[208];
    signed char L1CqualityFlag[208];
    signed char surfaceTypeIndex[208];
    signed char totalColumnWaterVaporIndex[208];
    short airmassLiftIndex[208];
    short temp2mIndex[208];
    signed char sunGlintAngle[208];
    signed char probabilityOfPrecip[208];
    short precipitationYesNoFlag[208];
    float surfacePrecipitation[208];
    float frozenPrecipitation[208];
    float convectivePrecipitation[208];
    float rainWaterPath[208];
    float cloudWaterPath[208];
```

```
    float iceWaterPath[208];
    float mostLikelyPrecipitation[208];
    float precip1stTertial[208];
    float precip2ndTertial[208];
    short profileTemp2mIndex[208];
    short profileNumber[208][5];
    float profileScale[208][5];
} L2AGPROFTMI_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFTMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    REAL*4 sunLocalTime(208)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(208)
    BYTE qualityFlag(208)
    BYTE L1CqualityFlag(208)
    BYTE surfaceTypeIndex(208)
    BYTE totalColumnWaterVaporIndex(208)
    INTEGER*2 airmassLiftIndex(208)
    INTEGER*2 temp2mIndex(208)
    BYTE sunGlintAngle(208)
    BYTE probabilityOfPrecip(208)
    INTEGER*2 precipitationYesNoFlag(208)
    REAL*4 surfacePrecipitation(208)
    REAL*4 frozenPrecipitation(208)
    REAL*4 convectivePrecipitation(208)
    REAL*4 rainWaterPath(208)
    REAL*4 cloudWaterPath(208)
    REAL*4 iceWaterPath(208)
    REAL*4 mostLikelyPrecipitation(208)
    REAL*4 precip1stTertial(208)
    REAL*4 precip2ndTertial(208)
    INTEGER*2 profileTemp2mIndex(208)
    INTEGER*2 profileNumber(5,208)
    REAL*4 profileScale(5,208)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

5.32 2AGPROFSSMI - Radiometer Profiling

2AGPROFSSMI, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2017. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 80 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use the 2AGPROFSSMI format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	128	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 429 through Figure 433 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

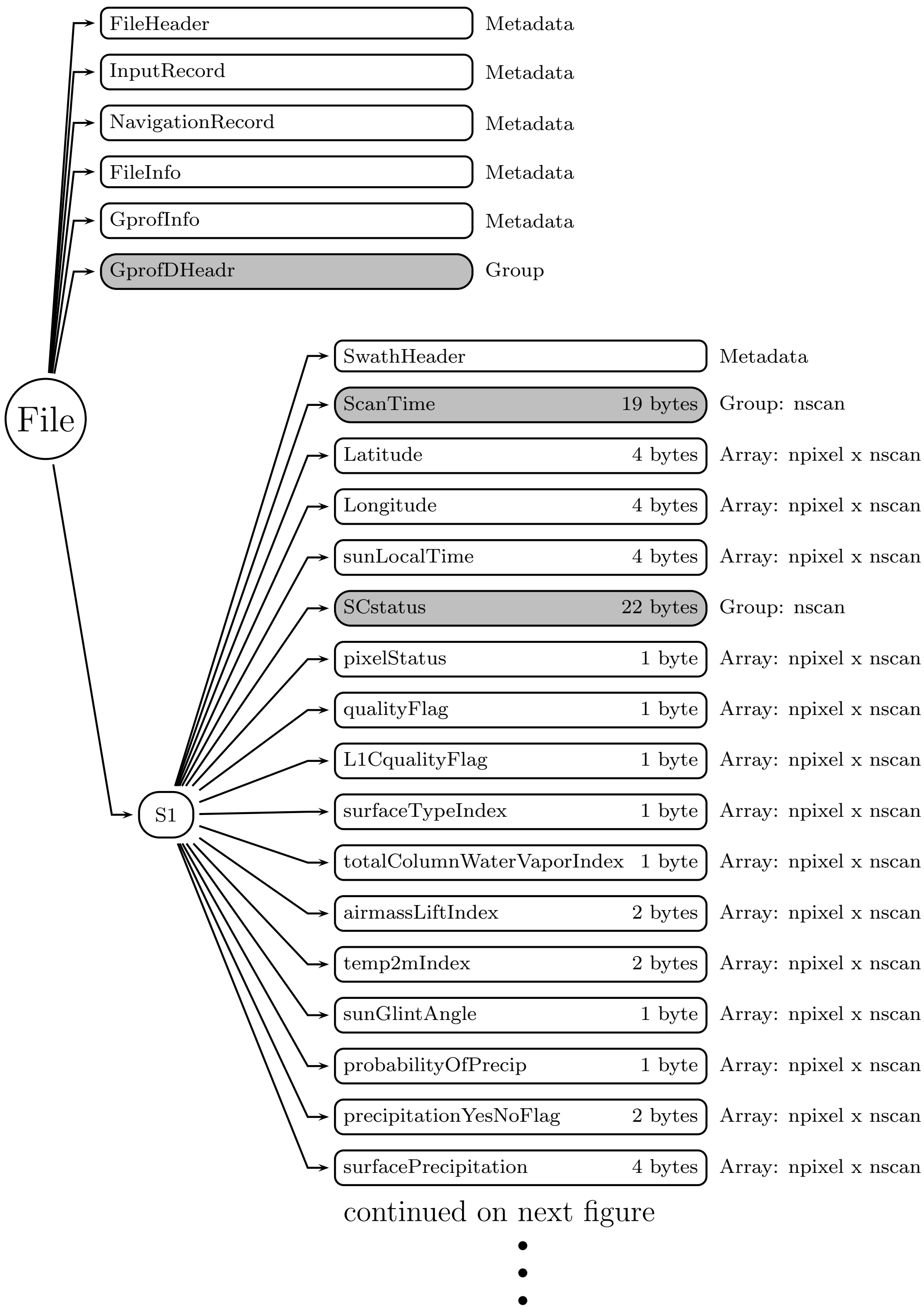


Figure 429: Data Format Structure for 2AGPROFSSMI, Radiometer Profiling

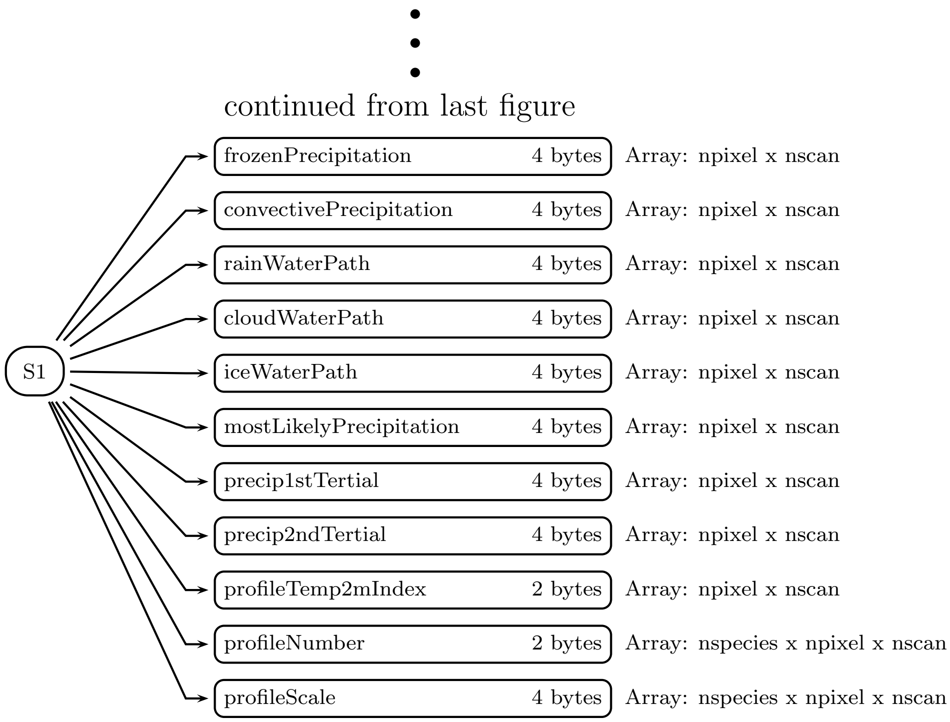


Figure 430: Data Format Structure for 2AGPROFSSMI, Radiometer Profiling

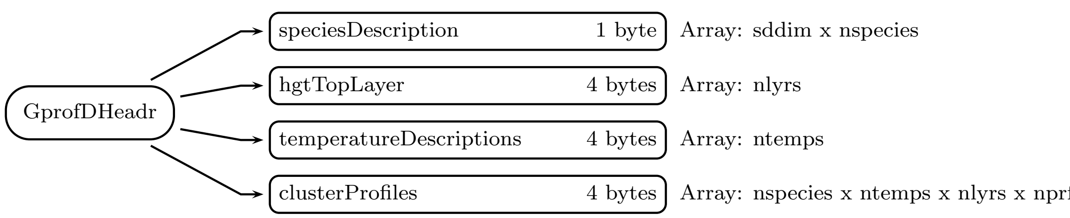


Figure 431: Data Format Structure for 2AGPROFSSMI, GprofDHeadr

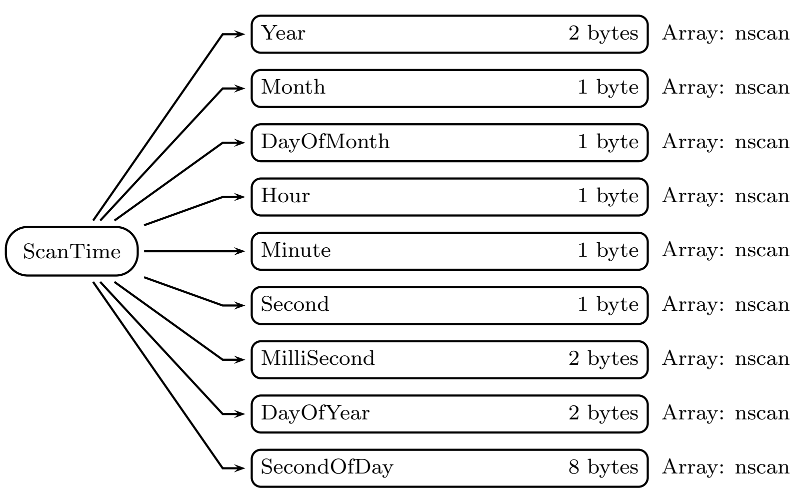


Figure 432: Data Format Structure for 2AGPROFSSMI, ScanTime

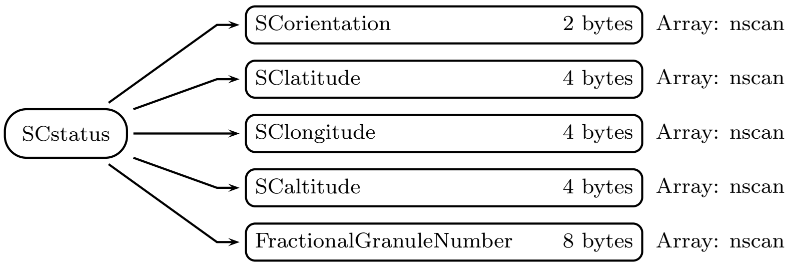


Figure 433: Data Format Structure for 2AGPROFSSMI, SCstatus

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value
```

```
Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to

frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:
-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description

below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFSSMI_H_
#define _TK_2AGPROFSSMI_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;
```

```
#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFSSMI_S1_
#define _L2AGPROFSSMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[128];
    float Longitude[128];
    float sunLocalTime[128];
    SCSTATUS SCstatus;
    signed char pixelStatus[128];
    signed char qualityFlag[128];
    signed char L1CqualityFlag[128];
    signed char surfaceTypeIndex[128];
    signed char totalColumnWaterVaporIndex[128];
    short airmassLiftIndex[128];
    short temp2mIndex[128];
    signed char sunGlintAngle[128];
    signed char probabilityOfPrecip[128];
    short precipitationYesNoFlag[128];
    float surfacePrecipitation[128];
    float frozenPrecipitation[128];
    float convectivePrecipitation[128];
    float rainWaterPath[128];
    float cloudWaterPath[128];
```

```
    float iceWaterPath[128];
    float mostLikelyPrecipitation[128];
    float precip1stTertial[128];
    float precip2ndTertial[128];
    short profileTemp2mIndex[128];
    short profileNumber[128][5];
    float profileScale[128][5];
} L2AGPROFSSMI_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFSSMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(128)
    REAL*4 Longitude(128)
    REAL*4 sunLocalTime(128)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(128)
    BYTE qualityFlag(128)
    BYTE L1CqualityFlag(128)
    BYTE surfaceTypeIndex(128)
    BYTE totalColumnWaterVaporIndex(128)
    INTEGER*2 airmassLiftIndex(128)
    INTEGER*2 temp2mIndex(128)
    BYTE sunGlintAngle(128)
    BYTE probabilityOfPrecip(128)
    INTEGER*2 precipitationYesNoFlag(128)
    REAL*4 surfacePrecipitation(128)
    REAL*4 frozenPrecipitation(128)
    REAL*4 convectivePrecipitation(128)
    REAL*4 rainWaterPath(128)
    REAL*4 cloudWaterPath(128)
    REAL*4 iceWaterPath(128)
    REAL*4 mostLikelyPrecipitation(128)
    REAL*4 precip1stTertial(128)
    REAL*4 precip2ndTertial(128)
    INTEGER*2 profileTemp2mIndex(128)
    INTEGER*2 profileNumber(5,128)
    REAL*4 profileScale(5,128)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

5.33 2AGPROFSSMIS - Radiometer Profiling

2AGPROFSSMIS, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use this format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	180	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 434 through Figure 438 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

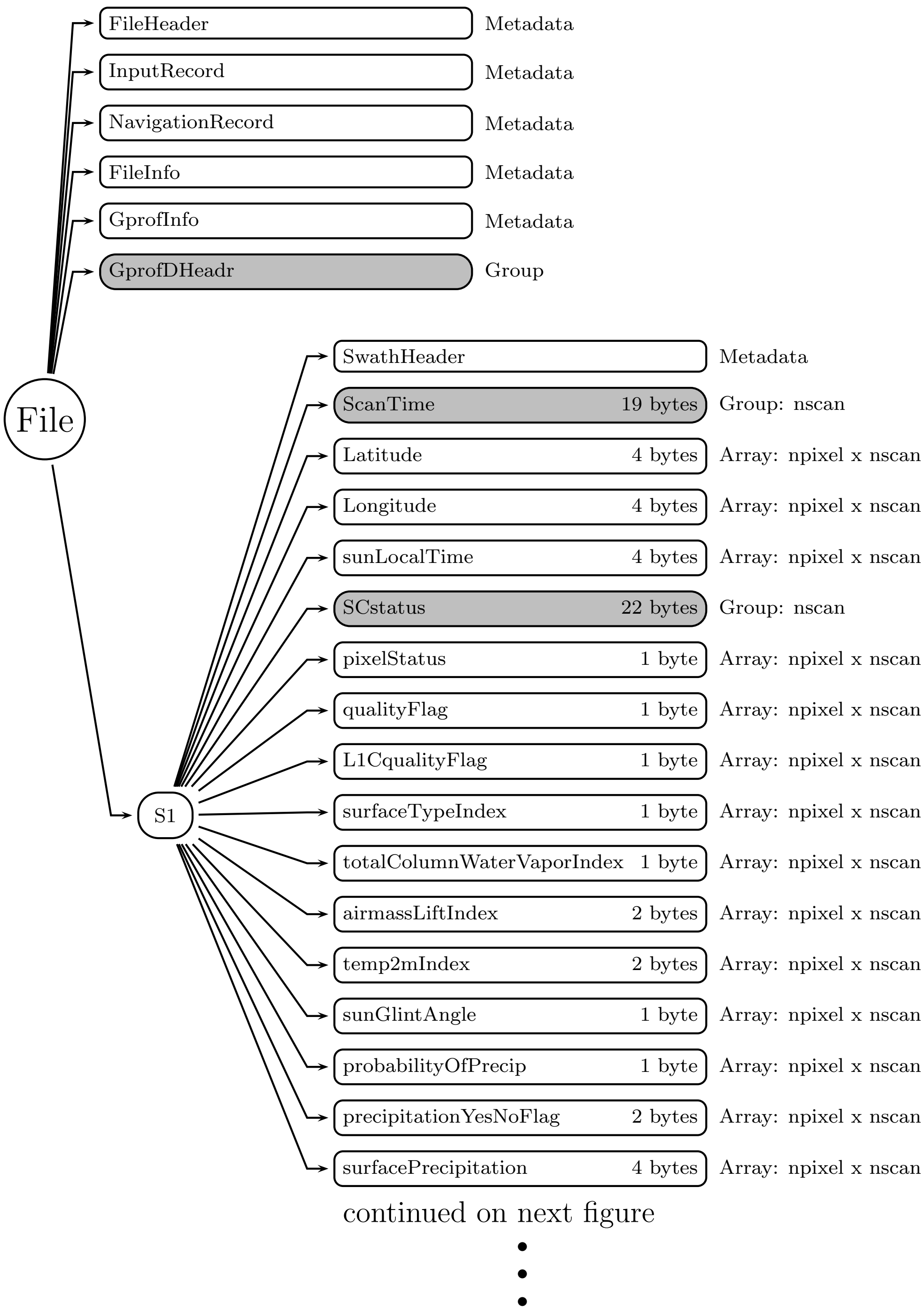


Figure 434: Data Format Structure for 2AGPROFSSMIS, Radiometer Profiling

continued from last figure

S1

frozenPrecipitation	4 bytes	Array: npixel x nscan
convectivePrecipitation	4 bytes	Array: npixel x nscan
rainWaterPath	4 bytes	Array: npixel x nscan
cloudWaterPath	4 bytes	Array: npixel x nscan
iceWaterPath	4 bytes	Array: npixel x nscan
mostLikelyPrecipitation	4 bytes	Array: npixel x nscan
precip1stTertial	4 bytes	Array: npixel x nscan
precip2ndTertial	4 bytes	Array: npixel x nscan
profileTemp2mIndex	2 bytes	Array: npixel x nscan
profileNumber	2 bytes	Array: nspecies x npixel x nscan
profileScale	4 bytes	Array: nspecies x npixel x nscan

Figure 435: Data Format Structure for 2AGPROFSSMIS, Radiometer Profiling

GprofDHeadr

speciesDescription	1 byte	Array: sddim x nspecies
hgtTopLayer	4 bytes	Array: nlyrs
temperatureDescriptions	4 bytes	Array: ntemps
clusterProfiles	4 bytes	Array: nspecies x ntemps x nlyrs x nprf

Figure 436: Data Format Structure for 2AGPROFSSMIS, GprofDHeadr

ScanTime

Year	2 bytes	Array: nscan
Month	1 byte	Array: nscan
DayOfMonth	1 byte	Array: nscan
Hour	1 byte	Array: nscan
Minute	1 byte	Array: nscan
Second	1 byte	Array: nscan
MilliSecond	2 bytes	Array: nscan
DayOfYear	2 bytes	Array: nscan
SecondOfDay	8 bytes	Array: nscan

Figure 437: Data Format Structure for 2AGPROFSSMIS, ScanTime

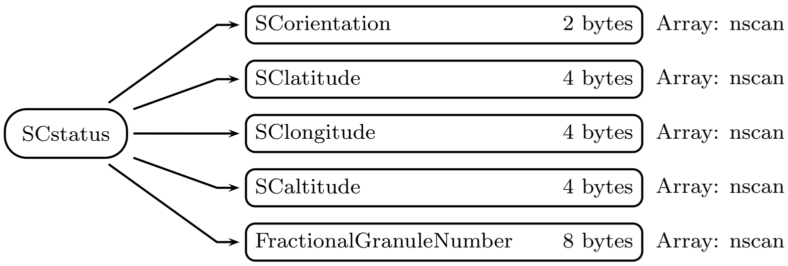


Figure 438: Data Format Structure for 2AGPROFSSMIS, SCstatus

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value
```

```
Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to

frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:
-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description

below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFSSMIS_H_
#define _TK_2AGPROFSSMIS_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;
```

```
#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFSSMIS_S1_
#define _L2AGPROFSSMIS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[180];
    float Longitude[180];
    float sunLocalTime[180];
    SCSTATUS SCstatus;
    signed char pixelStatus[180];
    signed char qualityFlag[180];
    signed char L1CqualityFlag[180];
    signed char surfaceTypeIndex[180];
    signed char totalColumnWaterVaporIndex[180];
    short airmassLiftIndex[180];
    short temp2mIndex[180];
    signed char sunGlintAngle[180];
    signed char probabilityOfPrecip[180];
    short precipitationYesNoFlag[180];
    float surfacePrecipitation[180];
    float frozenPrecipitation[180];
    float convectivePrecipitation[180];
    float rainWaterPath[180];
    float cloudWaterPath[180];
```

```
    float iceWaterPath[180];
    float mostLikelyPrecipitation[180];
    float precip1stTertial[180];
    float precip2ndTertial[180];
    short profileTemp2mIndex[180];
    short profileNumber[180][5];
    float profileScale[180][5];
} L2AGPROFSSMIS_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFSSMIS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(180)
    REAL*4 Longitude(180)
    REAL*4 sunLocalTime(180)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(180)
    BYTE qualityFlag(180)
    BYTE L1CqualityFlag(180)
    BYTE surfaceTypeIndex(180)
    BYTE totalColumnWaterVaporIndex(180)
    INTEGER*2 airmassLiftIndex(180)
    INTEGER*2 temp2mIndex(180)
    BYTE sunGlintAngle(180)
    BYTE probabilityOfPrecip(180)
    INTEGER*2 precipitationYesNoFlag(180)
    REAL*4 surfacePrecipitation(180)
    REAL*4 frozenPrecipitation(180)
    REAL*4 convectivePrecipitation(180)
    REAL*4 rainWaterPath(180)
    REAL*4 cloudWaterPath(180)
    REAL*4 iceWaterPath(180)
    REAL*4 mostLikelyPrecipitation(180)
    REAL*4 precip1stTertial(180)
    REAL*4 precip2ndTertial(180)
    INTEGER*2 profileTemp2mIndex(180)
    INTEGER*2 profileNumber(5,180)
    REAL*4 profileScale(5,180)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

5.34 2AGPROFAMSRE - Radiometer Profiling

2AGPROFAMSRE, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use this format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	392	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 439 through Figure 443 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

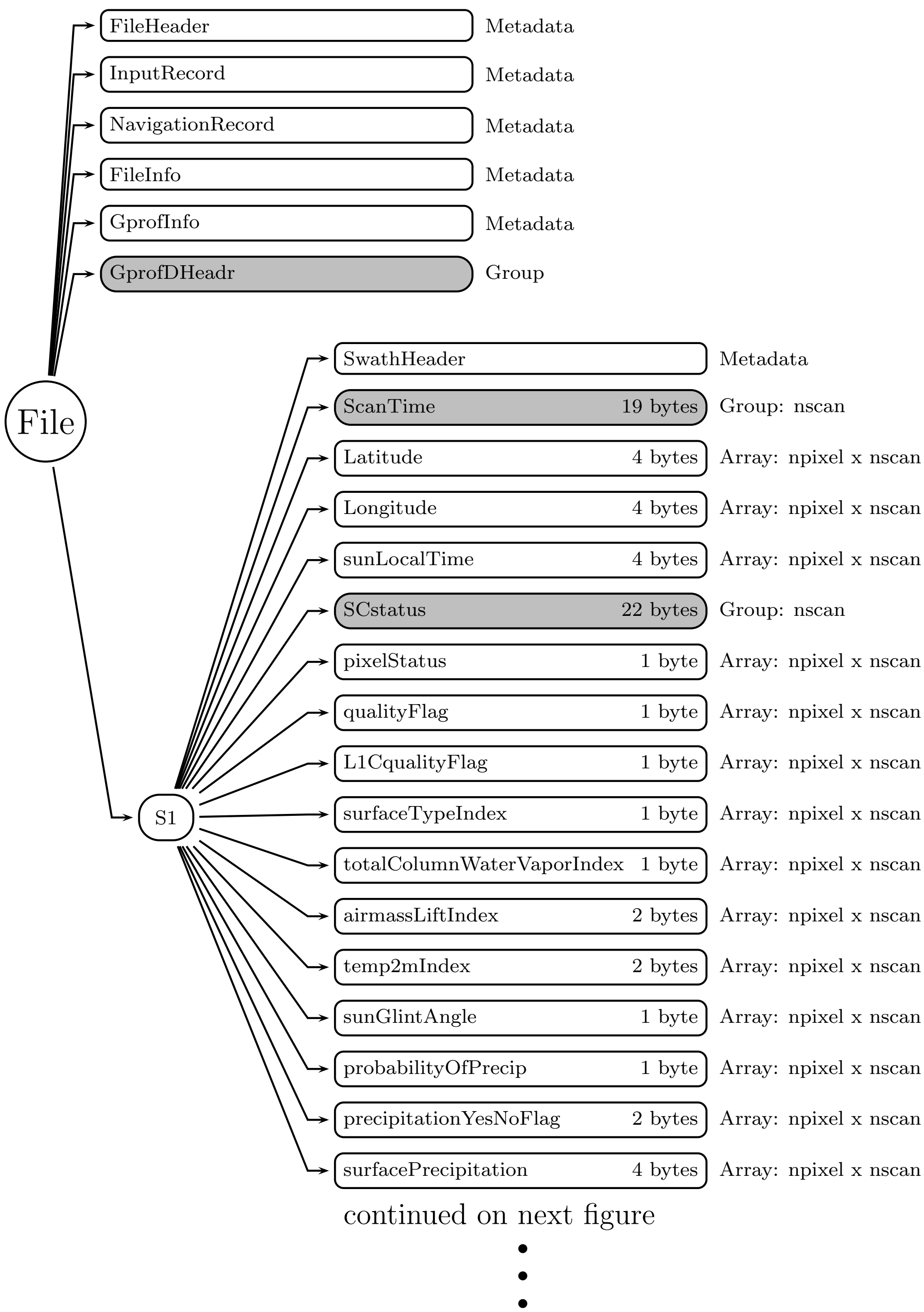


Figure 439: Data Format Structure for 2AGPROFAMSRE, Radiometer Profiling

continued from last figure

S1

frozenPrecipitation	4 bytes	Array: npixel x nscan
convectivePrecipitation	4 bytes	Array: npixel x nscan
rainWaterPath	4 bytes	Array: npixel x nscan
cloudWaterPath	4 bytes	Array: npixel x nscan
iceWaterPath	4 bytes	Array: npixel x nscan
mostLikelyPrecipitation	4 bytes	Array: npixel x nscan
precip1stTertial	4 bytes	Array: npixel x nscan
precip2ndTertial	4 bytes	Array: npixel x nscan
profileTemp2mIndex	2 bytes	Array: npixel x nscan
profileNumber	2 bytes	Array: nspecies x npixel x nscan
profileScale	4 bytes	Array: nspecies x npixel x nscan

Figure 440: Data Format Structure for 2AGPROFAMSRE, Radiometer Profiling

GprofDHeadr

speciesDescription	1 byte	Array: sddim x nspecies
hgtTopLayer	4 bytes	Array: nlyrs
temperatureDescriptions	4 bytes	Array: ntemps
clusterProfiles	4 bytes	Array: nspecies x ntemps x nlyrs x nprf

Figure 441: Data Format Structure for 2AGPROFAMSRE, GprofDHeadr

ScanTime

Year	2 bytes	Array: nscan
Month	1 byte	Array: nscan
DayOfMonth	1 byte	Array: nscan
Hour	1 byte	Array: nscan
Minute	1 byte	Array: nscan
Second	1 byte	Array: nscan
MilliSecond	2 bytes	Array: nscan
DayOfYear	2 bytes	Array: nscan
SecondOfDay	8 bytes	Array: nscan

Figure 442: Data Format Structure for 2AGPROFAMSRE, ScanTime

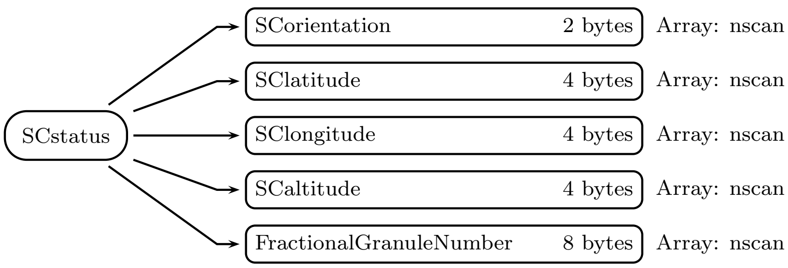


Figure 443: Data Format Structure for 2AGPROFAMSRE, SCstatus

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value
```

```
Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to

frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:
-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description

below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFAMSRE_H_
#define _TK_2AGPROFAMSRE_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;
```

```
#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFAMSRE_S1_
#define _L2AGPROFAMSRE_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[392];
    float Longitude[392];
    float sunLocalTime[392];
    SCSTATUS SCstatus;
    signed char pixelStatus[392];
    signed char qualityFlag[392];
    signed char L1CqualityFlag[392];
    signed char surfaceTypeIndex[392];
    signed char totalColumnWaterVaporIndex[392];
    short airmassLiftIndex[392];
    short temp2mIndex[392];
    signed char sunGlintAngle[392];
    signed char probabilityOfPrecip[392];
    short precipitationYesNoFlag[392];
    float surfacePrecipitation[392];
    float frozenPrecipitation[392];
    float convectivePrecipitation[392];
    float rainWaterPath[392];
    float cloudWaterPath[392];
```

```
    float iceWaterPath[392];
    float mostLikelyPrecipitation[392];
    float precip1stTertial[392];
    float precip2ndTertial[392];
    short profileTemp2mIndex[392];
    short profileNumber[392][5];
    float profileScale[392][5];
} L2AGPROFAMSRE_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFAMSRE_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(392)
    REAL*4 Longitude(392)
    REAL*4 sunLocalTime(392)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(392)
    BYTE qualityFlag(392)
    BYTE L1CqualityFlag(392)
    BYTE surfaceTypeIndex(392)
    BYTE totalColumnWaterVaporIndex(392)
    INTEGER*2 airmassLiftIndex(392)
    INTEGER*2 temp2mIndex(392)
    BYTE sunGlintAngle(392)
    BYTE probabilityOfPrecip(392)
    INTEGER*2 precipitationYesNoFlag(392)
    REAL*4 surfacePrecipitation(392)
    REAL*4 frozenPrecipitation(392)
    REAL*4 convectivePrecipitation(392)
    REAL*4 rainWaterPath(392)
    REAL*4 cloudWaterPath(392)
    REAL*4 iceWaterPath(392)
    REAL*4 mostLikelyPrecipitation(392)
    REAL*4 precip1stTertial(392)
    REAL*4 precip2ndTertial(392)
    INTEGER*2 profileTemp2mIndex(392)
    INTEGER*2 profileNumber(5,392)
    REAL*4 profileScale(5,392)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

5.35 2AGPROFAMSR2 - Radiometer Profiling

2AGPROFAMSR2, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use this format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	486	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 444 through Figure 448 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

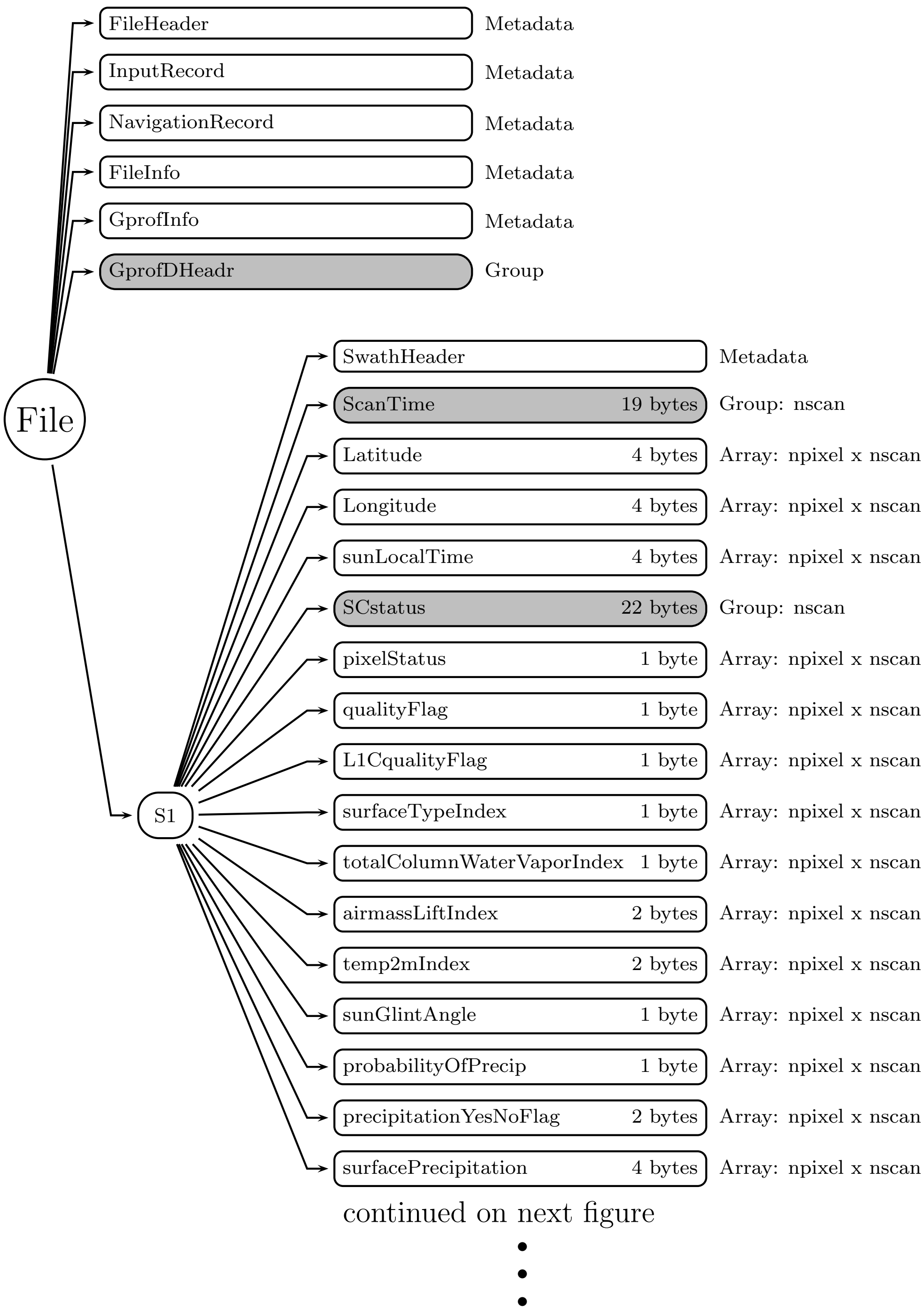


Figure 444: Data Format Structure for 2AGPROFAMSR2, Radiometer Profiling

continued from last figure

S1

frozenPrecipitation	4 bytes	Array: npixel x nscan
convectivePrecipitation	4 bytes	Array: npixel x nscan
rainWaterPath	4 bytes	Array: npixel x nscan
cloudWaterPath	4 bytes	Array: npixel x nscan
iceWaterPath	4 bytes	Array: npixel x nscan
mostLikelyPrecipitation	4 bytes	Array: npixel x nscan
precip1stTertial	4 bytes	Array: npixel x nscan
precip2ndTertial	4 bytes	Array: npixel x nscan
profileTemp2mIndex	2 bytes	Array: npixel x nscan
profileNumber	2 bytes	Array: nspecies x npixel x nscan
profileScale	4 bytes	Array: nspecies x npixel x nscan

Figure 445: Data Format Structure for 2AGPROFAMSR2, Radiometer Profiling

GprofDHeadr

speciesDescription	1 byte	Array: sddim x nspecies
hgtTopLayer	4 bytes	Array: nlyrs
temperatureDescriptions	4 bytes	Array: ntemps
clusterProfiles	4 bytes	Array: nspecies x ntemps x nlyrs x nprf

Figure 446: Data Format Structure for 2AGPROFAMSR2, GprofDHeadr

ScanTime

Year	2 bytes	Array: nscan
Month	1 byte	Array: nscan
DayOfMonth	1 byte	Array: nscan
Hour	1 byte	Array: nscan
Minute	1 byte	Array: nscan
Second	1 byte	Array: nscan
MilliSecond	2 bytes	Array: nscan
DayOfYear	2 bytes	Array: nscan
SecondOfDay	8 bytes	Array: nscan

Figure 447: Data Format Structure for 2AGPROFAMSR2, ScanTime

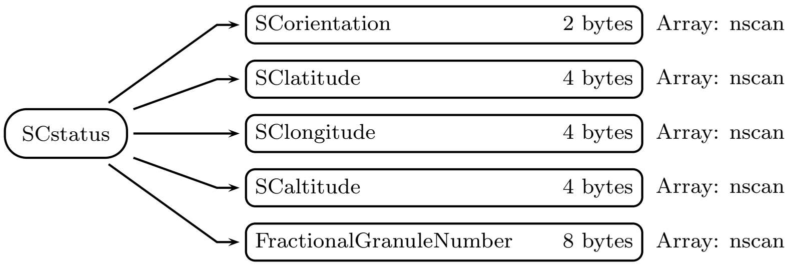


Figure 448: Data Format Structure for 2AGPROFAMSR2, SCstatus

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value
```

```
Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to

frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:

-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:

-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:

-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:

-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:

-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description

below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFAMSR2_H_
#define _TK_2AGPROFAMSR2_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;
```

```
#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFAMSR2_S1_
#define _L2AGPROFAMSR2_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[486];
    float Longitude[486];
    float sunLocalTime[486];
    SCSTATUS SCstatus;
    signed char pixelStatus[486];
    signed char qualityFlag[486];
    signed char L1CqualityFlag[486];
    signed char surfaceTypeIndex[486];
    signed char totalColumnWaterVaporIndex[486];
    short airmassLiftIndex[486];
    short temp2mIndex[486];
    signed char sunGlintAngle[486];
    signed char probabilityOfPrecip[486];
    short precipitationYesNoFlag[486];
    float surfacePrecipitation[486];
    float frozenPrecipitation[486];
    float convectivePrecipitation[486];
    float rainWaterPath[486];
    float cloudWaterPath[486];
```

```
    float iceWaterPath[486];
    float mostLikelyPrecipitation[486];
    float precip1stTertial[486];
    float precip2ndTertial[486];
    short profileTemp2mIndex[486];
    short profileNumber[486][5];
    float profileScale[486][5];
} L2AGPROFAMSR2_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFAMSR2_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(486)
    REAL*4 Longitude(486)
    REAL*4 sunLocalTime(486)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(486)
    BYTE qualityFlag(486)
    BYTE L1CqualityFlag(486)
    BYTE surfaceTypeIndex(486)
    BYTE totalColumnWaterVaporIndex(486)
    INTEGER*2 airmassLiftIndex(486)
    INTEGER*2 temp2mIndex(486)
    BYTE sunGlintAngle(486)
    BYTE probabilityOfPrecip(486)
    INTEGER*2 precipitationYesNoFlag(486)
    REAL*4 surfacePrecipitation(486)
    REAL*4 frozenPrecipitation(486)
    REAL*4 convectivePrecipitation(486)
    REAL*4 rainWaterPath(486)
    REAL*4 cloudWaterPath(486)
    REAL*4 iceWaterPath(486)
    REAL*4 mostLikelyPrecipitation(486)
    REAL*4 precip1stTertial(486)
    REAL*4 precip2ndTertial(486)
    INTEGER*2 profileTemp2mIndex(486)
    INTEGER*2 profileNumber(5,486)
    REAL*4 profileScale(5,486)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

5.36 2AGPROFATMS - Radiometer Profiling

2AGPROFATMS, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use this format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Note that the 3 outer pixels on each side of the swath are set to missing. I.e., 6 pixels in each swath are set to missing.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	96	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 459 through Figure 463 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in

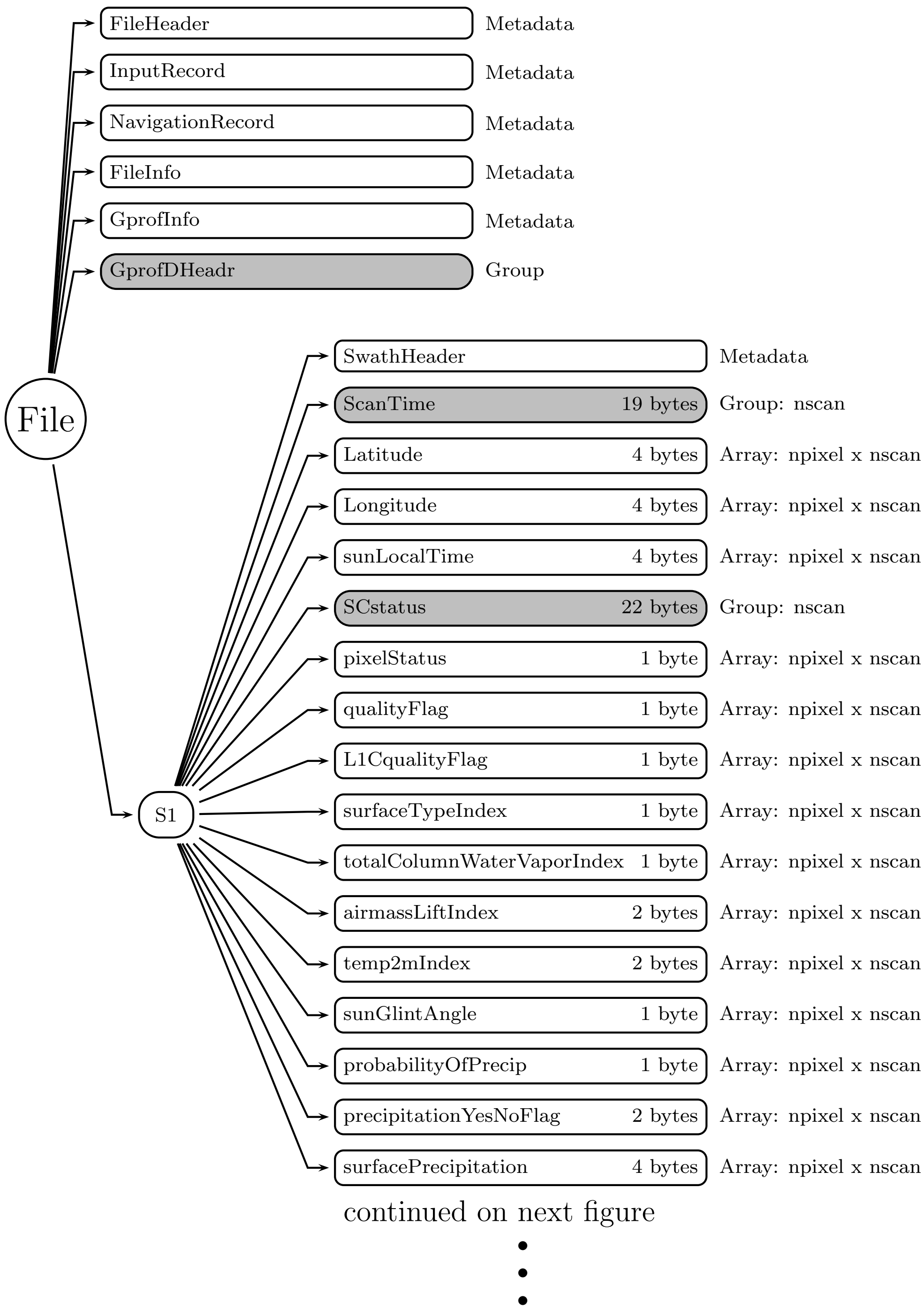


Figure 449: Data Format Structure for 2AGPROFATMS, Radiometer Profiling

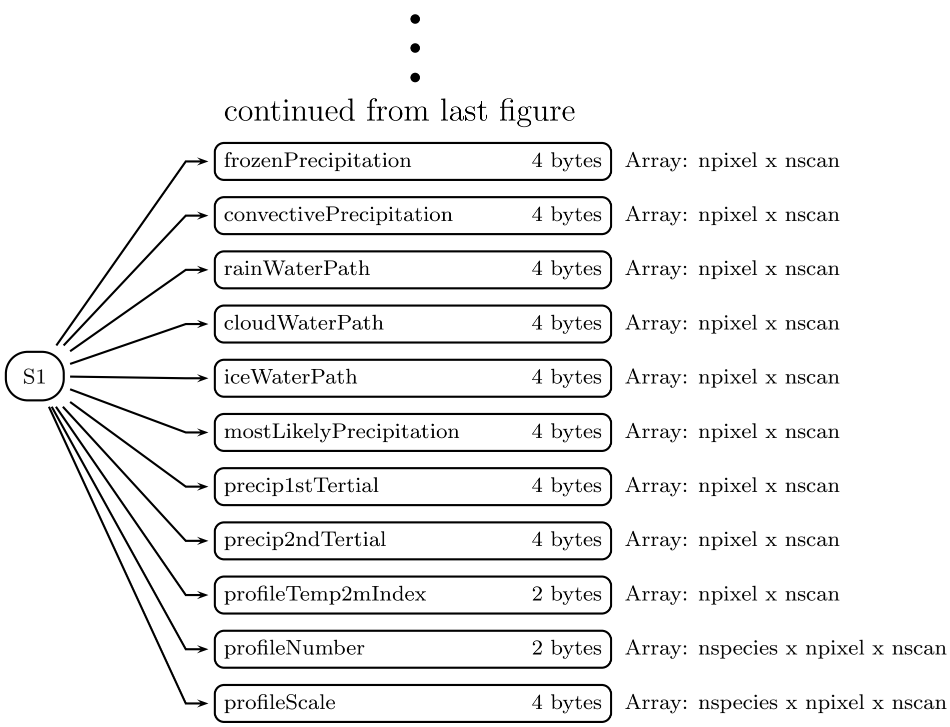


Figure 450: Data Format Structure for 2AGPROFATMS, Radiometer Profiling

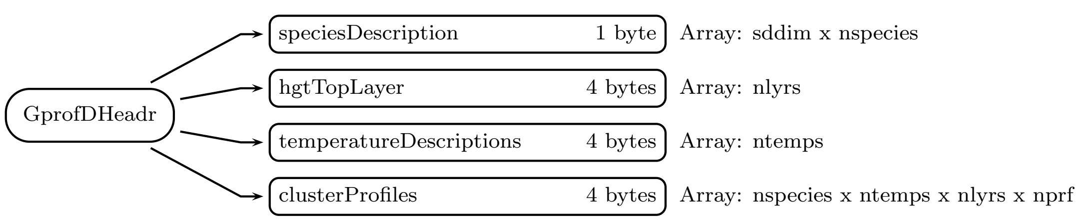


Figure 451: Data Format Structure for 2AGPROFATMS, GprofDHeadr

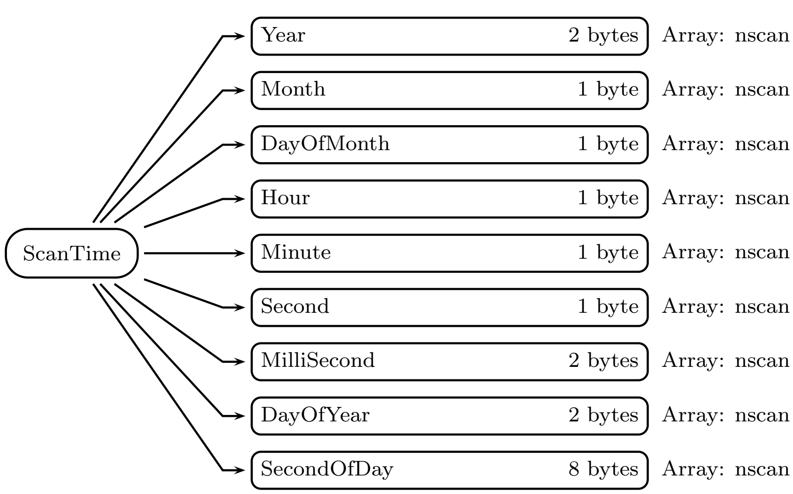


Figure 452: Data Format Structure for 2AGPROFATMS, ScanTime

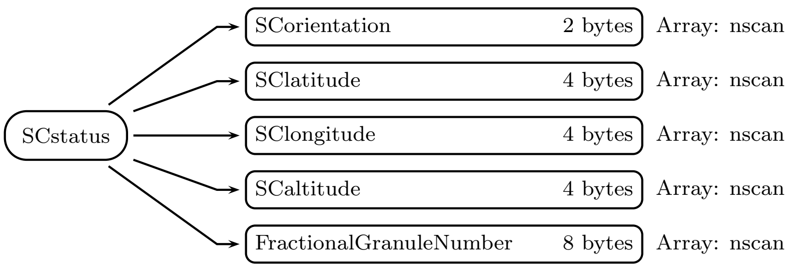


Figure 453: Data Format Structure for 2AGPROFATMS, SCstatus

Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)
A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value
```

```
Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to

frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:
-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description

below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFATMS_H_
#define _TK_2AGPROFATMS_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;
```

```
#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFATMS_S1_
#define _L2AGPROFATMS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    float sunLocalTime[96];
    SCSTATUS SCstatus;
    signed char pixelStatus[96];
    signed char qualityFlag[96];
    signed char L1CqualityFlag[96];
    signed char surfaceTypeIndex[96];
    signed char totalColumnWaterVaporIndex[96];
    short airmassLiftIndex[96];
    short temp2mIndex[96];
    signed char sunGlintAngle[96];
    signed char probabilityOfPrecip[96];
    short precipitationYesNoFlag[96];
    float surfacePrecipitation[96];
    float frozenPrecipitation[96];
    float convectivePrecipitation[96];
    float rainWaterPath[96];
    float cloudWaterPath[96];
```

```
    float iceWaterPath[96];
    float mostLikelyPrecipitation[96];
    float precip1stTertial[96];
    float precip2ndTertial[96];
    short profileTemp2mIndex[96];
    short profileNumber[96][5];
    float profileScale[96][5];
} L2AGPROFATMS_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFATMS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    REAL*4 sunLocalTime(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(96)
    BYTE qualityFlag(96)
    BYTE L1CqualityFlag(96)
    BYTE surfaceTypeIndex(96)
    BYTE totalColumnWaterVaporIndex(96)
    INTEGER*2 airmassLiftIndex(96)
    INTEGER*2 temp2mIndex(96)
    BYTE sunGlintAngle(96)
    BYTE probabilityOfPrecip(96)
    INTEGER*2 precipitationYesNoFlag(96)
    REAL*4 surfacePrecipitation(96)
    REAL*4 frozenPrecipitation(96)
    REAL*4 convectivePrecipitation(96)
    REAL*4 rainWaterPath(96)
    REAL*4 cloudWaterPath(96)
    REAL*4 iceWaterPath(96)
    REAL*4 mostLikelyPrecipitation(96)
    REAL*4 precip1stTertial(96)
    REAL*4 precip2ndTertial(96)
    INTEGER*2 profileTemp2mIndex(96)
    INTEGER*2 profileNumber(5,96)
    REAL*4 profileScale(5,96)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

5.37 2AGPROFAMSUB - Radiometer Profiling

2AGPROFAMSUB, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2017. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 80 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use the 2AGPROFAMSUB format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	90	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 454 through Figure 458 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

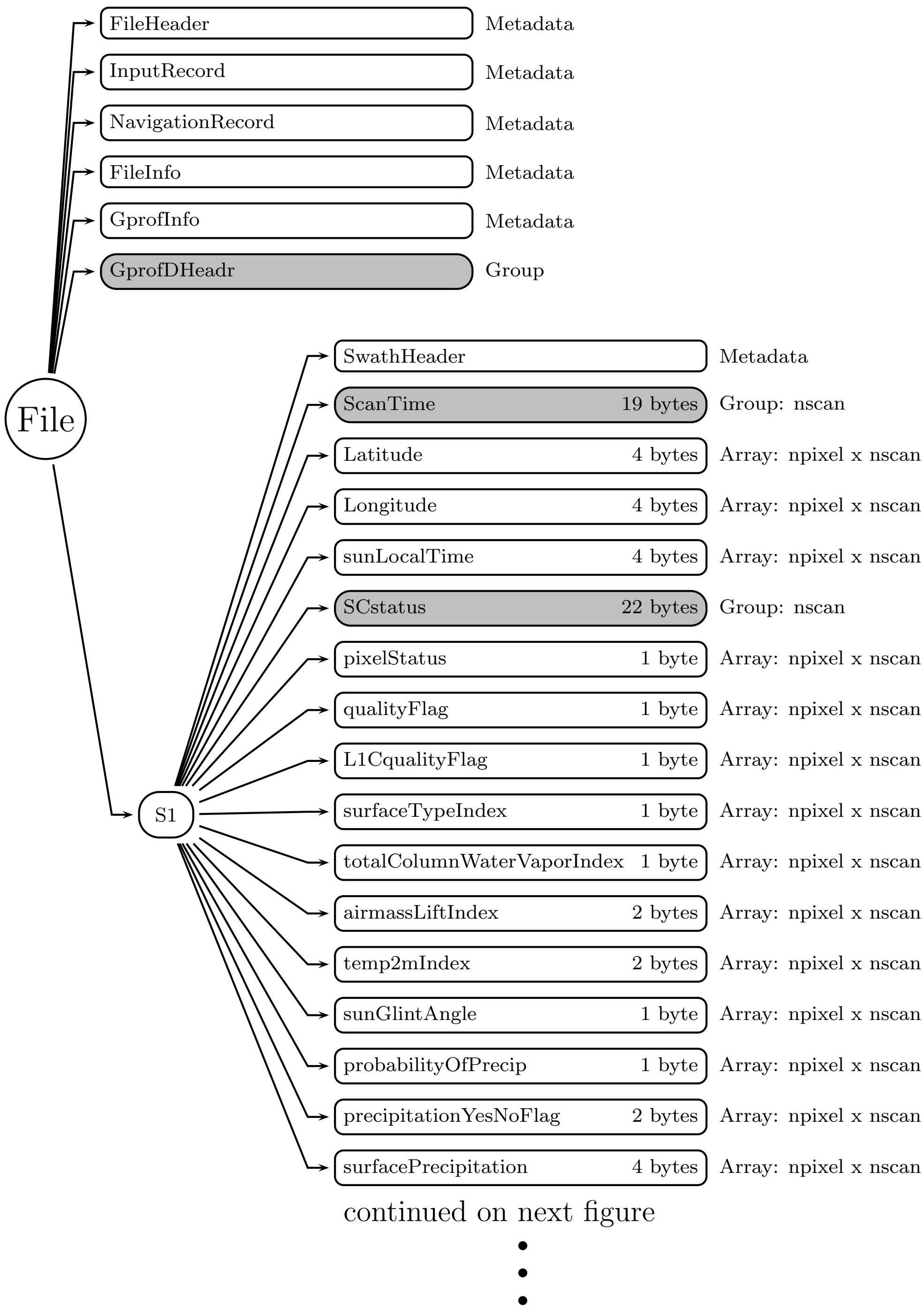


Figure 454: Data Format Structure for 2AGPROFAMSUB, Radiometer Profiling

continued from last figure

S1

frozenPrecipitation	4 bytes	Array: npixel x nscan
convectivePrecipitation	4 bytes	Array: npixel x nscan
rainWaterPath	4 bytes	Array: npixel x nscan
cloudWaterPath	4 bytes	Array: npixel x nscan
iceWaterPath	4 bytes	Array: npixel x nscan
mostLikelyPrecipitation	4 bytes	Array: npixel x nscan
precip1stTertial	4 bytes	Array: npixel x nscan
precip2ndTertial	4 bytes	Array: npixel x nscan
profileTemp2mIndex	2 bytes	Array: npixel x nscan
profileNumber	2 bytes	Array: nspecies x npixel x nscan
profileScale	4 bytes	Array: nspecies x npixel x nscan

Figure 455: Data Format Structure for 2AGPROFAMSUB, Radiometer Profiling

GprofDHeadr

speciesDescription	1 byte	Array: sddim x nspecies
hgtTopLayer	4 bytes	Array: nlyrs
temperatureDescriptions	4 bytes	Array: ntemps
clusterProfiles	4 bytes	Array: nspecies x ntemps x nlyrs x nprf

Figure 456: Data Format Structure for 2AGPROFAMSUB, GprofDHeadr

ScanTime

Year	2 bytes	Array: nscan
Month	1 byte	Array: nscan
DayOfMonth	1 byte	Array: nscan
Hour	1 byte	Array: nscan
Minute	1 byte	Array: nscan
Second	1 byte	Array: nscan
MilliSecond	2 bytes	Array: nscan
DayOfYear	2 bytes	Array: nscan
SecondOfDay	8 bytes	Array: nscan

Figure 457: Data Format Structure for 2AGPROFAMSUB, ScanTime

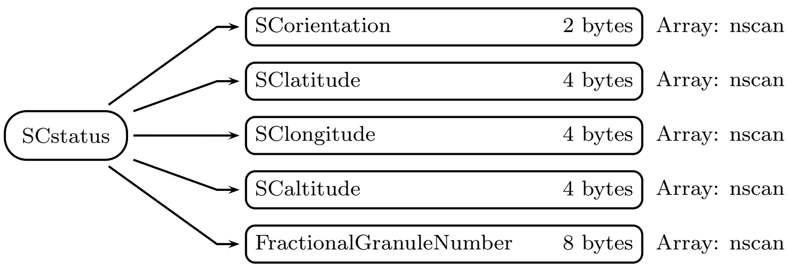


Figure 458: Data Format Structure for 2AGPROFAMSUB, SCstatus

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value
```

```
Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to

frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:
-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description

below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFAMSUB_H_
#define _TK_2AGPROFAMSUB_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;
```

```
#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFAMSUB_S1_
#define _L2AGPROFAMSUB_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    float sunLocalTime[90];
    SCSTATUS SCstatus;
    signed char pixelStatus[90];
    signed char qualityFlag[90];
    signed char L1CqualityFlag[90];
    signed char surfaceTypeIndex[90];
    signed char totalColumnWaterVaporIndex[90];
    short airmassLiftIndex[90];
    short temp2mIndex[90];
    signed char sunGlintAngle[90];
    signed char probabilityOfPrecip[90];
    short precipitationYesNoFlag[90];
    float surfacePrecipitation[90];
    float frozenPrecipitation[90];
    float convectivePrecipitation[90];
    float rainWaterPath[90];
    float cloudWaterPath[90];
```

```
    float iceWaterPath[90];
    float mostLikelyPrecipitation[90];
    float precip1stTertial[90];
    float precip2ndTertial[90];
    short profileTemp2mIndex[90];
    short profileNumber[90][5];
    float profileScale[90][5];
} L2AGPROFAMSUB_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFAMSUB_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    REAL*4 sunLocalTime(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(90)
    BYTE qualityFlag(90)
    BYTE L1CqualityFlag(90)
    BYTE surfaceTypeIndex(90)
    BYTE totalColumnWaterVaporIndex(90)
    INTEGER*2 airmassLiftIndex(90)
    INTEGER*2 temp2mIndex(90)
    BYTE sunGlintAngle(90)
    BYTE probabilityOfPrecip(90)
    INTEGER*2 precipitationYesNoFlag(90)
    REAL*4 surfacePrecipitation(90)
    REAL*4 frozenPrecipitation(90)
    REAL*4 convectivePrecipitation(90)
    REAL*4 rainWaterPath(90)
    REAL*4 cloudWaterPath(90)
    REAL*4 iceWaterPath(90)
    REAL*4 mostLikelyPrecipitation(90)
    REAL*4 precip1stTertial(90)
    REAL*4 precip2ndTertial(90)
    INTEGER*2 profileTemp2mIndex(90)
    INTEGER*2 profileNumber(5,90)
    REAL*4 profileScale(5,90)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

5.38 2AGPROFATMS - Radiometer Profiling

2AGPROFATMS, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use this format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Note that the 3 outer pixels on each side of the swath are set to missing. I.e., 6 pixels in each swath are set to missing.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	96	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 459 through Figure 463 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in

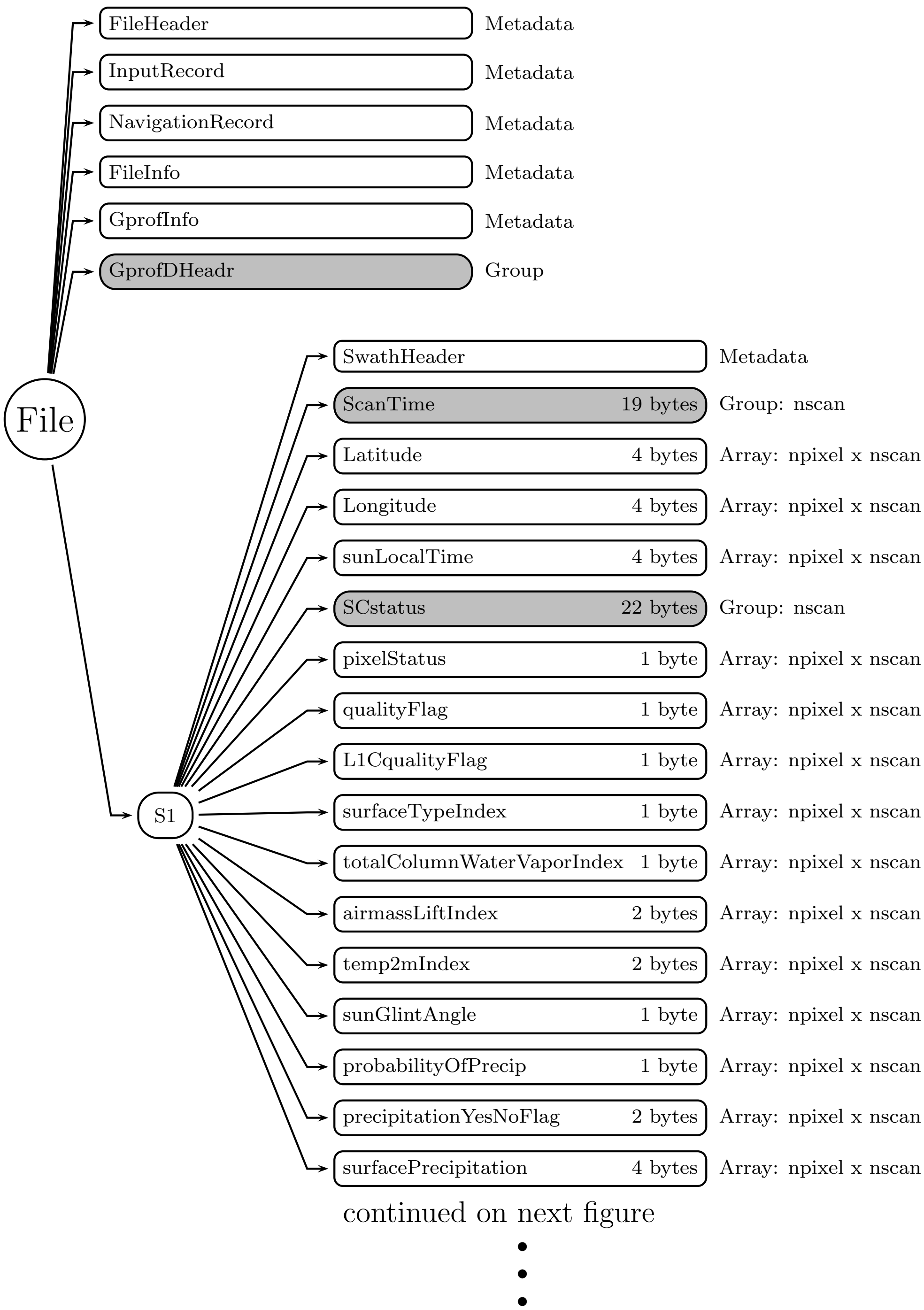


Figure 459: Data Format Structure for 2AGPROFATMS, Radiometer Profiling

continued from last figure

S1

frozenPrecipitation	4 bytes	Array: npixel x nscan
convectivePrecipitation	4 bytes	Array: npixel x nscan
rainWaterPath	4 bytes	Array: npixel x nscan
cloudWaterPath	4 bytes	Array: npixel x nscan
iceWaterPath	4 bytes	Array: npixel x nscan
mostLikelyPrecipitation	4 bytes	Array: npixel x nscan
precip1stTertial	4 bytes	Array: npixel x nscan
precip2ndTertial	4 bytes	Array: npixel x nscan
profileTemp2mIndex	2 bytes	Array: npixel x nscan
profileNumber	2 bytes	Array: nspecies x npixel x nscan
profileScale	4 bytes	Array: nspecies x npixel x nscan

Figure 460: Data Format Structure for 2AGPROFATMS, Radiometer Profiling

GprofDHeadr

speciesDescription	1 byte	Array: sddim x nspecies
hgtTopLayer	4 bytes	Array: nlyrs
temperatureDescriptions	4 bytes	Array: ntemps
clusterProfiles	4 bytes	Array: nspecies x ntemps x nlyrs x nprf

Figure 461: Data Format Structure for 2AGPROFATMS, GprofDHeadr

ScanTime

Year	2 bytes	Array: nscan
Month	1 byte	Array: nscan
DayOfMonth	1 byte	Array: nscan
Hour	1 byte	Array: nscan
Minute	1 byte	Array: nscan
Second	1 byte	Array: nscan
MilliSecond	2 bytes	Array: nscan
DayOfYear	2 bytes	Array: nscan
SecondOfDay	8 bytes	Array: nscan

Figure 462: Data Format Structure for 2AGPROFATMS, ScanTime

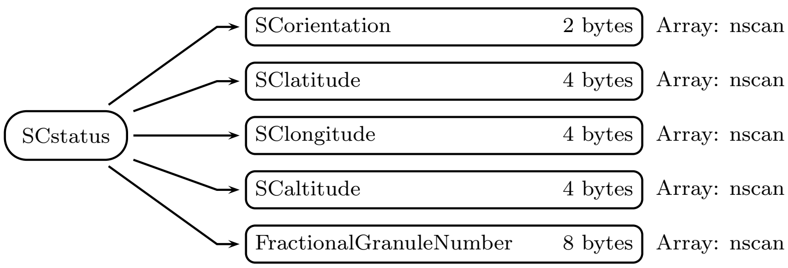


Figure 463: Data Format Structure for 2AGPROFATMS, SCstatus

Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value
```

```
Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to

frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:
-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description

below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFATMS_H_
#define _TK_2AGPROFATMS_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;
```

```
#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFATMS_S1_
#define _L2AGPROFATMS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[96];
    float Longitude[96];
    float sunLocalTime[96];
    SCSTATUS SCstatus;
    signed char pixelStatus[96];
    signed char qualityFlag[96];
    signed char L1CqualityFlag[96];
    signed char surfaceTypeIndex[96];
    signed char totalColumnWaterVaporIndex[96];
    short airmassLiftIndex[96];
    short temp2mIndex[96];
    signed char sunGlintAngle[96];
    signed char probabilityOfPrecip[96];
    short precipitationYesNoFlag[96];
    float surfacePrecipitation[96];
    float frozenPrecipitation[96];
    float convectivePrecipitation[96];
    float rainWaterPath[96];
    float cloudWaterPath[96];
```

```
    float iceWaterPath[96];
    float mostLikelyPrecipitation[96];
    float precip1stTertial[96];
    float precip2ndTertial[96];
    short profileTemp2mIndex[96];
    short profileNumber[96][5];
    float profileScale[96][5];
} L2AGPROFATMS_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFATMS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(96)
    REAL*4 Longitude(96)
    REAL*4 sunLocalTime(96)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(96)
    BYTE qualityFlag(96)
    BYTE L1CqualityFlag(96)
    BYTE surfaceTypeIndex(96)
    BYTE totalColumnWaterVaporIndex(96)
    INTEGER*2 airmassLiftIndex(96)
    INTEGER*2 temp2mIndex(96)
    BYTE sunGlintAngle(96)
    BYTE probabilityOfPrecip(96)
    INTEGER*2 precipitationYesNoFlag(96)
    REAL*4 surfacePrecipitation(96)
    REAL*4 frozenPrecipitation(96)
    REAL*4 convectivePrecipitation(96)
    REAL*4 rainWaterPath(96)
    REAL*4 cloudWaterPath(96)
    REAL*4 iceWaterPath(96)
    REAL*4 mostLikelyPrecipitation(96)
    REAL*4 precip1stTertial(96)
    REAL*4 precip2ndTertial(96)
    INTEGER*2 profileTemp2mIndex(96)
    INTEGER*2 profileNumber(5,96)
    REAL*4 profileScale(5,96)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

5.39 2AGPROFMHS - Radiometer Profiling

2AGPROFMHS, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Two products use this format: the regular product and the climate product. The regular product's filename starts with 2A and its input includes GANAL data. The climate product's filename starts with 2A-CLIM and its input includes ECMWF data.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	90	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	21	Number of characters in each species description.
ntemps	12	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	80	Number of unique profiles for each species and 2 meter Temperature index.

Figure 464 through Figure 468 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

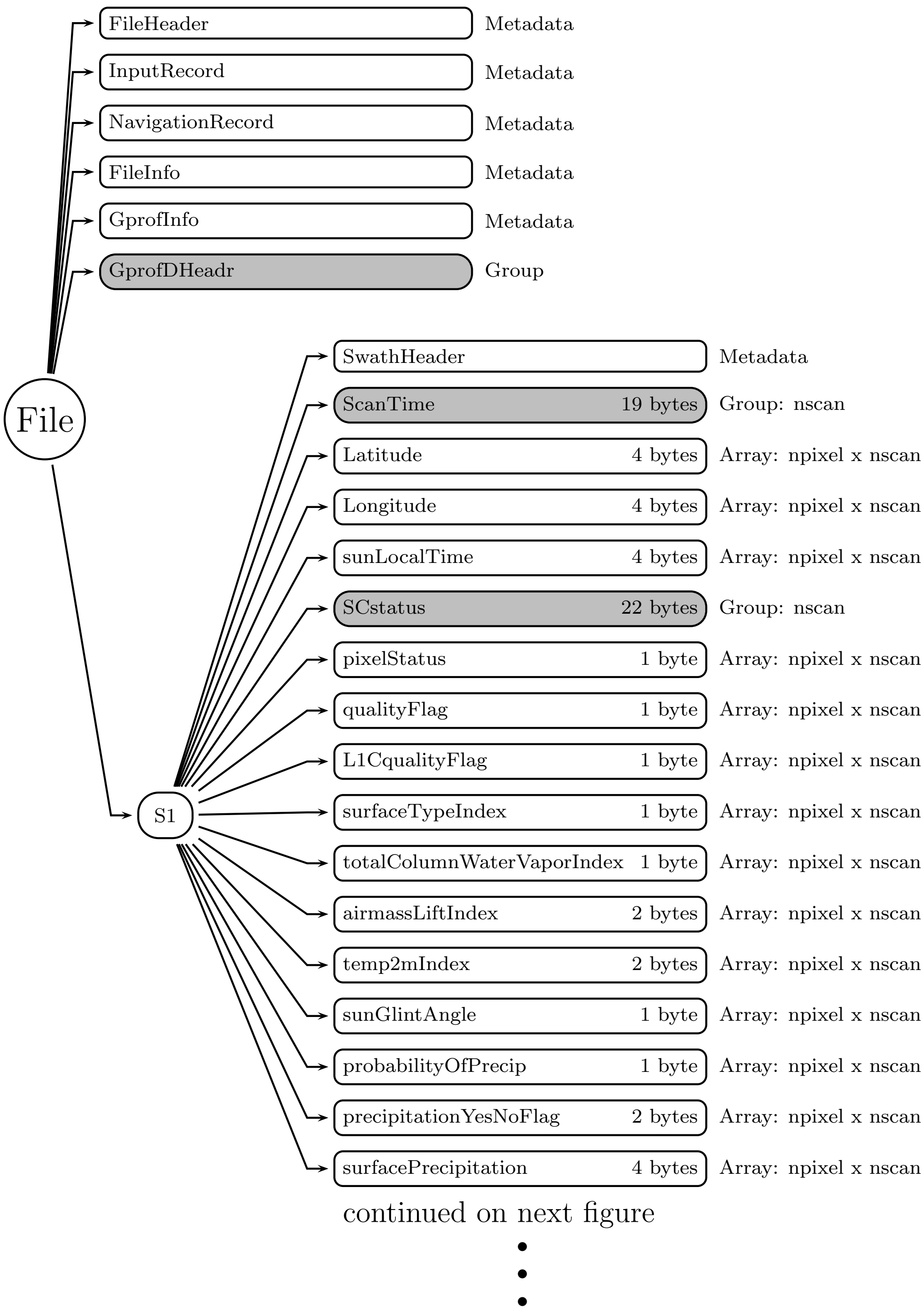


Figure 464: Data Format Structure for 2AGPROFMHS, Radiometer Profiling

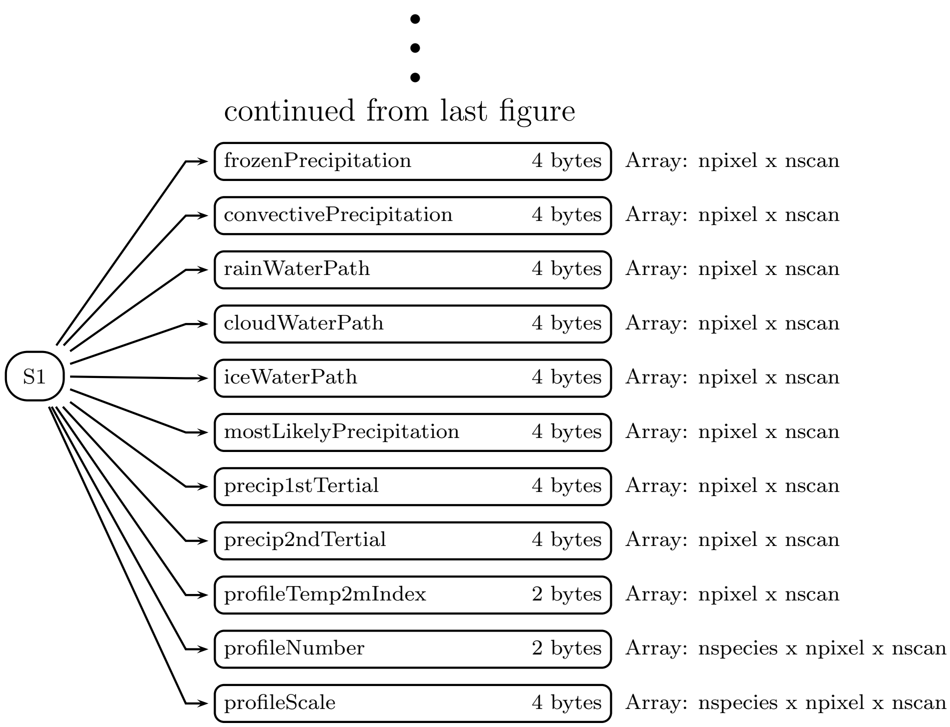


Figure 465: Data Format Structure for 2AGPROFMHS, Radiometer Profiling

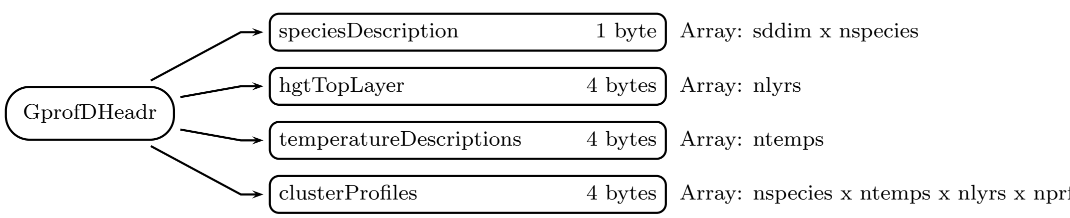


Figure 466: Data Format Structure for 2AGPROFMHS, GprofDHeadr

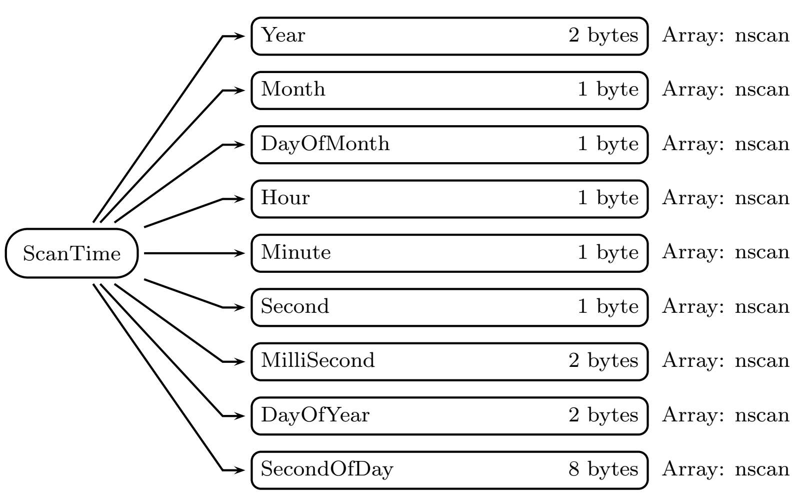


Figure 467: Data Format Structure for 2AGPROFMHS, ScanTime

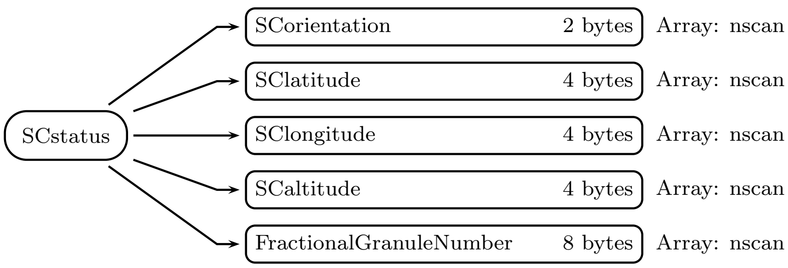


Figure 468: Data Format Structure for 2AGPROFMHS, SCstatus

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

GprofInfo (Metadata):
GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)

speciesDescription (1-byte char, array size: sddim x nspecies):
Description of each species. Special values are defined as:
255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):
Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. NOTE: Negative values are NOT valid values. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):
Temperature of 2 meter temperature indeces of clusterProfiles. NOTE: Negative values are NOT valid values. Values are in C. Special values are defined as:
-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):
Standard GPM profile structures. Dimensions are hydrometeor/heating species (5); 2 meter temperature index (12); vertical layers (28); and profile number (80). To recover values in a profile see the description below in the variable profileScale. NOTE: Negative values are NOT valid values.

Special values are defined as:
-9999.9 Missing value

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: npixel x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):
The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:
-9999 Missing value

SClatitude (4-byte float, array size: nscan):
Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):
Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan):
Values range from 0 to 1000 km. Special values are defined as:
-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
   0 : Valid pixel
   1 : Invalid Latitude / Longitude
   2 : Channel Tbs out of range
   3 : Surface code / histogram mismatch
   4 : Missing TCWV, T2m, or sfccode from preprocessor
   5 : No Bayesian Solution
 -99 : Missing value
```

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 4).

```
Valid values include:
0 : Pixel is "good" and has the highest confidence of the best retrieval.
1 : "Use with caution."  Pixels can be set to 1 for the following reasons:
   - Sunglint is present, RFI, geolocate, warm load
     or other L1C 'positive value' quality warning flags.
   - All sea-ice covered surfaces.
   - All snow covered surfaces.
   - Sensor channels are missing, but not critical ones.
2 : "Use pixel with extreme care over snow covered surface."
   This is a special value for snow covered surfaces only.
   The pixel is set to 2 if the probability of precipitation
   is of poor quality or indeterminate.  Use these pixels
   for climatological averaging of precipitation, but not
   for individual storm scale daily cases.
3 : "Use with extreme caution."  Pixels are set to 3 if
   they have channels missing critical to the retrieval,
   but the choice has been made to continue the retrieval
   for the pixel.
-99 : Missing value
```

L1CqualityFlag (1-byte integer, array size: npixel x nscan):
Based on the pixel quality from the input L1C data file. Range is -128 to 127.

```
0: Normal
1: Positive 1C Quality flag
3: Negative 1C Quality flag (not GMI)
Negative: Copied from negative 1C Quality flag (GMI only)
```

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7  : Decreasing vegetation
  8-11  : Decreasing snow cover
  12 : Standing Water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
 -99 : Missing value
```

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):
The integer total precipitable water used to select the correct database profiles. TotalColumnWaterVaporIndex is the nearest integer value to the model Total Precipitable Water. In the climate Gprof product the ECMWF model is used. In the standard Gprof product the GANAL model is used. In the NRT Gprof product the JMAfcst model is used. Values range from 0 to 78 mm. Special values are defined as:
-99 Missing value

airmassLiftIndex (2-byte integer, array size: npixel x nscan):

```
An index of atmospheric conditions conducive to
orographic precipitation for the Mountain rain
surface type. It indicates whether favorable
terrain-induced orographic uplift and moisture
convergence environments exist within 200 mb
of the surface, using pressure level wind and
specific humidity data from the ERA5 ECMWF
(Climate), GANAL (Standard) and JMAfcst (NRT)
models.  For the climate Gprof product, the
orographic/non-orographic environments are further
subclassified as convective or stratiform
using ERA5 convective precipitation proportion.

Gprof Standard and NRT version values range from 0 to 1.
0: No orographic moisture enhancement
1: Orographic moisture enhancement
-9999: Missing value
```

```
Gprof climate version values range from 0 to 3.
0: No orographic moisture enhancement, stratiform
1: Orographic moisture enhancement, stratiform
2: No orographic moisture enhancement, convective
3: Orographic moisture enhancement, convective
-9999: Missing value
```

temp2mIndex (2-byte integer, array size: npixel x nscan):
The 2 meter temperature Index used to select profiles in the database. Values are in K. Special values are defined as:
-9999 Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):
Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and the pixel's qualityFlag is lowered to 1. Values range from 0 to 127 degrees. Special values are defined as:
-88 Sun below horizon
-99 Missing

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

precipitationYesNoFlag (2-byte integer, array size: npixel x nscan):
This flag indicates whether the pixel is likely non-raining (0) or raining (1) based on the Bayesian probability of precipitation deemed to exceed the raining threshold from previous database comparisons. Special values are defined as:
-9999 Missing value

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Check pixelStatus for a valid retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous frozen precipitation rate at the surface. Check pixelStatus for a valid retrieval. A wet-bulb temperature scheme of Sims and Liu, doi: 10.1175/JHM-D-14-0211.1, is used to assign a portion (up to 100 percent) of the surface precipitation to

frozen precipitation. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface. Check pixelStatus for a valid retrieval. Defined using Combined/DPR precipitation type. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):
Total integrated rain water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):
Total integrated cloud liquid water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):
Total integrated ice water in the vertical atmospheric column. NOTE: Negative values are NOT valid values. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):
The surface precipitation value with the closest Tb match within the Bayesian retrieval. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 1st tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):
The surface precipitation value at the 2nd tertiary of the precipitation distribution. NOTE: Negative values are NOT valid precipitation values. Special values are defined as:
-9999.9 Missing value

profileTemp2mIndex (2-byte integer, array size: npixel x nscan):
Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:
-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):
Profile Number in the clusterProfiles array for each species. See profileScale description

below. Values range from 1 to 80. Special values are defined as:
-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):
profileScale is used to scale the values of the clusterProfiles array.

```
In order to recover a value of a single pixel,
select your species, level, and profile2mTempIndex,
then use profileNumber and profileScale
to obtain the value:

Where:
  S = species (1-5)
    Species defined in speciesDescription
  T = profile2mTempIndex (1-12)
    Temperatures defined in temperatureDescriptions
  L = profile level (1-28) Top of each level
    specified in hgtTopLayer
  P = profileNumber (1-80) for species S

In a Fortran program,
  P = profileNumber(S)
  Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)

In a C program,
  P = profileNumber[S-1]
  Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFMHS_H_
#define _TK_2AGPROFMHS_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;
```

```
#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFMHS_S1_
#define _L2AGPROFMHS_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[90];
    float Longitude[90];
    float sunLocalTime[90];
    SCSTATUS SCstatus;
    signed char pixelStatus[90];
    signed char qualityFlag[90];
    signed char L1CqualityFlag[90];
    signed char surfaceTypeIndex[90];
    signed char totalColumnWaterVaporIndex[90];
    short airmassLiftIndex[90];
    short temp2mIndex[90];
    signed char sunGlintAngle[90];
    signed char probabilityOfPrecip[90];
    short precipitationYesNoFlag[90];
    float surfacePrecipitation[90];
    float frozenPrecipitation[90];
    float convectivePrecipitation[90];
    float rainWaterPath[90];
    float cloudWaterPath[90];
```

```
    float iceWaterPath[90];
    float mostLikelyPrecipitation[90];
    float precip1stTertial[90];
    float precip2ndTertial[90];
    short profileTemp2mIndex[90];
    short profileNumber[90][5];
    float profileScale[90][5];
} L2AGPROFMHS_S1;

#endif

#ifndef _GPROFDHEADR_
#define _GPROFDHEADR_

typedef struct {
    unsigned char speciesDescription[5][21];
    float hgtTopLayer[28];
    float temperatureDescriptions[12];
    float clusterProfiles[80][28][12][5];
} GPROFDHEADR;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SClatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFMHS_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(90)
    REAL*4 Longitude(90)
    REAL*4 sunLocalTime(90)
    RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(90)
    BYTE qualityFlag(90)
    BYTE L1CqualityFlag(90)
    BYTE surfaceTypeIndex(90)
    BYTE totalColumnWaterVaporIndex(90)
    INTEGER*2 airmassLiftIndex(90)
    INTEGER*2 temp2mIndex(90)
    BYTE sunGlintAngle(90)
    BYTE probabilityOfPrecip(90)
    INTEGER*2 precipitationYesNoFlag(90)
    REAL*4 surfacePrecipitation(90)
    REAL*4 frozenPrecipitation(90)
    REAL*4 convectivePrecipitation(90)
    REAL*4 rainWaterPath(90)
    REAL*4 cloudWaterPath(90)
    REAL*4 iceWaterPath(90)
    REAL*4 mostLikelyPrecipitation(90)
    REAL*4 precip1stTertial(90)
    REAL*4 precip2ndTertial(90)
    INTEGER*2 profileTemp2mIndex(90)
    INTEGER*2 profileNumber(5,90)
    REAL*4 profileScale(5,90)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
    CHARACTER speciesDescription(21,5)
    REAL*4 hgtTopLayer(28)
    REAL*4 temperatureDescriptions(12)
    REAL*4 clusterProfiles(5,12,28,80)
END STRUCTURE
```

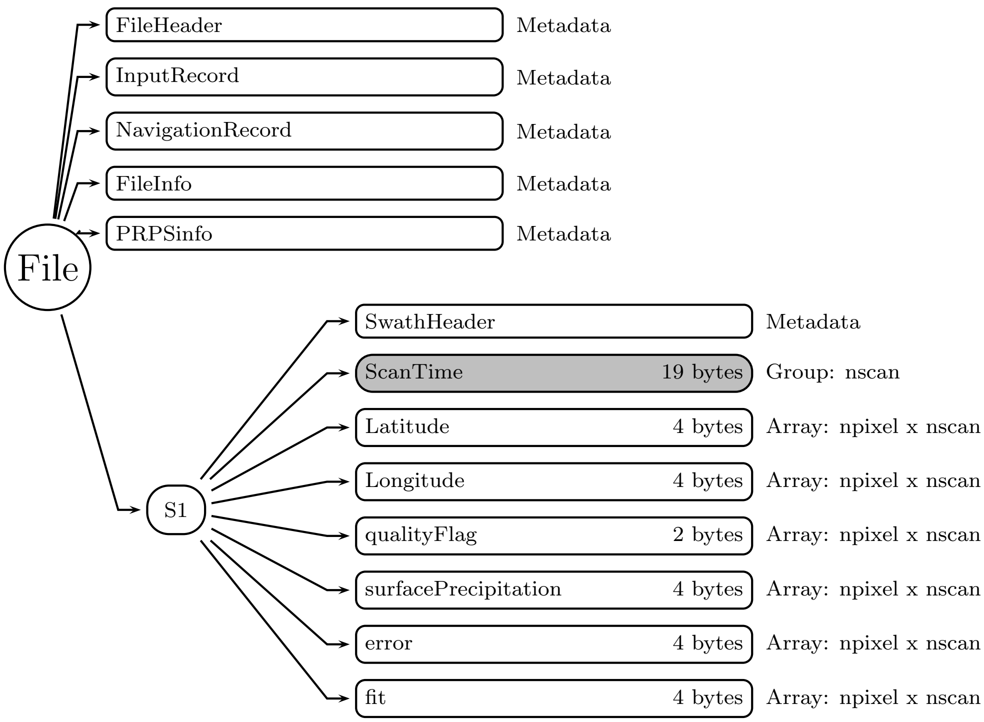


Figure 469: Data Format Structure for 2APRPSSAPHIR, Radiometer Profiling

5.40 2APRPSSAPHIR - Radiometer Profiling

2APRPSSAPHIR, "Radiometer Profiling", generates surface rainfall on a pixel by pixel basis from radiometer brightness temperature data using the Precipitation Retrieval Profile Scheme PRPS2017.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	182	Number of pixels in each scan.

Figure 469 through Figure 470 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

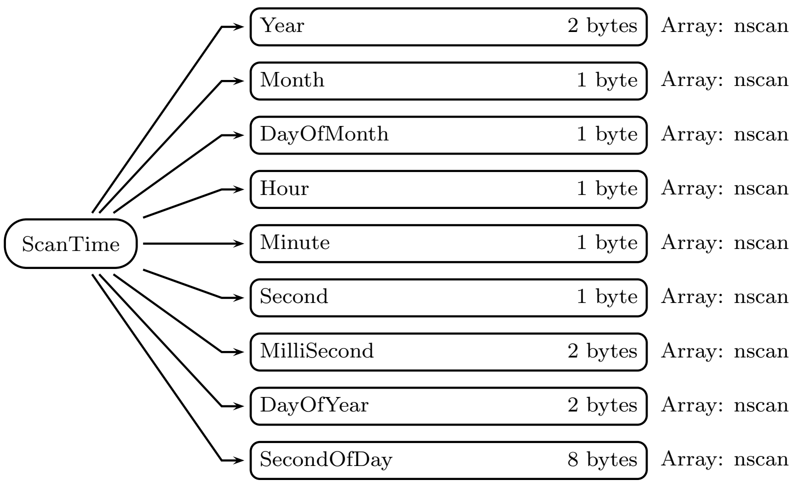


Figure 470: Data Format Structure for 2APRPSSAPHIR, ScanTime

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

PRPSinfo (Metadata):
PRPSinfo contains metadata required by PRPS. Used by 2APRPS products. See Metadata for GPM Products for details.

S1 (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

qualityFlag (2-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 2).

```
Valid values include:
0 : All is OK
```

```
1 : Bad Tcs
2 : Altitude too high
-999 : Missing value
```

surfacePrecipitation (4-byte float, array size: npixel x nscan):
The instantaneous precipitation rate at the surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

error (4-byte float, array size: npixel x nscan):
The RMSE of the chosen profiles at the surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

fit (4-byte float, array size: npixel x nscan):
How well the observed Tcs match the database Tcs. It is calculated as the mean(sum(Tcobs-Tcdtb)). Values are in K. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_2APRPSSAPHIR_H_
#define _TK_2APRPSSAPHIR_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2APRPSSAPHIR_S1_
#define _L2APRPSSAPHIR_S1_

typedef struct {
```

```
    SCANTIME ScanTime;
    float Latitude[182];
    float Longitude[182];
    short qualityFlag[182];
    float surfacePrecipitation[182];
    float error[182];
    float fit[182];
} L2APRPSSAPHIR_S1;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2APRPSSAPHIR_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(182)
    REAL*4 Longitude(182)
    INTEGER*2 qualityFlag(182)
    REAL*4 surfacePrecipitation(182)
    REAL*4 error(182)
    REAL*4 fit(182)
END STRUCTURE
```

5.41 3GPROF - GPROF Profiling

3GPROF, "GPROF Profiling", produces global 0.25^o x 0.25^o gridded means using Level 2 Gprof data. Vertical hydrometeor profiles and surface rainfall means are computed.

Various pixel counts are also reported. The PI is Joyce Chou. The product can be monthly or daily. The following sections describe the structure and contents of the format.

Dimension definitions:

lonv	2	Number of longitude bounds.
latv	2	Number of latitude bounds.
lon	1440	Number of 0.25^o grid intervals of longitude from 180^o W to 180^o E.
lat	720	Number of 0.25^o grid intervals of latitude from 90^o S to 90^o N.
layerv	2	Number of layer bounds.
layer	28	Number of vertical layers.

Figure 471 through Figure 472 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

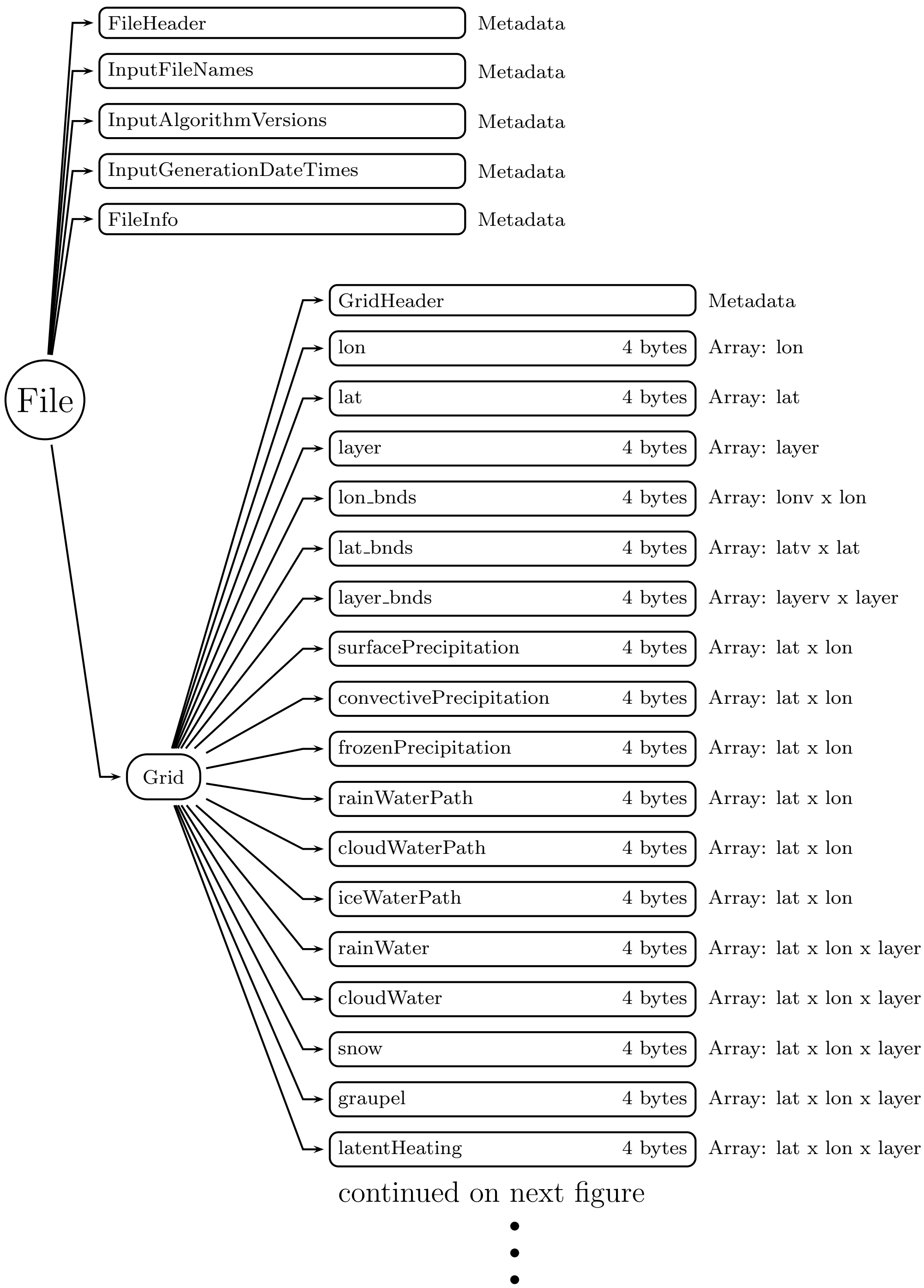
Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

lon (4-byte float, array size: lon):
Longitude at the center of 0.25^o grid intervals of longitude from 180^o W to 180^o E.

lat (4-byte float, array size: lat):
Latitude at the center of 0.25^o grid intervals of latitude from 90^o S to 90^o N.

layer (4-byte float, array size: layer):
Height at the center of vertical layer.



continued on next figure

Figure 471: Data Format Structure for 3GPROF, GPROF Profiling

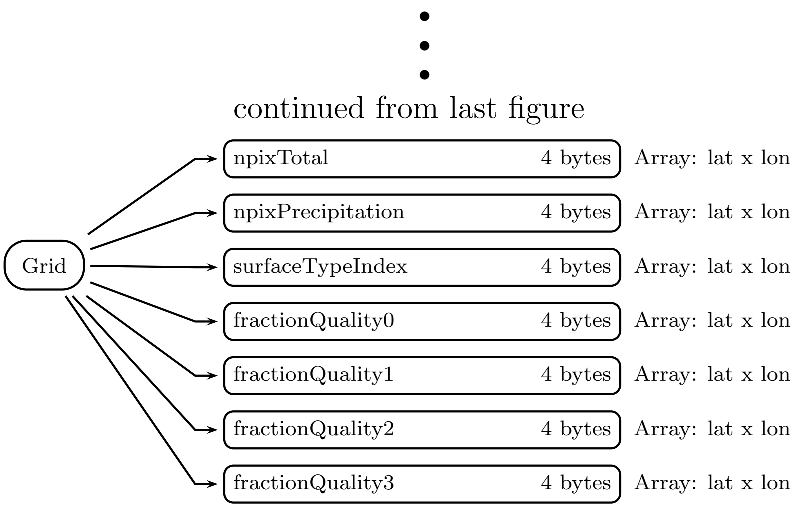


Figure 472: Data Format Structure for 3GPROF, GPROF Profiling

lon_bnds (4-byte float, array size: lonv x lon):
Longitude of the west and east edges of the grid boxes. Values range from -180 to 180 degrees_east. Special values are defined as:
-9999.9 Missing value

lat_bnds (4-byte float, array size: latv x lat):
Latitude of the south and north edges of the grid boxes. Values range from -90 to 90 degrees_north. Special values are defined as:
-9999.9 Missing value

layer_bnds (4-byte float, array size: layerv x layer):
Height of the lower and upper edges of the layers. Values range from 0 to 18 kilometers. Special values are defined as:
-9999.9 Missing value

surfacePrecipitation (4-byte float, array size: lat x lon):
The monthly mean of the instantaneous precipitation rate at the surface for each grid. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

convectivePrecipitation (4-byte float, array size: lat x lon):
The monthly mean of the instantaneous convective precipitation rate at the surface for each grid. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

frozenPrecipitation (4-byte float, array size: lat x lon):
The monthly mean of the instantaneous frozen precipitation rate at the surface for each grid. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

rainWaterPath (4-byte float, array size: lat x lon):
The monthly mean of the total integrated rain water in the vertical atmospheric column.

Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

cloudWaterPath (4-byte float, array size: lat x lon):
The monthly mean of the total integrated cloud water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

iceWaterPath (4-byte float, array size: lat x lon):
The monthly mean of the total integrated ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2. Special values are defined as:
-9999.9 Missing value

rainWater (4-byte float, array size: lat x lon x layer):
The monthly mean of the rain water content for each grid at each vertical layer. Values range from 0 to 10 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudWater (4-byte float, array size: lat x lon x layer):
The monthly mean of the cloud liquid water content for each grid at each vertical layer. Values range from 0 to 10 g/m^3. Special values are defined as:
-9999.9 Missing value

snow (4-byte float, array size: lat x lon x layer):
The monthly mean of the snow liquid water content for each grid at each vertical layer. Values range from 0 to 10 g/m^3. Special values are defined as:
-9999.9 Missing value

graupel (4-byte float, array size: lat x lon x layer):
The monthly mean of the graupel liquid water content for each grid at each vertical layer. Values range from 0 to 10 g/m^3. Special values are defined as:
-9999.9 Missing value

latentHeating (4-byte float, array size: lat x lon x layer):
The monthly mean of the latent heating for each grid at each vertical layer. Values range from 0 to 10 K/hr. Special values are defined as:
-9999.9 Missing value

npixTotal (4-byte integer, array size: lat x lon):
The monthly number of pixels with pixelStatus equal to zero for each grid. pixelStatus equal to zero means the pixel is valid and has a retrieval. npixTotal is used to compute the monthly means described above. Values range from 0 to 10000. Special values are defined as:
-9999 Missing value

npixPrecipitation (4-byte integer, array size: lat x lon):
The monthly number of pixels with surfacePrecipitation greater than 0 and precipitationYesNoFlag equal to 1 for each grid. Values range from 0 to 10000. Special values are defined as:
-9999 Missing value

surfaceTypeIndex (4-byte integer, array size: lat x lon):
Indicates the type of surface (Range 0 - 99).

```
  Codes include
  1  : Ocean
  2  : Sea-Ice
  3-7 : Decreasing vegetation
  8-11 : Decreasing snow cover
  12 : Standing water
  13 : Ocean or water Coast
  14 : Mixed land/ocean or water coast
  15 : Land coast
  16 : Sea-ice edge
  17 : Mountain rain
  18 : Mountain snow
  60 : Multiple surface types
 -99 : Missing value
```

fractionQuality0 (4-byte float, array size: lat x lon):
The fraction of the retrieved pixels in a given grid box identified as good retrievals. For regions where there are no retrieval issues this will be 1.0. Areas with surface screening or contamination issues with questionable retrievals during the accumulation period will have values less than one and should thus be used with caution for any quantitative analysis. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

fractionQuality1 (4-byte float, array size: lat x lon):
The fraction of total pixels with qualityFlag equal to 1 (use with caution) for each grid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

fractionQuality2 (4-byte float, array size: lat x lon):
The fraction of total pixels with qualityFlag equal to 2 (use with extreme care over snow covered surface) for each grid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

fractionQuality3 (4-byte float, array size: lat x lon):
The fraction of total pixels with qualityFlag equal to 3 (use with extreme caution) for each grid. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3GPROF_H_
#define _TK_3GPROF_H_
```

```
#ifndef _L3GPROF_GRID_
#define _L3GPROF_GRID_

typedef struct {
    float lon[1440];
    float lat[720];
    float layer[28];
    float lon_bnds[1440][2];
    float lat_bnds[720][2];
    float layer_bnds[28][2];
    float surfacePrecipitation[1440][720];
    float convectivePrecipitation[1440][720];
    float frozenPrecipitation[1440][720];
    float rainWaterPath[1440][720];
    float cloudWaterPath[1440][720];
    float iceWaterPath[1440][720];
    float rainWater[28][1440][720];
    float cloudWater[28][1440][720];
    float snow[28][1440][720];
    float graupel[28][1440][720];
    float latentHeating[28][1440][720];
    int npixTotal[1440][720];
    int npixPrecipitation[1440][720];
    int surfaceTypeIndex[1440][720];
    float fractionQuality0[1440][720];
    float fractionQuality1[1440][720];
    float fractionQuality2[1440][720];
    float fractionQuality3[1440][720];
} L3GPROF_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GPROF_GRID/
    REAL*4 lon(1440)
    REAL*4 lat(720)
    REAL*4 layer(28)
    REAL*4 lon_bnds(2,1440)
    REAL*4 lat_bnds(2,720)
    REAL*4 layer_bnds(2,28)
```

```
    REAL*4 surfacePrecipitation(720,1440)
    REAL*4 convectivePrecipitation(720,1440)
    REAL*4 frozenPrecipitation(720,1440)
    REAL*4 rainWaterPath(720,1440)
    REAL*4 cloudWaterPath(720,1440)
    REAL*4 iceWaterPath(720,1440)
    REAL*4 rainWater(720,1440,28)
    REAL*4 cloudWater(720,1440,28)
    REAL*4 snow(720,1440,28)
    REAL*4 graupel(720,1440,28)
    REAL*4 latentHeating(720,1440,28)
    INTEGER*4 npixTotal(720,1440)
    INTEGER*4 npixPrecipitation(720,1440)
    INTEGER*4 surfaceTypeIndex(720,1440)
    REAL*4 fractionQuality0(720,1440)
    REAL*4 fractionQuality1(720,1440)
    REAL*4 fractionQuality2(720,1440)
    REAL*4 fractionQuality3(720,1440)
END STRUCTURE
```

5.42 3PRPSSAPHIR - Gridded PRPS

3PRPSSAPHIR, "Gridded PRPS", produces global 0.25^o x 0.25^o gridded means using Level 2 PRPS data. Surface precipitation means are computed. Various pixel counts are also reported. The PI is Joyce Chou. The product can be monthly or daily. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	720	Number of 0.25^o grid intervals of latitude from 90^oN to 90^oS.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180^oW to 180^oE.

Figure 473 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

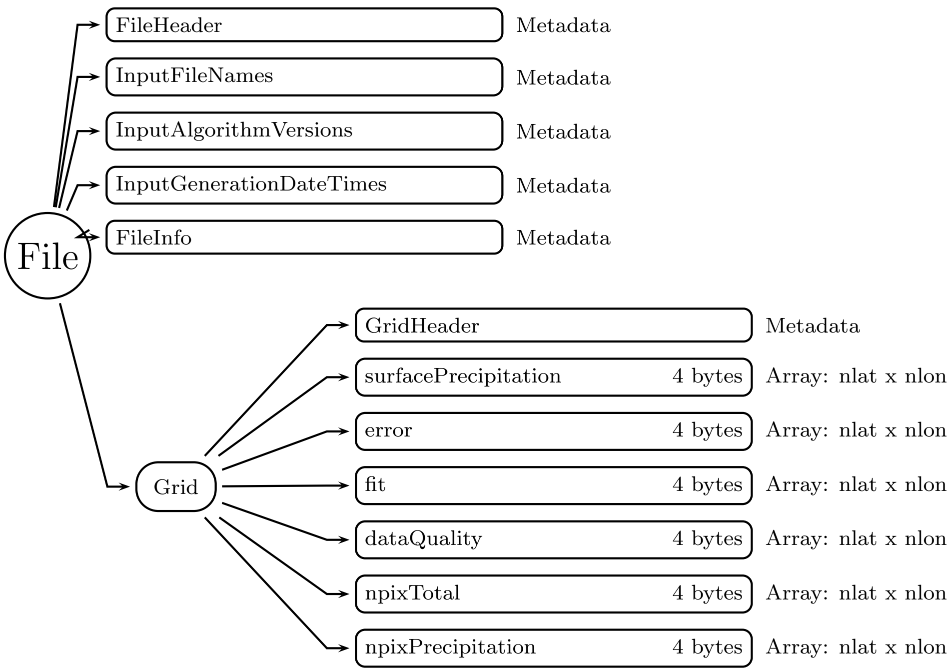


Figure 473: Data Format Structure for 3PRPSSAPHIR, Gridded PRPS

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

surfacePrecipitation (4-byte float, array size: nlat x nlon):
The monthly mean of the instantaneous precipitation rate at the surface for each grid box. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

error (4-byte float, array size: nlat x nlon):
The monthly mean of the L2 error values for each grid box. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

fit (4-byte float, array size: nlat x nlon):
The monthly mean of the L2 fit values for each grid box. Values are in K. Special values are defined as:
-9999.9 Missing value

dataQuality (4-byte float, array size: nlat x nlon):
The monthly percent of pixels with qualityFlag equal to 0. A value of 100 means all pixels in the grid box are good. Values range from 0 to 100 percent. Special values are defined as:
-9999.9 Missing value

npixTotal (4-byte integer, array size: nlat x nlon):
The monthly number of pixels in each grid box. Values range from 0 to 10000. Special values are defined as:
-9999 Missing value

npixPrecipitation (4-byte integer, array size: nlat x nlon):
The monthly number of pixels in each grid box with surfacePrecipitation greater than 0. Values range from 0 to 10000. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3PRPSSAPHIR_H_
#define _TK_3PRPSSAPHIR_H_

#ifndef _L3PRPSSAPHIR_GRID_
#define _L3PRPSSAPHIR_GRID_

typedef struct {
    float surfacePrecipitation[1440][720];
    float error[1440][720];
    float fit[1440][720];
    float dataQuality[1440][720];
    int npixTotal[1440][720];
    int npixPrecipitation[1440][720];
} L3PRPSSAPHIR_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3PRPSSAPHIR_GRID/
```

```
    REAL*4 surfacePrecipitation(720,1440)
    REAL*4 error(720,1440)
    REAL*4 fit(720,1440)
    REAL*4 dataQuality(720,1440)
    INTEGER*4 npixTotal(720,1440)
    INTEGER*4 npixPrecipitation(720,1440)
END STRUCTURE
```

5.43 1BKu - Ku Power

The Ku Level-1B product, 1BKu, "Ku Power," is written as a swath structure. The swath name is "FS", for Full Scan Swath. The Ka Level-1B product, 1BKa, is closely related. The scan times in 1BKa are identical to the scan times in 1BKu. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.
nbin	260	Number of range bins in each ray.
SVBFd	3	Number in sunVectorInBodyFrame.
nfcifT	2	Number in fcifTemp.
nlnaT	2	Number in lnaTemp.
nrdaT	2	Number in rdaTemp.
ndc1T	2	Number in divcomb1Temp.
ndc2T	2	Number in divcomb2Temp.
nsspaT	2	Number in sspaTemp.

Figure 474 through Figure 484 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

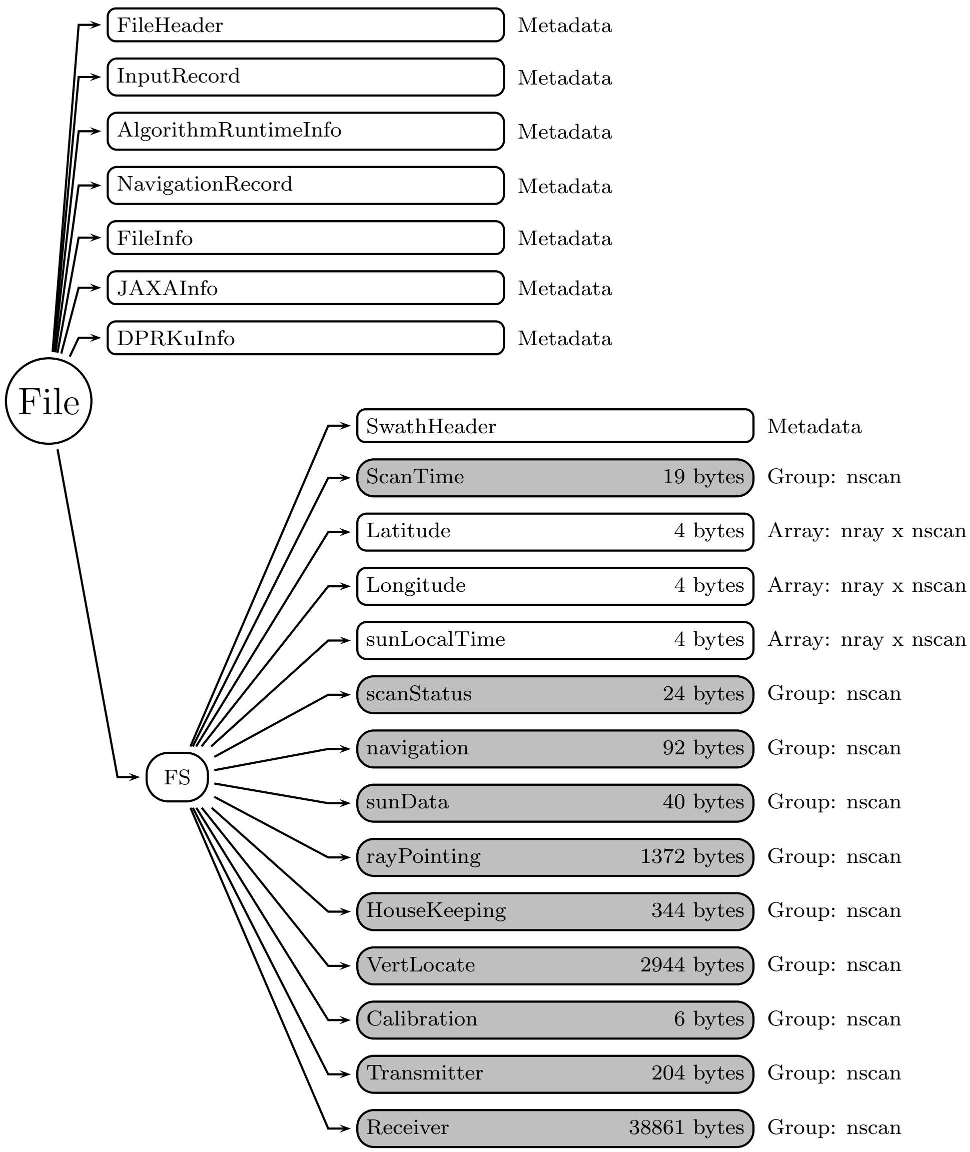


Figure 474: Data Format Structure for 1BKu, Ku Power

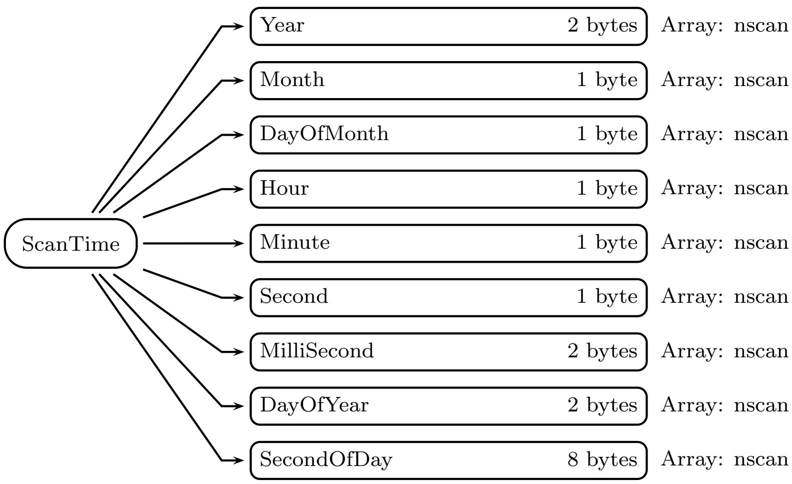


Figure 475: Data Format Structure for 1BKu, ScanTime

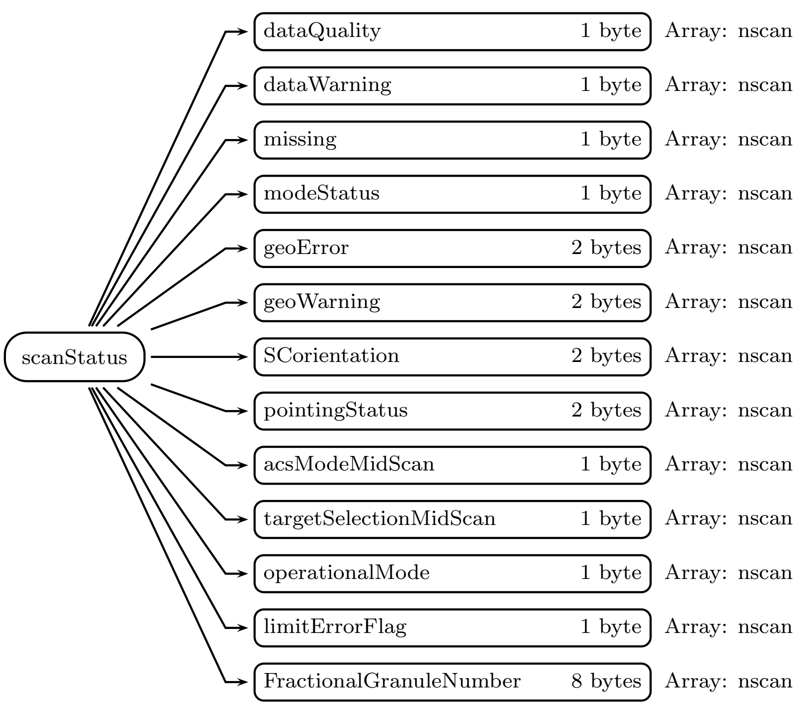


Figure 476: Data Format Structure for 1BKu, scanStatus

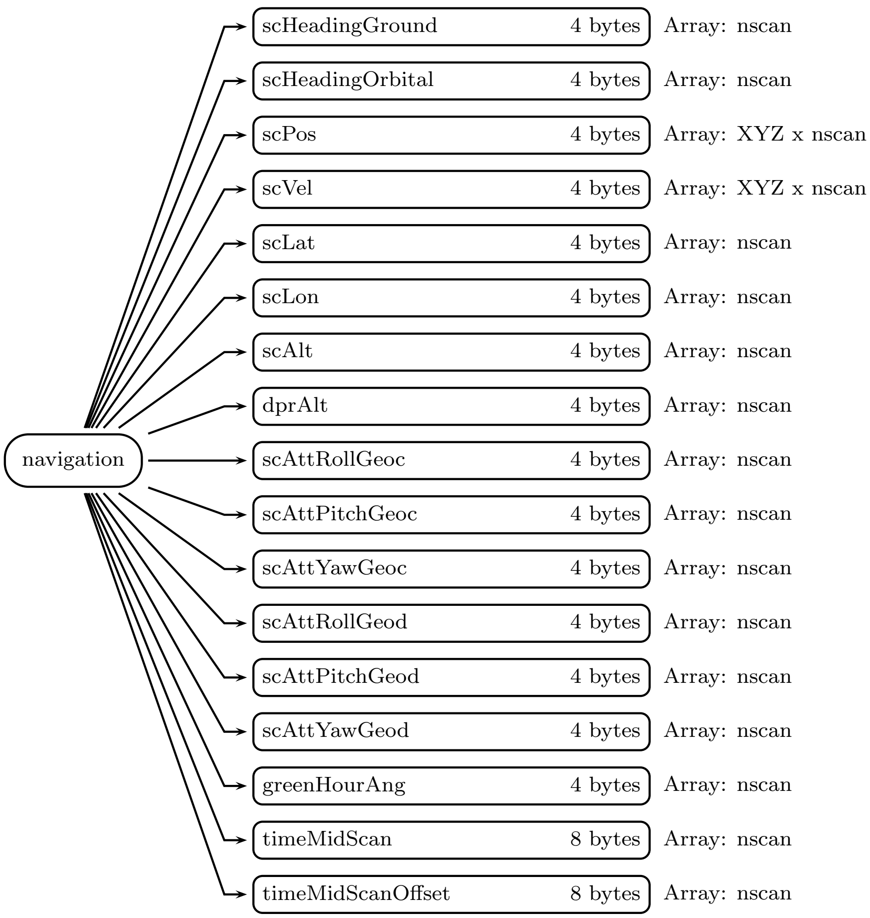


Figure 477: Data Format Structure for 1BKu, navigation

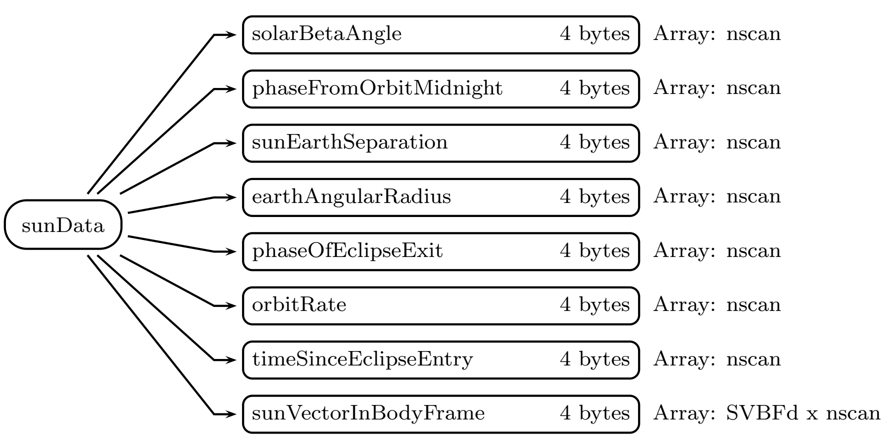


Figure 478: Data Format Structure for 1BKu, sunData

rayPointing

rayDirectionX	4 bytes	Array: nray x nscan
rayDirectionY	4 bytes	Array: nray x nscan
instrumentYaw	4 bytes	Array: nray x nscan
instrumentPitch	4 bytes	Array: nray x nscan
instrumentRoll	4 bytes	Array: nray x nscan
rayTiming	4 bytes	Array: nray x nscan
scanAngle	4 bytes	Array: nray x nscan

Figure 479: Data Format Structure for 1BKu, rayPointing

HouseKeeping

rxAtt	1 byte	Array: nscan
rxAttGainOffset	4 bytes	Array: nscan
binDiffPeakDEM	2 bytes	Array: nray x nscan
scTime	8 bytes	Array: nscan
vprfTableVersion	1 byte	Array: nscan
vprfTableSelect	1 byte	Array: nscan
catchingInt	1 byte	Array: nscan
scdpFlag	1 byte	Array: nscan
fcifFlag	1 byte	Array: nscan
logAmpNoiseLevel	2 bytes	Array: nscan
delay	2 bytes	Array: nscan
seqCountL1A	2 bytes	Array: nscan
fcifTemp	2 bytes	Array: nfcifT x nscan
lnaTemp	2 bytes	Array: nlnaT x nscan
rdaTemp	2 bytes	Array: nrdaT x nscan
divcomb1Temp	2 bytes	Array: ndc1T x nscan
divcomb2Temp	2 bytes	Array: ndc2T x nscan
sspaTemp	2 bytes	Array: nsspaT x nscan
rxGain	4 bytes	Array: nray x nscan
fcifFlagAB	1 byte	Array: nscan
scdpFlagAB	1 byte	Array: nscan

Figure 480: Data Format Structure for 1BKu, HouseKeeping

VertLocate

landOceanFlag	2 bytes	Array: nray x nscan
scLocalZenith	4 bytes	Array: nray x nscan
startBinRange	8 bytes	Array: nray x nscan
echoHighResBinNumber	2 bytes	Array: nray x nscan
echoLowResBinNumber	2 bytes	Array: nray x nscan
binEllipsoid	2 bytes	Array: nray x nscan
scRangeEllipsoid	4 bytes	Array: nray x nscan
binDEM	2 bytes	Array: nray x nscan
scRangeDEM	4 bytes	Array: nray x nscan
DEMHmean	2 bytes	Array: nray x nscan
binDEMHtop	2 bytes	Array: nray x nscan
binDEMHbottom	2 bytes	Array: nray x nscan
binEchoPeak	2 bytes	Array: nray x nscan
alongTrackBeamWidth	4 bytes	Array: nray x nscan
crossTrackBeamWidth	4 bytes	Array: nray x nscan
mainlobeEdge	2 bytes	Array: nray x nscan
sidelobeRange	2 bytes	Array: nray x nscan
ellipsoidBinOffset	4 bytes	Array: nray x nscan
binMirrorImage	2 bytes	Array: nray x nscan
rangeBinSize	4 bytes	Array: nscan
ratioLand	1 byte	Array: nray x nscan
ratioOcean	1 byte	Array: nray x nscan
ratioInLand	1 byte	Array: nray x nscan
ratioCoast	1 byte	Array: nray x nscan

Figure 481: Data Format Structure for 1BKu, VertLocate

Calibration

fcifInPower	2 bytes	Array: nscan
intAttSelect	1 byte	Array: nscan
sspaLnaSelect	2 bytes	Array: nscan
angleBinSelect	1 byte	Array: nscan

Figure 482: Data Format Structure for 1BKu, Calibration

Figure 483: Data Format Structure for 1BKu, Transmitter

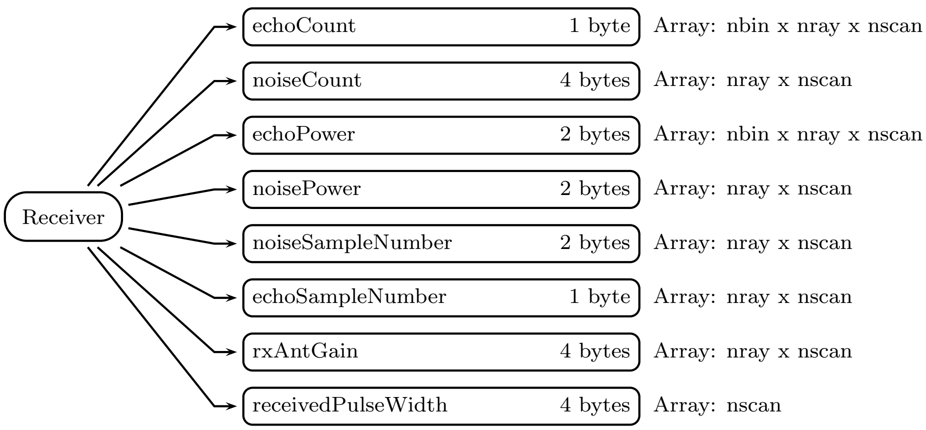


Figure 484: Data Format Structure for 1BKu, Receiver

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

DPRKuInfo (Metadata):
Contains DPR information. See Metadata for GPM Products for details.

FS (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
```

```
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft

axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
```

```
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of

the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values

range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayPointing (Group)

rayDirectionX (4-byte float, array size: nray x nscan):
Unit ray direction x component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayDirectionY (4-byte float, array size: nray x nscan):
Unit ray direction y component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

instrumentYaw (4-byte float, array size: nray x nscan):
Yaw of mechanical coordinates w.r.t. geodetic coordinates. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

instrumentPitch (4-byte float, array size: nray x nscan):
Pitch of mechanical coordinates w.r.t. geodetic coordinates. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

instrumentRoll (4-byte float, array size: nray x nscan):
Roll of mechanical coordinates w.r.t. geodetic coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

rayTiming (4-byte float, array size: nray x nscan):
The time delay from the secondary header packet time tag to each ray (assumed as mid-time of all radar pulses for the associated rayDirection). Values range from 0 to 1.6 s. Special values are defined as:
-9999.9 Missing value

scanAngle (4-byte float, array size: nray x nscan):
Angle (degrees) of the ray from nominal nadir offset about the mechanical x_axis. The sign of the angle is consistent with the sensor y-axis, i.e., the angle is positive to the right of the direction of travel if the spacecraft is in normal mode. Values range from -18 to 18 degrees. Special values are defined as:
-9999.9 Missing value

HouseKeeping (Group)

rxAtt (1-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 12 dB. Special values are defined as:
-99 Missing value

rxAttGainOffset (4-byte float, array size: nscan):
The actual gain of rxAtt considering the temperature dependence. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDiffPeakDEM (2-byte integer, array size: nray x nscan):
The number of range bins between binEchoPeak and binDEM. It is used to ensure that the VPRF is switched in accordance with the GPM satellite altitude. Values range from -260 to 260 range bin number at NS and MS, from -130 to 130 range bin number at HS respectively. Values range from -260 to 260 range bin number. Special values are defined as:
-9999 Missing value

scTime (8-byte float, array size: nscan):
Scan time expressed as TAI time with and epoch of 0000Z Jan 6, 1980. This time matches

the time in ScanTime. Special values are defined as:
-9999.9 Missing value

vprfTableVersion (1-byte integer, array size: nscan):
The version number of VPRF table which is used in L1B process. Values range from 1 to 127 number. Special values are defined as:
-99 Missing value

vprfTableSelect (1-byte integer, array size: nscan):
The selected number of VPRF table for altitude (h, km) which is used in L1B process. The range is 1 to 25.

```
h LT 396.5 = 1
396.5 LE h LT 397.5 = 2
397.5 LE h LT 398.5 = 3
398.5 LE h LT 399.5 = 4
399.5 LE h LT 400.5 = 5
400.5 LE h LT 401.5 = 6
401.5 LE h LT 402.5 = 7
402.5 LE h LT 403.5 = 8
403.5 LE h LT 404.5 = 9
404.5 LE h LT 405.5 = 10
405.5 LE h LT 406.5 = 11
406.5 LE h LT 407.5 = 12
407.5 LE h LT 408.5 = 13
408.5 LE h LT 409.5 = 14
409.5 LE h LT 410.5 = 15
410.5 LE h LT 411.5 = 16
411.5 LE h LT 412.5 = 17
412.5 LE h LT 413.5 = 18
413.5 LE h LT 414.5 = 19
414.5 LE h LT 415.5 = 20
415.5 LE h LT 416.5 = 21
416.5 LE h LT 417.5 = 22
417.5 LE h LT 418.5 = 23
418.5 LE h LT 419.5 = 24
419.5 LE h = 25

where
LT mean less than and
LE means less than or equal to
```

catchingInt (1-byte integer, array size: nscan):
The timing that receive window is open for the first reflected TX pulse. If catchingInt is set to 12, then the first TX pulse is received with receive window after the twelfth TX

pulse. In the case of nominal operation, catchingInt is set to 12, that is, the VPRF table is used. In other cases, including GPS-status trouble, catchingInt is set 8 and limited PRF is loaded. Values range from 8 to 12 number. Special values are defined as:
-99 Missing value

scdpFlag (1-byte integer, array size: nscan):
The side of the SCDP system and system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry.
3   Priority is 2 at Basic System Table. Refer to Basic System Table.
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

fcifFlag (1-byte integer, array size: nscan):
The side of FCIF system and the system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry
3   Priority is 2 at Basic System Table. Refer to Basic System Table
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

logAmpNoiseLevel (2-byte integer, array size: nscan):
The Noise Level at Log Amp Termination which is stored in science telemetry. Values are in counts. Special values are defined as:
-9999 Missing value

delay (2-byte integer, array size: nscan):
The timing offset value from space craft time in NS. In MS and HS, it is defined as offset time value from the base delay time. They are used to adjust for beam matching of along track direction. Values range from 0 to 3360 number. Special values are defined as:
-9999 Missing value

seqCountL1A (2-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 27000 counts. Special values are defined as:
-9999 Missing value

fcifTemp (2-byte integer, array size: nfcifT x nscan):
The temperature of FCIF component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

lnaTemp (2-byte integer, array size: nlnaT x nscan):
The temperature of LNA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C.

rdaTemp (2-byte integer, array size: nrdaT x nscan):
he temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C Attenuator setting levels of Received radar antenna.Values are 0, 3, 6, 9 and 12 in dB. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb1Temp (2-byte integer, array size: ndc1T x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb2Temp (2-byte integer, array size: ndc2T x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

sspaTemp (2-byte integer, array size: nsspaT x nscan):
The temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

rxGain (4-byte float, array size: nray x nscan):
The total receiver gain from FCIF input to antenna input. Values are in dB. Special values are defined as:
-9999.9 Missing value

fcifFlagAB (1-byte integer, array size: nscan):
FCIF A-side/B-side information. This flag does not include information on the source of the decision about the fcifFlag. Special values are defined as:
-99 Missing value

scdpFlagAB (1-byte integer, array size: nscan):
FCIF A-side/B-side information. This flag does not include information on the source of the decision about the scdpFlag. Special values are defined as:
-99 Missing value

VertLocate (Group)

landOceanFlag (2-byte integer, array size: nray x nscan):
Land or ocean information. The values of the flag are:

```
0 = Water
1 = Land
2 = Coast
3 = Inland Water
```

scLocalZenith (4-byte float, array size: nray x nscan):
The angle, in degrees, between the local zenith and the beam's center line. The local (geodetic) zenith at the intersection of the ray and the earth ellipsoid is used. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

startBinRange (8-byte float, array size: nray x nscan):
The distance from the satellite to the center of the first range bin. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

echoHighResBinNumber (2-byte integer, array size: nray x nscan):
The number of sampling without thinning out (over sampling).. Range of 1-260 for NS and MS and 1-130 at HS. EDIT Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

```
Meaning in Normal Mode:
0 = Over sampling range bin OR
1 = Normal sampling range bin
2 = Interpolated range bin
-99 = Outrange bin of the observation area
Meaning in internal calibration mode:
0: In internal calibration mode, this value is stored 1- 42 range bin for each
```

`ray.`
`-99: missing value. In internal calibration mode, this value is stored after 43 range bin for each ray as missing.`

echoLowResBinNumber (2-byte integer, array size: nray x nscan):
The number of sampling after thinning out the normal sample. From 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Values range from 0 to 260 range bin number. Special values are defined as:
-9999 Missing value

binEllipsoid (2-byte integer, array size: nray x nscan):
The range bin number of the earth ellipsoid. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

scRangeEllipsoid (4-byte float, array size: nray x nscan):
The distance from instrument to ellipsoid calculated by GeoTK. Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

binDEM (2-byte integer, array size: nray x nscan):
Range bin number of the average DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing.

scRangeDEM (4-byte float, array size: nray x nscan):
The value is calculted as scRangeEllipsoid - DEMHmean secand(localZenithAngle). Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

DEMHmean (2-byte integer, array size: nray x nscan):
Averaged DEM height, whose SRTM-30. Values range from 0 to 9000 m. Special values are defined as:
-9999 Missing value

binDEMHtop (2-byte integer, array size: nray x nscan):
The range bin number of the maximum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binDEMHbottom (2-byte integer, array size: nray x nscan):
The range bin number of the minimum DEM surface elevation in a box centered on the

IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binEchoPeak (2-byte integer, array size: nray x nscan):
The range bin number which has maximum echoPower in each scan and each angle bin. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

alongTrackBeamWidth (4-byte float, array size: nray x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power in the along-track direction.

crossTrackBeamWidth (4-byte float, array size: nray x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power along the cross-track direction.

mainlobeEdge (2-byte integer, array size: nray x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the edge of the clutter from the mainlobe.

sidelobeRange (2-byte integer, array size: nray x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter psition from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
The distance between center of binEllipsoid range bin and Ellipsoid position.

binMirrorImage (2-byte integer, array size: nray x nscan):
Range bin of the mirror image.

rangeBinSize (4-byte float, array size: nscan):
The range bin size. With VPRF, the size for NS and MS is 250.32670 m and for HS 250.32670 m. With limited PRF, the size is 250.32670 m for all three swaths.

ratioLand (1-byte integer, array size: nray x nscan):
Ratio of land area to total area in a footprint.

ratioOcean (1-byte integer, array size: nray x nscan):
Ratio of ocean area to total area in a footprint.

ratioInLand (1-byte integer, array size: nray x nscan):
Ratio of inland water area to total area in a footprint.

ratioCoast (1-byte integer, array size: nray x nscan):
Ratio of coast area to total area in a footprint.

Calibration (Group)

fcifInPower (2-byte integer, array size: nscan):
Input power value of FCIF and is set at internal calibration mode. At another mode, the value of fcifInPower is set as missing. Values are in 0.01 dBm. Special values are defined as:
-30000 Missing value

intAttSelect (1-byte integer, array size: nscan):
The selected number of internal attenuation that is controlled automatically with 32 steps and is set by internal mode. At another mode, the value of fcifInPower is set as missing. Values range from 1 to 32 step. Special values are defined as:
-99 Missing value

sspaLnaSelect (2-byte integer, array size: nscan):
In SSPA mode, sspaLnaSelect stores the number of LNA. In LNA mode, sspaLnaSelect stores the number of SSPA. In other modes, sspaLnaSelect is given the missing value. Values range from 1 to 128 number. Special values are defined as:
-9999 Missing value

angleBinSelect (1-byte integer, array size: nscan):
In SSPA and LNA mode, angleBinSelect contains the selected beam number. In other operational modes, angleBinSelect is set to missing. Values range from 1 to 49 number. Special values are defined as:
-99 Missing value

Transmitter (Group)

radarTransPower (4-byte float, array size: nscan):
The total (sum) power of 128 SSPA elements corrected with SSPA temperature in orbit. It is based on ground test temperature data of SSPA transmission power. Special value -9999.9 for missing scan and internal calibration mode.

transPulseWidth (4-byte float, array size: nscan):
Transmitted pulse width corrected with FCIF temperature in orbit, based on temperature test data of FCIF. Values range from 0.0000015 to 0.0000017 s. Special value -9999.9 for missing scan and internal calibration mode.

txAntGain (4-byte float, array size: nray x nscan):
Transmitted radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

Receiver (Group)

echoCount (1-byte char, array size: nbin x nray x nscan):
The total signal count at the antenna input that includes both echo and noise power. The signal count is stored on both observation mode and calibration mode. It is basically a copy of science telemetry raw data for sampling range bins. 0 is set to both interpolated range bin and outrange bin of the observation area.

noiseCount (4-byte float, array size: nray x nscan):
An average of the received noise count for each angle bins during suspended 4 pulses. The value -9999.9 means missing scan and inernal calibration mode.

echoPower (2-byte integer, array size: nbin x nray x nscan):
The total signal power at the antenna input that includes both echo and noise power. The numerical value of echoPower is 100 times the power expressed in dBm when the data is valid. Values between -12000 and -2000, which correspond to the power between -120 dBm and -20 dBm, are the valid values. If the echoPower is measured outside the receiving range window that depends on the pulse repetition frequency, -29999 is stored. If the data is not valid for other reasons, -30000 is stored.

```
Special values:
"Count value": internal calibration mode.
-29999 : Outrange bins of the observation area.
-30000 : Missing value
```

noisePower (2-byte integer, array size: nray x nscan):
An average of the received noise power for each angle bins during suspended 4 pulses. Values in dBm are multiplied by 100 and stored in the file as a 2-byte integer. The unit in the file is thus 0.01 dBm. The range is -120 dBm to -20 dBm which corresponds to values in the file from -12000 to -2000. The value -30000 means missing scan and internal calibration mode.

noiseSampleNumber (2-byte integer, array size: nray x nscan):
The number of noise samplings. This value is considered with frequency agility, the number of noise sampling pulse and sampling dependency, so the value is the quadruple of the value defined by the VPRF table. Values range from 0 to 1000 number. Special value -9999 for missing and internal calibration mode.

echoSampleNumber (1-byte integer, array size: nray x nscan):
The number of received pulse. This value is considered with frequency agility so the value is the double of the value defined by the VHRF table. Values range from 0 to 120 number. Special values are defined as:

48	Internal Calibration Mode
-99	Missing scan

rxAntGain (4-byte float, array size: nray x nscan):
Received radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

receivedPulseWidth (4-byte float, array size: nscan):
Received pulse width (s) after passing through band pass filter of FCIF. Special value -9999.9 for missing scan and internal calibration mode.

C Structure Header file:

```
#ifndef _TK_1BKu_H_
#define _TK_1BKu_H_

#ifndef _L1BKu_RECEIVER_
#define _L1BKu_RECEIVER_

typedef struct {
    unsigned char echoCount[49][260];
    float noiseCount[49];
    short echoPower[49][260];
    short noisePower[49];
    short noiseSampleNumber[49];
    signed char echoSampleNumber[49];
    float rxAntGain[49];
    float receivedPulseWidth;
} L1BKu_RECEIVER;

#endif

#ifndef _L1BKu_TRANSMITTER_
#define _L1BKu_TRANSMITTER_

typedef struct {
    float radarTransPower;
    float transPulseWidth;
    float txAntGain[49];
} L1BKu_TRANSMITTER;

#endif

#ifndef _L1BKu_CALIBRATION_
#define _L1BKu_CALIBRATION_

typedef struct {
```

```
    short fcifInPower;
    signed char intAttSelect;
    short sspaLnaSelect;
    signed char angleBinSelect;
} L1BKu_CALIBRATION;

#endif

#ifndef _L1BKu_VERTLOCATE_
#define _L1BKu_VERTLOCATE_

typedef struct {
    short landOceanFlag[49];
    float scLocalZenith[49];
    double startBinRange[49];
    short echoHighResBinNumber[49];
    short echoLowResBinNumber[49];
    short binEllipsoid[49];
    float scRangeEllipsoid[49];
    short binDEM[49];
    float scRangeDEM[49];
    short DEMHmean[49];
    short binDEMHtop[49];
    short binDEMHbottom[49];
    short binEchoPeak[49];
    float alongTrackBeamWidth[49];
    float crossTrackBeamWidth[49];
    short mainlobeEdge[49];
    short sidelobeRange[49];
    float ellipsoidBinOffset[49];
    short binMirrorImage[49];
    float rangeBinSize;
    signed char ratioLand[49];
    signed char ratioOcean[49];
    signed char ratioInLand[49];
    signed char ratioCoast[49];
} L1BKu_VERTLOCATE;

#endif

#ifndef _L1BKu_HOUSEKEEPING_
#define _L1BKu_HOUSEKEEPING_
```

```
typedef struct {
    signed char rxAtt;
    float rxAttGainOffset;
    short binDiffPeakDEM[49];
    double scTime;
    signed char vprfTableVersion;
    signed char vprfTableSelect;
    signed char catchingInt;
    signed char scdpFlag;
    signed char fcifFlag;
    short logAmpNoiseLevel;
    short delay;
    short seqCountL1A;
    short fcifTemp[2];
    short lnaTemp[2];
    short rdaTemp[2];
    short divcomb1Temp[2];
    short divcomb2Temp[2];
    short sspaTemp[2];
    float rxGain[49];
    signed char fcifFlagAB;
    signed char scdpFlagAB;
} L1BKu_HOUSEKEEPING;

#endif

#ifndef _L1BKu_RAYPOINTING_
#define _L1BKu_RAYPOINTING_

typedef struct {
    float rayDirectionX[49];
    float rayDirectionY[49];
    float instrumentYaw[49];
    float instrumentPitch[49];
    float instrumentRoll[49];
    float rayTiming[49];
    float scanAngle[49];
} L1BKu_RAYPOINTING;

#endif

#ifndef _L1BKu_SUNDATA_
#define _L1BKu_SUNDATA_
```

```
typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BKu_SUNDATA;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1BKu_SCANSTATUS_
#define _L1BKu_SCANSTATUS_

typedef struct {
```

```
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L1BKu_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BKu_FS_
#define _L1BKu_FS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float sunLocalTime[49];
    L1BKu_SCANSTATUS scanStatus;
```

```
    NAVIGATION navigation;
    L1BKu_SUNDATA sunData;
    L1BKu_RAYPOINTING rayPointing;
    L1BKu_HOUSEKEEPING HouseKeeping;
    L1BKu_VERTLOCATE VertLocate;
    L1BKu_CALIBRATION Calibration;
    L1BKu_TRANSMITTER Transmitter;
    L1BKu_RECEIVER Receiver;
} L1BKu_FS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BKu_RECEIVER/
    CHARACTER echoCount(260,49)
    REAL*4 noiseCount(49)
    INTEGER*2 echoPower(260,49)
    INTEGER*2 noisePower(49)
    INTEGER*2 noiseSampleNumber(49)
    BYTE echoSampleNumber(49)
    REAL*4 rxAntGain(49)
    REAL*4 receivedPulseWidth
END STRUCTURE

STRUCTURE /L1BKu_TRANSMITTER/
    REAL*4 radarTransPower
    REAL*4 transPulseWidth
    REAL*4 txAntGain(49)
END STRUCTURE

STRUCTURE /L1BKu_CALIBRATION/
    INTEGER*2 fcifInPower
    BYTE intAttSelect
    INTEGER*2 sspaLnaSelect
    BYTE angleBinSelect
END STRUCTURE

STRUCTURE /L1BKu_VERTLOCATE/
    INTEGER*2 landOceanFlag(49)
    REAL*4 scLocalZenith(49)
```

```
    REAL*8 startBinRange(49)
    INTEGER*2 echoHighResBinNumber(49)
    INTEGER*2 echoLowResBinNumber(49)
    INTEGER*2 binEllipsoid(49)
    REAL*4 scRangeEllipsoid(49)
    INTEGER*2 binDEM(49)
    REAL*4 scRangeDEM(49)
    INTEGER*2 DEMHmean(49)
    INTEGER*2 binDEMHtop(49)
    INTEGER*2 binDEMHbottom(49)
    INTEGER*2 binEchoPeak(49)
    REAL*4 alongTrackBeamWidth(49)
    REAL*4 crossTrackBeamWidth(49)
    INTEGER*2 mainlobeEdge(49)
    INTEGER*2 sidelobeRange(49)
    REAL*4 ellipsoidBinOffset(49)
    INTEGER*2 binMirrorImage(49)
    REAL*4 rangeBinSize
    BYTE ratioLand(49)
    BYTE ratioOcean(49)
    BYTE ratioInLand(49)
    BYTE ratioCoast(49)
END STRUCTURE

STRUCTURE /L1BKu_HOUSEKEEPING/
    BYTE rxAtt
    REAL*4 rxAttGainOffset
    INTEGER*2 binDiffPeakDEM(49)
    REAL*8 scTime
    BYTE vprfTableVersion
    BYTE vprfTableSelect
    BYTE catchingInt
    BYTE scdpFlag
    BYTE fcifFlag
    INTEGER*2 logAmpNoiseLevel
    INTEGER*2 delay
    INTEGER*2 seqCountL1A
    INTEGER*2 fcifTemp(2)
    INTEGER*2 lnaTemp(2)
    INTEGER*2 rdaTemp(2)
    INTEGER*2 divcomb1Temp(2)
    INTEGER*2 divcomb2Temp(2)
    INTEGER*2 sspaTemp(2)
```

```
    REAL*4 rxGain(49)
    BYTE fcifFlagAB
    BYTE scdpFlagAB
END STRUCTURE

STRUCTURE /L1BKu_RAYPOINTING/
    REAL*4 rayDirectionX(49)
    REAL*4 rayDirectionY(49)
    REAL*4 instrumentYaw(49)
    REAL*4 instrumentPitch(49)
    REAL*4 instrumentRoll(49)
    REAL*4 rayTiming(49)
    REAL*4 scanAngle(49)
END STRUCTURE

STRUCTURE /L1BKu_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
```

```
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BKu_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BKu_FS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    RECORD /L1BKu_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BKu_SUNDATA/ sunData
    RECORD /L1BKu_RAYPOINTING/ rayPointing
    RECORD /L1BKu_HOUSEKEEPING/ HouseKeeping
    RECORD /L1BKu_VERTLOCATE/ VertLocate
    RECORD /L1BKu_CALIBRATION/ Calibration
```

```
    RECORD /L1BKu_TRANSMITTER/ Transmitter
    RECORD /L1BKu_RECEIVER/ Receiver
END STRUCTURE
```

5.44 1BKa - Ka Power

The Ka Level-1B product, 1BKa, "Ka Power," is written as a two-swath structure. The first swath is MS for Matched beam scan Swath. MS contains rays that match the middle 25 1BKu rays in location. The second swath is HS for High sensitivity beam scan Swath. HS contains high sensitivity rays which are close to the middle 25 1BKu rays in location. The Ku Level-1B product, 1BKu, is closely related. The scanTime in 1BKu is identical to the scanTime in 1BKa. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nrayMS	25	Number of rays (angle bins) in each Matched scan.
nbinMS	260	Number of range bins in each Matched angle bin.
nrayHS	24	Number of rays (angle bins) in each High Sensitivity scan.
nbinHS	130	Number of range bins in each High Sensitivity angle bin.
SVBFd	3	Number in sunVectorInBodyFrame.
nfcifT	2	Number in fcifTemp.
nlnaT	2	Number in lnaTemp.
nrdaT	2	Number in rdaTemp.
ndc1T	2	Number in divcomb1Temp.
ndc2T	2	Number in divcomb2Temp.
nsspaT	2	Number in sspaTemp.

Figure 485 through Figure 507 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

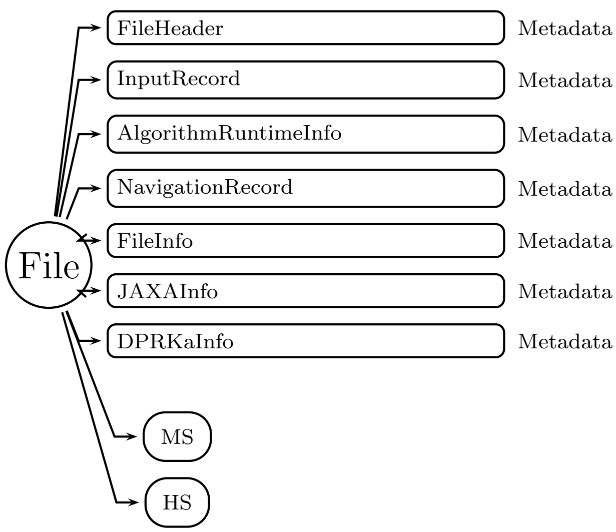


Figure 485: Data Format Structure for 1BKa, Ka Power

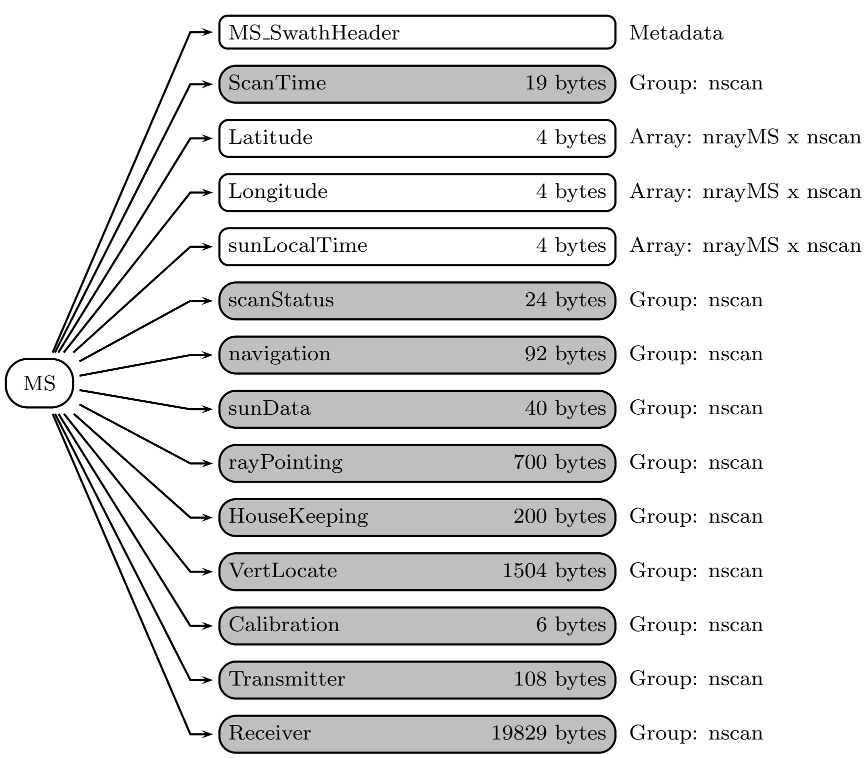


Figure 486: Data Format Structure for 1BKa, MS

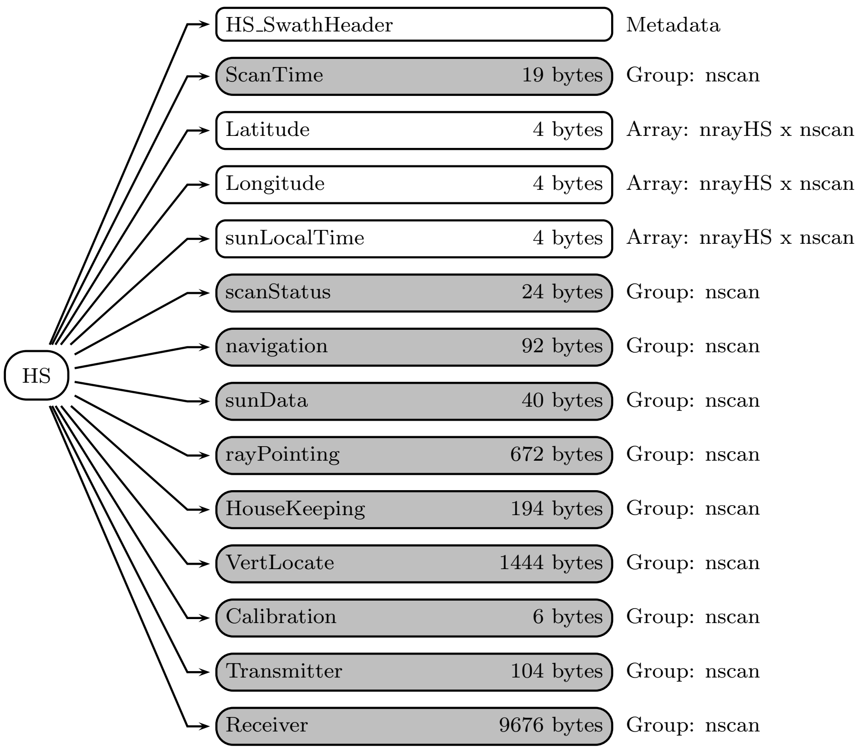


Figure 487: Data Format Structure for 1BKa, HS

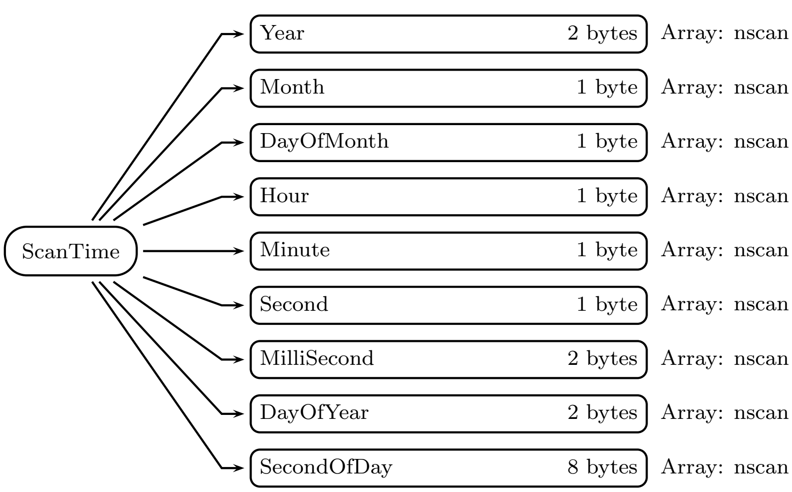


Figure 488: Data Format Structure for 1BKa, MS, ScanTime

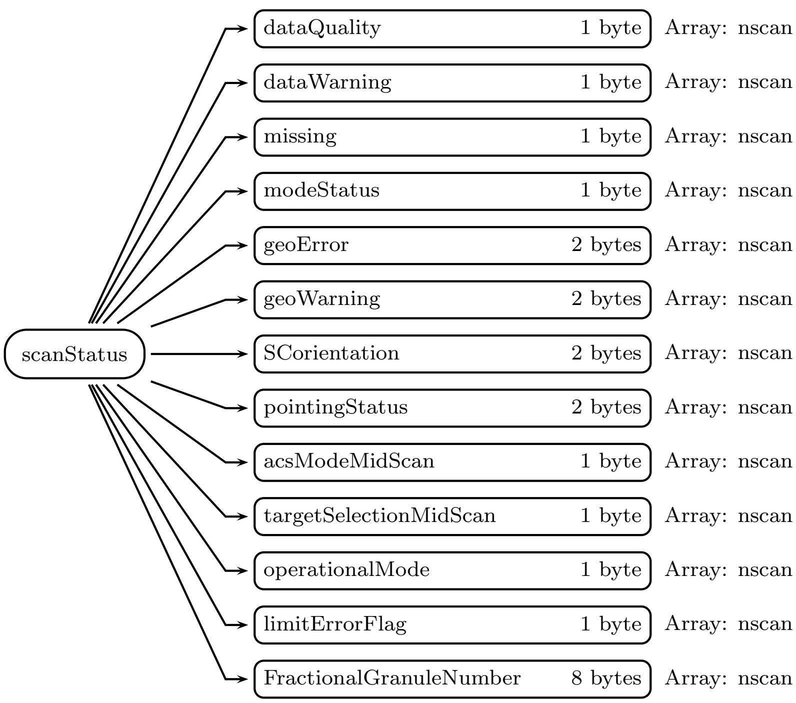


Figure 489: Data Format Structure for 1BKa, MS, scanStatus

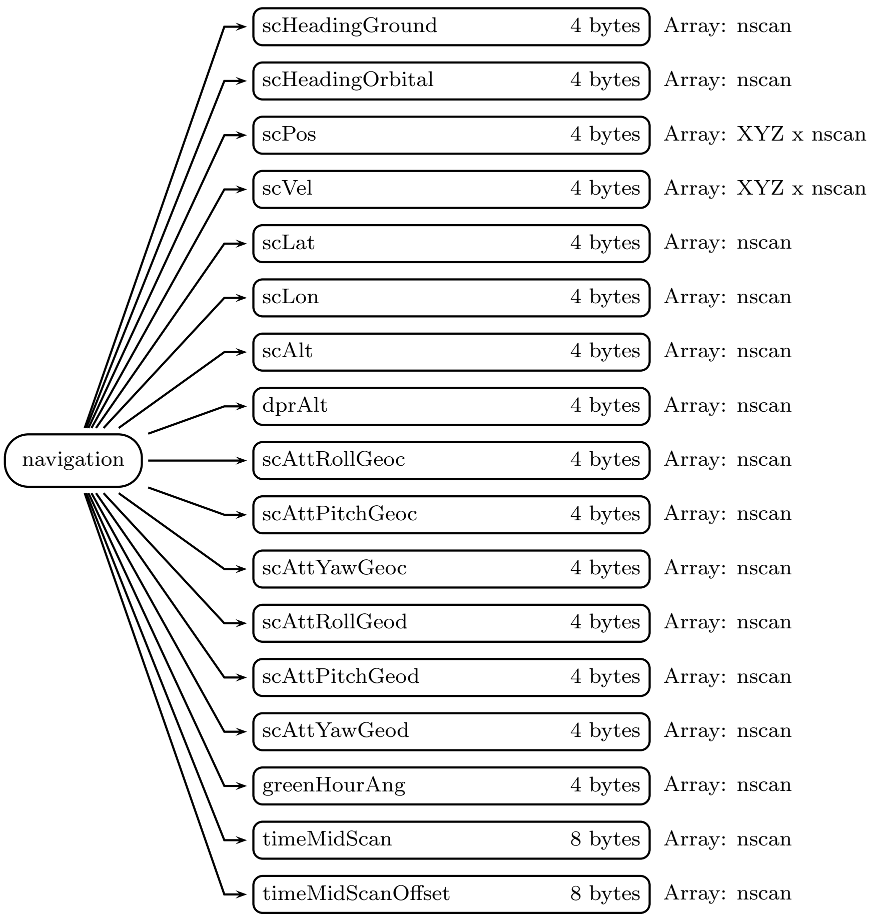


Figure 490: Data Format Structure for 1BKa, MS, navigation

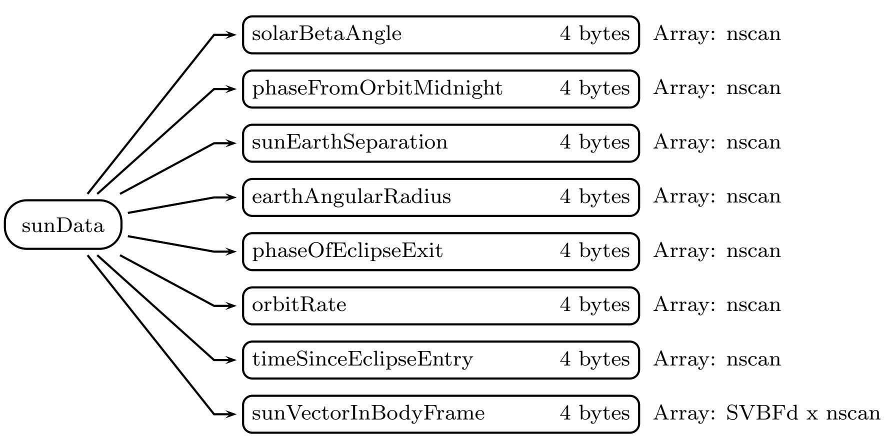


Figure 491: Data Format Structure for 1BKa, MS, sunData

rayPointing

rayDirectionX	4 bytes	Array: nrayMS x nscan
rayDirectionY	4 bytes	Array: nrayMS x nscan
instrumentYaw	4 bytes	Array: nrayMS x nscan
instrumentPitch	4 bytes	Array: nrayMS x nscan
instrumentRoll	4 bytes	Array: nrayMS x nscan
rayTiming	4 bytes	Array: nrayMS x nscan
scanAngle	4 bytes	Array: nrayMS x nscan

Figure 492: Data Format Structure for 1BKa, MS, rayPointing

HouseKeeping

rxAtt	1 byte	Array: nscan
rxAttGainOffset	4 bytes	Array: nscan
binDiffPeakDEM	2 bytes	Array: nrayMS x nscan
scTime	8 bytes	Array: nscan
vprfTableVersion	1 byte	Array: nscan
vprfTableSelect	1 byte	Array: nscan
catchingInt	1 byte	Array: nscan
scdpFlag	1 byte	Array: nscan
fcifFlag	1 byte	Array: nscan
logAmpNoiseLevel	2 bytes	Array: nscan
delay	2 bytes	Array: nscan
seqCountL1A	2 bytes	Array: nscan
fcifTemp	2 bytes	Array: nfcifT x nscan
lnaTemp	2 bytes	Array: nlnaT x nscan
rdaTemp	2 bytes	Array: nrdaT x nscan
divcomb1Temp	2 bytes	Array: ndc1T x nscan
divcomb2Temp	2 bytes	Array: ndc2T x nscan
sspaTemp	2 bytes	Array: nsspaT x nscan
rxGain	4 bytes	Array: nrayMS x nscan
fcifFlagAB	1 byte	Array: nscan
scdpFlagAB	1 byte	Array: nscan

Figure 493: Data Format Structure for 1BKa, MS, HouseKeeping

VertLocate

landOceanFlag	2 bytes	Array: nrayMS x nscan
scLocalZenith	4 bytes	Array: nrayMS x nscan
startBinRange	8 bytes	Array: nrayMS x nscan
echoHighResBinNumber	2 bytes	Array: nrayMS x nscan
echoLowResBinNumber	2 bytes	Array: nrayMS x nscan
binEllipsoid	2 bytes	Array: nrayMS x nscan
scRangeEllipsoid	4 bytes	Array: nrayMS x nscan
binDEM	2 bytes	Array: nrayMS x nscan
scRangeDEM	4 bytes	Array: nrayMS x nscan
DEMHmean	2 bytes	Array: nrayMS x nscan
binDEMHtop	2 bytes	Array: nrayMS x nscan
binDEMHbottom	2 bytes	Array: nrayMS x nscan
binEchoPeak	2 bytes	Array: nrayMS x nscan
alongTrackBeamWidth	4 bytes	Array: nrayMS x nscan
crossTrackBeamWidth	4 bytes	Array: nrayMS x nscan
mainlobeEdge	2 bytes	Array: nrayMS x nscan
sidelobeRange	2 bytes	Array: nrayMS x nscan
ellipsoidBinOffset	4 bytes	Array: nrayMS x nscan
binMirrorImage	2 bytes	Array: nrayMS x nscan
rangeBinSize	4 bytes	Array: nscan
ratioLand	1 byte	Array: nrayMS x nscan
ratioOcean	1 byte	Array: nrayMS x nscan
ratioInLand	1 byte	Array: nrayMS x nscan
ratioCoast	1 byte	Array: nrayMS x nscan

Figure 494: Data Format Structure for 1BKa, MS, VertLocate

Calibration

fcifInPower	2 bytes	Array: nscan
intAttSelect	1 byte	Array: nscan
sspaLnaSelect	2 bytes	Array: nscan
angleBinSelect	1 byte	Array: nscan

Figure 495: Data Format Structure for 1BKa, MS, Calibration

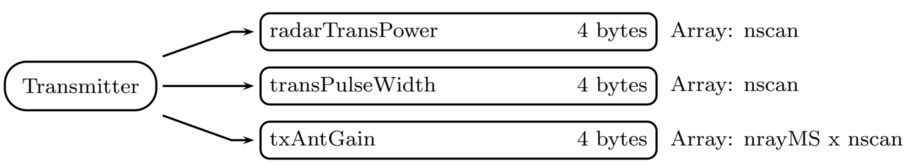


Figure 496: Data Format Structure for 1BKa, MS, Transmitter

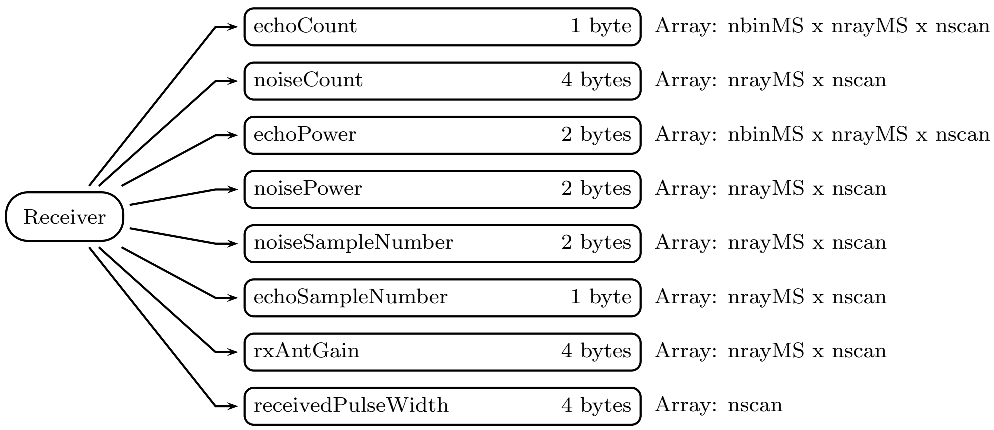


Figure 497: Data Format Structure for 1BKa, MS, Receiver

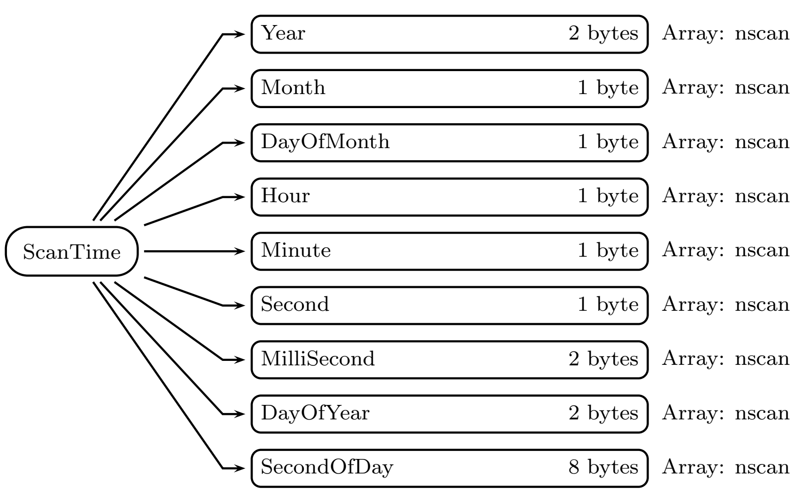


Figure 498: Data Format Structure for 1BKa, HS, ScanTime

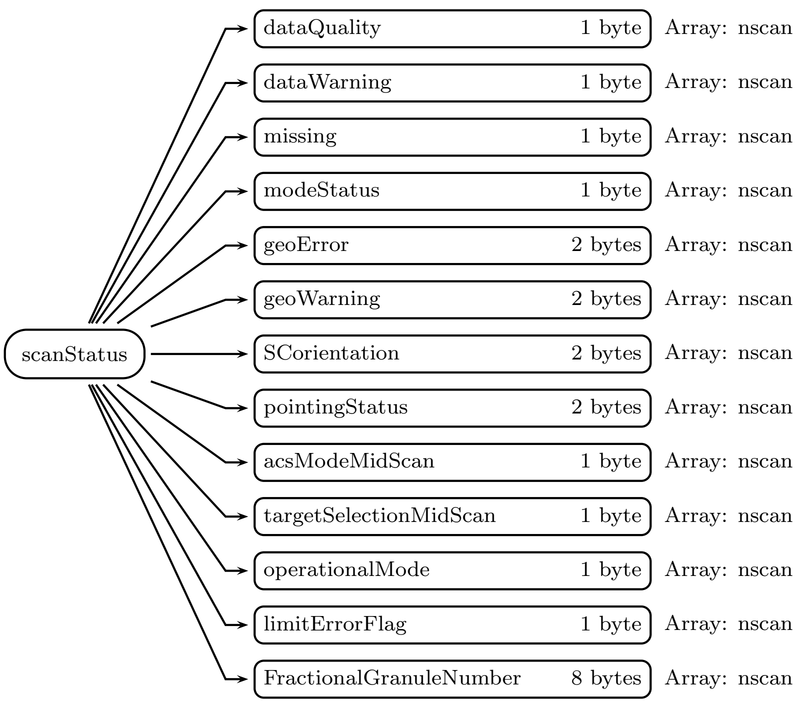


Figure 499: Data Format Structure for 1BKa, HS, scanStatus

navigation

scHeadingGround	4 bytes	Array: nscan
scHeadingOrbital	4 bytes	Array: nscan
scPos	4 bytes	Array: XYZ x nscan
scVel	4 bytes	Array: XYZ x nscan
scLat	4 bytes	Array: nscan
scLon	4 bytes	Array: nscan
scAlt	4 bytes	Array: nscan
dprAlt	4 bytes	Array: nscan
scAttRollGeoc	4 bytes	Array: nscan
scAttPitchGeoc	4 bytes	Array: nscan
scAttYawGeoc	4 bytes	Array: nscan
scAttRollGeod	4 bytes	Array: nscan
scAttPitchGeod	4 bytes	Array: nscan
scAttYawGeod	4 bytes	Array: nscan
greenHourAng	4 bytes	Array: nscan
timeMidScan	8 bytes	Array: nscan
timeMidScanOffset	8 bytes	Array: nscan

Figure 500: Data Format Structure for 1BKa, HS, navigation

sunData

solarBetaAngle	4 bytes	Array: nscan
phaseFromOrbitMidnight	4 bytes	Array: nscan
sunEarthSeparation	4 bytes	Array: nscan
earthAngularRadius	4 bytes	Array: nscan
phaseOfEclipseExit	4 bytes	Array: nscan
orbitRate	4 bytes	Array: nscan
timeSinceEclipseEntry	4 bytes	Array: nscan
sunVectorInBodyFrame	4 bytes	Array: SVBFd x nscan

Figure 501: Data Format Structure for 1BKa, HS, sunData

rayPointing	rayDirectionX	4 bytes	Array: nrayHS x nscan
	rayDirectionY	4 bytes	Array: nrayHS x nscan
	instrumentYaw	4 bytes	Array: nrayHS x nscan
	instrumentPitch	4 bytes	Array: nrayHS x nscan
	instrumentRoll	4 bytes	Array: nrayHS x nscan
	rayTiming	4 bytes	Array: nrayHS x nscan
	scanAngle	4 bytes	Array: nrayHS x nscan

Figure 502: Data Format Structure for 1BKa, HS, rayPointing

HouseKeeping	rxAtt	1 byte	Array: nscan
	rxAttGainOffset	4 bytes	Array: nscan
	binDiffPeakDEM	2 bytes	Array: nrayHS x nscan
	scTime	8 bytes	Array: nscan
	vprfTableVersion	1 byte	Array: nscan
	vprfTableSelect	1 byte	Array: nscan
	catchingInt	1 byte	Array: nscan
	scdpFlag	1 byte	Array: nscan
	fcifFlag	1 byte	Array: nscan
	logAmpNoiseLevel	2 bytes	Array: nscan
	delay	2 bytes	Array: nscan
	seqCountL1A	2 bytes	Array: nscan
	fcifTemp	2 bytes	Array: nfcifT x nscan
	lnaTemp	2 bytes	Array: nlnaT x nscan
	rdaTemp	2 bytes	Array: nrdaT x nscan
	divcomb1Temp	2 bytes	Array: ndc1T x nscan
	divcomb2Temp	2 bytes	Array: ndc2T x nscan
	sspaTemp	2 bytes	Array: nsspaT x nscan
	rxGain	4 bytes	Array: nrayHS x nscan
	fcifFlagAB	1 byte	Array: nscan
	scdpFlagAB	1 byte	Array: nscan

Figure 503: Data Format Structure for 1BKa, HS, HouseKeeping

VertLocate

landOceanFlag	2 bytes	Array: nrayHS x nscan
scLocalZenith	4 bytes	Array: nrayHS x nscan
startBinRange	8 bytes	Array: nrayHS x nscan
echoHighResBinNumber	2 bytes	Array: nrayHS x nscan
echoLowResBinNumber	2 bytes	Array: nrayHS x nscan
binEllipsoid	2 bytes	Array: nrayHS x nscan
scRangeEllipsoid	4 bytes	Array: nrayHS x nscan
binDEM	2 bytes	Array: nrayHS x nscan
scRangeDEM	4 bytes	Array: nrayHS x nscan
DEMHmean	2 bytes	Array: nrayHS x nscan
binDEMHtop	2 bytes	Array: nrayHS x nscan
binDEMHbottom	2 bytes	Array: nrayHS x nscan
binEchoPeak	2 bytes	Array: nrayHS x nscan
alongTrackBeamWidth	4 bytes	Array: nrayHS x nscan
crossTrackBeamWidth	4 bytes	Array: nrayHS x nscan
mainlobeEdge	2 bytes	Array: nrayHS x nscan
sidelobeRange	2 bytes	Array: nrayHS x nscan
ellipsoidBinOffset	4 bytes	Array: nrayHS x nscan
binMirrorImage	2 bytes	Array: nrayHS x nscan
rangeBinSize	4 bytes	Array: nscan
ratioLand	1 byte	Array: nrayHS x nscan
ratioOcean	1 byte	Array: nrayHS x nscan
ratioInLand	1 byte	Array: nrayHS x nscan
ratioCoast	1 byte	Array: nrayHS x nscan

Figure 504: Data Format Structure for 1BKa, HS, VertLocate

Calibration

fcifInPower	2 bytes	Array: nscan
intAttSelect	1 byte	Array: nscan
sspaLnaSelect	2 bytes	Array: nscan
angleBinSelect	1 byte	Array: nscan

Figure 505: Data Format Structure for 1BKa, HS, Calibration

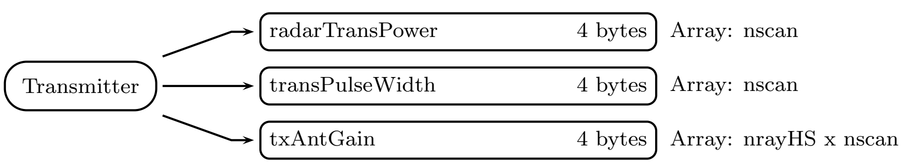


Figure 506: Data Format Structure for 1BKa, HS, Transmitter

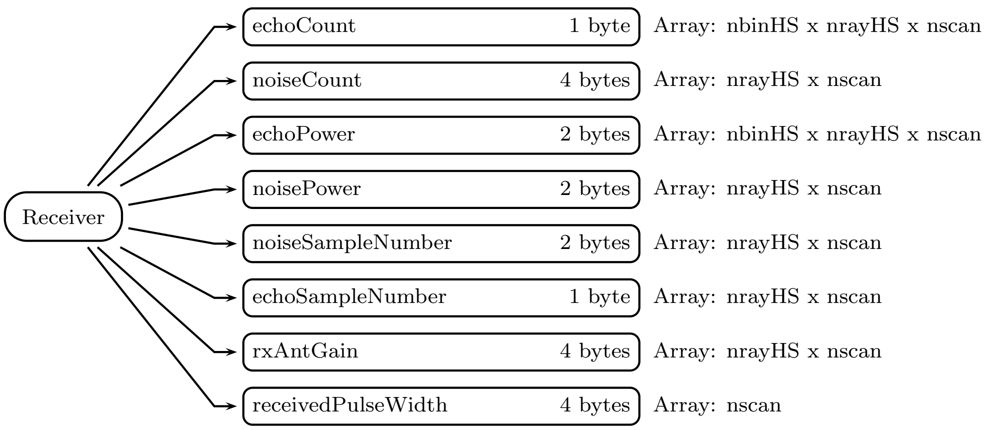


Figure 507: Data Format Structure for 1BKa, HS, Receiver

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

DPRKaInfo (Metadata):
Contains DPR information. See Metadata for GPM Products for details.

MS (Swath)

MS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in MS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayMS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayMS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nrayMS x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in MS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
```

```
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft

axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
```

```
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of

the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in MS)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values

range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group in MS)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayPointing (Group in MS)

rayDirectionX (4-byte float, array size: nrayMS x nscan):
Unit ray direction x component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayDirectionY (4-byte float, array size: nrayMS x nscan):
Unit ray direction y component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

instrumentYaw (4-byte float, array size: nrayMS x nscan):
Yaw of mechanical coordinates w.r.t. geodetic coordinates. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

instrumentPitch (4-byte float, array size: nrayMS x nscan):
Pitch of mechanical coordinates w.r.t. geodetic coordinates. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

instrumentRoll (4-byte float, array size: nrayMS x nscan):
Roll of mechanical coordinates w.r.t. geodetic coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

rayTiming (4-byte float, array size: nrayMS x nscan):
The time delay from the secondary header packet time tag to each ray (assumed as mid-time of all radar pulses for the associated rayDirection). Values range from 0 to 1.6 s. Special values are defined as:
-9999.9 Missing value

scanAngle (4-byte float, array size: nrayMS x nscan):
Angle (degrees) of the ray from nominal nadir offset about the mechanical x_axis. The sign of the angle is consistent with the sensor y-axis, i.e., the angle is positive to the right of the direction of travel if the spacecraft is in normal mode. Values range from -18 to 18 degrees. Special values are defined as:
-9999.9 Missing value

HouseKeeping (Group in MS)

rxAtt (1-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 12 dB. Special values are defined as:
-99 Missing value

rxAttGainOffset (4-byte float, array size: nscan):
The actual gain of rxAtt considering the temperature dependence. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDiffPeakDEM (2-byte integer, array size: nrayMS x nscan):
The number of range bins between binEchoPeak and binDEM. It is used to ensure that the VPRF is switched in accordance with the GPM satellite altitude. Values range from -260 to 260 range bin number at NS and MS, from -130 to 130 range bin number at HS respectively. Values range from -260 to 260 range bin number. Special values are defined as:
-9999 Missing value

scTime (8-byte float, array size: nscan):
Scan time expressed as TAI time with and epoch of 0000Z Jan 6, 1980. This time matches

the time in ScanTime. Special values are defined as:
-9999.9 Missing value

vprfTableVersion (1-byte integer, array size: nscan):
The version number of VPRF table which is used in L1B process. Values range from 1 to 127 number. Special values are defined as:
-99 Missing value

vprfTableSelect (1-byte integer, array size: nscan):
The selected number of VPRF table for altitude (h, km) which is used in L1B process. The range is 1 to 25.

```
h LT 396.5 = 1
396.5 LE h LT 397.5 = 2
397.5 LE h LT 398.5 = 3
398.5 LE h LT 399.5 = 4
399.5 LE h LT 400.5 = 5
400.5 LE h LT 401.5 = 6
401.5 LE h LT 402.5 = 7
402.5 LE h LT 403.5 = 8
403.5 LE h LT 404.5 = 9
404.5 LE h LT 405.5 = 10
405.5 LE h LT 406.5 = 11
406.5 LE h LT 407.5 = 12
407.5 LE h LT 408.5 = 13
408.5 LE h LT 409.5 = 14
409.5 LE h LT 410.5 = 15
410.5 LE h LT 411.5 = 16
411.5 LE h LT 412.5 = 17
412.5 LE h LT 413.5 = 18
413.5 LE h LT 414.5 = 19
414.5 LE h LT 415.5 = 20
415.5 LE h LT 416.5 = 21
416.5 LE h LT 417.5 = 22
417.5 LE h LT 418.5 = 23
418.5 LE h LT 419.5 = 24
419.5 LE h = 25

where
LT mean less than and
LE means less than or equal to
```

catchingInt (1-byte integer, array size: nscan):
The timing that receive window is open for the first reflected TX pulse. If catchingInt is set to 12, then the first TX pulse is received with receive window after the twelfth TX

pulse. In the case of nominal operation, catchingInt is set to 12, that is, the VPRF table is used. In other cases, including GPS-status trouble, catchingInt is set 8 and limited PRF is loaded. Values range from 8 to 12 number. Special values are defined as:
-99 Missing value

scdpFlag (1-byte integer, array size: nscan):
The side of the SCDP system and system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry.
3   Priority is 2 at Basic System Table. Refer to Basic System Table.
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

fcifFlag (1-byte integer, array size: nscan):
The side of FCIF system and the system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry
3   Priority is 2 at Basic System Table. Refer to Basic System Table
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

logAmpNoiseLevel (2-byte integer, array size: nscan):
The Noise Level at Log Amp Termination which is stored in science telemetry. Values are in counts. Special values are defined as:
-9999 Missing value

delay (2-byte integer, array size: nscan):
The timing offset value from space craft time in NS. In MS and HS, it is defined as offset time value from the base delay time. They are used to adjust for beam matching of along track direction. Values range from 0 to 3360 number. Special values are defined as:
-9999 Missing value

seqCountL1A (2-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 27000 counts. Special values are defined as:
-9999 Missing value

fcifTemp (2-byte integer, array size: nfcifT x nscan):
The temperature of FCIF component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

lnaTemp (2-byte integer, array size: nlnaT x nscan):
The temperature of LNA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C.

rdaTemp (2-byte integer, array size: nrdaT x nscan):
he temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C Attenuator setting levels of Received radar antenna.Values are 0, 3, 6, 9 and 12 in dB. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb1Temp (2-byte integer, array size: ndc1T x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb2Temp (2-byte integer, array size: ndc2T x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

sspaTemp (2-byte integer, array size: nsspaT x nscan):
The temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

rxGain (4-byte float, array size: nrayMS x nscan):
The total receiver gain from FCIF input to antenna input. Values are in dB. Special values are defined as:
-9999.9 Missing value

fcifFlagAB (1-byte integer, array size: nscan):
FCIF A-side/B-side information. This flag does not include information on the source of the decision about the fcifFlag. Special values are defined as:
-99 Missing value

scdpFlagAB (1-byte integer, array size: nscan):
FCIF A-side/B-side information. This flag does not include information on the source of the decision about the scdpFlag. Special values are defined as:
-99 Missing value

VertLocate (Group in MS)

landOceanFlag (2-byte integer, array size: nrayMS x nscan):
Land or ocean information. The values of the flag are:

```
0 = Water
1 = Land
2 = Coast
3 = Inland Water
```

scLocalZenith (4-byte float, array size: nrayMS x nscan):
The angle, in degrees, between the local zenith and the beam's center line. The local (geodetic) zenith at the intersection of the ray and the earth ellipsoid is used. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

startBinRange (8-byte float, array size: nrayMS x nscan):
The distance from the satellite to the center of the first range bin. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

echoHighResBinNumber (2-byte integer, array size: nrayMS x nscan):
The number of sampling without thinning out (over sampling).. Range of 1-260 for NS and MS and 1-130 at HS. EDIT Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

```
Meaning in Normal Mode:
0 = Over sampling range bin OR
1 = Normal sampling range bin
2 = Interpolated range bin
-99 = Outrange bin of the observation area
Meaning in internal calibration mode:
0: In internal calibration mode, this value is stored 1- 42 range bin for each
```

`ray.`
`-99: missing value. In internal calibration mode, this value is stored after 43 range bin for each ray as missing.`

echoLowResBinNumber (2-byte integer, array size: nrayMS x nscan):
The number of sampling after thinning out the normal sample. From 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Values range from 0 to 260 range bin number. Special values are defined as:
-9999 Missing value

binEllipsoid (2-byte integer, array size: nrayMS x nscan):
The range bin number of the earth ellipsoid. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

scRangeEllipsoid (4-byte float, array size: nrayMS x nscan):
The distance from instrument to ellipsoid calculated by GeoTK. Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

binDEM (2-byte integer, array size: nrayMS x nscan):
Range bin number of the average DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing.

scRangeDEM (4-byte float, array size: nrayMS x nscan):
The value is calculted as scRangeEllipsoid - DEMHmean secand(localZenithAngle). Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

DEMHmean (2-byte integer, array size: nrayMS x nscan):
Averaged DEM height, whose SRTM-30. Values range from 0 to 9000 m. Special values are defined as:
-9999 Missing value

binDEMHtop (2-byte integer, array size: nrayMS x nscan):
The range bin number of the maximum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binDEMHbottom (2-byte integer, array size: nrayMS x nscan):
The range bin number of the minimum DEM surface elevation in a box centered on the

IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binEchoPeak (2-byte integer, array size: nrayMS x nscan):
The range bin number which has maximum echoPower in each scan and each angle bin. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

alongTrackBeamWidth (4-byte float, array size: nrayMS x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power in the along-track direction.

crossTrackBeamWidth (4-byte float, array size: nrayMS x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power along the cross-track direction.

mainlobeEdge (2-byte integer, array size: nrayMS x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the edge of the clutter from the mainlobe.

sidelobeRange (2-byte integer, array size: nrayMS x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter psition from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

ellipsoidBinOffset (4-byte float, array size: nrayMS x nscan):
The distance between center of binEllipsoid range bin and Ellipsoid position.

binMirrorImage (2-byte integer, array size: nrayMS x nscan):
Range bin of the mirror image.

rangeBinSize (4-byte float, array size: nscan):
The range bin size. With VPRF, the size for NS and MS is 250.32670 m and for HS 250.32670 m. With limited PRF, the size is 250.32670 m for all three swaths.

ratioLand (1-byte integer, array size: nrayMS x nscan):
Ratio of land area to total area in a footprint.

ratioOcean (1-byte integer, array size: nrayMS x nscan):
Ratio of ocean area to total area in a footprint.

ratioInLand (1-byte integer, array size: nrayMS x nscan):
Ratio of inland water area to total area in a footprint.

ratioCoast (1-byte integer, array size: nrayMS x nscan):
Ratio of coast area to total area in a footprint.

Calibration (Group in MS)

fcifInPower (2-byte integer, array size: nscan):
Input power value of FCIF and is set at internal calibration mode. At another mode, the value of fcifInPower is set as missing. Values are in 0.01 dBm. Special values are defined as:
-30000 Missing value

intAttSelect (1-byte integer, array size: nscan):
The selected number of internal attenuation that is controlled automatically with 32 steps and is set by internal mode. At another mode, the value of fcifInPower is set as missing. Values range from 1 to 32 step. Special values are defined as:
-99 Missing value

sspaLnaSelect (2-byte integer, array size: nscan):
In SSPA mode, sspaLnaSelect stores the number of LNA. In LNA mode, sspaLnaSelect stores the number of SSPA. In other modes, sspaLnaSelect is given the missing value. Values range from 1 to 128 number. Special values are defined as:
-9999 Missing value

angleBinSelect (1-byte integer, array size: nscan):
In SSPA and LNA mode, angleBinSelect contains the selected beam number. In other operational modes, angleBinSelect is set to missing. Values range from 1 to 49 number. Special values are defined as:
-99 Missing value

Transmitter (Group in MS)

radarTransPower (4-byte float, array size: nscan):
The total (sum) power of 128 SSPA elements corrected with SSPA temperature in orbit. It is based on ground test temperature data of SSPA transmission power. Special value -9999.9 for missing scan and internal calibration mode.

transPulseWidth (4-byte float, array size: nscan):
Transmitted pulse width corrected with FCIF temperature in orbit, based on temperature test data of FCIF. Values range from 0.0000015 to 0.0000017 s. Special value -9999.9 for missing scan and internal calibration mode.

txAntGain (4-byte float, array size: nrayMS x nscan):
Transmitted radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

Receiver (Group in MS)

echoCount (1-byte char, array size: nbinMS x nrayMS x nscan):
The total signal count at the antenna input that includes both echo and noise power. The signal count is stored on both observation mode and calibration mode. It is basically a copy of science telemetry raw data for sampling range bins. 0 is set to both interpolated range bin and outrange bin of the observation area.

noiseCount (4-byte float, array size: nrayMS x nscan):
An average of the received noise count for each angle bins during suspended 4 pulses. The value -9999.9 means missing scan and inernal calibration mode.

echoPower (2-byte integer, array size: nbinMS x nrayMS x nscan):
The total signal power at the antenna input that includes both echo and noise power. The numerical value of echoPower is 100 times the power expressed in dBm when the data is valid. Values between -12000 and -2000, which correspond to the power between -120 dBm and -20 dBm, are the valid values. If the echoPower is measured outside the receiving range window that depends on the pulse repetition frequency, -29999 is stored. If the data is not valid for other reasons, -30000 is stored.

```
Special values:
"Count value": internal calibration mode.
-29999 : Outrange bins of the observation area.
-30000 : Missing value
```

noisePower (2-byte integer, array size: nrayMS x nscan):
An average of the received noise power for each angle bins during suspended 4 pulses. Values in dBm are multiplied by 100 and stored in the file as a 2-byte integer. The unit in the file is thus 0.01 dBm. The range is -120 dBm to -20 dBm which corresponds to values in the file from -12000 to -2000. The value -30000 means missing scan and internal calibration mode.

noiseSampleNumber (2-byte integer, array size: nrayMS x nscan):
The number of noise samplings. This value is considered with frequency agility, the number of noise sampling pulse and sampling dependency, so the value is the quadruple of the value defined by the VPRF table. Values range from 0 to 1000 number. Special value -9999 for missing and internal calibration mode.

echoSampleNumber (1-byte integer, array size: nrayMS x nscan):
The number of received pulse. This value is considered with frequency agility so the value is the double of the value defined by the VHRF table. Values range from 0 to 120 number. Special values are defined as:

48	Internal Calibration Mode
-99	Missing scan

rxAntGain (4-byte float, array size: nrayMS x nscan):
Received radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

receivedPulseWidth (4-byte float, array size: nscan):
Received pulse width (s) after passing through band pass filter of FCIF. Special value -9999.9 for missing scan and internal calibration mode.

HS (Swath)

HS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in HS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayHS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayHS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nrayHS x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in HS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken

down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
```

```
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
```

```
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in HS)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values

range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed

using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group in HS)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction

so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayPointing (Group in HS)

rayDirectionX (4-byte float, array size: nrayHS x nscan):
Unit ray direction x component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayDirectionY (4-byte float, array size: nrayHS x nscan):
Unit ray direction y component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

instrumentYaw (4-byte float, array size: nrayHS x nscan):
Yaw of mechanical coordinates w.r.t. geodetic coordinates. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

instrumentPitch (4-byte float, array size: nrayHS x nscan):
Pitch of mechanical coordinates w.r.t. geodetic coordinates. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

instrumentRoll (4-byte float, array size: nrayHS x nscan):
Roll of mechanical coordinates w.r.t. geodetic coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

rayTiming (4-byte float, array size: nrayHS x nscan):
The time delay from the secondary header packet time tag to each ray (assumed as mid-time of all radar pulses for the associated rayDirection). Values range from 0 to 1.6 s. Special values are defined as:
-9999.9 Missing value

scanAngle (4-byte float, array size: nrayHS x nscan):
Angle (degrees) of the ray from nominal nadir offset about the mechanical x_axis. The sign of the angle is consistent with the sensor y-axis, i.e., the angle is positive to the right of the direction of travel if the spacecraft is in normal mode. Values range from -18 to 18 degrees. Special values are defined as:
-9999.9 Missing value

HouseKeeping (Group in HS)

rxAtt (1-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 12 dB. Special values are defined as:
-99 Missing value

rxAttGainOffset (4-byte float, array size: nscan):
The actual gain of rxAtt considering the temperature dependence. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDiffPeakDEM (2-byte integer, array size: nrayHS x nscan):
The number of range bins between binEchoPeak and binDEM. It is used to ensure that

the VPRF is switched in accordance with the GPM satellite altitude. Values range from -260 to 260 range bin number at NS and MS, from -130 to 130 range bin number at HS respectively. Values range from -260 to 260 range bin number. Special values are defined as:
-9999 Missing value

scTime (8-byte float, array size: nscan):
Scan time expressed as TAI time with and epoch of 0000Z Jan 6, 1980. This time matches the time in ScanTime. Special values are defined as:
-9999.9 Missing value

vprfTableVersion (1-byte integer, array size: nscan):
The version number of VPRF table which is used in L1B process. Values range from 1 to 127 number. Special values are defined as:
-99 Missing value

vprfTableSelect (1-byte integer, array size: nscan):
The selected number of VPRF table for altitude (h, km) which is used in L1B process. The range is 1 to 25.

```
h LT 396.5 = 1
396.5 LE h LT 397.5 = 2
397.5 LE h LT 398.5 = 3
398.5 LE h LT 399.5 = 4
399.5 LE h LT 400.5 = 5
400.5 LE h LT 401.5 = 6
401.5 LE h LT 402.5 = 7
402.5 LE h LT 403.5 = 8
403.5 LE h LT 404.5 = 9
404.5 LE h LT 405.5 = 10
405.5 LE h LT 406.5 = 11
406.5 LE h LT 407.5 = 12
407.5 LE h LT 408.5 = 13
408.5 LE h LT 409.5 = 14
409.5 LE h LT 410.5 = 15
410.5 LE h LT 411.5 = 16
411.5 LE h LT 412.5 = 17
412.5 LE h LT 413.5 = 18
413.5 LE h LT 414.5 = 19
414.5 LE h LT 415.5 = 20
415.5 LE h LT 416.5 = 21
416.5 LE h LT 417.5 = 22
417.5 LE h LT 418.5 = 23
418.5 LE h LT 419.5 = 24
419.5 LE h = 25
```

```
where
LT mean less than and
LE means less than or equal to
```

catchingInt (1-byte integer, array size: nscan):
The timing that receive window is open for the first reflected TX pulse. If catchingInt is set to 12, then the first TX pulse is received with receive window after the twelfth TX pulse. In the case of nominal operation, catchingInt is set to 12, that is, the VPRF table is used. In other cases, including GPS-status trouble, catchingInt is set 8 and limited PRF is loaded. Values range from 8 to 12 number. Special values are defined as:
-99 Missing value

scdpFlag (1-byte integer, array size: nscan):
The side of the SCDP system and system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry.
3   Priority is 2 at Basic System Table. Refer to Basic System Table.
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

fcifFlag (1-byte integer, array size: nscan):
The side of FCIF system and the system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry
3   Priority is 2 at Basic System Table. Refer to Basic System Table
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

logAmpNoiseLevel (2-byte integer, array size: nscan):
The Noise Level at Log Amp Termination which is stored in science telemetry. Values are in counts. Special values are defined as:
-9999 Missing value

delay (2-byte integer, array size: nscan):
The timing offset value from space craft time in NS. In MS and HS, it is defined as offset

time value from the base delay time. They are used to adjust for beam matching of along track direction. Values range from 0 to 3360 number. Special values are defined as:
-9999 Missing value

seqCountL1A (2-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 27000 counts. Special values are defined as:
-9999 Missing value

fcifTemp (2-byte integer, array size: nfcifT x nscan):
The temperature of FCIF component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

lnaTemp (2-byte integer, array size: nlnaT x nscan):
The temperature of LNA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C.

rdaTemp (2-byte integer, array size: nrdaT x nscan):
he temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C Attenuator setting levels of Received radar antenna.Values are 0, 3, 6, 9 and 12 in dB. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb1Temp (2-byte integer, array size: ndc1T x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb2Temp (2-byte integer, array size: ndc2T x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

sspaTemp (2-byte integer, array size: nsspaT x nscan):
The temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is

-50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

rxGain (4-byte float, array size: nrayHS x nscan):
The total receiver gain from FCIF input to antenna input. Values are in dB. Special values are defined as:
-9999.9 Missing value

fcifFlagAB (1-byte integer, array size: nscan):
FCIF A-side/B-side information. This flag does not include information on the source of the decision about the fcifFlag. Special values are defined as:
-99 Missing value

scdpFlagAB (1-byte integer, array size: nscan):
FCIF A-side/B-side information. This flag does not include information on the source of the decision about the scdpFlag. Special values are defined as:
-99 Missing value

VertLocate (Group in HS)

landOceanFlag (2-byte integer, array size: nrayHS x nscan):
Land or ocean information. The values of the flag are:

```
0 = Water
1 = Land
2 = Coast
3 = Inland Water
```

scLocalZenith (4-byte float, array size: nrayHS x nscan):
The angle, in degrees, between the local zenith and the beam's center line. The local (geodetic) zenith at the intersection of the ray and the earth ellipsoid is used. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

startBinRange (8-byte float, array size: nrayHS x nscan):
The distance from the satellite to the center of the first range bin. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

echoHighResBinNumber (2-byte integer, array size: nrayHS x nscan):
The number of sampling without thinning out (over sampling).. Range of 1-260 for NS and MS and 1-130 at HS. EDIT Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

```
Meaning in Normal Mode:
0 = Over sampling range bin OR
1 = Normal sampling range bin
2 = Interpolated range bin
-99 = Outrange bin of the observation area
Meaning in internal calibration mode:
0: In internal calibration mode, this value is stored 1- 42 range bin for each
ray.
-99: missing value. In internal calibration mode, this value is stored after 43
range bin for each ray as missing.
```

echoLowResBinNumber (2-byte integer, array size: nrayHS x nscan):
The number of sampling after thinning out the normal sample. From 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Values range from 0 to 260 range bin number. Special values are defined as:
-9999 Missing value

binEllipsoid (2-byte integer, array size: nrayHS x nscan):
The range bin number of the earth ellipsoid. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

scRangeEllipsoid (4-byte float, array size: nrayHS x nscan):
The distance from instrument to ellipsoid calculated by GeoTK. Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

binDEM (2-byte integer, array size: nrayHS x nscan):
Range bin number of the average DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing.

scRangeDEM (4-byte float, array size: nrayHS x nscan):
The value is calculted as scRangeEllipsoid - DEMHmean secand(localZenithAngle). Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

DEMHmean (2-byte integer, array size: nrayHS x nscan):
Averaged DEM height, whose SRTM-30. Values range from 0 to 9000 m. Special values are defined as:
-9999 Missing value

binDEMHtop (2-byte integer, array size: nrayHS x nscan):
The range bin number of the maximum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction

of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binDEMHbottom (2-byte integer, array size: nrayHS x nscan):
The range bin number of the minimum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binEchoPeak (2-byte integer, array size: nrayHS x nscan):
The range bin number which has maximum echoPower in each scan and each angle bin. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

alongTrackBeamWidth (4-byte float, array size: nrayHS x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power in the along-track direction.

crossTrackBeamWidth (4-byte float, array size: nrayHS x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power along the cross-track direction.

mainlobeEdge (2-byte integer, array size: nrayHS x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the edge of the clutter from the mainlobe.

sidelobeRange (2-byte integer, array size: nrayHS x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter psition from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

ellipsoidBinOffset (4-byte float, array size: nrayHS x nscan):
The distance between center of binEllipsoid range bin and Ellipsoid position.

binMirrorImage (2-byte integer, array size: nrayHS x nscan):
Range bin of the mirror image.

rangeBinSize (4-byte float, array size: nscan):
The range bin size. With VPRF, the size for NS and MS is 250.32670 m and for HS 250.32670 m. With limited PRF, the size is 250.32670 m for all three swaths.

ratioLand (1-byte integer, array size: nrayHS x nscan):
Ratio of land area to total area in a footprint.

ratioOcean (1-byte integer, array size: nrayHS x nscan):
Ratio of ocean area to total area in a footprint.

ratioInLand (1-byte integer, array size: nrayHS x nscan):
Ratio of inland water area to total area in a footprint.

ratioCoast (1-byte integer, array size: nrayHS x nscan):
Ratio of coast area to total area in a footprint.

Calibration (Group in HS)

fcifInPower (2-byte integer, array size: nscan):
Input power value of FCIF and is set at internal calibration mode. At another mode, the value of fcifInPower is set as missing. Values are in 0.01 dBm. Special values are defined as:
-30000 Missing value

intAttSelect (1-byte integer, array size: nscan):
The selected number of internal attenuation that is controlled automatically with 32 steps and is set by internal mode. At another mode, the value of fcifInPower is set as missing. Values range from 1 to 32 step. Special values are defined as:
-99 Missing value

sspaLnaSelect (2-byte integer, array size: nscan):
In SSPA mode, sspaLnaSelect stores the number of LNA. In LNA mode, sspaLnaSelect stores the number of SSPA. In other modes, sspaLnaSelect is given the missing value. Values range from 1 to 128 number. Special values are defined as:
-9999 Missing value

angleBinSelect (1-byte integer, array size: nscan):
In SSPA and LNA mode, angleBinSelect contains the selected beam number. In other operational modes, angleBinSelect is set to missing. Values range from 1 to 49 number. Special values are defined as:
-99 Missing value

Transmitter (Group in HS)

radarTransPower (4-byte float, array size: nscan):
The total (sum) power of 128 SSPA elements corrected with SSPA temperature in orbit. It is based on ground test temperature data of SSPA transmission power. Special value -9999.9 for missing scan and internal calibration mode.

transPulseWidth (4-byte float, array size: nscan):
Transmitted pulse width corrected with FCIF temperature in orbit, based on temperature

test data of FCIF. Values range from 0.0000015 to 0.0000017 s. Special value -9999.9 for missing scan and internal calibration mode.

txAntGain (4-byte float, array size: nrayHS x nscan):
Transmitted radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

Receiver (Group in HS)

echoCount (1-byte char, array size: nbinHS x nrayHS x nscan):
The total signal count at the antenna input that includes both echo and noise power. The signal count is stored on both observation mode and calibration mode. It is basically a copy of science telemetry raw data for sampling range bins. 0 is set to both interpolated range bin and outrange bin of the observation area.

noiseCount (4-byte float, array size: nrayHS x nscan):
An average of the received noise count for each angle bins during suspended 4 pulses. The value -9999.9 means missing scan and inernal calibration mode.

echoPower (2-byte integer, array size: nbinHS x nrayHS x nscan):
The total signal power at the antenna input that includes both echo and noise power. The numerical value of echoPower is 100 times the power expressed in dBm when the data is valid. Values between -12000 and -2000, which correspond to the power between -120 dBm and -20 dBm, are the valid values. If the echoPower is measured outside the receiving range window that depends on the pulse repetition frequency, -29999 is stored. If the data is not valid for other reasons, -30000 is stored.

```
Special values:
"Count value": internal calibration mode.
-29999 : Outrange bins of the observation area.
-30000 : Missing value
```

noisePower (2-byte integer, array size: nrayHS x nscan):
An average of the received noise power for each angle bins during suspended 4 pulses. Values in dBm are multiplied by 100 and stored in the file as a 2-byte integer. The unit in the file is thus 0.01 dBm. The range is -120 dBm to -20 dBm which corresponds to values in the file from -12000 to -2000. The value -30000 means missing scan and internal calibration mode.

noiseSampleNumber (2-byte integer, array size: nrayHS x nscan):
The number of noise samplings. This value is considered with frequency agility, the number of noise sampling pulse and sampling dependency, so the value is the quadruple of the value defined by the VPRF table. Values range from 0 to 1000 number. Special value -9999 for missing and internal calibration mode.

echoSampleNumber (1-byte integer, array size: nrayHS x nscan):
The number of received pulse. This value is considered with frequency agility so the value is the double of the value defined by the VHRF table. Values range from 0 to 120 number. Special values are defined as:

48	Internal Calibration Mode
-99	Missing scan

rxAntGain (4-byte float, array size: nrayHS x nscan):
Received radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

receivedPulseWidth (4-byte float, array size: nscan):
Received pulse width (s) after passing through band pass filter of FCIF. Special value -9999.9 for missing scan and internal calibration mode.

C Structure Header file:

```
#ifndef _TK_1BKa_H_
#define _TK_1BKa_H_

#ifndef _L1BKa_HS_RECEIVER_
#define _L1BKa_HS_RECEIVER_

typedef struct {
    unsigned char echoCount[24][130];
    float noiseCount[24];
    short echoPower[24][130];
    short noisePower[24];
    short noiseSampleNumber[24];
    signed char echoSampleNumber[24];
    float rxAntGain[24];
    float receivedPulseWidth;
} L1BKa_HS_RECEIVER;

#endif

#ifndef _L1BKa_HS_TRANSMITTER_
#define _L1BKa_HS_TRANSMITTER_

typedef struct {
    float radarTransPower;
    float transPulseWidth;
    float txAntGain[24];
} L1BKa_HS_TRANSMITTER;
```

```
#endif

#ifndef _L1BKa_HS_CALIBRATION_
#define _L1BKa_HS_CALIBRATION_

typedef struct {
    short fcifInPower;
    signed char intAttSelect;
    short sspaLnaSelect;
    signed char angleBinSelect;
} L1BKa_HS_CALIBRATION;

#endif

#ifndef _L1BKa_HS_VERTLOCATE_
#define _L1BKa_HS_VERTLOCATE_

typedef struct {
    short landOceanFlag[24];
    float scLocalZenith[24];
    double startBinRange[24];
    short echoHighResBinNumber[24];
    short echoLowResBinNumber[24];
    short binEllipsoid[24];
    float scRangeEllipsoid[24];
    short binDEM[24];
    float scRangeDEM[24];
    short DEMHmean[24];
    short binDEMHtop[24];
    short binDEMHbottom[24];
    short binEchoPeak[24];
    float alongTrackBeamWidth[24];
    float crossTrackBeamWidth[24];
    short mainlobeEdge[24];
    short sidelobeRange[24];
    float ellipsoidBinOffset[24];
    short binMirrorImage[24];
    float rangeBinSize;
    signed char ratioLand[24];
    signed char ratioOcean[24];
    signed char ratioInLand[24];
    signed char ratioCoast[24];
} L1BKa_HS_VERTLOCATE;
```

```
#endif

#ifndef _L1BKa_HS_HOUSEKEEPING_
#define _L1BKa_HS_HOUSEKEEPING_

typedef struct {
    signed char rxAtt;
    float rxAttGainOffset;
    short binDiffPeakDEM[24];
    double scTime;
    signed char vprfTableVersion;
    signed char vprfTableSelect;
    signed char catchingInt;
    signed char scdpFlag;
    signed char fcifFlag;
    short logAmpNoiseLevel;
    short delay;
    short seqCountL1A;
    short fcifTemp[2];
    short lnaTemp[2];
    short rdaTemp[2];
    short divcomb1Temp[2];
    short divcomb2Temp[2];
    short sspaTemp[2];
    float rxGain[24];
    signed char fcifFlagAB;
    signed char scdpFlagAB;
} L1BKa_HS_HOUSEKEEPING;

#endif

#ifndef _L1BKa_HS_RAYPOINTING_
#define _L1BKa_HS_RAYPOINTING_

typedef struct {
    float rayDirectionX[24];
    float rayDirectionY[24];
    float instrumentYaw[24];
    float instrumentPitch[24];
    float instrumentRoll[24];
    float rayTiming[24];
    float scanAngle[24];
```

```
} L1BKa_HS_RAYPOINTING;

#endif

#ifndef _L1BKa_HS_SUNDATA_
#define _L1BKa_HS_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BKa_HS_SUNDATA;

#endif

#ifndef _L1BKa_HS_SCANSTATUS_
#define _L1BKa_HS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L1BKa_HS_SCANSTATUS;

#endif

#ifndef _L1BKa_HS_
#define _L1BKa_HS_
```

```
typedef struct {
    SCANTIME ScanTime;
    float Latitude[24];
    float Longitude[24];
    float sunLocalTime[24];
    L1BKa_HS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L1BKa_HS_SUNDATA sunData;
    L1BKa_HS_RAYPOINTING rayPointing;
    L1BKa_HS_HOUSEKEEPING HouseKeeping;
    L1BKa_HS_VERTLOCATE VertLocate;
    L1BKa_HS_CALIBRATION Calibration;
    L1BKa_HS_TRANSMITTER Transmitter;
    L1BKa_HS_RECEIVER Receiver;
} L1BKa_HS;

#endif

#ifndef _L1BKa_MS_RECEIVER_
#define _L1BKa_MS_RECEIVER_

typedef struct {
    unsigned char echoCount[25][260];
    float noiseCount[25];
    short echoPower[25][260];
    short noisePower[25];
    short noiseSampleNumber[25];
    signed char echoSampleNumber[25];
    float rxAntGain[25];
    float receivedPulseWidth;
} L1BKa_MS_RECEIVER;

#endif

#ifndef _L1BKa_MS_TRANSMITTER_
#define _L1BKa_MS_TRANSMITTER_

typedef struct {
    float radarTransPower;
    float transPulseWidth;
    float txAntGain[25];
} L1BKa_MS_TRANSMITTER;
```

```
#endif

#ifndef _L1BKa_MS_CALIBRATION_
#define _L1BKa_MS_CALIBRATION_

typedef struct {
    short fcifInPower;
    signed char intAttSelect;
    short sspaLnaSelect;
    signed char angleBinSelect;
} L1BKa_MS_CALIBRATION;

#endif

#ifndef _L1BKa_MS_VERTLOCATE_
#define _L1BKa_MS_VERTLOCATE_

typedef struct {
    short landOceanFlag[25];
    float scLocalZenith[25];
    double startBinRange[25];
    short echoHighResBinNumber[25];
    short echoLowResBinNumber[25];
    short binEllipsoid[25];
    float scRangeEllipsoid[25];
    short binDEM[25];
    float scRangeDEM[25];
    short DEMHmean[25];
    short binDEMHtop[25];
    short binDEMHbottom[25];
    short binEchoPeak[25];
    float alongTrackBeamWidth[25];
    float crossTrackBeamWidth[25];
    short mainlobeEdge[25];
    short sidelobeRange[25];
    float ellipsoidBinOffset[25];
    short binMirrorImage[25];
    float rangeBinSize;
    signed char ratioLand[25];
    signed char ratioOcean[25];
    signed char ratioInLand[25];
    signed char ratioCoast[25];
```

```
} L1BKa_MS_VERTLOCATE;

#endif

#ifndef _L1BKa_MS_HOUSEKEEPING_
#define _L1BKa_MS_HOUSEKEEPING_

typedef struct {
    signed char rxAtt;
    float rxAttGainOffset;
    short binDiffPeakDEM[25];
    double scTime;
    signed char vprfTableVersion;
    signed char vprfTableSelect;
    signed char catchingInt;
    signed char scdpFlag;
    signed char fcifFlag;
    short logAmpNoiseLevel;
    short delay;
    short seqCountL1A;
    short fcifTemp[2];
    short lnaTemp[2];
    short rdaTemp[2];
    short divcomb1Temp[2];
    short divcomb2Temp[2];
    short sspaTemp[2];
    float rxGain[25];
    signed char fcifFlagAB;
    signed char scdpFlagAB;
} L1BKa_MS_HOUSEKEEPING;

#endif

#ifndef _L1BKa_MS_RAYPOINTING_
#define _L1BKa_MS_RAYPOINTING_

typedef struct {
    float rayDirectionX[25];
    float rayDirectionY[25];
    float instrumentYaw[25];
    float instrumentPitch[25];
    float instrumentRoll[25];
    float rayTiming[25];
```

```
    float scanAngle[25];
} L1BKa_MS_RAYPOINTING;

#endif

#ifndef _L1BKa_MS_SUNDATA_
#define _L1BKa_MS_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BKa_MS_SUNDATA;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;
```

```
#endif

#ifndef _L1BKa_MS_SCANSTATUS_
#define _L1BKa_MS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L1BKa_MS_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BKa_MS_
#define _L1BKa_MS_
```

```
typedef struct {
    SCANTIME ScanTime;
    float Latitude[25];
    float Longitude[25];
    float sunLocalTime[25];
    L1BKa_MS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L1BKa_MS_SUNDATA sunData;
    L1BKa_MS_RAYPOINTING rayPointing;
    L1BKa_MS_HOUSEKEEPING HouseKeeping;
    L1BKa_MS_VERTLOCATE VertLocate;
    L1BKa_MS_CALIBRATION Calibration;
    L1BKa_MS_TRANSMITTER Transmitter;
    L1BKa_MS_RECEIVER Receiver;
} L1BKa_MS;

#endif

#ifndef _L1BKa_SWATHS_
#define _L1BKa_SWATHS_

typedef struct {
    L1BKa_MS MS;
    L1BKa_HS HS;
} L1BKa_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BKa_HS_RECEIVER/
    CHARACTER echoCount(130,24)
    REAL*4 noiseCount(24)
    INTEGER*2 echoPower(130,24)
    INTEGER*2 noisePower(24)
    INTEGER*2 noiseSampleNumber(24)
    BYTE echoSampleNumber(24)
    REAL*4 rxAntGain(24)
    REAL*4 receivedPulseWidth
END STRUCTURE
```

```
STRUCTURE /L1BKa_HS_TRANSMITTER/
    REAL*4 radarTransPower
    REAL*4 transPulseWidth
    REAL*4 txAntGain(24)
END STRUCTURE

STRUCTURE /L1BKa_HS_CALIBRATION/
    INTEGER*2 fcifInPower
    BYTE intAttSelect
    INTEGER*2 sspaLnaSelect
    BYTE angleBinSelect
END STRUCTURE

STRUCTURE /L1BKa_HS_VERTLOCATE/
    INTEGER*2 landOceanFlag(24)
    REAL*4 scLocalZenith(24)
    REAL*8 startBinRange(24)
    INTEGER*2 echoHighResBinNumber(24)
    INTEGER*2 echoLowResBinNumber(24)
    INTEGER*2 binEllipsoid(24)
    REAL*4 scRangeEllipsoid(24)
    INTEGER*2 binDEM(24)
    REAL*4 scRangeDEM(24)
    INTEGER*2 DEMHmean(24)
    INTEGER*2 binDEMHtop(24)
    INTEGER*2 binDEMHbottom(24)
    INTEGER*2 binEchoPeak(24)
    REAL*4 alongTrackBeamWidth(24)
    REAL*4 crossTrackBeamWidth(24)
    INTEGER*2 mainlobeEdge(24)
    INTEGER*2 sidelobeRange(24)
    REAL*4 ellipsoidBinOffset(24)
    INTEGER*2 binMirrorImage(24)
    REAL*4 rangeBinSize
    BYTE ratioLand(24)
    BYTE ratioOcean(24)
    BYTE ratioInLand(24)
    BYTE ratioCoast(24)
END STRUCTURE

STRUCTURE /L1BKa_HS_HOUSEKEEPING/
    BYTE rxAtt
```

```
    REAL*4 rxAttGainOffset
    INTEGER*2 binDiffPeakDEM(24)
    REAL*8 scTime
    BYTE vprfTableVersion
    BYTE vprfTableSelect
    BYTE catchingInt
    BYTE scdpFlag
    BYTE fcifFlag
    INTEGER*2 logAmpNoiseLevel
    INTEGER*2 delay
    INTEGER*2 seqCountL1A
    INTEGER*2 fcifTemp(2)
    INTEGER*2 lnaTemp(2)
    INTEGER*2 rdaTemp(2)
    INTEGER*2 divcomb1Temp(2)
    INTEGER*2 divcomb2Temp(2)
    INTEGER*2 sspaTemp(2)
    REAL*4 rxGain(24)
    BYTE fcifFlagAB
    BYTE scdpFlagAB
END STRUCTURE

STRUCTURE /L1BKa_HS_RAYPOINTING/
    REAL*4 rayDirectionX(24)
    REAL*4 rayDirectionY(24)
    REAL*4 instrumentYaw(24)
    REAL*4 instrumentPitch(24)
    REAL*4 instrumentRoll(24)
    REAL*4 rayTiming(24)
    REAL*4 scanAngle(24)
END STRUCTURE

STRUCTURE /L1BKa_HS_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE
```

```
STRUCTURE /L1BKa_HS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BKa_HS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(24)
    REAL*4 Longitude(24)
    REAL*4 sunLocalTime(24)
    RECORD /L1BKa_HS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BKa_HS_SUNDATA/ sunData
    RECORD /L1BKa_HS_RAYPOINTING/ rayPointing
    RECORD /L1BKa_HS_HOUSEKEEPING/ HouseKeeping
    RECORD /L1BKa_HS_VERTLOCATE/ VertLocate
    RECORD /L1BKa_HS_CALIBRATION/ Calibration
    RECORD /L1BKa_HS_TRANSMITTER/ Transmitter
    RECORD /L1BKa_HS_RECEIVER/ Receiver
END STRUCTURE

STRUCTURE /L1BKa_MS_RECEIVER/
    CHARACTER echoCount(260,25)
    REAL*4 noiseCount(25)
    INTEGER*2 echoPower(260,25)
    INTEGER*2 noisePower(25)
    INTEGER*2 noiseSampleNumber(25)
    BYTE echoSampleNumber(25)
    REAL*4 rxAntGain(25)
    REAL*4 receivedPulseWidth
END STRUCTURE
```

```
STRUCTURE /L1BKa_MS_TRANSMITTER/
    REAL*4 radarTransPower
    REAL*4 transPulseWidth
    REAL*4 txAntGain(25)
END STRUCTURE

STRUCTURE /L1BKa_MS_CALIBRATION/
    INTEGER*2 fcifInPower
    BYTE intAttSelect
    INTEGER*2 sspaLnaSelect
    BYTE angleBinSelect
END STRUCTURE

STRUCTURE /L1BKa_MS_VERTLOCATE/
    INTEGER*2 landOceanFlag(25)
    REAL*4 scLocalZenith(25)
    REAL*8 startBinRange(25)
    INTEGER*2 echoHighResBinNumber(25)
    INTEGER*2 echoLowResBinNumber(25)
    INTEGER*2 binEllipsoid(25)
    REAL*4 scRangeEllipsoid(25)
    INTEGER*2 binDEM(25)
    REAL*4 scRangeDEM(25)
    INTEGER*2 DEMHmean(25)
    INTEGER*2 binDEMHtop(25)
    INTEGER*2 binDEMHbottom(25)
    INTEGER*2 binEchoPeak(25)
    REAL*4 alongTrackBeamWidth(25)
    REAL*4 crossTrackBeamWidth(25)
    INTEGER*2 mainlobeEdge(25)
    INTEGER*2 sidelobeRange(25)
    REAL*4 ellipsoidBinOffset(25)
    INTEGER*2 binMirrorImage(25)
    REAL*4 rangeBinSize
    BYTE ratioLand(25)
    BYTE ratioOcean(25)
    BYTE ratioInLand(25)
    BYTE ratioCoast(25)
END STRUCTURE

STRUCTURE /L1BKa_MS_HOUSEKEEPING/
    BYTE rxAtt
    REAL*4 rxAttGainOffset
```

```
    INTEGER*2 binDiffPeakDEM(25)
    REAL*8 scTime
    BYTE vprfTableVersion
    BYTE vprfTableSelect
    BYTE catchingInt
    BYTE scdpFlag
    BYTE fcifFlag
    INTEGER*2 logAmpNoiseLevel
    INTEGER*2 delay
    INTEGER*2 seqCountL1A
    INTEGER*2 fcifTemp(2)
    INTEGER*2 lnaTemp(2)
    INTEGER*2 rdaTemp(2)
    INTEGER*2 divcomb1Temp(2)
    INTEGER*2 divcomb2Temp(2)
    INTEGER*2 sspaTemp(2)
    REAL*4 rxGain(25)
    BYTE fcifFlagAB
    BYTE scdpFlagAB
END STRUCTURE

STRUCTURE /L1BKa_MS_RAYPOINTING/
    REAL*4 rayDirectionX(25)
    REAL*4 rayDirectionY(25)
    REAL*4 instrumentYaw(25)
    REAL*4 instrumentPitch(25)
    REAL*4 instrumentRoll(25)
    REAL*4 rayTiming(25)
    REAL*4 scanAngle(25)
END STRUCTURE

STRUCTURE /L1BKa_MS_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /NAVIGATION/
```

```
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BKa_MS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
```

```
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BKa_MS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(25)
    REAL*4 Longitude(25)
    REAL*4 sunLocalTime(25)
    RECORD /L1BKa_MS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BKa_MS_SUNDATA/ sunData
    RECORD /L1BKa_MS_RAYPOINTING/ rayPointing
    RECORD /L1BKa_MS_HOUSEKEEPING/ HouseKeeping
    RECORD /L1BKa_MS_VERTLOCATE/ VertLocate
    RECORD /L1BKa_MS_CALIBRATION/ Calibration
    RECORD /L1BKa_MS_TRANSMITTER/ Transmitter
    RECORD /L1BKa_MS_RECEIVER/ Receiver
END STRUCTURE

STRUCTURE /L1BKa_SWATHS/
    RECORD /L1BKa_MS/ MS;
    RECORD /L1BKa_HS/ HS;
END STRUCTURE
```

5.45 1BPR - PR Power

The PR Level-1B product, 1BPR, "PR Power," is written as a swath structure. The swath name is "FS", for Full Scan Swath. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.
nbin	260	Number of range bins in each ray. The data is observed at 250m but interpolated to 125m so the data format aligns with Ku from GPM/DPR.
SVBFd	3	Number in sunVectorInBodyFrame.
nfcifT	2	Number in fcifTemp.
nlnaT	2	Number in lnaTemp.
nrdaT	2	Number in rdaTemp.
ndc1T	2	Number in divcomb1Temp.
ndc2T	2	Number in divcomb2Temp.
nsspaT	2	Number in sspaTemp.

Figure 508 through Figure 518 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

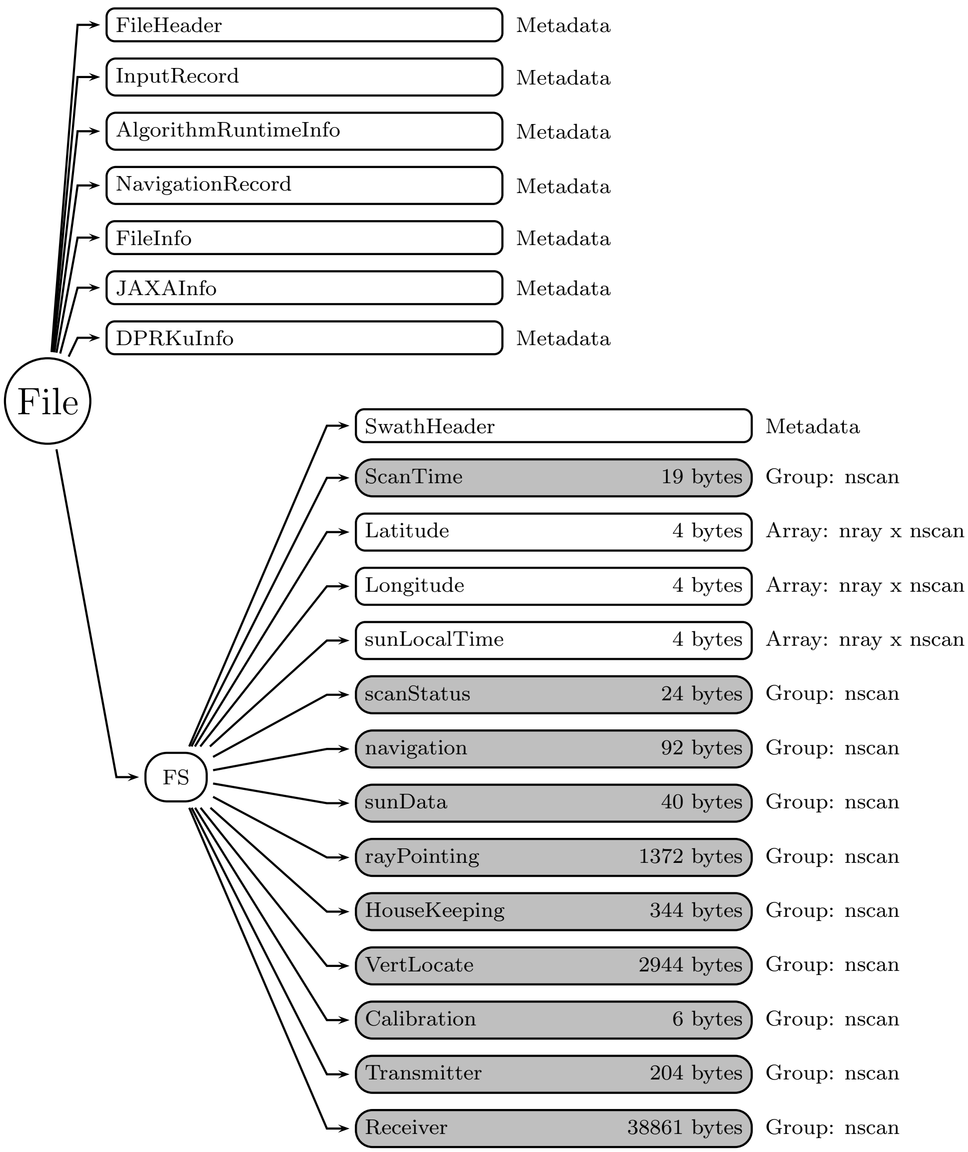


Figure 508: Data Format Structure for 1BPR, PR Power

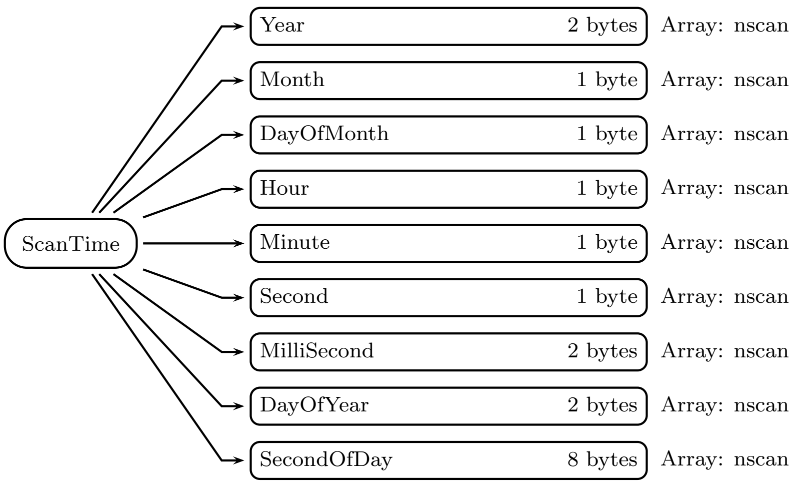


Figure 509: Data Format Structure for 1BPR, ScanTime

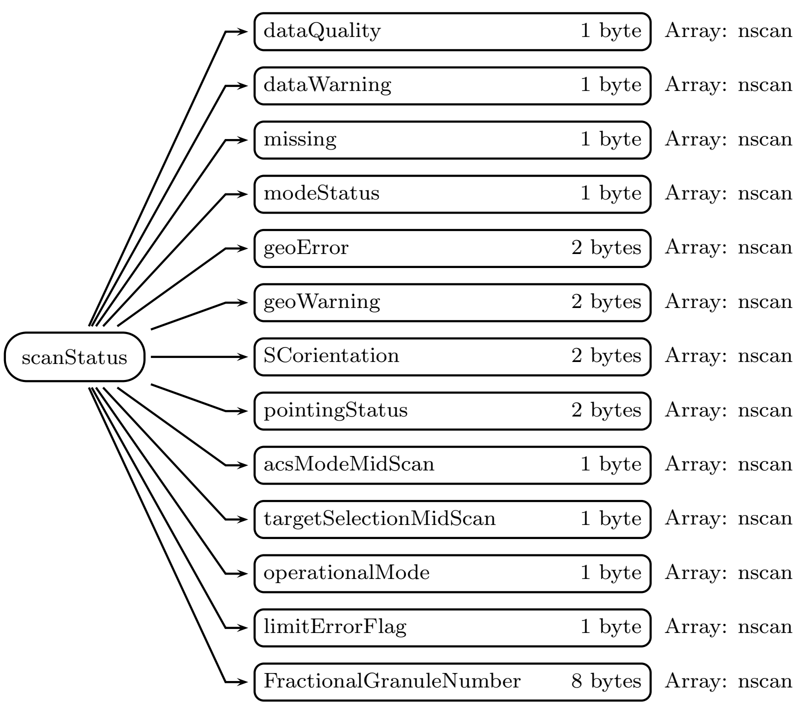


Figure 510: Data Format Structure for 1BPR, scanStatus

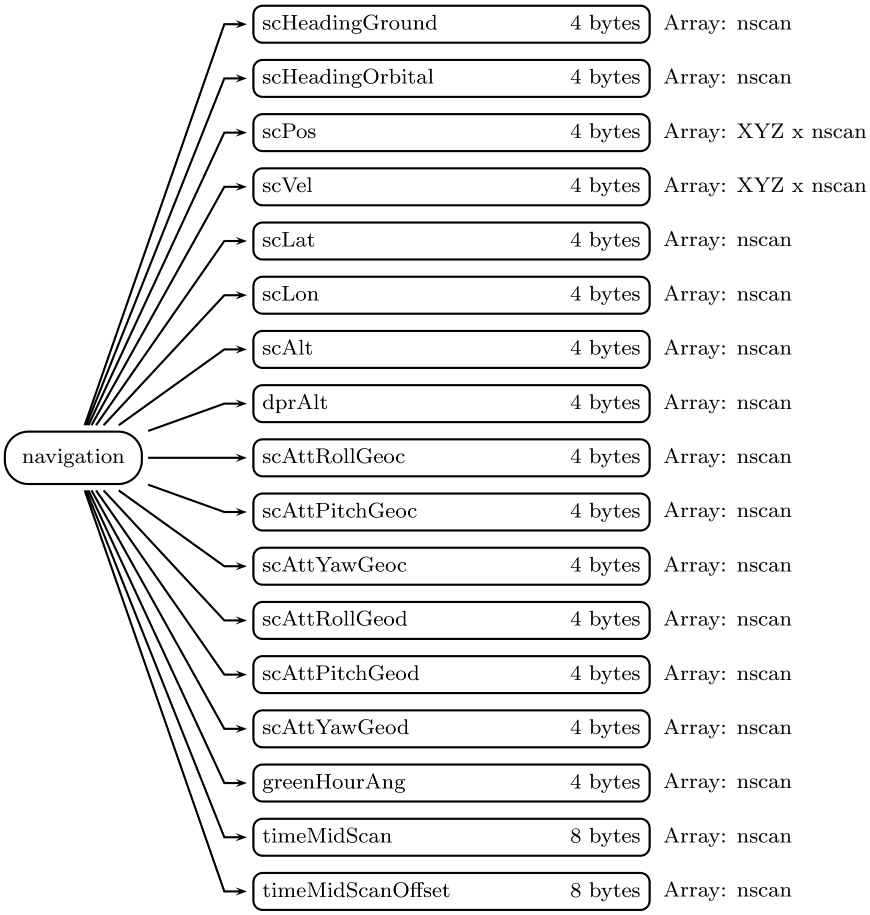


Figure 511: Data Format Structure for 1BPR, navigation

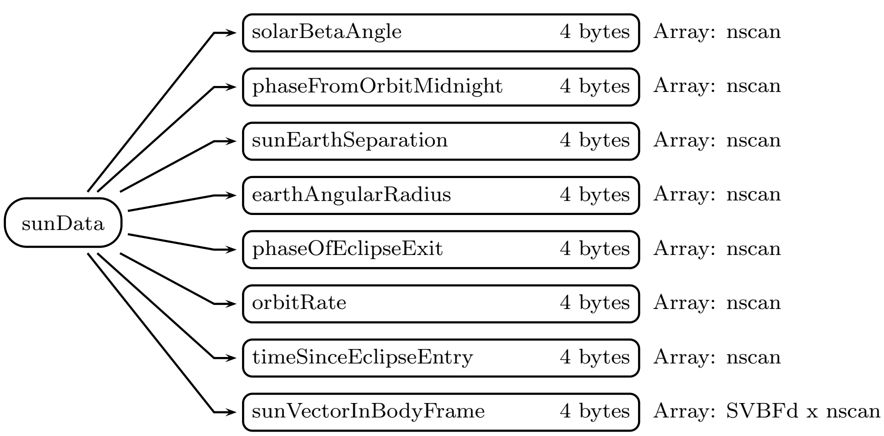


Figure 512: Data Format Structure for 1BPR, sunData

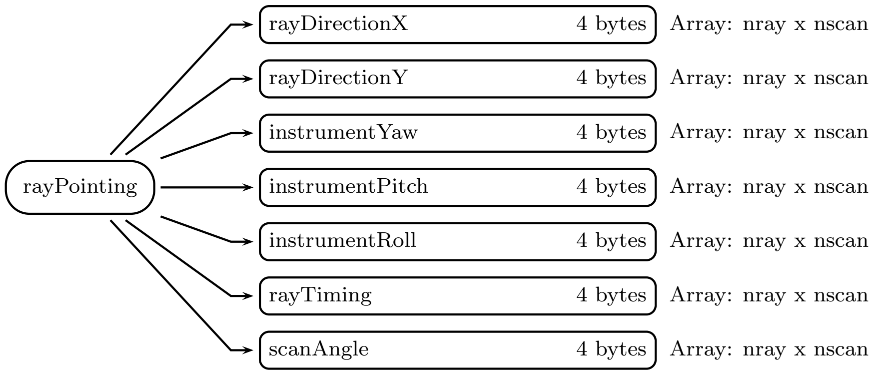


Figure 513: Data Format Structure for 1BPR, rayPointing

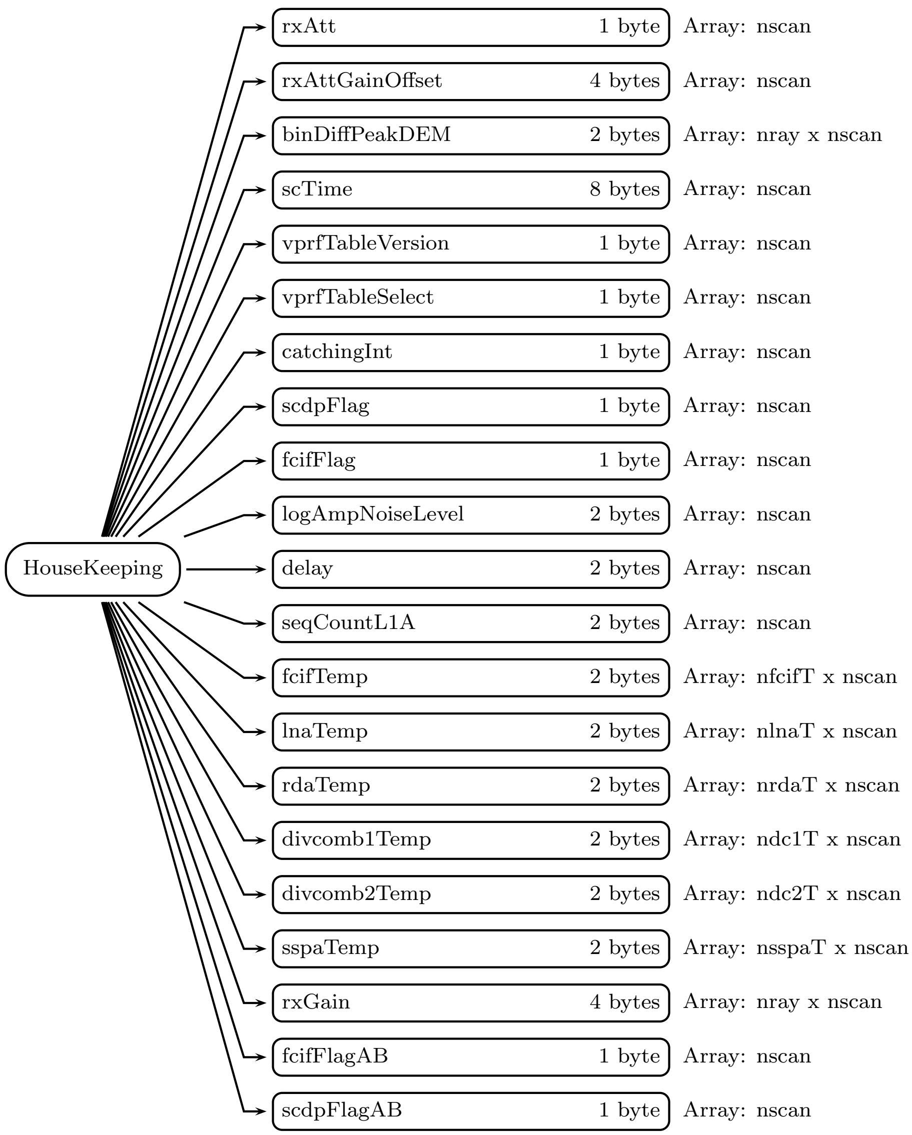


Figure 514: Data Format Structure for 1BPR, HouseKeeping

VertLocate

landOceanFlag	2 bytes	Array: nray x nscan
scLocalZenith	4 bytes	Array: nray x nscan
startBinRange	8 bytes	Array: nray x nscan
echoHighResBinNumber	2 bytes	Array: nray x nscan
echoLowResBinNumber	2 bytes	Array: nray x nscan
binEllipsoid	2 bytes	Array: nray x nscan
scRangeEllipsoid	4 bytes	Array: nray x nscan
binDEM	2 bytes	Array: nray x nscan
scRangeDEM	4 bytes	Array: nray x nscan
DEMHmean	2 bytes	Array: nray x nscan
binDEMHtop	2 bytes	Array: nray x nscan
binDEMHbottom	2 bytes	Array: nray x nscan
binEchoPeak	2 bytes	Array: nray x nscan
alongTrackBeamWidth	4 bytes	Array: nray x nscan
crossTrackBeamWidth	4 bytes	Array: nray x nscan
mainlobeEdge	2 bytes	Array: nray x nscan
sidelobeRange	2 bytes	Array: nray x nscan
ellipsoidBinOffset	4 bytes	Array: nray x nscan
binMirrorImage	2 bytes	Array: nray x nscan
rangeBinSize	4 bytes	Array: nscan
ratioLand	1 byte	Array: nray x nscan
ratioOcean	1 byte	Array: nray x nscan
ratioInLand	1 byte	Array: nray x nscan
ratioCoast	1 byte	Array: nray x nscan

Figure 515: Data Format Structure for 1BPR, VertLocate

Calibration

fcifInPower	2 bytes	Array: nscan
intAttSelect	1 byte	Array: nscan
sspaLnaSelect	2 bytes	Array: nscan
angleBinSelect	1 byte	Array: nscan

Figure 516: Data Format Structure for 1BPR, Calibration

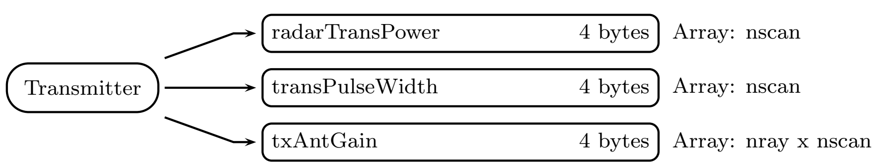


Figure 517: Data Format Structure for 1BPR, Transmitter

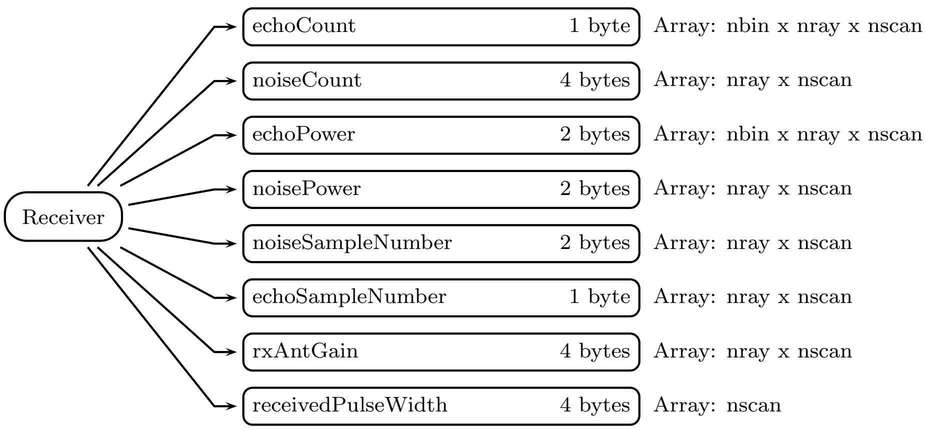


Figure 518: Data Format Structure for 1BPR, Receiver

FileHeader (Metadata):
FileHeader contains metadata of general interest. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

DPRKuInfo (Metadata):
Contains DPR information. See Metadata for GPM Products for details.

FS (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are

defined as:
 -9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
 -9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
 -9999.9 Missing value

scanStatus (Group)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
```

```
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft

axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
90    -Y forward (yaw 90)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
```

```
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of

the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in True of Date (TOD) Earth-Centered Inertial (ECI) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (m/s) of the spacecraft in TOD ECI Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values

range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

sunData (Group)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: SVBFd x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayPointing (Group)

rayDirectionX (4-byte float, array size: nray x nscan):
Unit ray direction x component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

rayDirectionY (4-byte float, array size: nray x nscan):
Unit ray direction y component in mechanical coordinates. Values range from -1.0 to 1.0. Special values are defined as:
-9999.9 Missing value

instrumentYaw (4-byte float, array size: nray x nscan):
Yaw of mechanical coordinates w.r.t. geodetic coordinates. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

instrumentPitch (4-byte float, array size: nray x nscan):
Pitch of mechanical coordinates w.r.t. geodetic coordinates. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

instrumentRoll (4-byte float, array size: nray x nscan):
Roll of mechanical coordinates w.r.t. geodetic coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

rayTiming (4-byte float, array size: nray x nscan):
The time delay from the secondary header packet time tag to each ray (assumed as mid-time of all radar pulses for the associated rayDirection). Values range from 0 to 1.6 s. Special values are defined as:
-9999.9 Missing value

scanAngle (4-byte float, array size: nray x nscan):
Angle (degrees) of the ray from nominal nadir offset about the mechanical x_axis. The sign of the angle is consistent with the sensor y-axis, i.e., the angle is positive to the right of the direction of travel if the spacecraft is in normal mode. Values range from -18 to 18 degrees. Special values are defined as:
-9999.9 Missing value

HouseKeeping (Group)

rxAtt (1-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 12 dB. Special values are defined as:
-99 Missing value

rxAttGainOffset (4-byte float, array size: nscan):
The actual gain of rxAtt considering the temperature dependence. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDiffPeakDEM (2-byte integer, array size: nray x nscan):
The number of range bins between binEchoPeak and binDEM. It is used to ensure that the VPRF is switched in accordance with the GPM satellite altitude. Values range from -260 to 260 range bin number at NS and MS, from -130 to 130 range bin number at HS respectively. Values range from -260 to 260 range bin number. Special values are defined as:
-9999 Missing value

scTime (8-byte float, array size: nscan):
Scan time expressed as TAI time with and epoch of 0000Z Jan 6, 1980. This time matches

the time in ScanTime. Special values are defined as:
-9999.9 Missing value

vprfTableVersion (1-byte integer, array size: nscan):
The version number of VPRF table which is used in L1B process. Values range from 1 to 127 number. Special values are defined as:
-99 Missing value

vprfTableSelect (1-byte integer, array size: nscan):
The selected number of VPRF table for altitude (h, km) which is used in L1B process. The range is 1 to 25.

```
h LT 396.5 = 1
396.5 LE h LT 397.5 = 2
397.5 LE h LT 398.5 = 3
398.5 LE h LT 399.5 = 4
399.5 LE h LT 400.5 = 5
400.5 LE h LT 401.5 = 6
401.5 LE h LT 402.5 = 7
402.5 LE h LT 403.5 = 8
403.5 LE h LT 404.5 = 9
404.5 LE h LT 405.5 = 10
405.5 LE h LT 406.5 = 11
406.5 LE h LT 407.5 = 12
407.5 LE h LT 408.5 = 13
408.5 LE h LT 409.5 = 14
409.5 LE h LT 410.5 = 15
410.5 LE h LT 411.5 = 16
411.5 LE h LT 412.5 = 17
412.5 LE h LT 413.5 = 18
413.5 LE h LT 414.5 = 19
414.5 LE h LT 415.5 = 20
415.5 LE h LT 416.5 = 21
416.5 LE h LT 417.5 = 22
417.5 LE h LT 418.5 = 23
418.5 LE h LT 419.5 = 24
419.5 LE h = 25

where
LT mean less than and
LE means less than or equal to
```

catchingInt (1-byte integer, array size: nscan):
The timing that receive window is open for the first reflected TX pulse. If catchingInt is set to 12, then the first TX pulse is received with receive window after the twelfth TX

pulse. In the case of nominal operation, catchingInt is set to 12, that is, the VPRF table is used. In other cases, including GPS-status trouble, catchingInt is set 8 and limited PRF is loaded. Values range from 8 to 12 number. Special values are defined as:
-99 Missing value

scdpFlag (1-byte integer, array size: nscan):
The side of the SCDP system and system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry.
3   Priority is 2 at Basic System Table. Refer to Basic System Table.
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

fcifFlag (1-byte integer, array size: nscan):
The side of FCIF system and the system table used.

```
Bit Meaning if bit=1
0   B-side is used (if bit=0, then A-side used)
1   Priority is 1 at Basic System Table. Refer to Basic System Table.
2   Priority is 2 at Basic System Table. Refer to HK telemetry
3   Priority is 2 at Basic System Table. Refer to Basic System Table
4   (Spare)
5   (Spare)
6   (Spare)
7   (Spare)
```

logAmpNoiseLevel (2-byte integer, array size: nscan):
The Noise Level at Log Amp Termination which is stored in science telemetry. Values are in counts. Special values are defined as:
-9999 Missing value

delay (2-byte integer, array size: nscan):
The timing offset value from space craft time in NS. In MS and HS, it is defined as offset time value from the base delay time. They are used to adjust for beam matching of along track direction. Values range from 0 to 3360 number. Special values are defined as:
-9999 Missing value

seqCountL1A (2-byte integer, array size: nscan):
The scan number which is determined by the L1A product. Values range from 0 to 27000 counts. Special values are defined as:
-9999 Missing value

fcifTemp (2-byte integer, array size: nfcifT x nscan):
The temperature of FCIF component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

lnaTemp (2-byte integer, array size: nlnaT x nscan):
The temperature of LNA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C.

rdaTemp (2-byte integer, array size: nrdaT x nscan):
The temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C Attenuator setting levels of Received radar antenna.Values are 0, 3, 6, 9 and 12 in dB. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb1Temp (2-byte integer, array size: ndc1T x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

divcomb2Temp (2-byte integer, array size: ndc2T x nscan):
The temperature of divcomb2, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

sspaTemp (2-byte integer, array size: nsspaT x nscan):
The temperature of RDA component, which is averaged during about 3 minutes. The first dimension is temperature and the other is the number of referenced HK telemetry. Temperature values are multiplied by 100 and stored as a 2 byte integer. The range is -50C to 50C. Values range from -5000 to 5000 0.01 C. Special values are defined as:
-9999 Missing value

rxGain (4-byte float, array size: nray x nscan):
The total receiver gain from FCIF input to antenna input. Values are in dB. Special values are defined as:
-9999.9 Missing value

fcifFlagAB (1-byte integer, array size: nscan):
FCIF A-side/B-side information. This flag does not include information on the source of the decision about the fcifFlag. Special values are defined as:
-99 Missing value

scdpFlagAB (1-byte integer, array size: nscan):
FCIF A-side/B-side information. This flag does not include information on the source of the decision about the scdpFlag. Special values are defined as:
-99 Missing value

VertLocate (Group)

landOceanFlag (2-byte integer, array size: nray x nscan):
Land or ocean information. The values of the flag are:

```
0 = Water
1 = Land
2 = Coast
3 = Inland Water
```

scLocalZenith (4-byte float, array size: nray x nscan):
The angle, in degrees, between the local zenith and the beam's center line. The local (geodetic) zenith at the intersection of the ray and the earth ellipsoid is used. Values range from 0 to 90 degrees. Special values are defined as:
-9999.9 Missing value

startBinRange (8-byte float, array size: nray x nscan):
The distance from the satellite to the center of the first range bin. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

echoHighResBinNumber (2-byte integer, array size: nray x nscan):
The number of sampling without thinning out (over sampling).. Range of 1-260 for NS and MS and 1-130 at HS. EDIT Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

```
Meaning in Normal Mode:
0 = Over sampling range bin OR
1 = Normal sampling range bin
2 = Interpolated range bin
-99 = Outrange bin of the observation area
Meaning in internal calibration mode:
0: In internal calibration mode, this value is stored 1- 42 range bin for each
```

```
ray.
-99: missing value. In internal calibration mode, this value is stored after 43
range bin for each ray as missing.
```

echoLowResBinNumber (2-byte integer, array size: nray x nscan):
The number of sampling after thinning out the normal sample. From 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Values range from 0 to 260 range bin number. Special values are defined as:
-9999 Missing value

binEllipsoid (2-byte integer, array size: nray x nscan):
The range bin number of the earth ellipsoid. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

scRangeEllipsoid (4-byte float, array size: nray x nscan):
The distance from instrument to ellipsoid calculated by GeoTK. Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

binDEM (2-byte integer, array size: nray x nscan):
Range bin number of the average DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS while from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing.

scRangeDEM (4-byte float, array size: nray x nscan):
The value is calculted as scRangeEllipsoid - DEMHmean secand(localZenithAngle). Values range from 0 to 500000 m. Special values are defined as:
-9999.9 Missing value

DEMHmean (2-byte integer, array size: nray x nscan):
Averaged DEM height, whose SRTM-30. Values range from 0 to 9000 m. Special values are defined as:
-9999 Missing value

binDEMHtop (2-byte integer, array size: nray x nscan):
The range bin number of the maximum DEM surface elevation in a box centered on the IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binDEMHbottom (2-byte integer, array size: nray x nscan):
The range bin number of the minimum DEM surface elevation in a box centered on the

IFOV. Reference width is 5 km x 5 km. Reference number of pixels in the direction of latitude is 7. On the other hand, the number of pixels in the direction of longitude reference is changed to 21-7 by latitude. Values range from 1 to 260 range bin number at NS and MS, from 1 to 130 at HS. Special value is -9999 for missing scan, internal calbration mode, or in case DEM is missing. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km.

binEchoPeak (2-byte integer, array size: nray x nscan):
The range bin number which has maximum echoPower in each scan and each angle bin. Values range from 1 to 260 range bin number. Special values are defined as:
-9999 Missing value

alongTrackBeamWidth (4-byte float, array size: nray x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power in the along-track direction.

crossTrackBeamWidth (4-byte float, array size: nray x nscan):
Radar beamwidth (degrees) at the point transmitted power reaches one half of peak power along the cross-track direction.

mainlobeEdge (2-byte integer, array size: nray x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the edge of the clutter from the mainlobe.

sidelobeRange (2-byte integer, array size: nray x nscan):
Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter psition from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
The distance between center of binEllipsoid range bin and Ellipsoid position.

binMirrorImage (2-byte integer, array size: nray x nscan):
Range bin of the mirror image.

rangeBinSize (4-byte float, array size: nscan):
The range bin size. With VPRF, the size for NS and MS is 250.32670 m and for HS 250.32670 m. With limited PRF, the size is 250.32670 m for all three swaths.

ratioLand (1-byte integer, array size: nray x nscan):
Ratio of land area to total area in a footprint.

ratioOcean (1-byte integer, array size: nray x nscan):
Ratio of ocean area to total area in a footprint.

ratioInLand (1-byte integer, array size: nray x nscan):
Ratio of inland water area to total area in a footprint.

ratioCoast (1-byte integer, array size: nray x nscan):
Ratio of coast area to total area in a footprint.

Calibration (Group)

fcifInPower (2-byte integer, array size: nscan):
Input power value of FCIF and is set at internal calibration mode. At another mode, the value of fcifInPower is set as missing. Values are in 0.01 dBm. Special values are defined as:
-30000 Missing value

intAttSelect (1-byte integer, array size: nscan):
The selected number of internal attenuation that is controlled automatically with 32 steps and is set by internal mode. At another mode, the value of fcifInPower is set as missing. Values range from 1 to 32 step. Special values are defined as:
-99 Missing value

sspaLnaSelect (2-byte integer, array size: nscan):
In SSPA mode, sspaLnaSelect stores the number of LNA. In LNA mode, sspaLnaSelect stores the number of SSPA. In other modes, sspaLnaSelect is given the missing value. Values range from 1 to 128 number. Special values are defined as:
-9999 Missing value

angleBinSelect (1-byte integer, array size: nscan):
In SSPA and LNA mode, angleBinSelect contains the selected beam number. In other operational modes, angleBinSelect is set to missing. Values range from 1 to 49 number. Special values are defined as:
-99 Missing value

Transmitter (Group)

radarTransPower (4-byte float, array size: nscan):
The total (sum) power of 128 SSPA elements corrected with SSPA temperature in orbit. It is based on ground test temperature data of SSPA transmission power. Special value -9999.9 for missing scan and internal calibration mode.

transPulseWidth (4-byte float, array size: nscan):
Transmitted pulse width corrected with FCIF temperature in orbit, based on temperature test data of FCIF. Values range from 0.0000015 to 0.0000017 s. Special value -9999.9 for missing scan and internal calibration mode.

txAntGain (4-byte float, array size: nray x nscan):
Transmitted radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

Receiver (Group)

echoCount (1-byte char, array size: nbin x nray x nscan):
The total signal count at the antenna input that includes both echo and noise power. The signal count is stored on both observation mode and calibration mode. It is basically a copy of science telemetry raw data for sampling range bins. 0 is set to both interpolated range bin and outrange bin of the observation area.

noiseCount (4-byte float, array size: nray x nscan):
An average of the received noise count for each angle bins during suspended 4 pulses. The value -9999.9 means missing scan and inernal calibration mode.

echoPower (2-byte integer, array size: nbin x nray x nscan):
The total signal power at the antenna input that includes both echo and noise power. The numerical value of echoPower is 100 times the power expressed in dBm when the data is valid. Values between -12000 and -2000, which correspond to the power between -120 dBm and -20 dBm, are the valid values. If the echoPower is measured outside the receiving range window that depends on the pulse repetition frequency, -29999 is stored. If the data is not valid for other reasons, -30000 is stored.

```
Special values:
"Count value": internal calibration mode.
-29999 : Outrange bins of the observation area.
-30000 : Missing value
```

noisePower (2-byte integer, array size: nray x nscan):
An average of the received noise power for each angle bins during suspended 4 pulses. Values in dBm are multiplied by 100 and stored in the file as a 2-byte integer. The unit in the file is thus 0.01 dBm. The range is -120 dBm to -20 dBm which corresponds to values in the file from -12000 to -2000. The value -30000 means missing scan and internal calibration mode.

noiseSampleNumber (2-byte integer, array size: nray x nscan):
The number of noise samplings. This value is considered with frequency agility, the number of noise sampling pulse and sampling dependency, so the value is the quadruple of the value defined by the VPRF table. Values range from 0 to 1000 number. Special value -9999 for missing and internal calibration mode.

echoSampleNumber (1-byte integer, array size: nray x nscan):
The number of received pulse. This value is considered with frequency agility so the value is the double of the value defined by the VHRF table. Values range from 0 to 120 number. Special values are defined as:

48	Internal Calibration Mode
-99	Missing scan

rxAntGain (4-byte float, array size: nray x nscan):
Received radar antenna effectiveness (dB). Special value -9999.9 for missing scan and internal calibration mode.

receivedPulseWidth (4-byte float, array size: nscan):
Received pulse width (s) after passing through band pass filter of FCIF. Special value -9999.9 for missing scan and internal calibration mode.

C Structure Header file:

```
#ifndef _TK_1BPR_H_
#define _TK_1BPR_H_

#ifndef _L1BPR_RECEIVER_
#define _L1BPR_RECEIVER_

typedef struct {
    unsigned char echoCount[49][260];
    float noiseCount[49];
    short echoPower[49][260];
    short noisePower[49];
    short noiseSampleNumber[49];
    signed char echoSampleNumber[49];
    float rxAntGain[49];
    float receivedPulseWidth;
} L1BPR_RECEIVER;

#endif

#ifndef _L1BPR_TRANSMITTER_
#define _L1BPR_TRANSMITTER_

typedef struct {
    float radarTransPower;
    float transPulseWidth;
    float txAntGain[49];
} L1BPR_TRANSMITTER;

#endif

#ifndef _L1BPR_CALIBRATION_
#define _L1BPR_CALIBRATION_

typedef struct {
```

```
    short fcifInPower;
    signed char intAttSelect;
    short sspaLnaSelect;
    signed char angleBinSelect;
} L1BPR_CALIBRATION;

#endif

#ifndef _L1BPR_VERTLOCATE_
#define _L1BPR_VERTLOCATE_

typedef struct {
    short landOceanFlag[49];
    float scLocalZenith[49];
    double startBinRange[49];
    short echoHighResBinNumber[49];
    short echoLowResBinNumber[49];
    short binEllipsoid[49];
    float scRangeEllipsoid[49];
    short binDEM[49];
    float scRangeDEM[49];
    short DEMHmean[49];
    short binDEMHtop[49];
    short binDEMHbottom[49];
    short binEchoPeak[49];
    float alongTrackBeamWidth[49];
    float crossTrackBeamWidth[49];
    short mainlobeEdge[49];
    short sidelobeRange[49];
    float ellipsoidBinOffset[49];
    short binMirrorImage[49];
    float rangeBinSize;
    signed char ratioLand[49];
    signed char ratioOcean[49];
    signed char ratioInLand[49];
    signed char ratioCoast[49];
} L1BPR_VERTLOCATE;

#endif

#ifndef _L1BPR_HOUSEKEEPING_
#define _L1BPR_HOUSEKEEPING_
```

```
typedef struct {
    signed char rxAtt;
    float rxAttGainOffset;
    short binDiffPeakDEM[49];
    double scTime;
    signed char vprfTableVersion;
    signed char vprfTableSelect;
    signed char catchingInt;
    signed char scdpFlag;
    signed char fcifFlag;
    short logAmpNoiseLevel;
    short delay;
    short seqCountL1A;
    short fcifTemp[2];
    short lnaTemp[2];
    short rdaTemp[2];
    short divcomb1Temp[2];
    short divcomb2Temp[2];
    short sspaTemp[2];
    float rxGain[49];
    signed char fcifFlagAB;
    signed char scdpFlagAB;
} L1BPR_HOUSEKEEPING;

#endif

#ifndef _L1BPR_RAYPOINTING_
#define _L1BPR_RAYPOINTING_

typedef struct {
    float rayDirectionX[49];
    float rayDirectionY[49];
    float instrumentYaw[49];
    float instrumentPitch[49];
    float instrumentRoll[49];
    float rayTiming[49];
    float scanAngle[49];
} L1BPR_RAYPOINTING;

#endif

#ifndef _L1BPR_SUNDATA_
#define _L1BPR_SUNDATA_
```

```
typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BPR_SUNDATA;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L1BPR_SCANSTATUS_
#define _L1BPR_SCANSTATUS_

typedef struct {
```

```
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L1BPR_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BPR_FS_
#define _L1BPR_FS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float sunLocalTime[49];
    L1BPR_SCANSTATUS scanStatus;
```

```
    NAVIGATION navigation;
    L1BPR_SUNDATA sunData;
    L1BPR_RAYPOINTING rayPointing;
    L1BPR_HOUSEKEEPING HouseKeeping;
    L1BPR_VERTLOCATE VertLocate;
    L1BPR_CALIBRATION Calibration;
    L1BPR_TRANSMITTER Transmitter;
    L1BPR_RECEIVER Receiver;
} L1BPR_FS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BPR_RECEIVER/
    CHARACTER echoCount(260,49)
    REAL*4 noiseCount(49)
    INTEGER*2 echoPower(260,49)
    INTEGER*2 noisePower(49)
    INTEGER*2 noiseSampleNumber(49)
    BYTE echoSampleNumber(49)
    REAL*4 rxAntGain(49)
    REAL*4 receivedPulseWidth
END STRUCTURE

STRUCTURE /L1BPR_TRANSMITTER/
    REAL*4 radarTransPower
    REAL*4 transPulseWidth
    REAL*4 txAntGain(49)
END STRUCTURE

STRUCTURE /L1BPR_CALIBRATION/
    INTEGER*2 fcifInPower
    BYTE intAttSelect
    INTEGER*2 sspaLnaSelect
    BYTE angleBinSelect
END STRUCTURE

STRUCTURE /L1BPR_VERTLOCATE/
    INTEGER*2 landOceanFlag(49)
    REAL*4 scLocalZenith(49)
```

```
    REAL*8 startBinRange(49)
    INTEGER*2 echoHighResBinNumber(49)
    INTEGER*2 echoLowResBinNumber(49)
    INTEGER*2 binEllipsoid(49)
    REAL*4 scRangeEllipsoid(49)
    INTEGER*2 binDEM(49)
    REAL*4 scRangeDEM(49)
    INTEGER*2 DEMHmean(49)
    INTEGER*2 binDEMHtop(49)
    INTEGER*2 binDEMHbottom(49)
    INTEGER*2 binEchoPeak(49)
    REAL*4 alongTrackBeamWidth(49)
    REAL*4 crossTrackBeamWidth(49)
    INTEGER*2 mainlobeEdge(49)
    INTEGER*2 sidelobeRange(49)
    REAL*4 ellipsoidBinOffset(49)
    INTEGER*2 binMirrorImage(49)
    REAL*4 rangeBinSize
    BYTE ratioLand(49)
    BYTE ratioOcean(49)
    BYTE ratioInLand(49)
    BYTE ratioCoast(49)
END STRUCTURE

STRUCTURE /L1BPR_HOUSEKEEPING/
    BYTE rxAtt
    REAL*4 rxAttGainOffset
    INTEGER*2 binDiffPeakDEM(49)
    REAL*8 scTime
    BYTE vprfTableVersion
    BYTE vprfTableSelect
    BYTE catchingInt
    BYTE scdpFlag
    BYTE fcifFlag
    INTEGER*2 logAmpNoiseLevel
    INTEGER*2 delay
    INTEGER*2 seqCountL1A
    INTEGER*2 fcifTemp(2)
    INTEGER*2 lnaTemp(2)
    INTEGER*2 rdaTemp(2)
    INTEGER*2 divcomb1Temp(2)
    INTEGER*2 divcomb2Temp(2)
    INTEGER*2 sspaTemp(2)
```

```
    REAL*4 rxGain(49)
    BYTE fcifFlagAB
    BYTE scdpFlagAB
END STRUCTURE

STRUCTURE /L1BPR_RAYPOINTING/
    REAL*4 rayDirectionX(49)
    REAL*4 rayDirectionY(49)
    REAL*4 instrumentYaw(49)
    REAL*4 instrumentPitch(49)
    REAL*4 instrumentRoll(49)
    REAL*4 rayTiming(49)
    REAL*4 scanAngle(49)
END STRUCTURE

STRUCTURE /L1BPR_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
```

```
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BPR_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BPR_FS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    RECORD /L1BPR_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L1BPR_SUNDATA/ sunData
    RECORD /L1BPR_RAYPOINTING/ rayPointing
    RECORD /L1BPR_HOUSEKEEPING/ HouseKeeping
    RECORD /L1BPR_VERTLOCATE/ VertLocate
    RECORD /L1BPR_CALIBRATION/ Calibration
```

```
    RECORD /L1BPR_TRANSMITTER/ Transmitter
    RECORD /L1BPR_RECEIVER/ Receiver
END STRUCTURE
```

5.46 2AKu - Ku precipitation

The Ku Level-2A product, 2AKu, "Ku precipitation," is written as a 1 swath structure. The swath is FS, full scans. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each FS scan.
nbin	176	Number of range bins in each NS and MS ray. Bin interval is 125 m. 0 is at the top. 175 is the bin of the earth ellipsoid.
nbinSZP	7	Number of range bins for sigmaZeroProfile.
nNP	4	Number of NP kinds.
nearFar	2	Near reference, Far reference.
foreBack	2	Foreward, Backward.
method	6	Number of SRT methods.
nsdew	3	Number of standard deviation effective ways.
nNode	5	Number of binNode.
nDSD	2	Number of DSD parameters. Parameters are dBNw and Dm (mm).
LS	2	Liquid, solid.
nNUBF	3	Number of NUBF parameters.
two	2	Two.

Figure 519 through Figure 530 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

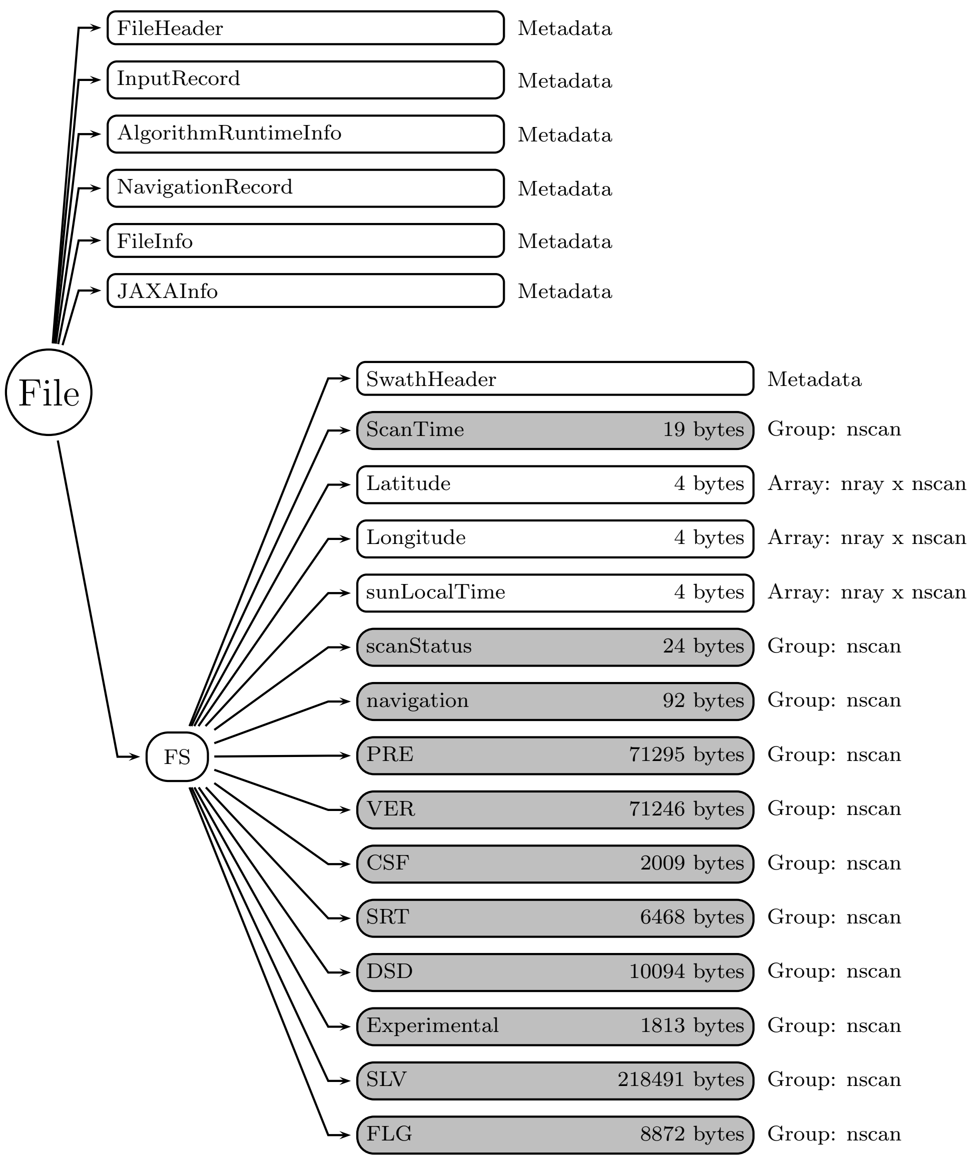


Figure 519: Data Format Structure for 2AKu, Ku precipitation

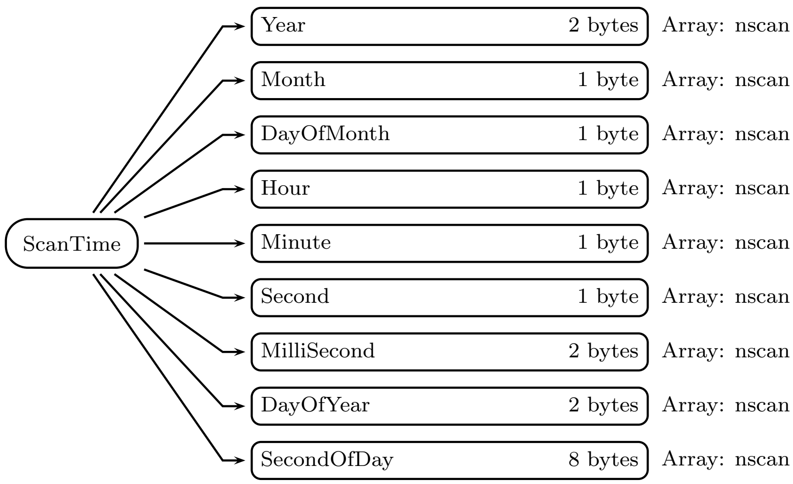


Figure 520: Data Format Structure for 2AKu, ScanTime

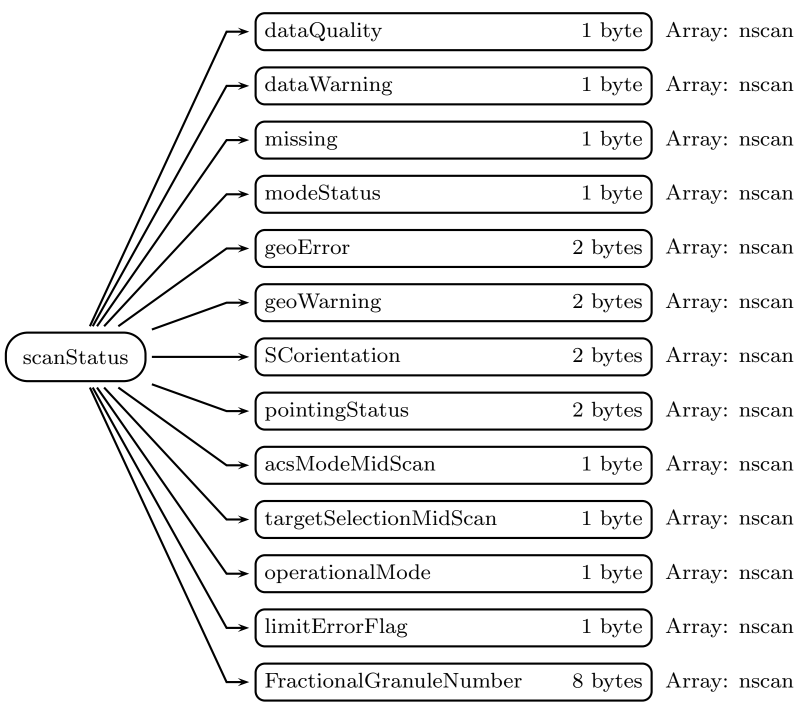


Figure 521: Data Format Structure for 2AKu, scanStatus

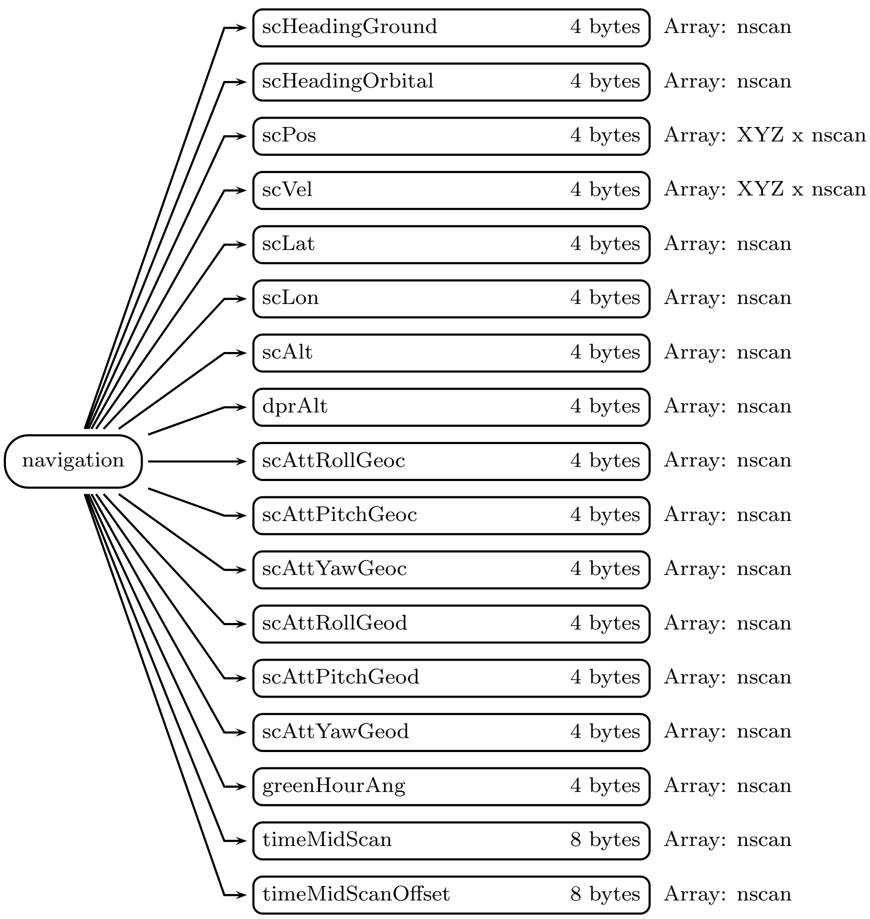


Figure 522: Data Format Structure for 2AKu, navigation

PRE	elevation	4 bytes	Array: nray x nscan
	landSurfaceType	4 bytes	Array: nray x nscan
	localZenithAngle	4 bytes	Array: nray x nscan
	flagPrecip	4 bytes	Array: nray x nscan
	flagSigmaZeroSaturation	1 byte	Array: nray x nscan
	binRealSurface	2 bytes	Array: nray x nscan
	binStormTop	2 bytes	Array: nray x nscan
	heightStormTop	4 bytes	Array: nray x nscan
	height	4 bytes	Array: nbin x nray x nscan
	binClutterFreeBottom	2 bytes	Array: nray x nscan
	sigmaZeroMeasured	4 bytes	Array: nray x nscan
	zFactorMeasured	4 bytes	Array: nbin x nray x nscan
	ellipsoidBinOffset	4 bytes	Array: nray x nscan
	snRatioAtRealSurface	4 bytes	Array: nray x nscan
	adjustFactor	4 bytes	Array: nray x nscan
	snowIceCover	1 byte	Array: nray x nscan
	binMirrorImageL2	2 bytes	Array: nray x nscan
	echoCountRealSurface	1 byte	Array: nray x nscan

Figure 523: Data Format Structure for 2AKu, PRE

VER	airTemperature	4 bytes	Array: nbin x nray x nscan
	binZeroDeg	2 bytes	Array: nray x nscan
	attenuationNP	4 bytes	Array: nbin x nray x nscan
	piaNP	4 bytes	Array: nNP x nray x nscan
	piaNPrainFree	4 bytes	Array: nNP x nray x nscan
	sigmaZeroNPCorrected	4 bytes	Array: nray x nscan
	heightZeroDeg	4 bytes	Array: nray x nscan
	flagInversion	2 bytes	Array: nray x nscan
	binZeroDegSecondary	2 bytes	Array: nray x nscan

Figure 524: Data Format Structure for 2AKu, VER

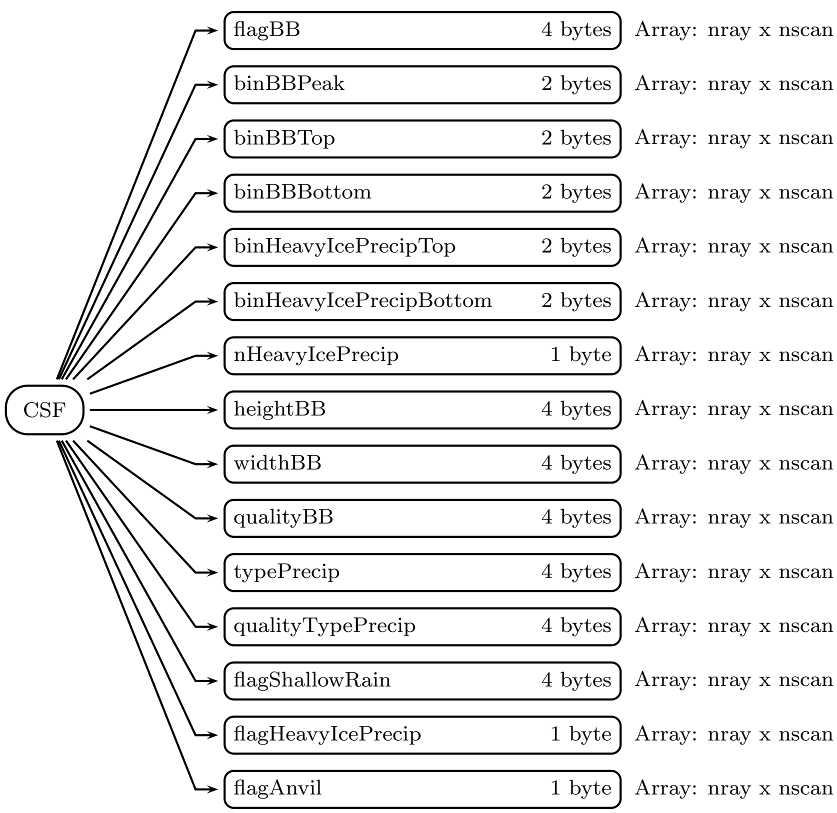


Figure 525: Data Format Structure for 2AKu, CSF

SRT

pathAtten	4 bytes	Array: nray x nscan
PIAalt	4 bytes	Array: method x nray x nscan
PIAhb	4 bytes	Array: nray x nscan
PIAhybrid	4 bytes	Array: nray x nscan
PIAweight	4 bytes	Array: method x nray x nscan
PIAweightHY	4 bytes	Array: two x nray x nscan
refScanID	2 bytes	Array: nearFar x foreBack x nray x nscan
reliabFactor	4 bytes	Array: nray x nscan
RFactorAlt	4 bytes	Array: method x nray x nscan
reliabFactorHY	4 bytes	Array: nray x nscan
reliabFlag	2 bytes	Array: nray x nscan
reliabFlagHY	2 bytes	Array: nray x nscan
stddevEff	4 bytes	Array: nsdew x nray x nscan
stddevHY	4 bytes	Array: nray x nscan
zeta	4 bytes	Array: nray x nscan

Figure 526: Data Format Structure for 2AKu, SRT

DSD

phase	1 byte	Array: nbin x nray x nscan
binNode	2 bytes	Array: nNode x nray x nscan
paramRDm	4 bytes	Array: nNode x nray x nscan

Figure 527: Data Format Structure for 2AKu, DSD

Experimental

precipRateESurface2	4 bytes	Array: nray x nscan
precipRateESurface2Status	1 byte	Array: nray x nscan
sigmaZeroProfile	4 bytes	Array: nbinSZP x nray x nscan
seaIceConcentration	4 bytes	Array: nray x nscan

Figure 528: Data Format Structure for 2AKu, Experimental

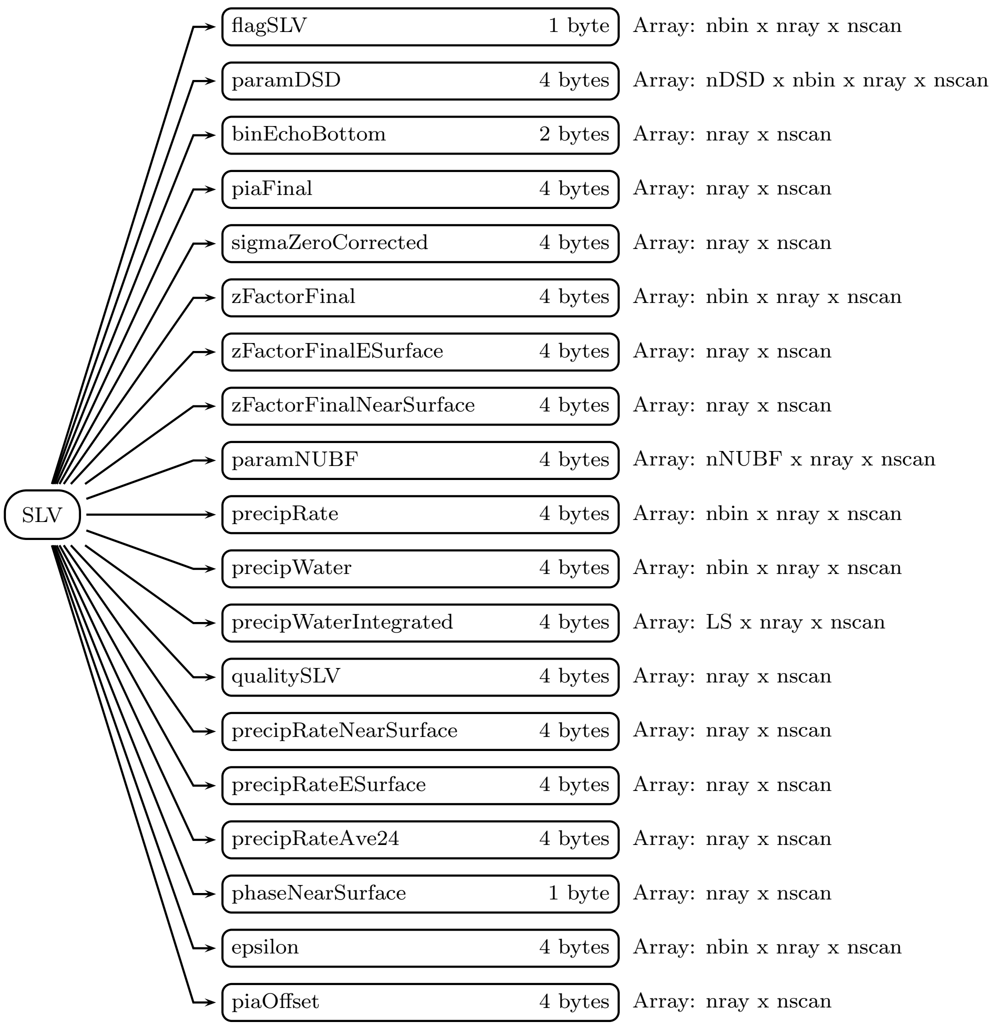


Figure 529: Data Format Structure for 2AKu, SLV

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):

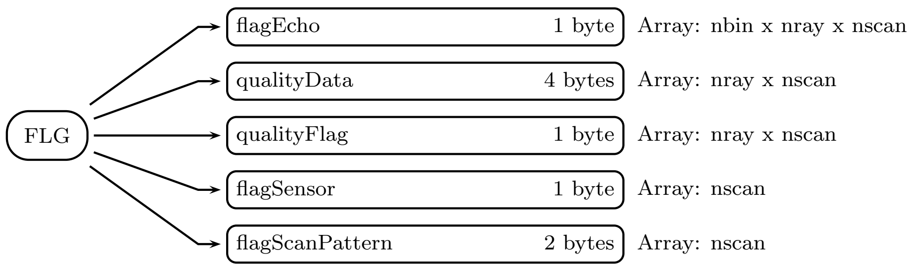


Figure 530: Data Format Structure for 2AKu, FLG

NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

FS (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate

bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
```

```
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
```

```
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction

of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the

Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0

to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group)

elevation (4-byte float, array size: nray x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nray x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nray x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nray x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
```

```
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nray x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0  : normal (under saturated level)
1  : possible saturated level at real surface
2  : saturated level at real surface
99 : missing
```

binRealSurface (2-byte integer, array size: nray x nscan):
Range bin number for real surface. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nray x nscan):
Range bin number for the storm top. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nray x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

height (4-byte float, array size: nbin x nray x nscan):
Height. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nray x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nray x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values

are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nray x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

adjustFactor (4-byte float, array size: nray x nscan):
Adjustment factor (dB) for zFactorMeasured (dBZm') and sigmaZeroMeasured (dBs0m'). dBZm' and dBs0m' are used and stored as follows:

```
dBZm' = dBZm - adjustFactor
dBs0m' = dBs0m - adjustFactor
The adjustment factor is the sum of 3 components:
base adjustment for instrument dependency,
angle-bin adjustment for angle-bin dependency, and
temporal adjustment for orbit number dependency.
```

snowIceCover (1-byte integer, array size: nray x nscan):
TBD. Special values are defined as:
-99 Missing value

binMirrorImageL2 (2-byte integer, array size: nray x nscan):
Range bin number of the mirror image.

echoCountRealSurface (1-byte char, array size: nray x nscan):
Echo count at a surface position (binRealSurface). Missing value = 0.

VER (Group)

airTemperature (4-byte float, array size: nbin x nray x nscan):
Air Temperature. Values are in K. Special values are defined as:
-9999.9 Missing value

binZeroDeg (2-byte integer, array size: nray x nscan):

```
Range bin number with 0 degrees C level.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(FS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbin x nray x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nray x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

piaNPrainFree (4-byte float, array size: nNP x nray x nscan):
TBD Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nray x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nray x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

flagInversion (2-byte integer, array size: nray x nscan):

```
TBD
```

binZeroDegSecondary (2-byte integer, array size: nray x nscan):
TBD Special values are defined as:
-9999 Missing value

CSF (Group)

flagBB (4-byte integer, array size: nray x nscan):
Bright band (BB) exists or not. The definition is different for L2 DPR on the one hand and L2 Ku and L2 Ka on the other.

```
L2 DPR:
0      no Bright Band
1      Bright Band detected by Ku and DFRm
2      Bright Band detected by Ku only
3      Bright Band detected by DFRm only
-1111  No rain value
-9999  Missing value

L2 Ku and L2 Ka:
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nray x nscan):
Range bin number for the peak of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS

swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

nHeavyIcePrecip (1-byte char, array size: nray x nscan):
TBD. Special values are defined as:
0 Missing value

heightBB (4-byte float, array size: nray x nscan):
Height of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nray x nscan):
The width of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nray x nscan):

```
Quality of the bright band.
When the bright band is detected,
a larger positive number indicates lower
```

```
confidence in the detection.

The Ku detection is clear, but
the Ka and DPR detection is
somewhat doubtful.

The meaning of qualityBB has not
been finalized.

3      Smeared bright band
2      Not so clear bright band
1      Clear bright band
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nray x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value

Let abcdefgh be the 8 digit number,

  abcdefgh

then
   a: Main rain type. (a=1,2,3),
   b: 0,
   c: 0,
   d: V rain type,
   e: H rain type,
   f: BB,
   g: Shallow rain,
   h: Small size cell.
----------------------------------------------------
The following numbers appear as Ku and Ka (MS/HS) rain types:
```

```
   ---- stratiform
   1001H100
   10031000
   ---- convective
   2001H1xy (x>0 or y>0)
   2002Hbxy
   200310xy (x>0 or y>0)
   200320xy
   ---- other
   300330xy
where H is the rain type by H-method, and b depends on BB,
x on shallow rain and y on small size cell:
  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  b = 0: BB not detected,
      1: BB detected.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
==============================================================
```

In the DPR product, rain type by the DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 8    DFRm method cannot be applicable at Part B (in this case
       the conventional method determines the major rain type)
     = 9    DFRm method cannot be applicable at Part A (in this case
       the conventional method determines the major rain type)

-1111  No rain value
```

```
-9999  Missing value

 If dual frequency data is not available
 but Ku-only or Ka-olny is available,
 rain type is expressed by the following 8 digit number:
   10xxxxxx --- stratiform,
   20xxxxxx --- convective,
   30xxxxxx --- other,
 wihch is a copy of Ku-only module or Ka-only module.

 If dual frequency data is available, rain type is
 expressed by
   1qxxxxxx --- stratiform,
   2qxxxxxx --- convective,
   3qxxxxxx --- other,
 where q>0.
 Thus, by examining q, users can understand whether
 data is processed by dual frequency algorithm or
 single frequency algorithm.
 =======================================
 For MS and HS, DFRm method is used.
 =======================================
 DFRm decision classifies rain type into
    stratiform,
    convective,
 and
    transition.
 ----------------------------------------------------------
 The DPR numbering rule can be summarized as follows:
 Let opqrstuv be the 8 digit number, then
    o: Main rain type. (o=1,2,3),
    p: DFRm rain type. (p=0,1,2,4,8,9, with p=0 for single frequency data only),
    q: DFRm BB. (q=0,1),
    r: V rain type (by conventional V-method).
       Basically r=0 for inner swath and r>0 for outer swath.
       However, r>0 when only single frequency data is available,
    s: H rain type,
    t: = 0 for innner swath,
         1 when BB is detected in the outer swath.
    u: Shallow rain,
    v: Small size cell.
 ============================
 ============================
```

```
DFRm type can be obtained by examining p
============================
The meaning of p is as follows:
 p = 0: single frequency data only (dual frequncy data not available),
     1: stratiform by DFRm method,
     2: convective by DFRm method,
     4: transition by DFRm method,
     8: DFRm decision not available,
     9: DFRm decision not available.
Note that p>0 always in DPR processing, which is different
from Ku-only or Ka-only result.
In Ku-only or Ka-only rain type numbering, p=0 always.
-----------------------------------------------------------
===============================================
The following numbers appear as DPR rain types:
===============================================
**************************
*   For FS outer swath   *
**************************
  --- stratiform
  1901H100
  19031000
  --- convective
  2901H1xy (x>0 or y>0, see R\_type\_classification\_dpr2)
  2902Hwxy
  290310xy (x>0, y>0, see R\_type\_classification\_dpr2)
  290320xy
  --- other
  390330xy

*******************************
*  For FS inner swath and MS  *
*******************************
  --- stratiform
  11B0H0xy
  14B01000
  19001000 --- H decision only
  19011000 --- MS rain >0 but no FS rain; MS V and H determine rain type
           or FS rain >0 but no MS rain; FS V and H determine rain type
  19013000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
           or FS rain >0 but no MS rain; FS V and H determine rain type
  19031000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
           or FS rain >0 but no MS rain; FS V and H determine rain type
```

```
  --- convective
  2100H0xy (x>0 or y>0)
  2110H00y (y>0)
  2200H0xy
  2210H00y
  2400H0xy
  2410H00y
  290010xy --- H decision only (x>0 or y>0)
  290020xy --- H decision only
  2901H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
            (x>0 or y>0 for H=1,3)
  2902H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  290310xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            (x>0 or y>0)
  290320xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  --- other
  340030xy
  390030xy --- H decision only
  390330xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type

**************
*   For HS   *
**************
  --- stratiform
  11B0H000
  14B01000
  19001000 --- H decision only
  --- convective
  21B0H0x0 (x>0)
  22B0H0x0
  240010x0 (x>0, 24B010x0 with B=0)
  240020x0
  241010x0 (x>0, 24B010x0 with B=1)
  290010x0 (x>0) --- H decision only
  290020x0 --- H decision only
  --- other
  340030x0
  390030x0 --- H decision only
```

```
where w depends on BB by conventional V-method, B on BB
by DFRm method, H on H-method, x on shallow rain
and y on small size cell:
  w = 0: BB not detected by conventional V-method,
      1: BB detected by conventional V-methd.

  B = 0: BB not detected by DFRm method,
      1: BB detected by DFRm methd.

  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
In the above, x>0 and y>0 are taken care of in the function
R\_type\_classification\_dpr2().
==============================================================
```

qualityTypePrecip (4-byte integer, array size: nray x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nray x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

flagHeavyIcePrecip (1-byte integer, array size: nray x nscan):
This flag denotes strong or severe precipitation accompanied by solid ice hydrometeors above the -10 degree C isotherm. Special values are defined as:
0 Missing value

flagAnvil (1-byte integer, array size: nray x nscan):

```
flagAnvil is 1 when anvil is detected by the Ku-band radar,
0 when anvil is not detected, and
-99 when the data is missing.

Note that Ka-band decision is not made because of a lower
sensitivity of Ka-band radar (therefore, there does not
exist any Ka-band flagAnvil; only Ku-band flagAnvil
is available in Ku-only and DPR FS).
```

SRT (Group)

pathAtten (4-byte float, array size: nray x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAalt (4-byte float, array size: method x nray x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhb (4-byte float, array size: nray x nscan):
The 2-way attenuation of HB.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhybrid (4-byte float, array size: nray x nscan):
The 2-way attenuation from a weighted combination of HB and SRT.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweightHY (4-byte float, array size: two x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nray x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

reliabFactor (4-byte float, array size: nray x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nray x nscan):
The reliability factors associated with the individual PIA estimates corresponding to

PIAalt. Special values are defined as:
-9999.9 Missing value

reliabFactorHY (4-byte float, array size: nray x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nray x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff $>$ 3 ; PIAeff estimate is considered reliable
= 2 if 3 $\geq$ Rel_eff $>$ 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff $\leq$ 1 ; PIAeff is unreliable
= 4 if SNR_at surface $<$ 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

reliabFlagHY (2-byte integer, array size: nray x nscan):
TBD.

Special values are defined as:
-9999 Missing value

stddevEff (4-byte float, array size: nsdew x nray x nscan):
The effective standard deviation of PIA-SRT computed 3 ways.

Special values are defined as:
-9999.9 Missing value

stddevHY (4-byte float, array size: nray x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

zeta (4-byte float, array size: nray x nscan):
The term in the HB estimate of path attenuation.

Special values are defined as:
-9999.9 Missing value

DSD (Group)

phase (1-byte char, array size: nbin x nray x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                       the top and peak of bright band
phase = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nray x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For FS and MS swaths,
bin numbers are 1-based ranging
```

```
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

paramRDm (4-byte float, array size: nNode x nray x nscan):
TBD Special values are defined as:
-9999.9 Missing value

Experimental (Group)

precipRateESurface2 (4-byte float, array size: nray x nscan):
Estimates Surface Precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nray x nscan):
Status of the estimated surface precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZP x nray x nscan):
Surface backscattering cross section profile around the current ifov. For information on this experimental field contact the Joint DPR Team. Values are in dB. Special values are defined as:
-9999.9 Missing value

seaIceConcentration (4-byte float, array size: nray x nscan):
Sea ice concentration estimated by Ku. For information on this experimental field contact the Joint DPR Team. Values range from 30 to 100 percent. Special values are defined as:
-9999.9 Missing value

SLV (Group)

flagSLV (1-byte integer, array size: nbin x nray x nscan):
Special values are defined as:
-99 Missing value

paramDSD (4-byte float, array size: nDSD x nbin x nray x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

binEchoBottom (2-byte integer, array size: nray x nscan):
For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nray x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nray x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorFinal (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramNUBF (4-byte float, array size: nNUBF x nray x nscan):
TBD. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbin x nray x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWater (4-byte float, array size: nbin x nray x nscan):
The amount of precipitable water. Values are in kg/m^3. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nray x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined

as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nray x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nray x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nray x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nray x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nray x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbin x nray x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

piaOffset (4-byte float, array size: nray x nscan):
TBD. Values are in dB. Special values are defined as:
-9999.9 Missing value

FLG (Group)

flagEcho (1-byte integer, array size: nbin x nray x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nray x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
```

```
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

qualityFlag (1-byte integer, array size: nray x nscan):
Flag derived from qualityData with the following values: Special values are defined as:
-99 Missing value

```
Value    Meaning
0        High quality.  No issues.
1        Low quality (DPR modules had warnings but still made a retrieval)
2        Bad (DPR modules had errors or dataQuality is bad and
         retrieval is missing)
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

flagScanPattern (2-byte integer, array size: nscan):

```
Flag of scan pattern.

Value  Meaning
1      TBD
-99    Missing
```

C Structure Header file:

```
#ifndef _TK_2AKu_H_
#define _TK_2AKu_H_
```

```
#ifndef _L2AKu_FLG_
#define _L2AKu_FLG_

typedef struct {
    signed char flagEcho[49][176];
    int qualityData[49];
    signed char qualityFlag[49];
    signed char flagSensor;
    short flagScanPattern;
} L2AKu_FLG;

#endif

#ifndef _L2AKu_SLV_
#define _L2AKu_SLV_

typedef struct {
    signed char flagSLV[49][176];
    float paramDSD[49][176][2];
    short binEchoBottom[49];
    float piaFinal[49];
    float sigmaZeroCorrected[49];
    float zFactorFinal[49][176];
    float zFactorFinalESurface[49];
    float zFactorFinalNearSurface[49];
    float paramNUBF[49][3];
    float precipRate[49][176];
    float precipWater[49][176];
    float precipWaterIntegrated[49][2];
    int qualitySLV[49];
    float precipRateNearSurface[49];
    float precipRateESurface[49];
    float precipRateAve24[49];
    unsigned char phaseNearSurface[49];
    float epsilon[49][176];
    float piaOffset[49];
} L2AKu_SLV;

#endif

#ifndef _L2AKu_EXPERIMENTAL_
#define _L2AKu_EXPERIMENTAL_
```

```
typedef struct {
    float precipRateESurface2[49];
    unsigned char precipRateESurface2Status[49];
    float sigmaZeroProfile[49][7];
    float seaIceConcentration[49];
} L2AKu_EXPERIMENTAL;

#endif

#ifndef _L2AKu_DSD_
#define _L2AKu_DSD_

typedef struct {
    unsigned char phase[49][176];
    short binNode[49][5];
    float paramRDm[49][5];
} L2AKu_DSD;

#endif

#ifndef _L2AKu_SRT_
#define _L2AKu_SRT_

typedef struct {
    float pathAtten[49];
    float PIAalt[49][6];
    float PIAhb[49];
    float PIAhybrid[49];
    float PIAweight[49][6];
    float PIAweightHY[49][2];
    short refScanID[49][2][2];
    float reliabFactor[49];
    float RFactorAlt[49][6];
    float reliabFactorHY[49];
    short reliabFlag[49];
    short reliabFlagHY[49];
    float stddevEff[49][3];
    float stddevHY[49];
    float zeta[49];
} L2AKu_SRT;

#endif
```

```
#ifndef _L2AKu_CSF_
#define _L2AKu_CSF_

typedef struct {
    int flagBB[49];
    short binBBPeak[49];
    short binBBTop[49];
    short binBBBottom[49];
    short binHeavyIcePrecipTop[49];
    short binHeavyIcePrecipBottom[49];
    unsigned char nHeavyIcePrecip[49];
    float heightBB[49];
    float widthBB[49];
    int qualityBB[49];
    int typePrecip[49];
    int qualityTypePrecip[49];
    int flagShallowRain[49];
    signed char flagHeavyIcePrecip[49];
    signed char flagAnvil[49];
} L2AKu_CSF;

#endif

#ifndef _L2AKu_VER_
#define _L2AKu_VER_

typedef struct {
    float airTemperature[49][176];
    short binZeroDeg[49];
    float attenuationNP[49][176];
    float piaNP[49][4];
    float piaNPrainFree[49][4];
    float sigmaZeroNPCorrected[49];
    float heightZeroDeg[49];
    short flagInversion[49];
    short binZeroDegSecondary[49];
} L2AKu_VER;

#endif

#ifndef _L2AKu_PRE_
#define _L2AKu_PRE_
```

```
typedef struct {
    float elevation[49];
    int landSurfaceType[49];
    float localZenithAngle[49];
    int flagPrecip[49];
    unsigned char flagSigmaZeroSaturation[49];
    short binRealSurface[49];
    short binStormTop[49];
    float heightStormTop[49];
    float height[49][176];
    short binClutterFreeBottom[49];
    float sigmaZeroMeasured[49];
    float zFactorMeasured[49][176];
    float ellipsoidBinOffset[49];
    float snRatioAtRealSurface[49];
    float adjustFactor[49];
    signed char snowIceCover[49];
    short binMirrorImageL2[49];
    unsigned char echoCountRealSurface[49];
} L2AKu_PRE;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
```

```
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2AKu_SCANSTATUS_
#define _L2AKu_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2AKu_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif
```

```
#ifndef _L2AKu_FS_
#define _L2AKu_FS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float sunLocalTime[49];
    L2AKu_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2AKu_PRE PRE;
    L2AKu_VER VER;
    L2AKu_CSF CSF;
    L2AKu_SRT SRT;
    L2AKu_DSD DSD;
    L2AKu_EXPERIMENTAL Experimental;
    L2AKu_SLV SLV;
    L2AKu_FLG FLG;
} L2AKu_FS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2AKu_FLG/
    BYTE flagEcho(176,49)
    INTEGER*4 qualityData(49)
    BYTE qualityFlag(49)
    BYTE flagSensor
    INTEGER*2 flagScanPattern
END STRUCTURE

STRUCTURE /L2AKu_SLV/
    BYTE flagSLV(176,49)
    REAL*4 paramDSD(2,176,49)
    INTEGER*2 binEchoBottom(49)
    REAL*4 piaFinal(49)
    REAL*4 sigmaZeroCorrected(49)
    REAL*4 zFactorFinal(176,49)
    REAL*4 zFactorFinalESurface(49)
```

```
    REAL*4 zFactorFinalNearSurface(49)
    REAL*4 paramNUBF(3,49)
    REAL*4 precipRate(176,49)
    REAL*4 precipWater(176,49)
    REAL*4 precipWaterIntegrated(2,49)
    INTEGER*4 qualitySLV(49)
    REAL*4 precipRateNearSurface(49)
    REAL*4 precipRateESurface(49)
    REAL*4 precipRateAve24(49)
    CHARACTER phaseNearSurface(49)
    REAL*4 epsilon(176,49)
    REAL*4 piaOffset(49)
END STRUCTURE

STRUCTURE /L2AKu_EXPERIMENTAL/
    REAL*4 precipRateESurface2(49)
    CHARACTER precipRateESurface2Status(49)
    REAL*4 sigmaZeroProfile(7,49)
    REAL*4 seaIceConcentration(49)
END STRUCTURE

STRUCTURE /L2AKu_DSD/
    CHARACTER phase(176,49)
    INTEGER*2 binNode(5,49)
    REAL*4 paramRDm(5,49)
END STRUCTURE

STRUCTURE /L2AKu_SRT/
    REAL*4 pathAtten(49)
    REAL*4 PIAalt(6,49)
    REAL*4 PIAhb(49)
    REAL*4 PIAhybrid(49)
    REAL*4 PIAweight(6,49)
    REAL*4 PIAweightHY(2,49)
    INTEGER*2 refScanID(2,2,49)
    REAL*4 reliabFactor(49)
    REAL*4 RFactorAlt(6,49)
    REAL*4 reliabFactorHY(49)
    INTEGER*2 reliabFlag(49)
    INTEGER*2 reliabFlagHY(49)
    REAL*4 stddevEff(3,49)
    REAL*4 stddevHY(49)
    REAL*4 zeta(49)
```

```
END STRUCTURE

STRUCTURE /L2AKu_CSF/
    INTEGER*4 flagBB(49)
    INTEGER*2 binBBPeak(49)
    INTEGER*2 binBBTop(49)
    INTEGER*2 binBBBottom(49)
    INTEGER*2 binHeavyIcePrecipTop(49)
    INTEGER*2 binHeavyIcePrecipBottom(49)
    CHARACTER nHeavyIcePrecip(49)
    REAL*4 heightBB(49)
    REAL*4 widthBB(49)
    INTEGER*4 qualityBB(49)
    INTEGER*4 typePrecip(49)
    INTEGER*4 qualityTypePrecip(49)
    INTEGER*4 flagShallowRain(49)
    BYTE flagHeavyIcePrecip(49)
    BYTE flagAnvil(49)
END STRUCTURE

STRUCTURE /L2AKu_VER/
    REAL*4 airTemperature(176,49)
    INTEGER*2 binZeroDeg(49)
    REAL*4 attenuationNP(176,49)
    REAL*4 piaNP(4,49)
    REAL*4 piaNPrainFree(4,49)
    REAL*4 sigmaZeroNPCorrected(49)
    REAL*4 heightZeroDeg(49)
    INTEGER*2 flagInversion(49)
    INTEGER*2 binZeroDegSecondary(49)
END STRUCTURE

STRUCTURE /L2AKu_PRE/
    REAL*4 elevation(49)
    INTEGER*4 landSurfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 flagPrecip(49)
    CHARACTER flagSigmaZeroSaturation(49)
    INTEGER*2 binRealSurface(49)
    INTEGER*2 binStormTop(49)
    REAL*4 heightStormTop(49)
    REAL*4 height(176,49)
    INTEGER*2 binClutterFreeBottom(49)
```

```
    REAL*4 sigmaZeroMeasured(49)
    REAL*4 zFactorMeasured(176,49)
    REAL*4 ellipsoidBinOffset(49)
    REAL*4 snRatioAtRealSurface(49)
    REAL*4 adjustFactor(49)
    BYTE snowIceCover(49)
    INTEGER*2 binMirrorImageL2(49)
    CHARACTER echoCountRealSurface(49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2AKu_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
```

```
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AKu_FS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    RECORD /L2AKu_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2AKu_PRE/ PRE
    RECORD /L2AKu_VER/ VER
    RECORD /L2AKu_CSF/ CSF
    RECORD /L2AKu_SRT/ SRT
    RECORD /L2AKu_DSD/ DSD
    RECORD /L2AKu_EXPERIMENTAL/ Experimental
    RECORD /L2AKu_SLV/ SLV
    RECORD /L2AKu_FLG/ FLG
END STRUCTURE
```

5.47 2AKa - Ka precipitation

The Ka Level-2A product, 2AKa, "Ka precipitation," is written as a 2 swath structure. The swaths are FS, full scans, and HS, high sensitivity scans. The following sections describe the structure and contents of the format.

Dimension definitions:

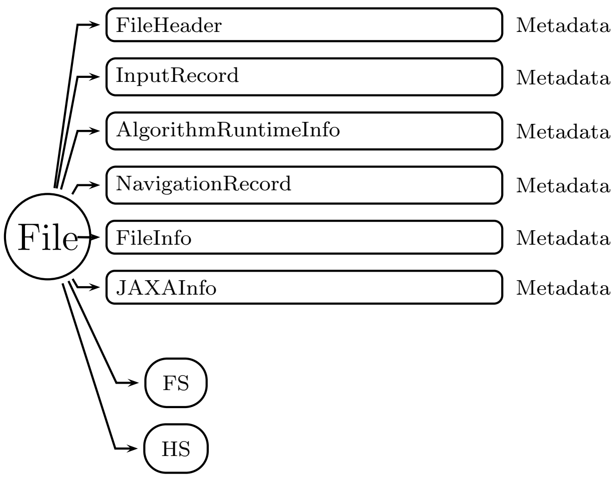


Figure 531: Data Format Structure for 2AKa, Ka precipitation

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each FS scan.
nrayHS	24	Number of angle bins in each HS scan.
nbin	176	Number of range bins in each FS ray. Bin interval is 125 m. 0 is at the top. 175 is the bin of the earth ellipsoid.
nbinHS	88	Number of range bins in each HS ray. Bin interval is 250 m. 0 is at the top. 87 is the bin of the earth ellipsoid.
nbinSZP	7	Number of range bins for sigmaZeroProfile.
nbinSZPHS	5	Number of range bins for sigmaZeroProfile in each HS scan.
nNP	4	Number of NP kinds.
nearFar	2	Near reference, Far reference.
foreBack	2	Foreward, Backward.
method	6	Number of SRT methods.
nsdew	3	Number of standard deviation effective ways.
nNode	5	Number of binNode.
nDSD	2	Number of DSD parameters. Parameters are dBNw and Dm (mm).
LS	2	Liquid, solid.
nNUBF	3	Number of NUBF parameters.
two	2	Two.
three	3	Number 3.

Figure 531 through Figure 555 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

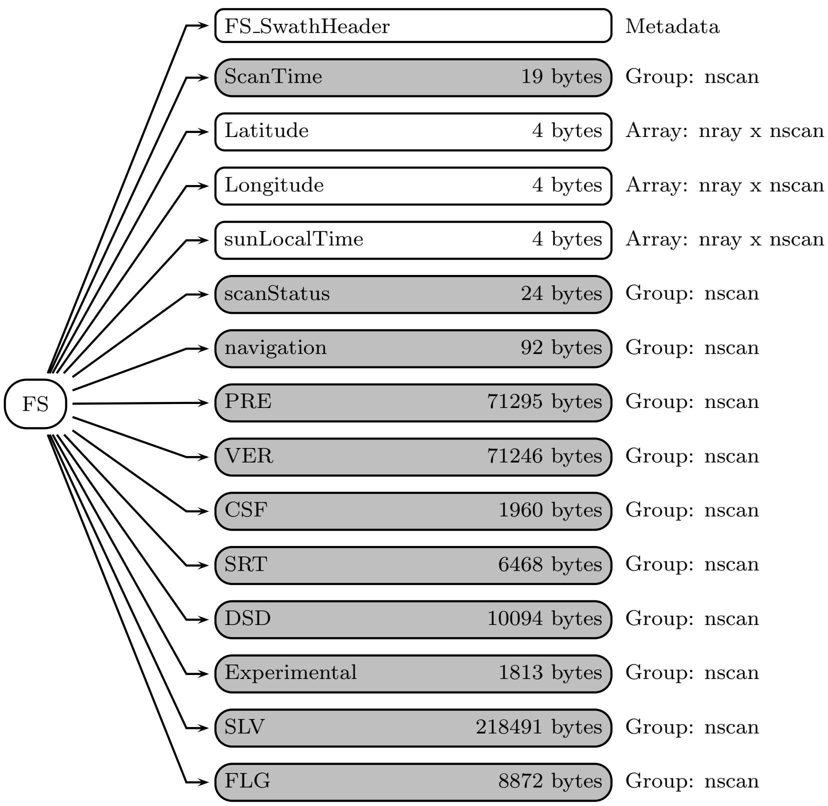


Figure 532: Data Format Structure for 2AKa, FS

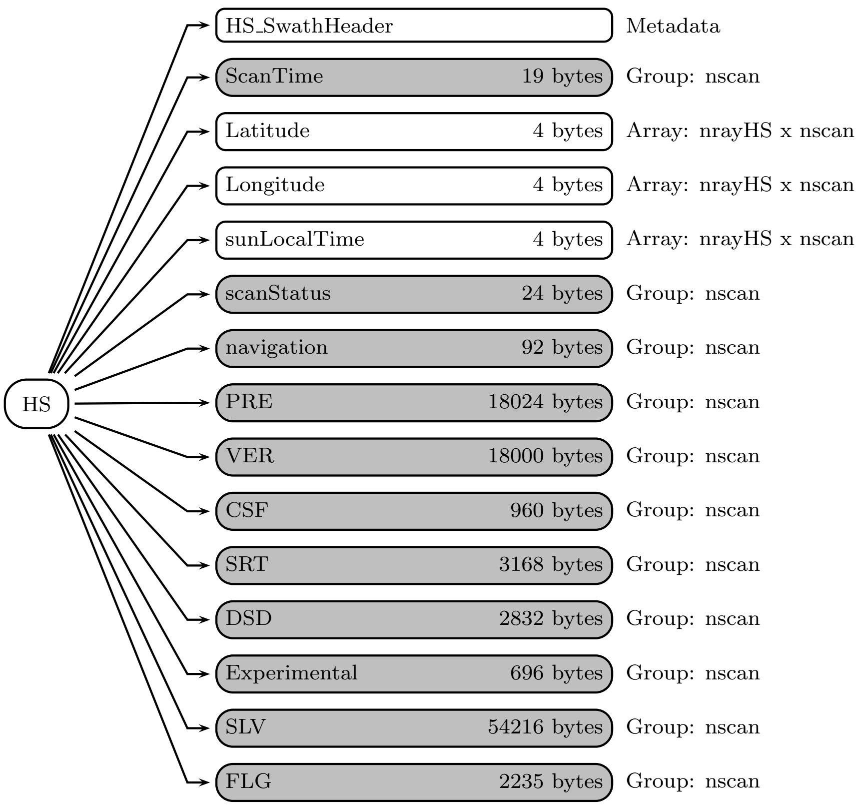


Figure 533: Data Format Structure for 2AKa, HS

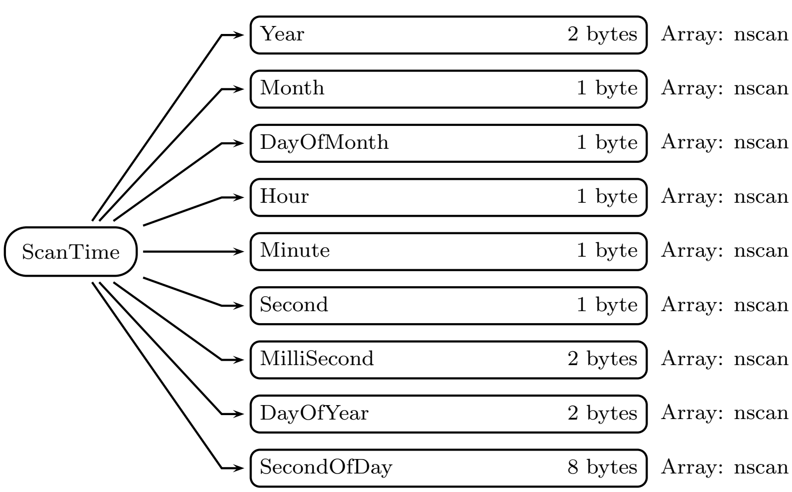


Figure 534: Data Format Structure for 2AKa, FS, ScanTime

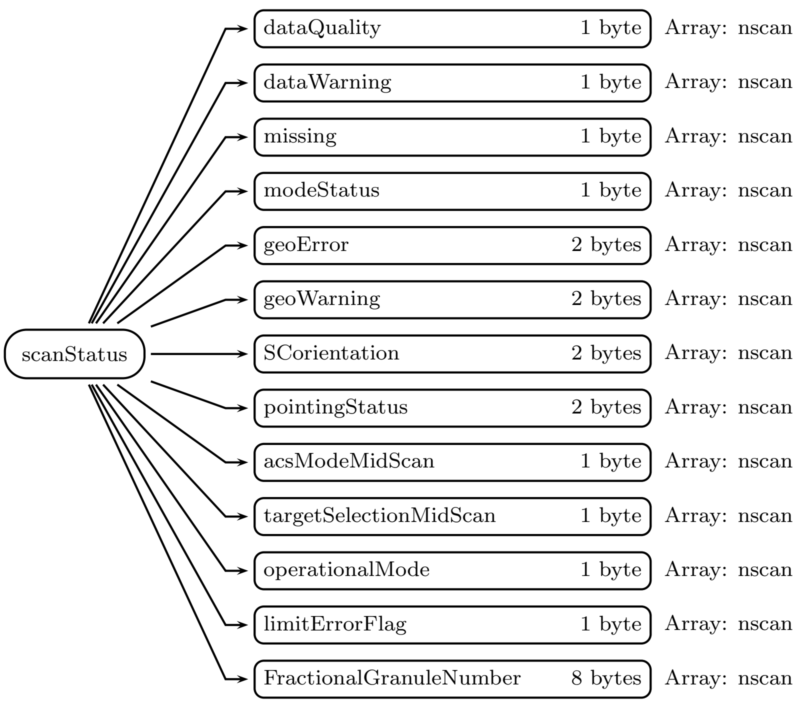


Figure 535: Data Format Structure for 2AKa, FS, scanStatus

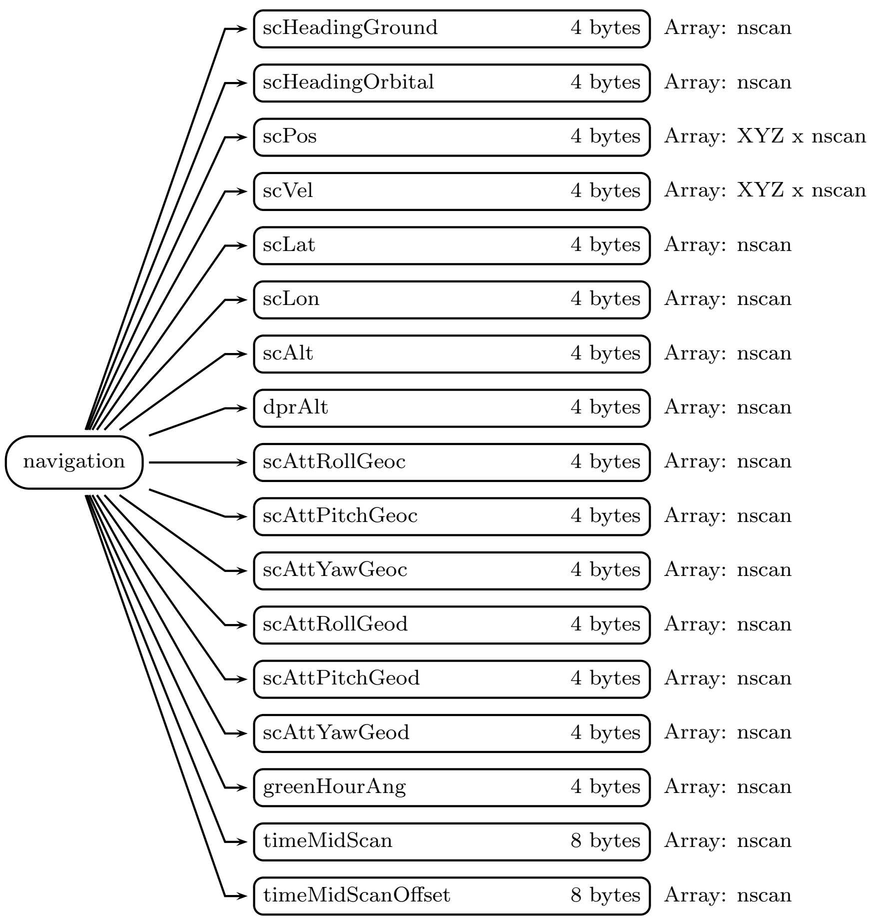


Figure 536: Data Format Structure for 2AKa, FS, navigation

PRE

elevation	4 bytes	Array: nray x nscan
landSurfaceType	4 bytes	Array: nray x nscan
localZenithAngle	4 bytes	Array: nray x nscan
flagPrecip	4 bytes	Array: nray x nscan
flagSigmaZeroSaturation	1 byte	Array: nray x nscan
binRealSurface	2 bytes	Array: nray x nscan
binStormTop	2 bytes	Array: nray x nscan
heightStormTop	4 bytes	Array: nray x nscan
height	4 bytes	Array: nbin x nray x nscan
binClutterFreeBottom	2 bytes	Array: nray x nscan
sigmaZeroMeasured	4 bytes	Array: nray x nscan
zFactorMeasured	4 bytes	Array: nbin x nray x nscan
ellipsoidBinOffset	4 bytes	Array: nray x nscan
snRatioAtRealSurface	4 bytes	Array: nray x nscan
adjustFactor	4 bytes	Array: nray x nscan
snowIceCover	1 byte	Array: nray x nscan
binMirrorImageL2	2 bytes	Array: nray x nscan
echoCountRealSurface	1 byte	Array: nray x nscan

Figure 537: Data Format Structure for 2AKa, FS, PRE

VER

airTemperature	4 bytes	Array: nbin x nray x nscan
binZeroDeg	2 bytes	Array: nray x nscan
attenuationNP	4 bytes	Array: nbin x nray x nscan
piaNP	4 bytes	Array: nNP x nray x nscan
piaNPrainFree	4 bytes	Array: nNP x nray x nscan
sigmaZeroNPCorrected	4 bytes	Array: nray x nscan
heightZeroDeg	4 bytes	Array: nray x nscan
flagInversion	2 bytes	Array: nray x nscan
binZeroDegSecondary	2 bytes	Array: nray x nscan

Figure 538: Data Format Structure for 2AKa, FS, VER

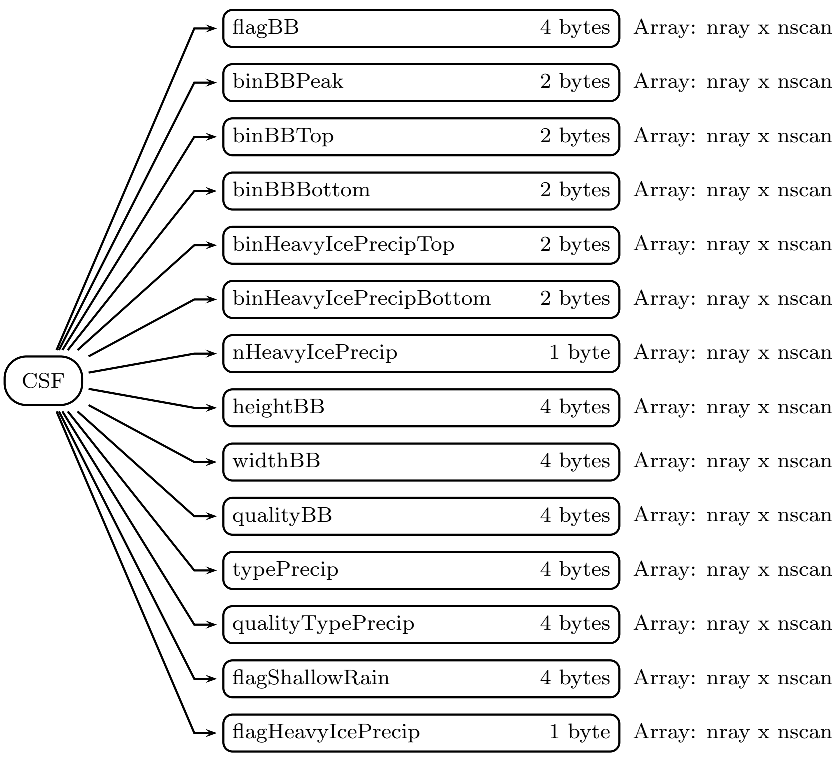


Figure 539: Data Format Structure for 2AKa, FS, CSF

SRT

pathAtten	4 bytes	Array: nray x nscan
PIAalt	4 bytes	Array: method x nray x nscan
PIAhb	4 bytes	Array: nray x nscan
PIAhybrid	4 bytes	Array: nray x nscan
PIAweight	4 bytes	Array: method x nray x nscan
PIAweightHY	4 bytes	Array: two x nray x nscan
refScanID	2 bytes	Array: nearFar x foreBack x nray x nscan
reliabFactor	4 bytes	Array: nray x nscan
RFactorAlt	4 bytes	Array: method x nray x nscan
reliabFactorHY	4 bytes	Array: nray x nscan
reliabFlag	2 bytes	Array: nray x nscan
reliabFlagHY	2 bytes	Array: nray x nscan
stddevEff	4 bytes	Array: nsdew x nray x nscan
stddevHY	4 bytes	Array: nray x nscan
zeta	4 bytes	Array: nray x nscan

Figure 540: Data Format Structure for 2AKa, FS, SRT

DSD

phase	1 byte	Array: nbin x nray x nscan
binNode	2 bytes	Array: nNode x nray x nscan
paramRDm	4 bytes	Array: nNode x nray x nscan

Figure 541: Data Format Structure for 2AKa, FS, DSD

Experimental

precipRateESurface2	4 bytes	Array: nray x nscan
precipRateESurface2Status	1 byte	Array: nray x nscan
sigmaZeroProfile	4 bytes	Array: nbinSZP x nray x nscan
seaIceConcentration	4 bytes	Array: nray x nscan

Figure 542: Data Format Structure for 2AKa, FS, Experimental

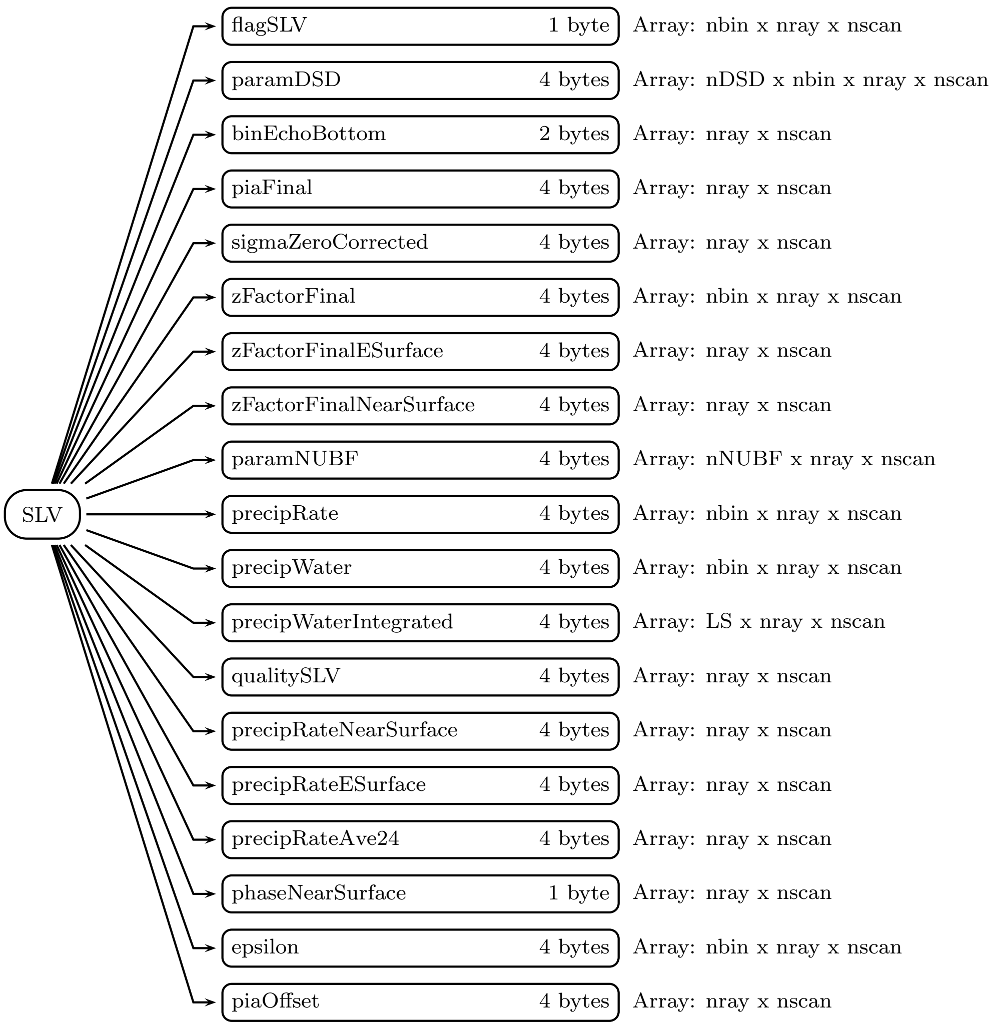


Figure 543: Data Format Structure for 2AKa, FS, SLV

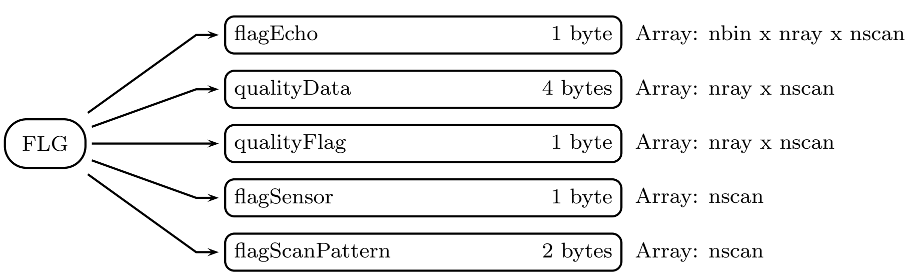


Figure 544: Data Format Structure for 2AKa, FS, FLG

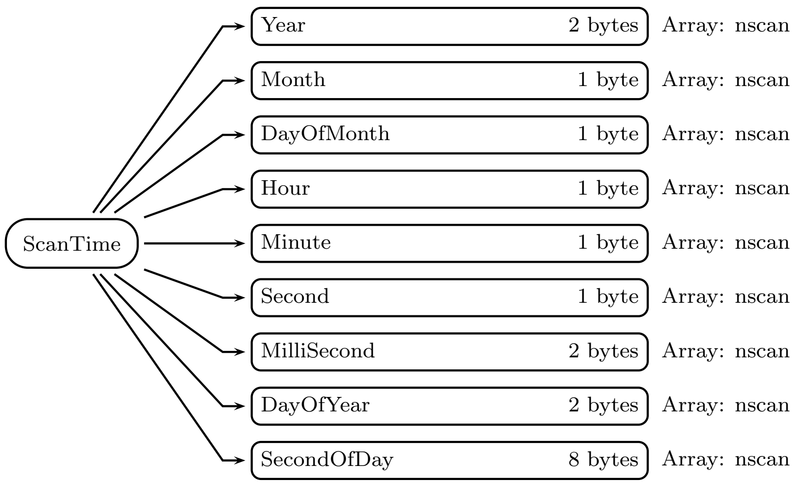


Figure 545: Data Format Structure for 2AKa, HS, ScanTime

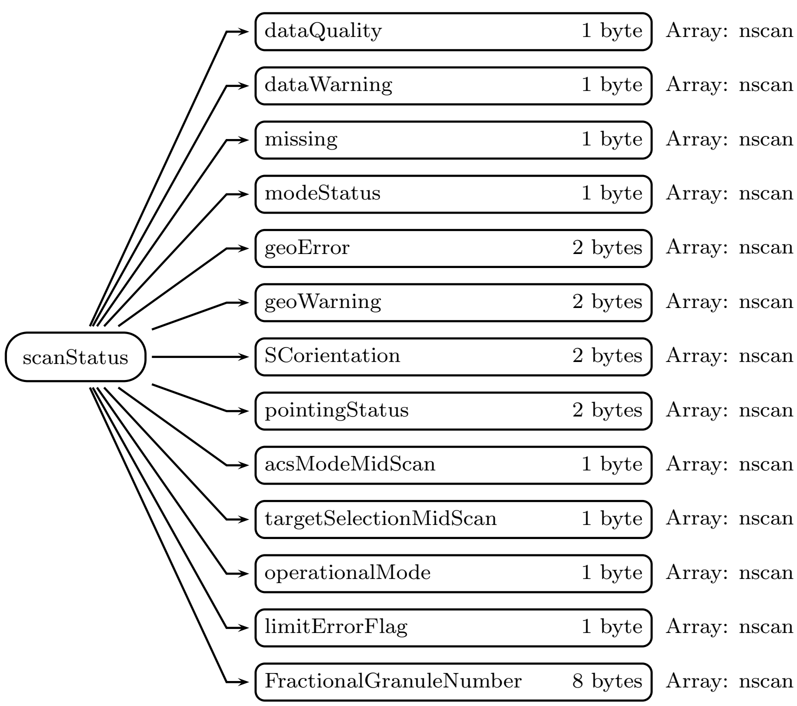


Figure 546: Data Format Structure for 2AKa, HS, scanStatus

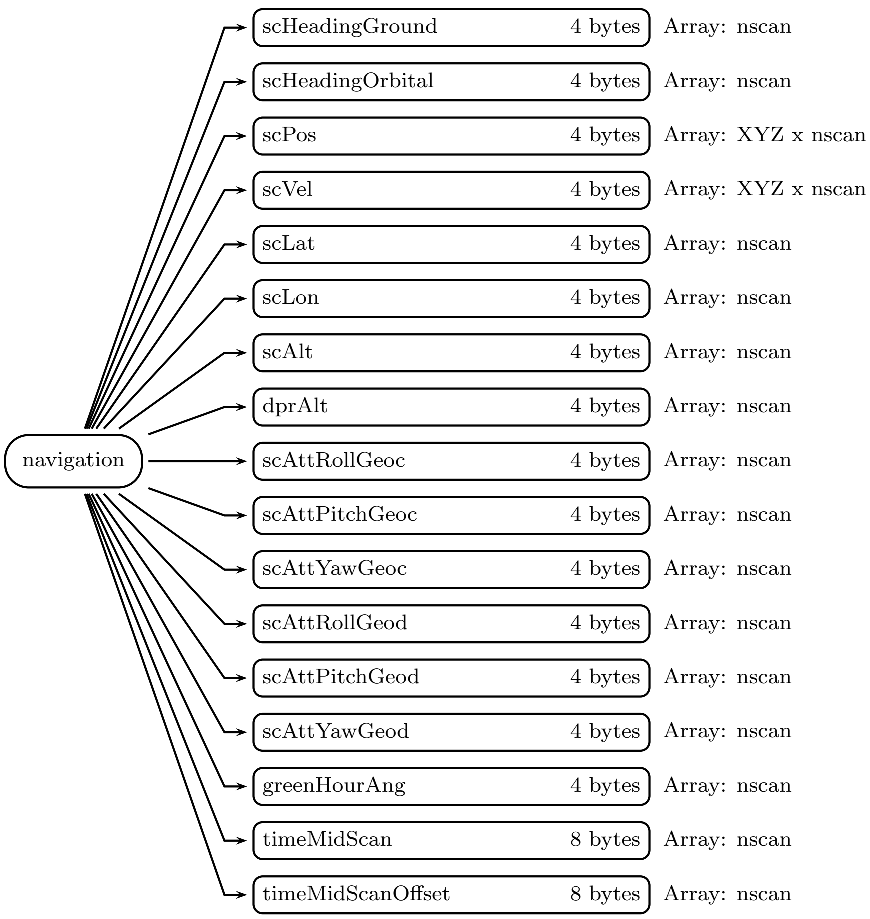


Figure 547: Data Format Structure for 2AKa, HS, navigation

PRE

elevation	4 bytes	Array: nrayHS x nscan
landSurfaceType	4 bytes	Array: nrayHS x nscan
localZenithAngle	4 bytes	Array: nrayHS x nscan
flagPrecip	4 bytes	Array: nrayHS x nscan
flagSigmaZeroSaturation	1 byte	Array: nrayHS x nscan
binRealSurface	2 bytes	Array: nrayHS x nscan
binStormTop	2 bytes	Array: nrayHS x nscan
heightStormTop	4 bytes	Array: nrayHS x nscan
height	4 bytes	Array: nbinHS x nrayHS x nscan
binClutterFreeBottom	2 bytes	Array: nrayHS x nscan
sigmaZeroMeasured	4 bytes	Array: nrayHS x nscan
zFactorMeasured	4 bytes	Array: nbinHS x nrayHS x nscan
ellipsoidBinOffset	4 bytes	Array: nrayHS x nscan
snRatioAtRealSurface	4 bytes	Array: nrayHS x nscan
adjustFactor	4 bytes	Array: nrayHS x nscan
snowIceCover	1 byte	Array: nrayHS x nscan
binMirrorImageL2	2 bytes	Array: nrayHS x nscan
echoCountRealSurface	1 byte	Array: nrayHS x nscan

Figure 548: Data Format Structure for 2AKa, HS, PRE

VER

airTemperature	4 bytes	Array: nbinHS x nrayHS x nscan
binZeroDeg	2 bytes	Array: nrayHS x nscan
attenuationNP	4 bytes	Array: nbinHS x nrayHS x nscan
piaNP	4 bytes	Array: nNP x nrayHS x nscan
piaNPrainFree	4 bytes	Array: nNP x nrayHS x nscan
sigmaZeroNPCorrected	4 bytes	Array: nrayHS x nscan
heightZeroDeg	4 bytes	Array: nrayHS x nscan
flagInversion	2 bytes	Array: nrayHS x nscan
binZeroDegSecondary	2 bytes	Array: nrayHS x nscan

Figure 549: Data Format Structure for 2AKa, HS, VER

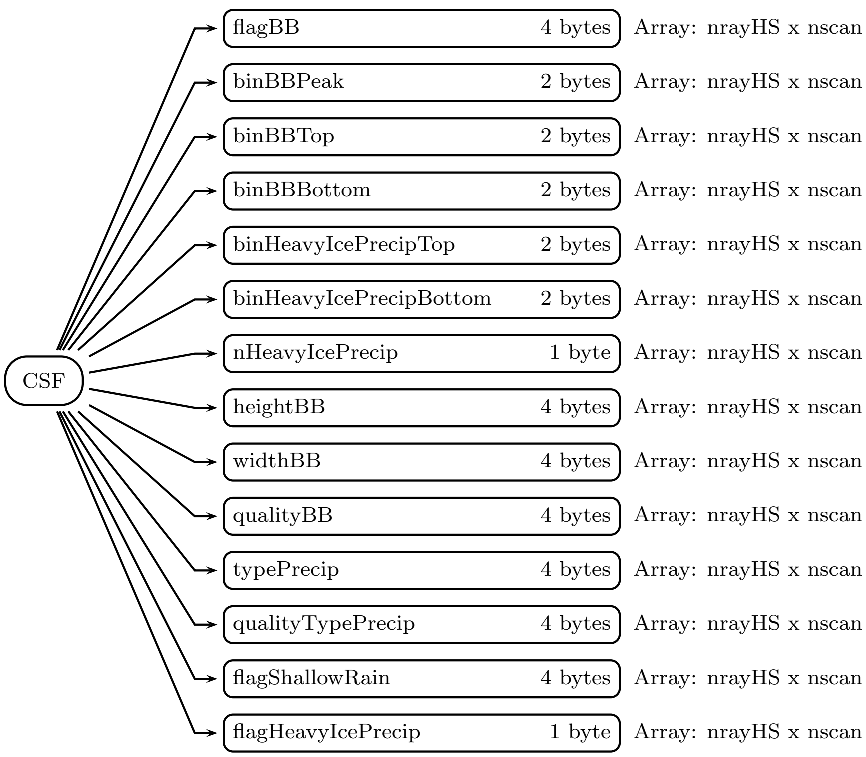


Figure 550: Data Format Structure for 2AKa, HS, CSF

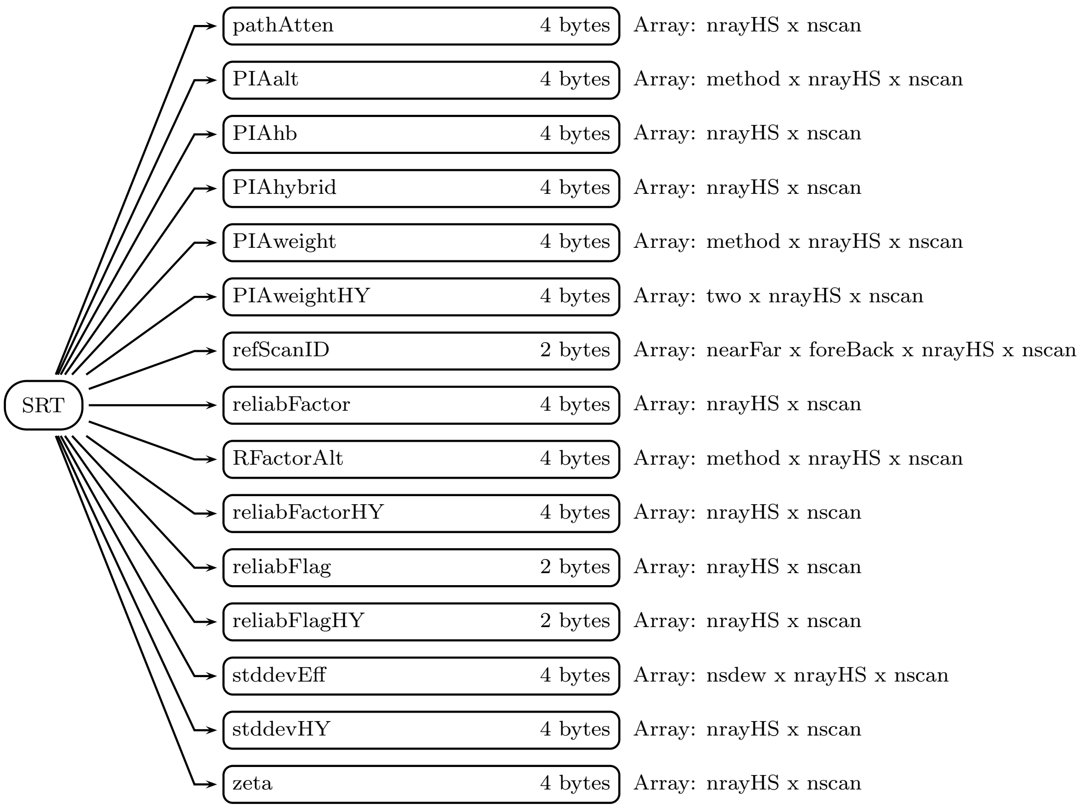


Figure 551: Data Format Structure for 2AKa, HS, SRT

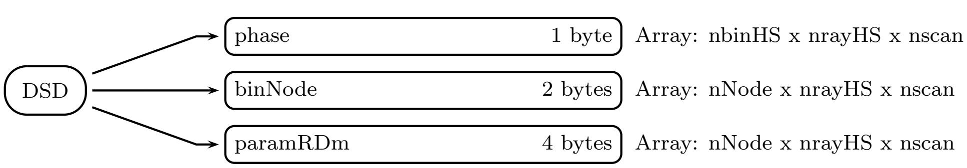


Figure 552: Data Format Structure for 2AKa, HS, DSD

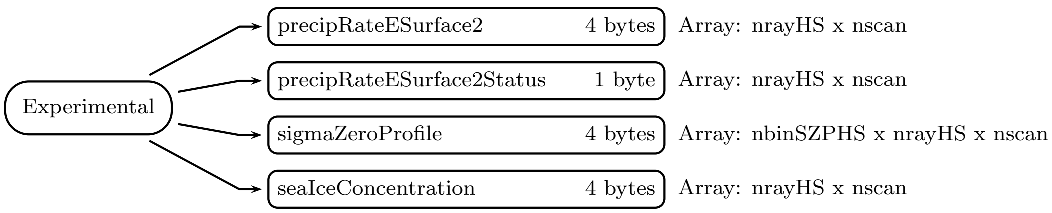


Figure 553: Data Format Structure for 2AKa, HS, Experimental

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

FS (Swath)

FS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in FS)

A UTC time associated with the scan.

SLV

flagSLV	1 byte	Array: nbinHS x nrayHS x nscan
paramDSD	4 bytes	Array: nDSD x nbinHS x nrayHS x nscan
binEchoBottom	2 bytes	Array: nrayHS x nscan
piaFinal	4 bytes	Array: nrayHS x nscan
sigmaZeroCorrected	4 bytes	Array: nrayHS x nscan
zFactorFinal	4 bytes	Array: nbinHS x nrayHS x nscan
zFactorFinalESurface	4 bytes	Array: nrayHS x nscan
zFactorFinalNearSurface	4 bytes	Array: nrayHS x nscan
paramNUBF	4 bytes	Array: nNUBF x nrayHS x nscan
precipRate	4 bytes	Array: nbinHS x nrayHS x nscan
precipWater	4 bytes	Array: nbinHS x nrayHS x nscan
precipWaterIntegrated	4 bytes	Array: LS x nrayHS x nscan
qualitySLV	4 bytes	Array: nrayHS x nscan
precipRateNearSurface	4 bytes	Array: nrayHS x nscan
precipRateESurface	4 bytes	Array: nrayHS x nscan
precipRateAve24	4 bytes	Array: nrayHS x nscan
phaseNearSurface	1 byte	Array: nrayHS x nscan
epsilon	4 bytes	Array: nbinHS x nrayHS x nscan
piaOffset	4 bytes	Array: nrayHS x nscan

Figure 554: Data Format Structure for 2AKa, HS, SLV

FLG

flagEcho	1 byte	Array: nbinHS x nrayHS x nscan
qualityData	4 bytes	Array: nrayHS x nscan
qualityFlag	1 byte	Array: nrayHS x nscan
flagSensor	1 byte	Array: nscan
flagScanPattern	2 bytes	Array: nscan

Figure 555: Data Format Structure for 2AKa, HS, FLG

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in FS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
```

```
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
```

```
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in FS)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed

using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coor-

dinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group in FS)

elevation (4-byte float, array size: nray x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nray x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nray x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nray x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
```

```
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nray x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0  : normal (under saturated level)
1  : possible saturated level at real surface
2  : saturated level at real surface
99 : missing
```

binRealSurface (2-byte integer, array size: nray x nscan):
Range bin number for real surface. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nray x nscan):
Range bin number for the storm top. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nray x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

height (4-byte float, array size: nbin x nray x nscan):
Height. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nray x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nray x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nray x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

adjustFactor (4-byte float, array size: nray x nscan):
Adjustment factor (dB) for zFactorMeasured (dBZm') and sigmaZeroMeasured (dBs0m'). dBZm' and dBs0m' are used and stored as follows:

```
dBZm' = dBZm - adjustFactor
dBs0m' = dBs0m - adjustFactor
The adjustment factor is the sum of 3 components:
base adjustment for instrument dependency,
angle-bin adjustment for angle-bin dependency, and
temporal adjustment for orbit number dependency.
```

snowIceCover (1-byte integer, array size: nray x nscan):
TBD. Special values are defined as:
-99 Missing value

binMirrorImageL2 (2-byte integer, array size: nray x nscan):
Range bin number of the mirror image.

echoCountRealSurface (1-byte char, array size: nray x nscan):
Echo count at a surface position (binRealSurface). Missing value = 0.

VER (Group in FS)

airTemperature (4-byte float, array size: nbin x nray x nscan):
Air Temperature. Values are in K. Special values are defined as:
-9999.9 Missing value

binZeroDeg (2-byte integer, array size: nray x nscan):

```
Range bin number with 0 degrees C level.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(FS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbin x nray x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nray x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

piaNPrainFree (4-byte float, array size: nNP x nray x nscan):
TBD Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nray x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nray x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

flagInversion (2-byte integer, array size: nray x nscan):

```
TBD
```

binZeroDegSecondary (2-byte integer, array size: nray x nscan):
TBD Special values are defined as:
-9999 Missing value

CSF (Group in FS)

flagBB (4-byte integer, array size: nray x nscan):
Bright band (BB) exists or not. The definition is different for L2 DPR on the one hand and L2 Ku and L2 Ka on the other.

```
L2 DPR:
0      no Bright Band
1      Bright Band detected by Ku and DFRm
2      Bright Band detected by Ku only
3      Bright Band detected by DFRm only
-1111  No rain value
-9999  Missing value

L2 Ku and L2 Ka:
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nray x nscan):
Range bin number for the peak of bright band. For FS and MS swaths, bin numbers are

1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

nHeavyIcePrecip (1-byte char, array size: nray x nscan):
TBD. Special values are defined as:
0 Missing value

heightBB (4-byte float, array size: nray x nscan):
Height of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nray x nscan):
The width of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nray x nscan):

```
Quality of the bright band.
When the bright band is detected,
a larger positive number indicates lower
confidence in the detection.

The Ku detection is clear, but
the Ka and DPR detection is
somewhat doubtful.

The meaning of qualityBB has not
been finalized.

3      Smeared bright band
2      Not so clear bright band
1      Clear bright band
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nray x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value

Let abcdefgh be the 8 digit number,

  abcdefgh

then
```

```
   a: Main rain type. (a=1,2,3),
   b: 0,
   c: 0,
   d: V rain type,
   e: H rain type,
   f: BB,
   g: Shallow rain,
   h: Small size cell.
----------------------------------------------------
The following numbers appear as Ku and Ka (MS/HS) rain types:
   ---- stratiform
   1001H100
   10031000
   ---- convective
   2001H1xy (x>0 or y>0)
   2002Hbxy
   200310xy (x>0 or y>0)
   200320xy
   ---- other
   300330xy
where H is the rain type by H-method, and b depends on BB,
x on shallow rain and y on small size cell:
  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  b = 0: BB not detected,
      1: BB detected.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
==============================================================
```

In the DPR product, rain type by the DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN
```

```
DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 8    DFRm method cannot be applicable at Part B (in this case
       the conventional method determines the major rain type)
     = 9    DFRm method cannot be applicable at Part A (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value

 If dual frequency data is not available
 but Ku-only or Ka-olny is available,
 rain type is expressed by the following 8 digit number:
   10xxxxxx --- stratiform,
   20xxxxxx --- convective,
   30xxxxxx --- other,
 wihch is a copy of Ku-only module or Ka-only module.

 If dual frequency data is available, rain type is
 expressed by
   1qxxxxxx --- stratiform,
   2qxxxxxx --- convective,
   3qxxxxxx --- other,
 where q>0.
 Thus, by examining q, users can understand whether
 data is processed by dual frequency algorithm or
 single frequency algorithm.
 =======================================
 For MS and HS, DFRm method is used.
 =======================================
 DFRm decision classifies rain type into
    stratiform,
    convective,
 and
    transition.
 ----------------------------------------------------------
 The DPR numbering rule can be summarized as follows:
 Let opqrstuv be the 8 digit number, then
    o: Main rain type. (o=1,2,3),
    p: DFRm rain type. (p=0,1,2,4,8,9, with p=0 for single frequency data only),
    q: DFRm BB. (q=0,1),
```

```
   r: V rain type (by conventional V-method).
      Basically r=0 for inner swath and r>0 for outer swath.
      However, r>0 when only single frequency data is available,
   s: H rain type,
   t: = 0 for innner swath,
        1 when BB is detected in the outer swath.
   u: Shallow rain,
   v: Small size cell.
============================
============================
DFRm type can be obtained by examining p
============================
The meaning of p is as follows:
 p = 0: single frequency data only (dual frequncy data not available),
     1: stratiform by DFRm method,
     2: convective by DFRm method,
     4: transition by DFRm method,
     8: DFRm decision not available,
     9: DFRm decision not available.
Note that p>0 always in DPR processing, which is different
from Ku-only or Ka-only result.
In Ku-only or Ka-only rain type numbering, p=0 always.
----------------------------------------------------------
===============================================
The following numbers appear as DPR rain types:
===============================================
**************************
*   For FS outer swath   *
**************************
  --- stratiform
  1901H100
  19031000
  --- convective
  2901H1xy (x>0 or y>0, see R\_type\_classification\_dpr2)
  2902Hwxy
  290310xy (x>0, y>0, see R\_type\_classification\_dpr2)
  290320xy
  --- other
  390330xy

*******************************
*  For FS inner swath and MS  *
*******************************
```

```
  --- stratiform
  11B0H0xy
  14B01000
  19001000 --- H decision only
  19011000 --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type
  19013000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
             or FS rain >0 but no MS rain; FS V and H determine rain type
  19031000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
             or FS rain >0 but no MS rain; FS V and H determine rain type
  --- convective
  2100H0xy (x>0 or y>0)
  2110H00y (y>0)
  2200H0xy
  2210H00y
  2400H0xy
  2410H00y
  290010xy --- H decision only (x>0 or y>0)
  290020xy --- H decision only
  2901H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type
             (x>0 or y>0 for H=1,3)
  2902H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type
  290310xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             (x>0 or y>0)
  290320xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type
  --- other
  340030xy
  390030xy --- H decision only
  390330xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type

**************
*   For HS   *
**************
  --- stratiform
  11B0H000
  14B01000
  19001000 --- H decision only
  --- convective
  21B0H0x0 (x>0)
```

```
   22B0H0x0
   240010x0 (x>0, 24B010x0 with B=0)
   240020x0
   241010x0 (x>0, 24B010x0 with B=1)
   290010x0 (x>0) --- H decision only
   290020x0 --- H decision only
   --- other
   340030x0
   390030x0 --- H decision only

 where w depends on BB by conventional V-method, B on BB
 by DFRm method, H on H-method, x on shallow rain
 and y on small size cell:
   w = 0: BB not detected by conventional V-method,
       1: BB detected by conventional V-methd.

   B = 0: BB not detected by DFRm method,
       1: BB detected by DFRm methd.

   H = 1: stratiform by H-method,
       2: convective by H-method,
       3: other by H-method.

   x = 0: No shallow rain,
       1: Shallow isolated,
       3: Shallow non-isolated.

   y = 0: No small size cell,
       1: Single cell,
       2: Small size cell consisting of two adjacent pixels.
 In the above, x>0 and y>0 are taken care of in the function
 R\_type\_classification\_dpr2().
 =============================================================
```

qualityTypePrecip (4-byte integer, array size: nray x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nray x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

flagHeavyIcePrecip (1-byte integer, array size: nray x nscan):
This flag denotes strong or severe precipitation accompanied by solid ice hydrometeors above the -10 degree C isotherm. Special values are defined as:
0 Missing value

SRT (Group in FS)

pathAtten (4-byte float, array size: nray x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAalt (4-byte float, array size: method x nray x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhb (4-byte float, array size: nray x nscan):
The 2-way attenuation of HB.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhybrid (4-byte float, array size: nray x nscan):
The 2-way attenuation from a weighted combination of HB and SRT.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweightHY (4-byte float, array size: two x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nray x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

reliabFactor (4-byte float, array size: nray x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nray x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

reliabFactorHY (4-byte float, array size: nray x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nray x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff $>$ 3 ; PIAeff estimate is considered reliable
= 2 if 3 $\geq$ Rel_eff $>$ 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff $\leq$ 1 ; PIAeff is unreliable
= 4 if SNR_at surface $<$ 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

reliabFlagHY (2-byte integer, array size: nray x nscan):
TBD.

Special values are defined as:
-9999 Missing value

stddevEff (4-byte float, array size: nsdew x nray x nscan):
The effective standard deviation of PIA-SRT computed 3 ways.

Special values are defined as:
-9999.9 Missing value

stddevHY (4-byte float, array size: nray x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

zeta (4-byte float, array size: nray x nscan):
The term in the HB estimate of path attenuation.

Special values are defined as:
-9999.9 Missing value

DSD (Group in FS)

phase (1-byte char, array size: nbin x nray x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                       the top and peak of bright band
phase = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nray x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
```

```
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

paramRDm (4-byte float, array size: nNode x nray x nscan):
TBD Special values are defined as:
-9999.9 Missing value

Experimental (Group in FS)

precipRateESurface2 (4-byte float, array size: nray x nscan):
Estimates Surface Precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nray x nscan):
Status of the estimated surface precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZP x nray x nscan):
Surface backscattering cross section profile around the current ifov. For information on this experimental field contact the Joint DPR Team. Values are in dB. Special values are defined as:
-9999.9 Missing value

seaIceConcentration (4-byte float, array size: nray x nscan):
Sea ice concentration estimated by Ku. For information on this experimental field contact the Joint DPR Team. Values range from 30 to 100 percent. Special values are defined as:
-9999.9 Missing value

SLV (Group in FS)

flagSLV (1-byte integer, array size: nbin x nray x nscan):
Special values are defined as:
-99 Missing value

paramDSD (4-byte float, array size: nDSD x nbin x nray x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is

Dm in mm. Special values are defined as:
-9999.9 Missing value

binEchoBottom (2-byte integer, array size: nray x nscan):
For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nray x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nray x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorFinal (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramNUBF (4-byte float, array size: nNUBF x nray x nscan):
TBD. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbin x nray x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWater (4-byte float, array size: nbin x nray x nscan):
The amount of precipitable water. Values are in kg/m^3. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nray x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nray x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nray x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nray x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nray x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nray x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbin x nray x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

piaOffset (4-byte float, array size: nray x nscan):
TBD. Values are in dB. Special values are defined as:
-9999.9 Missing value

FLG (Group in FS)

flagEcho (1-byte integer, array size: nbin x nray x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nray x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
```

```
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

qualityFlag (1-byte integer, array size: nray x nscan):
Flag derived from qualityData with the following values: Special values are defined as:
-99 Missing value

```
Value    Meaning
0        High quality.  No issues.
1        Low quality (DPR modules had warnings but still made a retrieval)
2        Bad (DPR modules had errors or dataQuality is bad and
         retrieval is missing)
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

flagScanPattern (2-byte integer, array size: nscan):

```
Flag of scan pattern.

Value  Meaning
1      TBD
-99    Missing
```

HS (Swath)

HS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in HS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayHS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayHS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nrayHS x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in HS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
```

```
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
```

```
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
```

```
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

navigation (Group in HS)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:

-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:

-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group in HS)

elevation (4-byte float, array size: nrayHS x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nrayHS x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nrayHS x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nrayHS x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka
```

```
0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nrayHS x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0  : normal (under saturated level)
1  : possible saturated level at real surface
2  : saturated level at real surface
99 : missing
```

binRealSurface (2-byte integer, array size: nrayHS x nscan):
Range bin number for real surface. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for the storm top. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nrayHS x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

height (4-byte float, array size: nbinHS x nrayHS x nscan):
Height. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nrayHS x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nrayHS x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nrayHS x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

adjustFactor (4-byte float, array size: nrayHS x nscan):
Adjustment factor (dB) for zFactorMeasured (dBZm') and sigmaZeroMeasured (dBs0m'). dBZm' and dBs0m' are used and stored as follows:

```
dBZm' = dBZm - adjustFactor
dBs0m' = dBs0m - adjustFactor
The adjustment factor is the sum of 3 components:
base adjustment for instrument dependency,
angle-bin adjustment for angle-bin dependency, and
temporal adjustment for orbit number dependency.
```

snowIceCover (1-byte integer, array size: nrayHS x nscan):
TBD. Special values are defined as:
-99 Missing value

binMirrorImageL2 (2-byte integer, array size: nrayHS x nscan):
Range bin number of the mirror image.

echoCountRealSurface (1-byte char, array size: nrayHS x nscan):
Echo count at a surface position (binRealSurface). Missing value = 0.

VER (Group in HS)

airTemperature (4-byte float, array size: nbinHS x nrayHS x nscan):
Air Temperature. Values are in K. Special values are defined as:
-9999.9 Missing value

binZeroDeg (2-byte integer, array size: nrayHS x nscan):

```
Range bin number with 0 degrees C level.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(FS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nrayHS x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

piaNPrainFree (4-byte float, array size: nNP x nrayHS x nscan):
TBD Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nrayHS x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nrayHS x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

flagInversion (2-byte integer, array size: nrayHS x nscan):

```
TBD
```

binZeroDegSecondary (2-byte integer, array size: nrayHS x nscan):
TBD Special values are defined as:
-9999 Missing value

CSF (Group in HS)

flagBB (4-byte integer, array size: nrayHS x nscan):
Bright band (BB) exists or not. The definition is different for L2 DPR on the one hand and L2 Ku and L2 Ka on the other.

```
L2 DPR:
0      no Bright Band
1      Bright Band detected by Ku and DFRm
2      Bright Band detected by Ku only
3      Bright Band detected by DFRm only
-1111  No rain value
-9999  Missing value

L2 Ku and L2 Ka:
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nrayHS x nscan):
Range bin number for the peak of bright band. For FS and MS swaths, bin numbers are

1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for the top of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for the bottom of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for the top of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for the bottom of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

nHeavyIcePrecip (1-byte char, array size: nrayHS x nscan):
TBD. Special values are defined as:
0 Missing value

heightBB (4-byte float, array size: nrayHS x nscan):
Height of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nrayHS x nscan):
The width of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nrayHS x nscan):

```
Quality of the bright band.
When the bright band is detected,
a larger positive number indicates lower
confidence in the detection.

The Ku detection is clear, but
the Ka and DPR detection is
somewhat doubtful.

The meaning of qualityBB has not
been finalized.

3      Smeared bright band
2      Not so clear bright band
1      Clear bright band
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nrayHS x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value

Let abcdefgh be the 8 digit number,

  abcdefgh

then
```

```
   a: Main rain type. (a=1,2,3),
   b: 0,
   c: 0,
   d: V rain type,
   e: H rain type,
   f: BB,
   g: Shallow rain,
   h: Small size cell.
----------------------------------------------------
The following numbers appear as Ku and Ka (MS/HS) rain types:
   ---- stratiform
   1001H100
   10031000
   ---- convective
   2001H1xy (x>0 or y>0)
   2002Hbxy
   200310xy (x>0 or y>0)
   200320xy
   ---- other
   300330xy
where H is the rain type by H-method, and b depends on BB,
x on shallow rain and y on small size cell:
  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  b = 0: BB not detected,
      1: BB detected.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
=============================================================
```

In the DPR product, rain type by the DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN
```

```
DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 8    DFRm method cannot be applicable at Part B (in this case
       the conventional method determines the major rain type)
     = 9    DFRm method cannot be applicable at Part A (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value

 If dual frequency data is not available
 but Ku-only or Ka-olny is available,
 rain type is expressed by the following 8 digit number:
   10xxxxxx --- stratiform,
   20xxxxxx --- convective,
   30xxxxxx --- other,
 wihch is a copy of Ku-only module or Ka-only module.

 If dual frequency data is available, rain type is
 expressed by
   1qxxxxxx --- stratiform,
   2qxxxxxx --- convective,
   3qxxxxxx --- other,
 where q>0.
 Thus, by examining q, users can understand whether
 data is processed by dual frequency algorithm or
 single frequency algorithm.
 =======================================
 For MS and HS, DFRm method is used.
 =======================================
 DFRm decision classifies rain type into
    stratiform,
    convective,
 and
    transition.
 ----------------------------------------------------------
 The DPR numbering rule can be summarized as follows:
 Let opqrstuv be the 8 digit number, then
    o: Main rain type. (o=1,2,3),
    p: DFRm rain type. (p=0,1,2,4,8,9, with p=0 for single frequency data only),
    q: DFRm BB. (q=0,1),
```

```
   r: V rain type (by conventional V-method).
      Basically r=0 for inner swath and r>0 for outer swath.
      However, r>0 when only single frequency data is available,
   s: H rain type,
   t: = 0 for innner swath,
        1 when BB is detected in the outer swath.
   u: Shallow rain,
   v: Small size cell.
============================
============================
DFRm type can be obtained by examining p
============================
The meaning of p is as follows:
 p = 0: single frequency data only (dual frequncy data not available),
     1: stratiform by DFRm method,
     2: convective by DFRm method,
     4: transition by DFRm method,
     8: DFRm decision not available,
     9: DFRm decision not available.
Note that p>0 always in DPR processing, which is different
from Ku-only or Ka-only result.
In Ku-only or Ka-only rain type numbering, p=0 always.
----------------------------------------------------------
===============================================
The following numbers appear as DPR rain types:
===============================================
**************************
*   For FS outer swath   *
**************************
  --- stratiform
  1901H100
  19031000
  --- convective
  2901H1xy (x>0 or y>0, see R\_type\_classification\_dpr2)
  2902Hwxy
  290310xy (x>0, y>0, see R\_type\_classification\_dpr2)
  290320xy
  --- other
  390330xy

*******************************
*  For FS inner swath and MS  *
*******************************
```

```
  --- stratiform
  11B0H0xy
  14B01000
  19001000 --- H decision only
  19011000 --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type
  19013000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
             or FS rain >0 but no MS rain; FS V and H determine rain type
  19031000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
             or FS rain >0 but no MS rain; FS V and H determine rain type
  --- convective
  2100H0xy (x>0 or y>0)
  2110H00y (y>0)
  2200H0xy
  2210H00y
  2400H0xy
  2410H00y
  290010xy --- H decision only (x>0 or y>0)
  290020xy --- H decision only
  2901H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type
             (x>0 or y>0 for H=1,3)
  2902H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type
  290310xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             (x>0 or y>0)
  290320xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type
  --- other
  340030xy
  390030xy --- H decision only
  390330xy --- MS rain >0 but no FS rain; MS V and H determine rain type
             or FS rain >0 but no MS rain; FS V and H determine rain type

**************
*   For HS   *
**************
  --- stratiform
  11B0H000
  14B01000
  19001000 --- H decision only
  --- convective
  21B0H0x0 (x>0)
```

```
  22B0H0x0
  240010x0 (x>0, 24B010x0 with B=0)
  240020x0
  241010x0 (x>0, 24B010x0 with B=1)
  290010x0 (x>0) --- H decision only
  290020x0 --- H decision only
  --- other
  340030x0
  390030x0 --- H decision only

 where w depends on BB by conventional V-method, B on BB
 by DFRm method, H on H-method, x on shallow rain
 and y on small size cell:
  w = 0: BB not detected by conventional V-method,
      1: BB detected by conventional V-methd.

  B = 0: BB not detected by DFRm method,
      1: BB detected by DFRm methd.

  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
 In the above, x>0 and y>0 are taken care of in the function
 R\_type\_classification\_dpr2().
 =============================================================
```

qualityTypePrecip (4-byte integer, array size: nrayHS x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nrayHS x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

flagHeavyIcePrecip (1-byte integer, array size: nrayHS x nscan):
This flag denotes strong or severe precipitation accompanied by solid ice hydrometeors above the -10 degree C isotherm. Special values are defined as:
0 Missing value

SRT (Group in HS)

pathAtten (4-byte float, array size: nrayHS x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAalt (4-byte float, array size: method x nrayHS x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhb (4-byte float, array size: nrayHS x nscan):
The 2-way attenuation of HB.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhybrid (4-byte float, array size: nrayHS x nscan):
The 2-way attenuation from a weighted combination of HB and SRT.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nrayHS x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweightHY (4-byte float, array size: two x nrayHS x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nrayHS x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

reliabFactor (4-byte float, array size: nrayHS x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nrayHS x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

reliabFactorHY (4-byte float, array size: nrayHS x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nrayHS x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff $>$ 3 ; PIAeff estimate is considered reliable
= 2 if 3 $\geq$ Rel_eff $>$ 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff $\leq$ 1 ; PIAeff is unreliable
= 4 if SNR_at surface $<$ 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

reliabFlagHY (2-byte integer, array size: nrayHS x nscan):
TBD.

Special values are defined as:
-9999 Missing value

stddevEff (4-byte float, array size: nsdew x nrayHS x nscan):
The effective standard deviation of PIA-SRT computed 3 ways.

Special values are defined as:
-9999.9 Missing value

stddevHY (4-byte float, array size: nrayHS x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

zeta (4-byte float, array size: nrayHS x nscan):
The term in the HB estimate of path attenuation.

Special values are defined as:
-9999.9 Missing value

DSD (Group in HS)

phase (1-byte char, array size: nbinHS x nrayHS x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                       the top and peak of bright band
phase = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nrayHS x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
```

```
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

paramRDm (4-byte float, array size: nNode x nrayHS x nscan):
TBD Special values are defined as:
-9999.9 Missing value

Experimental (Group in HS)

precipRateESurface2 (4-byte float, array size: nrayHS x nscan):
Estimates Surface Precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nrayHS x nscan):
Status of the estimated surface precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZPHS x nrayHS x nscan):
Surface backscattering cross section profile around the current ifov. For information on this experimental field contact the Joint DPR Team. Values are in dB. Special values are defined as:
-9999.9 Missing value

seaIceConcentration (4-byte float, array size: nrayHS x nscan):
Sea ice concentration estimated by Ku. For information on this experimental field contact the Joint DPR Team. Values range from 30 to 100 percent. Special values are defined as:
-9999.9 Missing value

SLV (Group in HS)

flagSLV (1-byte integer, array size: nbinHS x nrayHS x nscan):
Special values are defined as:
-99 Missing value

paramDSD (4-byte float, array size: nDSD x nbinHS x nrayHS x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is

Dm in mm. Special values are defined as:
-9999.9 Missing value

binEchoBottom (2-byte integer, array size: nrayHS x nscan):
For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nrayHS x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nrayHS x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorFinal (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (4-byte float, array size: nrayHS x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (4-byte float, array size: nrayHS x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramNUBF (4-byte float, array size: nNUBF x nrayHS x nscan):
TBD. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbinHS x nrayHS x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWater (4-byte float, array size: nbinHS x nrayHS x nscan):
The amount of precipitable water. Values are in kg/m^3. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nrayHS x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nrayHS x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nrayHS x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nrayHS x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nrayHS x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nrayHS x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbinHS x nrayHS x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

piaOffset (4-byte float, array size: nrayHS x nscan):
TBD. Values are in dB. Special values are defined as:
-9999.9 Missing value

FLG (Group in HS)

flagEcho (1-byte integer, array size: nbinHS x nrayHS x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nrayHS x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
```

```
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

qualityFlag (1-byte integer, array size: nrayHS x nscan):
Flag derived from qualityData with the following values: Special values are defined as:
-99 Missing value

```
Value    Meaning
0        High quality.  No issues.
1        Low quality (DPR modules had warnings but still made a retrieval)
2        Bad (DPR modules had errors or dataQuality is bad and
         retrieval is missing)
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

flagScanPattern (2-byte integer, array size: nscan):

```
Flag of scan pattern.

Value  Meaning
1      TBD
-99    Missing
```

C Structure Header file:

```
#ifndef _TK_2AKa_H_
#define _TK_2AKa_H_

#ifndef _L2AKa_HS_FLG_
#define _L2AKa_HS_FLG_
```

```
typedef struct {
    signed char flagEcho[24][88];
    int qualityData[24];
    signed char qualityFlag[24];
    signed char flagSensor;
    short flagScanPattern;
} L2AKa_HS_FLG;

#endif

#ifndef _L2AKa_HS_SLV_
#define _L2AKa_HS_SLV_

typedef struct {
    signed char flagSLV[24][88];
    float paramDSD[24][88][2];
    short binEchoBottom[24];
    float piaFinal[24];
    float sigmaZeroCorrected[24];
    float zFactorFinal[24][88];
    float zFactorFinalESurface[24];
    float zFactorFinalNearSurface[24];
    float paramNUBF[24][3];
    float precipRate[24][88];
    float precipWater[24][88];
    float precipWaterIntegrated[24][2];
    int qualitySLV[24];
    float precipRateNearSurface[24];
    float precipRateESurface[24];
    float precipRateAve24[24];
    unsigned char phaseNearSurface[24];
    float epsilon[24][88];
    float piaOffset[24];
} L2AKa_HS_SLV;

#endif

#ifndef _L2AKa_HS_EXPERIMENTAL_
#define _L2AKa_HS_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[24];
    unsigned char precipRateESurface2Status[24];
```

```
    float sigmaZeroProfile[24][5];
    float seaIceConcentration[24];
} L2AKa_HS_EXPERIMENTAL;

#endif

#ifndef _L2AKa_HS_DSD_
#define _L2AKa_HS_DSD_

typedef struct {
    unsigned char phase[24][88];
    short binNode[24][5];
    float paramRDm[24][5];
} L2AKa_HS_DSD;

#endif

#ifndef _L2AKa_HS_SRT_
#define _L2AKa_HS_SRT_

typedef struct {
    float pathAtten[24];
    float PIAalt[24][6];
    float PIAhb[24];
    float PIAhybrid[24];
    float PIAweight[24][6];
    float PIAweightHY[24][2];
    short refScanID[24][2][2];
    float reliabFactor[24];
    float RFactorAlt[24][6];
    float reliabFactorHY[24];
    short reliabFlag[24];
    short reliabFlagHY[24];
    float stddevEff[24][3];
    float stddevHY[24];
    float zeta[24];
} L2AKa_HS_SRT;

#endif

#ifndef _L2AKa_HS_CSF_
#define _L2AKa_HS_CSF_
```

```
typedef struct {
    int flagBB[24];
    short binBBPeak[24];
    short binBBTop[24];
    short binBBBottom[24];
    short binHeavyIcePrecipTop[24];
    short binHeavyIcePrecipBottom[24];
    unsigned char nHeavyIcePrecip[24];
    float heightBB[24];
    float widthBB[24];
    int qualityBB[24];
    int typePrecip[24];
    int qualityTypePrecip[24];
    int flagShallowRain[24];
    signed char flagHeavyIcePrecip[24];
} L2AKa_HS_CSF;

#endif

#ifndef _L2AKa_HS_VER_
#define _L2AKa_HS_VER_

typedef struct {
    float airTemperature[24][88];
    short binZeroDeg[24];
    float attenuationNP[24][88];
    float piaNP[24][4];
    float piaNPrainFree[24][4];
    float sigmaZeroNPCorrected[24];
    float heightZeroDeg[24];
    short flagInversion[24];
    short binZeroDegSecondary[24];
} L2AKa_HS_VER;

#endif

#ifndef _L2AKa_HS_PRE_
#define _L2AKa_HS_PRE_

typedef struct {
    float elevation[24];
    int landSurfaceType[24];
    float localZenithAngle[24];
```

```
    int flagPrecip[24];
    unsigned char flagSigmaZeroSaturation[24];
    short binRealSurface[24];
    short binStormTop[24];
    float heightStormTop[24];
    float height[24][88];
    short binClutterFreeBottom[24];
    float sigmaZeroMeasured[24];
    float zFactorMeasured[24][88];
    float ellipsoidBinOffset[24];
    float snRatioAtRealSurface[24];
    float adjustFactor[24];
    signed char snowIceCover[24];
    short binMirrorImageL2[24];
    unsigned char echoCountRealSurface[24];
} L2AKa_HS_PRE;

#endif

#ifndef _L2AKa_HS_SCANSTATUS_
#define _L2AKa_HS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2AKa_HS_SCANSTATUS;

#endif

#ifndef _L2AKa_HS_
#define _L2AKa_HS_
```

```
typedef struct {
    SCANTIME ScanTime;
    float Latitude[24];
    float Longitude[24];
    float sunLocalTime[24];
    L2AKa_HS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2AKa_HS_PRE PRE;
    L2AKa_HS_VER VER;
    L2AKa_HS_CSF CSF;
    L2AKa_HS_SRT SRT;
    L2AKa_HS_DSD DSD;
    L2AKa_HS_EXPERIMENTAL Experimental;
    L2AKa_HS_SLV SLV;
    L2AKa_HS_FLG FLG;
} L2AKa_HS;

#endif

#ifndef _L2AKa_FS_FLG_
#define _L2AKa_FS_FLG_

typedef struct {
    signed char flagEcho[49][176];
    int qualityData[49];
    signed char qualityFlag[49];
    signed char flagSensor;
    short flagScanPattern;
} L2AKa_FS_FLG;

#endif

#ifndef _L2AKa_FS_SLV_
#define _L2AKa_FS_SLV_

typedef struct {
    signed char flagSLV[49][176];
    float paramDSD[49][176][2];
    short binEchoBottom[49];
    float piaFinal[49];
    float sigmaZeroCorrected[49];
    float zFactorFinal[49][176];
    float zFactorFinalESurface[49];
```

```
    float zFactorFinalNearSurface[49];
    float paramNUBF[49][3];
    float precipRate[49][176];
    float precipWater[49][176];
    float precipWaterIntegrated[49][2];
    int qualitySLV[49];
    float precipRateNearSurface[49];
    float precipRateESurface[49];
    float precipRateAve24[49];
    unsigned char phaseNearSurface[49];
    float epsilon[49][176];
    float piaOffset[49];
} L2AKa_FS_SLV;

#endif

#ifndef _L2AKa_FS_EXPERIMENTAL_
#define _L2AKa_FS_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[49];
    unsigned char precipRateESurface2Status[49];
    float sigmaZeroProfile[49][7];
    float seaIceConcentration[49];
} L2AKa_FS_EXPERIMENTAL;

#endif

#ifndef _L2AKa_FS_DSD_
#define _L2AKa_FS_DSD_

typedef struct {
    unsigned char phase[49][176];
    short binNode[49][5];
    float paramRDm[49][5];
} L2AKa_FS_DSD;

#endif

#ifndef _L2AKa_FS_SRT_
#define _L2AKa_FS_SRT_

typedef struct {
```

```
    float pathAtten[49];
    float PIAalt[49][6];
    float PIAhb[49];
    float PIAhybrid[49];
    float PIAweight[49][6];
    float PIAweightHY[49][2];
    short refScanID[49][2][2];
    float reliabFactor[49];
    float RFactorAlt[49][6];
    float reliabFactorHY[49];
    short reliabFlag[49];
    short reliabFlagHY[49];
    float stddevEff[49][3];
    float stddevHY[49];
    float zeta[49];
} L2AKa_FS_SRT;

#endif

#ifndef _L2AKa_FS_CSF_
#define _L2AKa_FS_CSF_

typedef struct {
    int flagBB[49];
    short binBBPeak[49];
    short binBBTop[49];
    short binBBBottom[49];
    short binHeavyIcePrecipTop[49];
    short binHeavyIcePrecipBottom[49];
    unsigned char nHeavyIcePrecip[49];
    float heightBB[49];
    float widthBB[49];
    int qualityBB[49];
    int typePrecip[49];
    int qualityTypePrecip[49];
    int flagShallowRain[49];
    signed char flagHeavyIcePrecip[49];
} L2AKa_FS_CSF;

#endif

#ifndef _L2AKa_FS_VER_
#define _L2AKa_FS_VER_
```

```
typedef struct {
    float airTemperature[49][176];
    short binZeroDeg[49];
    float attenuationNP[49][176];
    float piaNP[49][4];
    float piaNPrainFree[49][4];
    float sigmaZeroNPCorrected[49];
    float heightZeroDeg[49];
    short flagInversion[49];
    short binZeroDegSecondary[49];
} L2AKa_FS_VER;

#endif

#ifndef _L2AKa_FS_PRE_
#define _L2AKa_FS_PRE_

typedef struct {
    float elevation[49];
    int landSurfaceType[49];
    float localZenithAngle[49];
    int flagPrecip[49];
    unsigned char flagSigmaZeroSaturation[49];
    short binRealSurface[49];
    short binStormTop[49];
    float heightStormTop[49];
    float height[49][176];
    short binClutterFreeBottom[49];
    float sigmaZeroMeasured[49];
    float zFactorMeasured[49][176];
    float ellipsoidBinOffset[49];
    float snRatioAtRealSurface[49];
    float adjustFactor[49];
    signed char snowIceCover[49];
    short binMirrorImageL2[49];
    unsigned char echoCountRealSurface[49];
} L2AKa_FS_PRE;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_
```

```
typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2AKa_FS_SCANSTATUS_
#define _L2AKa_FS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2AKa_FS_SCANSTATUS;

#endif
```

```
#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AKa_FS_
#define _L2AKa_FS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float sunLocalTime[49];
    L2AKa_FS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2AKa_FS_PRE PRE;
    L2AKa_FS_VER VER;
    L2AKa_FS_CSF CSF;
    L2AKa_FS_SRT SRT;
    L2AKa_FS_DSD DSD;
    L2AKa_FS_EXPERIMENTAL Experimental;
    L2AKa_FS_SLV SLV;
    L2AKa_FS_FLG FLG;
} L2AKa_FS;

#endif

#ifndef _L2AKa_SWATHS_
#define _L2AKa_SWATHS_
```

```
typedef struct {
    L2AKa_FS FS;
    L2AKa_HS HS;
} L2AKa_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2AKa_HS_FLG/
    BYTE flagEcho(88,24)
    INTEGER*4 qualityData(24)
    BYTE qualityFlag(24)
    BYTE flagSensor
    INTEGER*2 flagScanPattern
END STRUCTURE

STRUCTURE /L2AKa_HS_SLV/
    BYTE flagSLV(88,24)
    REAL*4 paramDSD(2,88,24)
    INTEGER*2 binEchoBottom(24)
    REAL*4 piaFinal(24)
    REAL*4 sigmaZeroCorrected(24)
    REAL*4 zFactorFinal(88,24)
    REAL*4 zFactorFinalESurface(24)
    REAL*4 zFactorFinalNearSurface(24)
    REAL*4 paramNUBF(3,24)
    REAL*4 precipRate(88,24)
    REAL*4 precipWater(88,24)
    REAL*4 precipWaterIntegrated(2,24)
    INTEGER*4 qualitySLV(24)
    REAL*4 precipRateNearSurface(24)
    REAL*4 precipRateESurface(24)
    REAL*4 precipRateAve24(24)
    CHARACTER phaseNearSurface(24)
    REAL*4 epsilon(88,24)
    REAL*4 piaOffset(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_EXPERIMENTAL/
    REAL*4 precipRateESurface2(24)
```

```
    CHARACTER precipRateESurface2Status(24)
    REAL*4 sigmaZeroProfile(5,24)
    REAL*4 seaIceConcentration(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_DSD/
    CHARACTER phase(88,24)
    INTEGER*2 binNode(5,24)
    REAL*4 paramRDm(5,24)
END STRUCTURE

STRUCTURE /L2AKa_HS_SRT/
    REAL*4 pathAtten(24)
    REAL*4 PIAalt(6,24)
    REAL*4 PIAhb(24)
    REAL*4 PIAhybrid(24)
    REAL*4 PIAweight(6,24)
    REAL*4 PIAweightHY(2,24)
    INTEGER*2 refScanID(2,2,24)
    REAL*4 reliabFactor(24)
    REAL*4 RFactorAlt(6,24)
    REAL*4 reliabFactorHY(24)
    INTEGER*2 reliabFlag(24)
    INTEGER*2 reliabFlagHY(24)
    REAL*4 stddevEff(3,24)
    REAL*4 stddevHY(24)
    REAL*4 zeta(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_CSF/
    INTEGER*4 flagBB(24)
    INTEGER*2 binBBPeak(24)
    INTEGER*2 binBBTop(24)
    INTEGER*2 binBBBottom(24)
    INTEGER*2 binHeavyIcePrecipTop(24)
    INTEGER*2 binHeavyIcePrecipBottom(24)
    CHARACTER nHeavyIcePrecip(24)
    REAL*4 heightBB(24)
    REAL*4 widthBB(24)
    INTEGER*4 qualityBB(24)
    INTEGER*4 typePrecip(24)
    INTEGER*4 qualityTypePrecip(24)
    INTEGER*4 flagShallowRain(24)
```

```
    BYTE flagHeavyIcePrecip(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_VER/
    REAL*4 airTemperature(88,24)
    INTEGER*2 binZeroDeg(24)
    REAL*4 attenuationNP(88,24)
    REAL*4 piaNP(4,24)
    REAL*4 piaNPrainFree(4,24)
    REAL*4 sigmaZeroNPCorrected(24)
    REAL*4 heightZeroDeg(24)
    INTEGER*2 flagInversion(24)
    INTEGER*2 binZeroDegSecondary(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_PRE/
    REAL*4 elevation(24)
    INTEGER*4 landSurfaceType(24)
    REAL*4 localZenithAngle(24)
    INTEGER*4 flagPrecip(24)
    CHARACTER flagSigmaZeroSaturation(24)
    INTEGER*2 binRealSurface(24)
    INTEGER*2 binStormTop(24)
    REAL*4 heightStormTop(24)
    REAL*4 height(88,24)
    INTEGER*2 binClutterFreeBottom(24)
    REAL*4 sigmaZeroMeasured(24)
    REAL*4 zFactorMeasured(88,24)
    REAL*4 ellipsoidBinOffset(24)
    REAL*4 snRatioAtRealSurface(24)
    REAL*4 adjustFactor(24)
    BYTE snowIceCover(24)
    INTEGER*2 binMirrorImageL2(24)
    CHARACTER echoCountRealSurface(24)
END STRUCTURE

STRUCTURE /L2AKa_HS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
```

```
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L2AKa_HS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(24)
    REAL*4 Longitude(24)
    REAL*4 sunLocalTime(24)
    RECORD /L2AKa_HS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2AKa_HS_PRE/ PRE
    RECORD /L2AKa_HS_VER/ VER
    RECORD /L2AKa_HS_CSF/ CSF
    RECORD /L2AKa_HS_SRT/ SRT
    RECORD /L2AKa_HS_DSD/ DSD
    RECORD /L2AKa_HS_EXPERIMENTAL/ Experimental
    RECORD /L2AKa_HS_SLV/ SLV
    RECORD /L2AKa_HS_FLG/ FLG
END STRUCTURE

STRUCTURE /L2AKa_FS_FLG/
    BYTE flagEcho(176,49)
    INTEGER*4 qualityData(49)
    BYTE qualityFlag(49)
    BYTE flagSensor
    INTEGER*2 flagScanPattern
END STRUCTURE

STRUCTURE /L2AKa_FS_SLV/
    BYTE flagSLV(176,49)
    REAL*4 paramDSD(2,176,49)
    INTEGER*2 binEchoBottom(49)
    REAL*4 piaFinal(49)
    REAL*4 sigmaZeroCorrected(49)
    REAL*4 zFactorFinal(176,49)
    REAL*4 zFactorFinalESurface(49)
    REAL*4 zFactorFinalNearSurface(49)
```

```
    REAL*4 paramNUBF(3,49)
    REAL*4 precipRate(176,49)
    REAL*4 precipWater(176,49)
    REAL*4 precipWaterIntegrated(2,49)
    INTEGER*4 qualitySLV(49)
    REAL*4 precipRateNearSurface(49)
    REAL*4 precipRateESurface(49)
    REAL*4 precipRateAve24(49)
    CHARACTER phaseNearSurface(49)
    REAL*4 epsilon(176,49)
    REAL*4 piaOffset(49)
END STRUCTURE

STRUCTURE /L2AKa_FS_EXPERIMENTAL/
    REAL*4 precipRateESurface2(49)
    CHARACTER precipRateESurface2Status(49)
    REAL*4 sigmaZeroProfile(7,49)
    REAL*4 seaIceConcentration(49)
END STRUCTURE

STRUCTURE /L2AKa_FS_DSD/
    CHARACTER phase(176,49)
    INTEGER*2 binNode(5,49)
    REAL*4 paramRDm(5,49)
END STRUCTURE

STRUCTURE /L2AKa_FS_SRT/
    REAL*4 pathAtten(49)
    REAL*4 PIAalt(6,49)
    REAL*4 PIAhb(49)
    REAL*4 PIAhybrid(49)
    REAL*4 PIAweight(6,49)
    REAL*4 PIAweightHY(2,49)
    INTEGER*2 refScanID(2,2,49)
    REAL*4 reliabFactor(49)
    REAL*4 RFactorAlt(6,49)
    REAL*4 reliabFactorHY(49)
    INTEGER*2 reliabFlag(49)
    INTEGER*2 reliabFlagHY(49)
    REAL*4 stddevEff(3,49)
    REAL*4 stddevHY(49)
    REAL*4 zeta(49)
END STRUCTURE
```

```
STRUCTURE /L2AKa_FS_CSF/
    INTEGER*4 flagBB(49)
    INTEGER*2 binBBPeak(49)
    INTEGER*2 binBBTop(49)
    INTEGER*2 binBBBottom(49)
    INTEGER*2 binHeavyIcePrecipTop(49)
    INTEGER*2 binHeavyIcePrecipBottom(49)
    CHARACTER nHeavyIcePrecip(49)
    REAL*4 heightBB(49)
    REAL*4 widthBB(49)
    INTEGER*4 qualityBB(49)
    INTEGER*4 typePrecip(49)
    INTEGER*4 qualityTypePrecip(49)
    INTEGER*4 flagShallowRain(49)
    BYTE flagHeavyIcePrecip(49)
END STRUCTURE

STRUCTURE /L2AKa_FS_VER/
    REAL*4 airTemperature(176,49)
    INTEGER*2 binZeroDeg(49)
    REAL*4 attenuationNP(176,49)
    REAL*4 piaNP(4,49)
    REAL*4 piaNPrainFree(4,49)
    REAL*4 sigmaZeroNPCorrected(49)
    REAL*4 heightZeroDeg(49)
    INTEGER*2 flagInversion(49)
    INTEGER*2 binZeroDegSecondary(49)
END STRUCTURE

STRUCTURE /L2AKa_FS_PRE/
    REAL*4 elevation(49)
    INTEGER*4 landSurfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 flagPrecip(49)
    CHARACTER flagSigmaZeroSaturation(49)
    INTEGER*2 binRealSurface(49)
    INTEGER*2 binStormTop(49)
    REAL*4 heightStormTop(49)
    REAL*4 height(176,49)
    INTEGER*2 binClutterFreeBottom(49)
    REAL*4 sigmaZeroMeasured(49)
    REAL*4 zFactorMeasured(176,49)
```

```
    REAL*4 ellipsoidBinOffset(49)
    REAL*4 snRatioAtRealSurface(49)
    REAL*4 adjustFactor(49)
    BYTE snowIceCover(49)
    INTEGER*2 binMirrorImageL2(49)
    CHARACTER echoCountRealSurface(49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2AKa_FS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE
```

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AKa_FS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    RECORD /L2AKa_FS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2AKa_FS_PRE/ PRE
    RECORD /L2AKa_FS_VER/ VER
    RECORD /L2AKa_FS_CSF/ CSF
    RECORD /L2AKa_FS_SRT/ SRT
    RECORD /L2AKa_FS_DSD/ DSD
    RECORD /L2AKa_FS_EXPERIMENTAL/ Experimental
    RECORD /L2AKa_FS_SLV/ SLV
    RECORD /L2AKa_FS_FLG/ FLG
END STRUCTURE

STRUCTURE /L2AKa_SWATHS/
    RECORD /L2AKa_FS/ FS;
    RECORD /L2AKa_HS/ HS;
END STRUCTURE
```

5.48 2ADPR - DPR precipitation

The DPR Level-2A product, 2ADPR, "DPR precipitation," is written as a 2 swath structure. The swaths are FS, full scans, and HS, high sensitivity scans. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each FS scan.
nrayHS	24	Number of angle bins in each HS scan.
nbin	176	Number of range bins in each FS ray. Bin interval is 125 m. 0 is at the top. 175 is the bin of the earth ellipsoid.
nbinHS	88	Number of range bins in each HS ray. Bin interval is 250 m. 0 is at the top. 87 is the bin of the earth ellipsoid.
nfreq	2	Number of frequencies: 0- Ku, 1- Ka
nfreqHI	3	Number of frequencies.
nbinSZP	7	Number of range bins for sigmaZeroProfile.
nbinSZPHS	5	Number of range bins for sigmaZeroProfile in each HS scan.
nNP	4	Number of NP kinds.
nearFar	2	Near reference, Far reference.
foreBack	2	Foreward, Backward.
method	6	Number of SRT methods.
nsdew	3	Number of standard deviation effective ways.
nNode	5	Number of binNode.
nDSD	2	Number of DSD parameters. Parameters are dBNw and Dm (mm).
LS	2	Liquid, solid.
nNUBF	3	Number of NUBF parameters.
two	2	Number two.
three	3	Number three.
thirty	30	Number of NUBF parameters.
thirteen	13	Number of NUBF parameters.
ten	10	Number of NUBF parameters.
six	6	Number of NUBF parameters.
four	4	Number four.
eight	8	Number of NUBF parameters.

Figure 556 through Figure 581 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

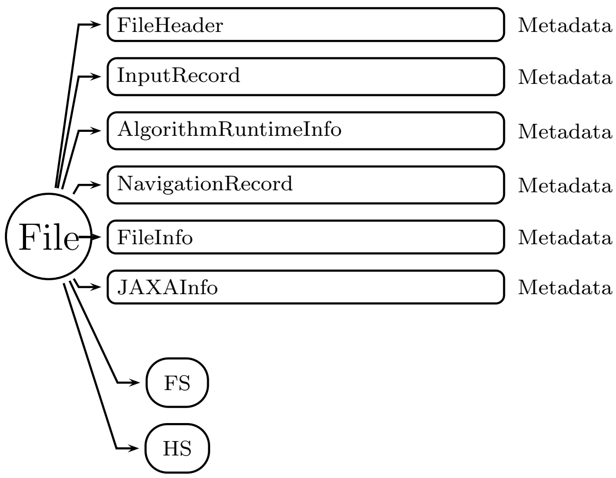


Figure 556: Data Format Structure for 2ADPR, DPR precipitation

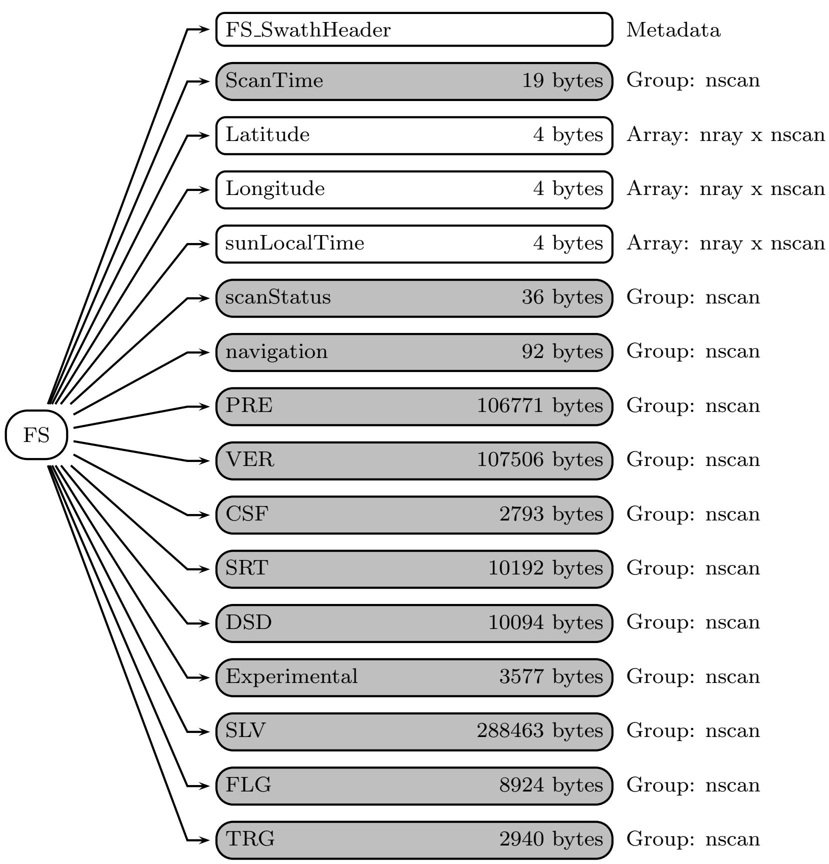


Figure 557: Data Format Structure for 2ADPR, FS

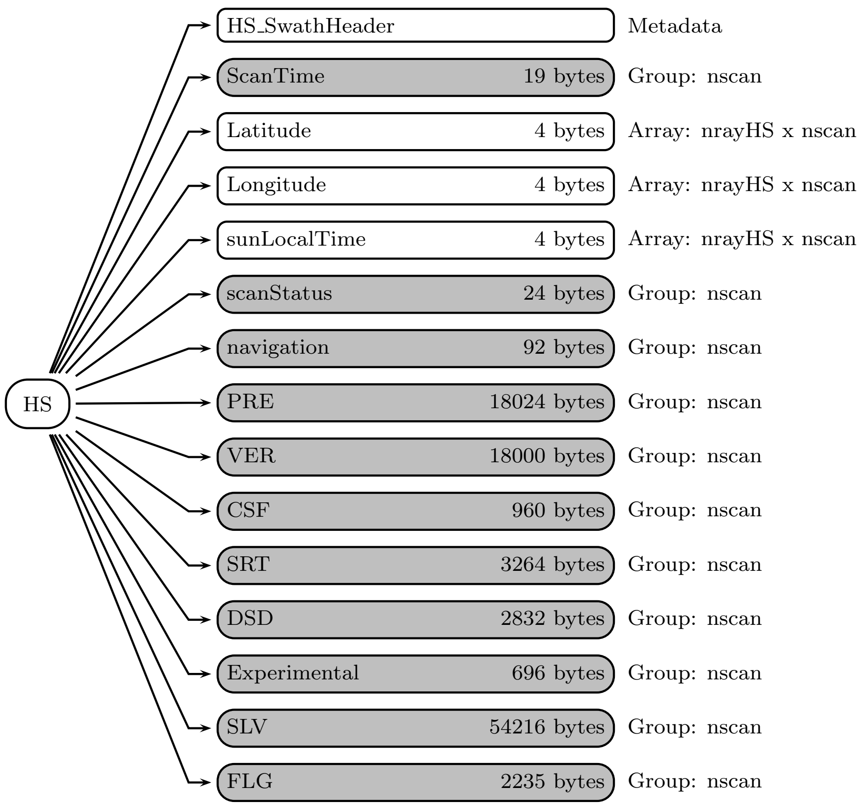


Figure 558: Data Format Structure for 2ADPR, HS

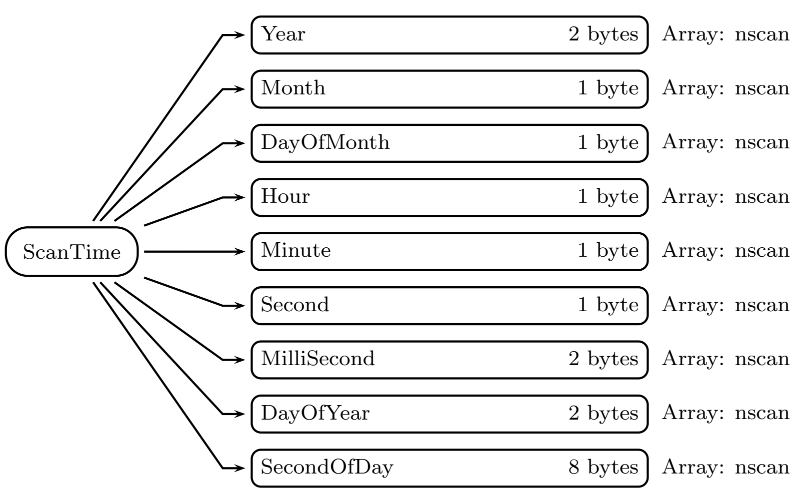


Figure 559: Data Format Structure for 2ADPR, FS, ScanTime

Figure 560: Data Format Structure for 2ADPR, FS, scanStatus

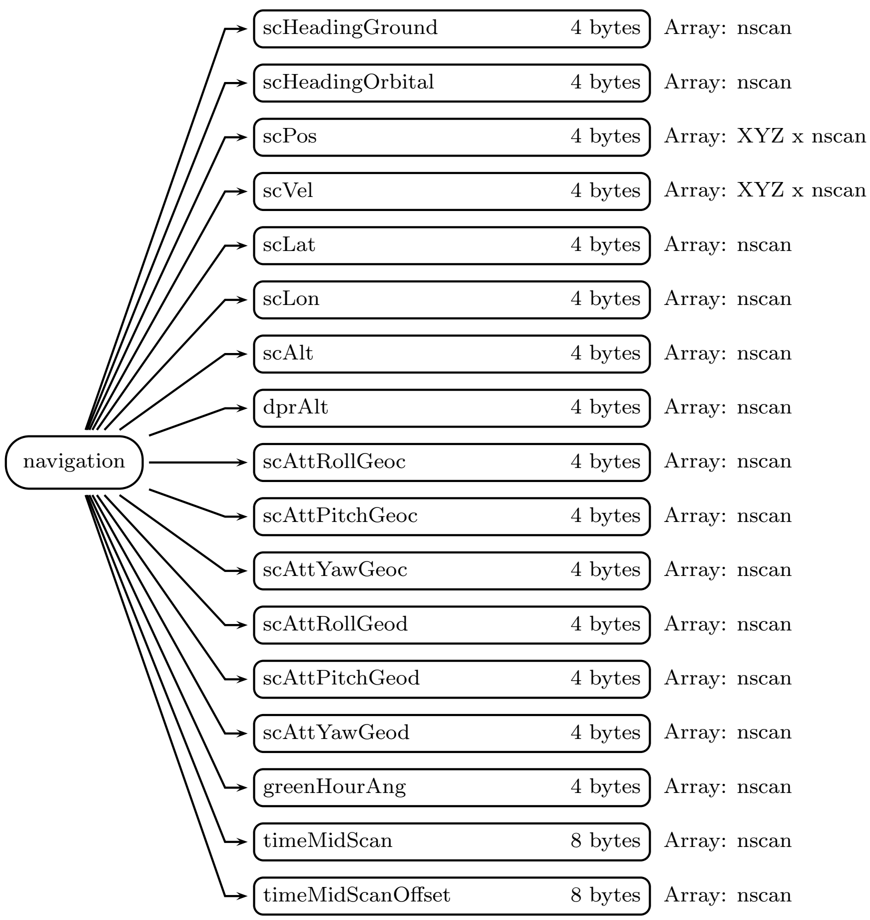


Figure 561: Data Format Structure for 2ADPR, FS, navigation

PRE

elevation	4 bytes	Array: nray x nscan
landSurfaceType	4 bytes	Array: nray x nscan
localZenithAngle	4 bytes	Array: nfreq x nray x nscan
flagPrecip	4 bytes	Array: nray x nscan
flagSigmaZeroSaturation	1 byte	Array: nfreq x nray x nscan
binRealSurface	2 bytes	Array: nfreq x nray x nscan
binStormTop	2 bytes	Array: nray x nscan
heightStormTop	4 bytes	Array: nray x nscan
height	4 bytes	Array: nbin x nray x nscan
binClutterFreeBottom	2 bytes	Array: nray x nscan
sigmaZeroMeasured	4 bytes	Array: nfreq x nray x nscan
zFactorMeasured	4 bytes	Array: nfreq x nbin x nray x nscan
ellipsoidBinOffset	4 bytes	Array: nray x nscan
snRatioAtRealSurface	4 bytes	Array: nfreq x nray x nscan
adjustFactor	4 bytes	Array: nfreq x nray x nscan
snowIceCover	1 byte	Array: nray x nscan
binMirrorImageL2	2 bytes	Array: nray x nscan
echoCountRealSurface	1 byte	Array: nfreq x nray x nscan

Figure 562: Data Format Structure for 2ADPR, FS, PRE

VER

airTemperature	4 bytes	Array: nbin x nray x nscan
binZeroDeg	2 bytes	Array: nray x nscan
attenuationNP	4 bytes	Array: nfreq x nbin x nray x nscan
piaNP	4 bytes	Array: nfreq x nNP x nray x nscan
piaNPrainFree	4 bytes	Array: nfreq x nNP x nray x nscan
sigmaZeroNPCorrected	4 bytes	Array: nfreq x nray x nscan
heightZeroDeg	4 bytes	Array: nray x nscan
flagInversion	2 bytes	Array: nray x nscan
binZeroDegSecondary	2 bytes	Array: nray x nscan

Figure 563: Data Format Structure for 2ADPR, FS, VER

CSF

flagBB	4 bytes	Array: nray x nscan
binBBPeak	2 bytes	Array: nray x nscan
binBBTop	2 bytes	Array: nray x nscan
binDFRmMLBottom	2 bytes	Array: nray x nscan
binDFRmMLTop	2 bytes	Array: nray x nscan
binBBBottom	2 bytes	Array: nray x nscan
binHeavyIcePrecipTop	2 bytes	Array: nfreqHI x nray x nscan
binHeavyIcePrecipBottom	2 bytes	Array: nfreqHI x nray x nscan
nHeavyIcePrecip	1 byte	Array: nfreqHI x nray x nscan
flagMLquality	1 byte	Array: nray x nscan
heightBB	4 bytes	Array: nray x nscan
widthBB	4 bytes	Array: nray x nscan
qualityBB	4 bytes	Array: nray x nscan
typePrecip	4 bytes	Array: nray x nscan
qualityTypePrecip	4 bytes	Array: nray x nscan
flagShallowRain	4 bytes	Array: nray x nscan
flagHeavyIcePrecip	1 byte	Array: nray x nscan
flagAnvil	1 byte	Array: nray x nscan
flagHail	1 byte	Array: nray x nscan

Figure 564: Data Format Structure for 2ADPR, FS, CSF

SRT

Name	Size	Dimensions
pathAtten	4 bytes	Array: nfreq x nray x nscan
PIAalt	4 bytes	Array: nfreq x method x nray x nscan
PIAdw	4 bytes	Array: nfreq x nray x nscan
PIAhb	4 bytes	Array: nfreq x nray x nscan
PIAhybrid	4 bytes	Array: nfreq x nray x nscan
piaExp	4 bytes	Array: nfreq x nray x nscan
PIAweight	4 bytes	Array: method x nray x nscan
PIAweightHY	4 bytes	Array: three x nray x nscan
refScanID	2 bytes	Array: nearFar x foreBack x nray x nscan
reliabFactor	4 bytes	Array: nray x nscan
RFactorAlt	4 bytes	Array: method x nray x nscan
reliabFactorHY	4 bytes	Array: nray x nscan
reliabFlag	2 bytes	Array: nray x nscan
reliabFlagHY	2 bytes	Array: nray x nscan
stddevEff	4 bytes	Array: nfreq x nsdew x nray x nscan
stddevHY	4 bytes	Array: nfreq x nray x nscan
zeta	4 bytes	Array: nfreq x nray x nscan

Figure 565: Data Format Structure for 2ADPR, FS, SRT

DSD

Name	Size	Dimensions
phase	1 byte	Array: nbin x nray x nscan
binNode	2 bytes	Array: nNode x nray x nscan
paramRDm	4 bytes	Array: nNode x nray x nscan

Figure 566: Data Format Structure for 2ADPR, FS, DSD

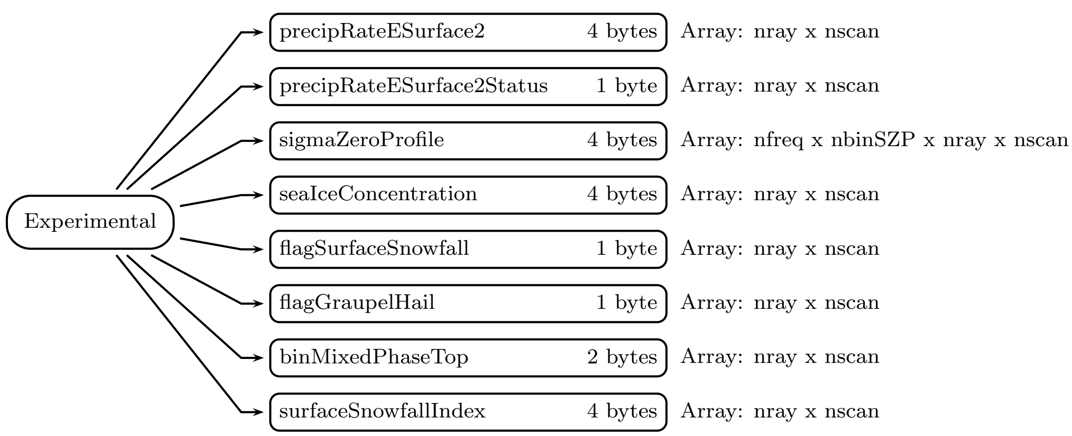


Figure 567: Data Format Structure for 2ADPR, FS, Experimental

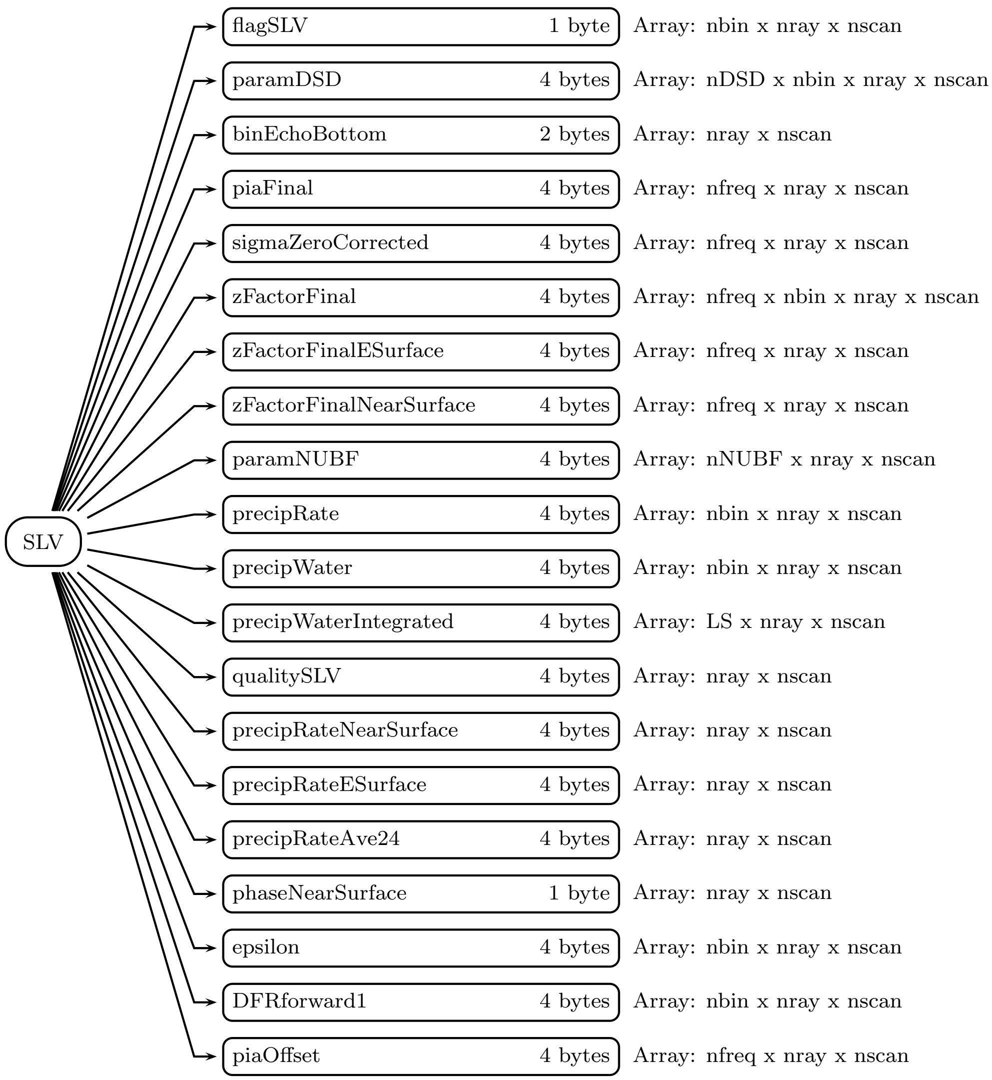


Figure 568: Data Format Structure for 2ADPR, FS, SLV

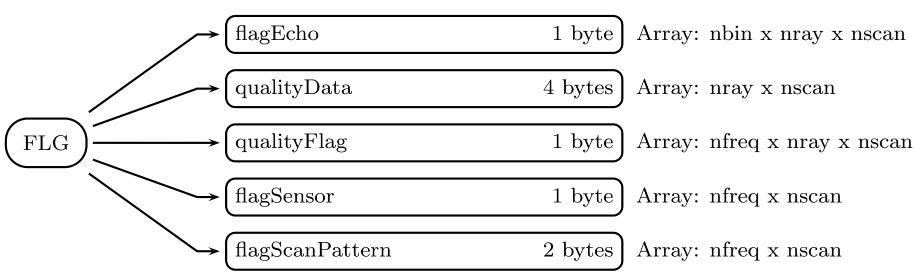


Figure 569: Data Format Structure for 2ADPR, FS, FLG

TRG

NUBFindex	4 bytes	Array: nray x nscan
MSindex	4 bytes	Array: nray x nscan
MSindexKu	4 bytes	Array: nray x nscan
MSindexKa	4 bytes	Array: nray x nscan
MSsurfPeakIndexKu	4 bytes	Array: nray x nscan
MSsurfPeakIndexKa	4 bytes	Array: nray x nscan
MSkneeDFRindex	4 bytes	Array: nray x nscan
MSslopesKu	4 bytes	Array: four x nray x nscan
MSslopesKa	4 bytes	Array: four x nray x nscan

Figure 570: Data Format Structure for 2ADPR, FS, TRG

ScanTime

Year	2 bytes	Array: nscan
Month	1 byte	Array: nscan
DayOfMonth	1 byte	Array: nscan
Hour	1 byte	Array: nscan
Minute	1 byte	Array: nscan
Second	1 byte	Array: nscan
MilliSecond	2 bytes	Array: nscan
DayOfYear	2 bytes	Array: nscan
SecondOfDay	8 bytes	Array: nscan

Figure 571: Data Format Structure for 2ADPR, HS, ScanTime

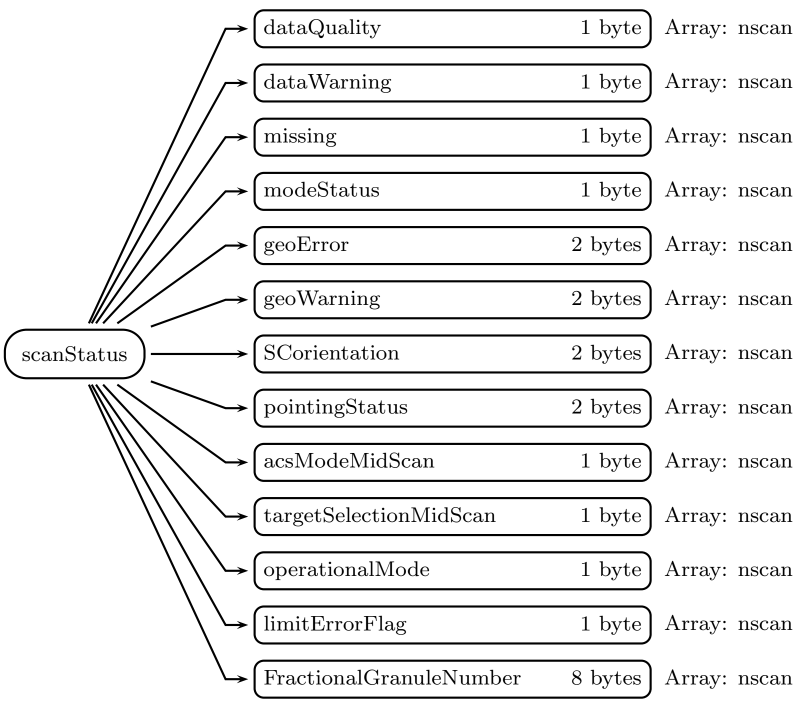


Figure 572: Data Format Structure for 2ADPR, HS, scanStatus

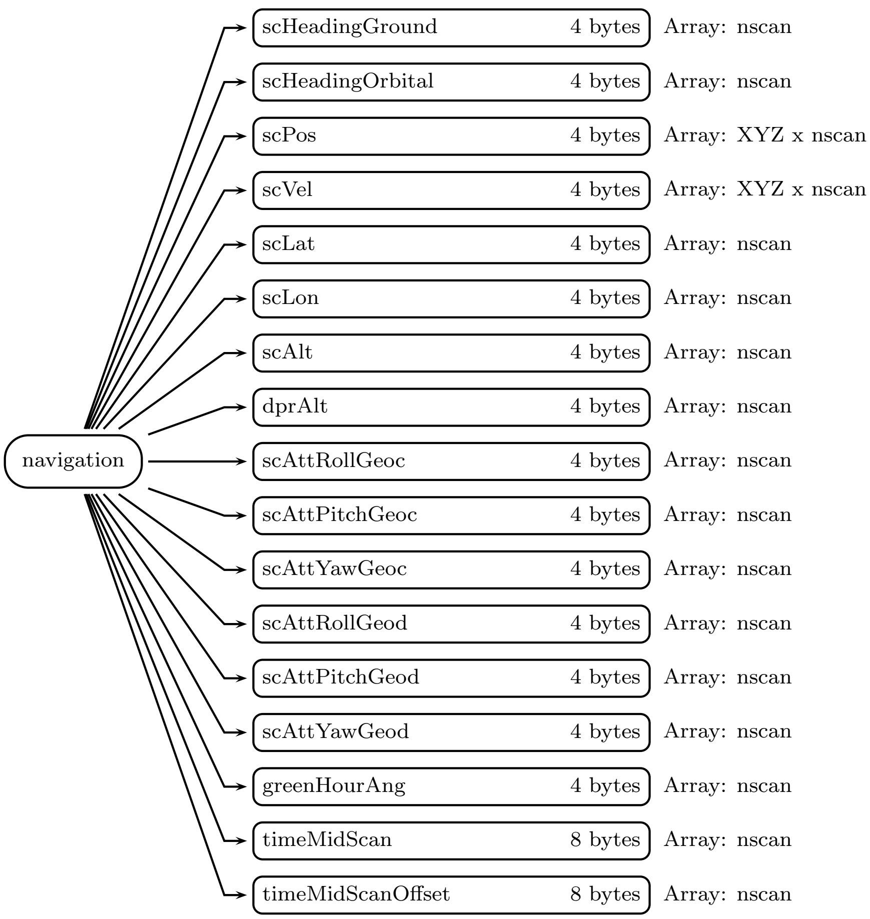


Figure 573: Data Format Structure for 2ADPR, HS, navigation

PRE

elevation	4 bytes	Array: nrayHS x nscan
landSurfaceType	4 bytes	Array: nrayHS x nscan
localZenithAngle	4 bytes	Array: nrayHS x nscan
flagPrecip	4 bytes	Array: nrayHS x nscan
flagSigmaZeroSaturation	1 byte	Array: nrayHS x nscan
binRealSurface	2 bytes	Array: nrayHS x nscan
binStormTop	2 bytes	Array: nrayHS x nscan
heightStormTop	4 bytes	Array: nrayHS x nscan
height	4 bytes	Array: nbinHS x nrayHS x nscan
binClutterFreeBottom	2 bytes	Array: nrayHS x nscan
sigmaZeroMeasured	4 bytes	Array: nrayHS x nscan
zFactorMeasured	4 bytes	Array: nbinHS x nrayHS x nscan
ellipsoidBinOffset	4 bytes	Array: nrayHS x nscan
snRatioAtRealSurface	4 bytes	Array: nrayHS x nscan
adjustFactor	4 bytes	Array: nrayHS x nscan
snowIceCover	1 byte	Array: nrayHS x nscan
binMirrorImageL2	2 bytes	Array: nrayHS x nscan
echoCountRealSurface	1 byte	Array: nrayHS x nscan

Figure 574: Data Format Structure for 2ADPR, HS, PRE

VER

airTemperature	4 bytes	Array: nbinHS x nrayHS x nscan
binZeroDeg	2 bytes	Array: nrayHS x nscan
attenuationNP	4 bytes	Array: nbinHS x nrayHS x nscan
piaNP	4 bytes	Array: nNP x nrayHS x nscan
piaNPrainFree	4 bytes	Array: nNP x nrayHS x nscan
sigmaZeroNPCorrected	4 bytes	Array: nrayHS x nscan
heightZeroDeg	4 bytes	Array: nrayHS x nscan
flagInversion	2 bytes	Array: nrayHS x nscan
binZeroDegSecondary	2 bytes	Array: nrayHS x nscan

Figure 575: Data Format Structure for 2ADPR, HS, VER

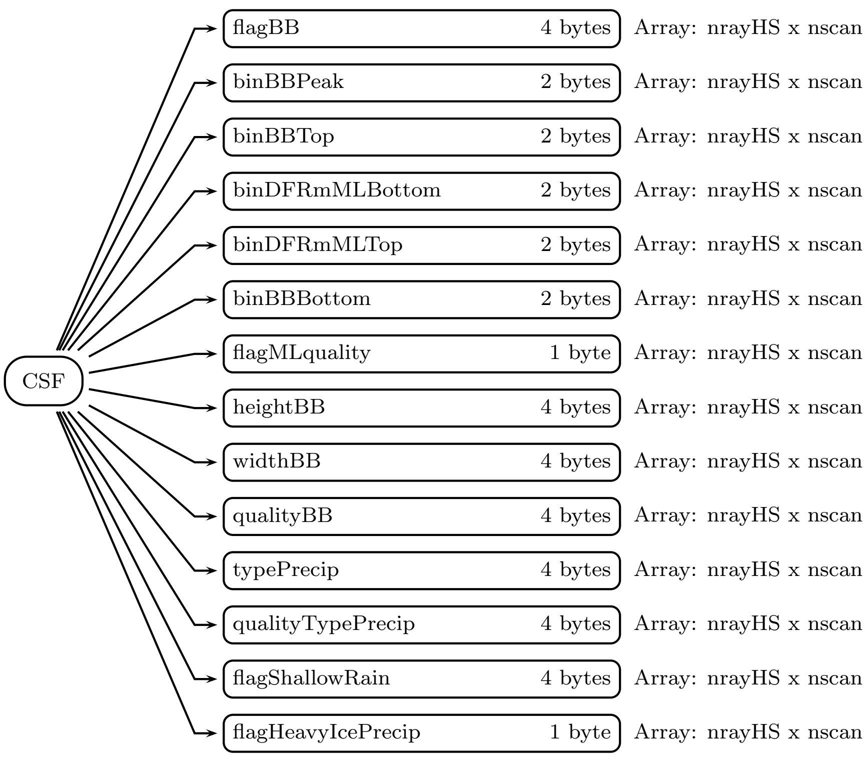


Figure 576: Data Format Structure for 2ADPR, HS, CSF

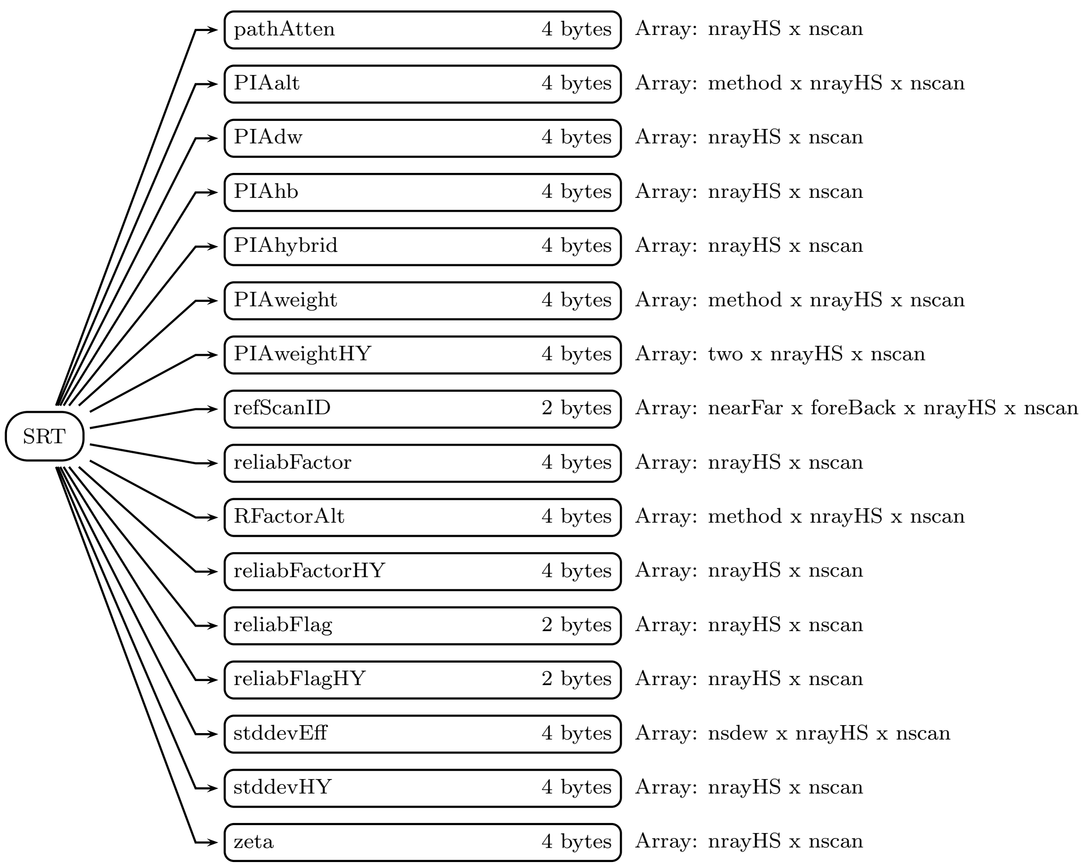


Figure 577: Data Format Structure for 2ADPR, HS, SRT

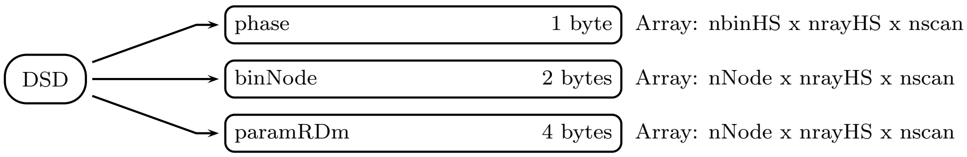


Figure 578: Data Format Structure for 2ADPR, HS, DSD

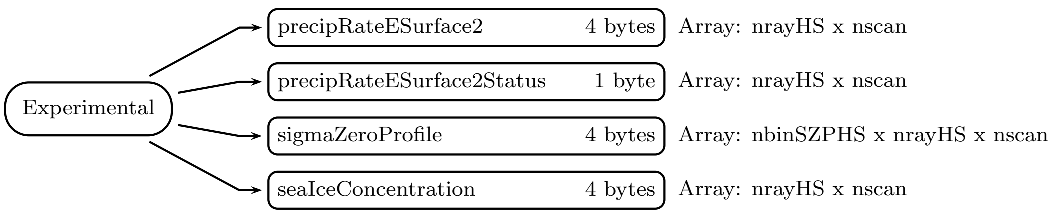


Figure 579: Data Format Structure for 2ADPR, HS, Experimental

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

FS (Swath)

FS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

SLV

flagSLV	1 byte	Array: nbinHS x nrayHS x nscan
paramDSD	4 bytes	Array: nDSD x nbinHS x nrayHS x nscan
binEchoBottom	2 bytes	Array: nrayHS x nscan
piaFinal	4 bytes	Array: nrayHS x nscan
sigmaZeroCorrected	4 bytes	Array: nrayHS x nscan
zFactorFinal	4 bytes	Array: nbinHS x nrayHS x nscan
zFactorFinalESurface	4 bytes	Array: nrayHS x nscan
zFactorFinalNearSurface	4 bytes	Array: nrayHS x nscan
paramNUBF	4 bytes	Array: nNUBF x nrayHS x nscan
precipRate	4 bytes	Array: nbinHS x nrayHS x nscan
precipWater	4 bytes	Array: nbinHS x nrayHS x nscan
precipWaterIntegrated	4 bytes	Array: LS x nrayHS x nscan
qualitySLV	4 bytes	Array: nrayHS x nscan
precipRateNearSurface	4 bytes	Array: nrayHS x nscan
precipRateESurface	4 bytes	Array: nrayHS x nscan
precipRateAve24	4 bytes	Array: nrayHS x nscan
phaseNearSurface	1 byte	Array: nrayHS x nscan
epsilon	4 bytes	Array: nbinHS x nrayHS x nscan
piaOffset	4 bytes	Array: nrayHS x nscan

Figure 580: Data Format Structure for 2ADPR, HS, SLV

FLG

flagEcho	1 byte	Array: nbinHS x nrayHS x nscan
qualityData	4 bytes	Array: nrayHS x nscan
qualityFlag	1 byte	Array: nrayHS x nscan
flagSensor	1 byte	Array: nscan
flagScanPattern	2 bytes	Array: nscan

Figure 581: Data Format Structure for 2ADPR, HS, FLG

ScanTime (Group in FS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod.

Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in FS)

dataQuality (1-byte integer, array size: nfreq x nscan):
A summary of data quality in the scan. New in V07, dataQuality is a 2-element array: one element for each frequency (0-Ku 1-Ka). If both elements are zero, the DPR scan may be used. If a single value for DPR quality is desired, the user may bitwise OR the values. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nfreq x nscan):
Flag of data warning for each scan. The same as with dataQuality, this is a 2-element array: one element for each frequency (0-Ku 1-Ka).

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nfreq x nscan):
Indicates whether information is contained in the scan data. The same as with dataQuality, this is a 2-element array: one element for each frequency (0-Ku 1-Ka). The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nfreq x nscan):
A summary of status modes. The same as with dataQuality, this is a 2-element array: one element for each frequency (0-Ku 1-Ka). If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nfreq x nscan):
A summary of geolocation errors in the scan. The same as with dataQuality, this is a 2-element array: one element for each frequency (0-Ku 1-Ka). geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
```

```
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nfreq x nscan):
A summary of geolocation warnings in the scan. The same as with dataQuality, this is a 2-element array: one element for each frequency (0-Ku 1-Ka). geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nfreq x nscan):
pointingStatus is provided by the geo Toolkit. The same as with dataQuality, this is a 2-element array: one element for each frequency (0-Ku 1-Ka). A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nfreq x nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
The same as with dataQuality, this is a 2-element
array: one element for each frequency ( 0-Ku 1-Ka).
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nfreq x nscan):

```
Bit flags for every ray with information
about echo power limit checks.
```

```
The same as with dataQuality, this is a 2-element
array: one element for each frequency ( 0-Ku 1-Ka).
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in FS)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the

Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group in FS)

elevation (4-byte float, array size: nray x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nray x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
```

```
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nfreq x nray x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nray x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nfreq x nray x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0  : normal (under saturated level)
1  : possible saturated level at real surface
2  : saturated level at real surface
99 : missing
```

binRealSurface (2-byte integer, array size: nfreq x nray x nscan):
Range bin number for real surface. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the

Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nray x nscan):
Range bin number for the storm top. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nray x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

height (4-byte float, array size: nbin x nray x nscan):
Height. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nray x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nfreq x nray x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nfreq x nbin x nray x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nfreq x nray x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

adjustFactor (4-byte float, array size: nfreq x nray x nscan):
Adjustment factor (dB) for zFactorMeasured (dBZm') and sigmaZeroMeasured (dBs0m'). dBZm' and dBs0m' are used and stored as follows:

```
dBZm' = dBZm - adjustFactor
dBs0m' = dBs0m - adjustFactor
The adjustment factor is the sum of 3 components:
base adjustment for instrument dependency,
angle-bin adjustment for angle-bin dependency, and
temporal adjustment for orbit number dependency.
```

snowIceCover (1-byte integer, array size: nray x nscan):
TBD. Special values are defined as:
-99 Missing value

binMirrorImageL2 (2-byte integer, array size: nray x nscan):
Range bin number of the mirror image.

echoCountRealSurface (1-byte char, array size: nfreq x nray x nscan):
Echo count at a surface position (binRealSurface). Missing value = 0.

VER (Group in FS)

airTemperature (4-byte float, array size: nbin x nray x nscan):
Air Temperature. Values are in K. Special values are defined as:
-9999.9 Missing value

binZeroDeg (2-byte integer, array size: nray x nscan):

```
Range bin number with 0 degrees C level.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
```

```
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(FS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nfreq x nbin x nray x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nfreq x nNP x nray x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

piaNPrainFree (4-byte float, array size: nfreq x nNP x nray x nscan):
TBD Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nfreq x nray x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nray x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

flagInversion (2-byte integer, array size: nray x nscan):

```
TBD
```

binZeroDegSecondary (2-byte integer, array size: nray x nscan):
TBD Special values are defined as:
-9999 Missing value

CSF (Group in FS)

flagBB (4-byte integer, array size: nray x nscan):
Bright band (BB) exists or not. The definition is different for L2 DPR on the one hand and L2 Ku and L2 Ka on the other.

```
L2 DPR:
0      no Bright Band
1      Bright Band detected by Ku and DFRm
2      Bright Band detected by Ku only
3      Bright Band detected by DFRm only
-1111  No rain value
-9999  Missing value

L2 Ku and L2 Ka:
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nray x nscan):
Range bin number for the peak of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binDFRmMLBottom (2-byte integer, array size: nray x nscan):
Range bin number for melting layer bottom detected by the DFRm method.

```
Value  Meaning
   >0  Range bin number when ML bottom is detected
    0  ML bottom not detected
-1111  Value for no rain in MS(HS) mode at Ka band
-9999  Missing
```

binDFRmMLTop (2-byte integer, array size: nray x nscan):
Range bin number for melting layer top detected by the DFRm method.

```
Value  Meaning
   >0  Range bin number when ML top is detected
    0  ML top not detected
```

```
-1111  Value for no rain in MS(HS) mode at Ka band
-9999  Missing
```

binBBBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipTop (2-byte integer, array size: nfreqHI x nray x nscan):
Range bin number for the top of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipBottom (2-byte integer, array size: nfreqHI x nray x nscan):
Range bin number for the bottom of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

nHeavyIcePrecip (1-byte char, array size: nfreqHI x nray x nscan):
The number of heavy ice precip. Special values are defined as:
0 Missing value

flagMLquality (1-byte char, array size: nray x nscan):
ML quality flag. Special values are defined as:
255 Missing value

heightBB (4-byte float, array size: nray x nscan):
Height of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nray x nscan):
The width of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nray x nscan):

```
Quality of the bright band.
When the bright band is detected,
a larger positive number indicates lower
confidence in the detection.

The Ku detection is clear, but
the Ka and DPR detection is
somewhat doubtful.

The meaning of qualityBB has not
been finalized.

3      Smeared bright band
2      Not so clear bright band
1      Clear bright band
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nray x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value

Let abcdefgh be the 8 digit number,

  abcdefgh

then
   a: Main rain type. (a=1,2,3),
   b: 0,
   c: 0,
   d: V rain type,
   e: H rain type,
   f: BB,
   g: Shallow rain,
```

```
   h: Small size cell.
----------------------------------------------------
The following numbers appear as Ku and Ka (MS/HS) rain types:
   ---- stratiform
   1001H100
   10031000
   ---- convective
   2001H1xy (x>0 or y>0)
   2002Hbxy
   200310xy (x>0 or y>0)
   200320xy
   ---- other
   300330xy
where H is the rain type by H-method, and b depends on BB,
x on shallow rain and y on small size cell:
  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  b = 0: BB not detected,
      1: BB detected.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
=============================================================
```

In the DPR product, rain type by the DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 8    DFRm method cannot be applicable at Part B (in this case
       the conventional method determines the major rain type)
     = 9    DFRm method cannot be applicable at Part A (in this case
```

```
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value

 If dual frequency data is not available
 but Ku-only or Ka-olny is available,
 rain type is expressed by the following 8 digit number:
   10xxxxxx --- stratiform,
   20xxxxxx --- convective,
   30xxxxxx --- other,
 wihch is a copy of Ku-only module or Ka-only module.

 If dual frequency data is available, rain type is
 expressed by
   1qxxxxxx --- stratiform,
   2qxxxxxx --- convective,
   3qxxxxxx --- other,
 where q>0.
 Thus, by examining q, users can understand whether
 data is processed by dual frequency algorithm or
 single frequency algorithm.
 =======================================
 For MS and HS, DFRm method is used.
 =======================================
 DFRm decision classifies rain type into
    stratiform,
    convective,
 and
    transition.
 ----------------------------------------------------------
 The DPR numbering rule can be summarized as follows:
 Let opqrstuv be the 8 digit number, then
    o: Main rain type. (o=1,2,3),
    p: DFRm rain type. (p=0,1,2,4,8,9, with p=0 for single frequency data only),
    q: DFRm BB. (q=0,1),
    r: V rain type (by conventional V-method).
       Basically r=0 for inner swath and r>0 for outer swath.
       However, r>0 when only single frequency data is available,
    s: H rain type,
    t: = 0 for innner swath,
         1 when BB is detected in the outer swath.
    u: Shallow rain,
```

```
   v: Small size cell.
============================
============================
DFRm type can be obtained by examining p
============================
The meaning of p is as follows:
 p = 0: single frequency data only (dual frequncy data not available),
     1: stratiform by DFRm method,
     2: convective by DFRm method,
     4: transition by DFRm method,
     8: DFRm decision not available,
     9: DFRm decision not available.
Note that p>0 always in DPR processing, which is different
from Ku-only or Ka-only result.
In Ku-only or Ka-only rain type numbering, p=0 always.
----------------------------------------------------------
===============================================
The following numbers appear as DPR rain types:
===============================================
**************************
*   For FS outer swath   *
**************************
  --- stratiform
  1901H100
  19031000
  --- convective
  2901H1xy (x>0 or y>0, see R\_type\_classification\_dpr2)
  2902Hwxy
  290310xy (x>0, y>0, see R\_type\_classification\_dpr2)
  290320xy
  --- other
  390330xy

*******************************
*  For FS inner swath and MS  *
*******************************
  --- stratiform
  11B0H0xy
  14B01000
  19001000 --- H decision only
  19011000 --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  19013000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
```

```
            or FS rain >0 but no MS rain; FS V and H determine rain type
  19031000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
            or FS rain >0 but no MS rain; FS V and H determine rain type
  --- convective
  2100H0xy (x>0 or y>0)
  2110H00y (y>0)
  2200H0xy
  2210H00y
  2400H0xy
  2410H00y
  290010xy --- H decision only (x>0 or y>0)
  290020xy --- H decision only
  2901H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
            (x>0 or y>0 for H=1,3)
  2902H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  290310xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            (x>0 or y>0)
  290320xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  --- other
  340030xy
  390030xy --- H decision only
  390330xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type

**************
*   For HS   *
**************
  --- stratiform
  11B0H000
  14B01000
  19001000 --- H decision only
  --- convective
  21B0H0x0 (x>0)
  22B0H0x0
  240010x0 (x>0, 24B010x0 with B=0)
  240020x0
  241010x0 (x>0, 24B010x0 with B=1)
  290010x0 (x>0) --- H decision only
  290020x0 --- H decision only
  --- other
```

```
  340030x0
  390030x0 --- H decision only

 where w depends on BB by conventional V-method, B on BB
 by DFRm method, H on H-method, x on shallow rain
 and y on small size cell:
   w = 0: BB not detected by conventional V-method,
       1: BB detected by conventional V-methd.

   B = 0: BB not detected by DFRm method,
       1: BB detected by DFRm methd.

   H = 1: stratiform by H-method,
       2: convective by H-method,
       3: other by H-method.

   x = 0: No shallow rain,
       1: Shallow isolated,
       3: Shallow non-isolated.

   y = 0: No small size cell,
       1: Single cell,
       2: Small size cell consisting of two adjacent pixels.
 In the above, x>0 and y>0 are taken care of in the function
 R\_type\_classification\_dpr2().
 =============================================================
```

qualityTypePrecip (4-byte integer, array size: nray x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nray x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
```

```
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

flagHeavyIcePrecip (1-byte integer, array size: nray x nscan):
This flag denotes strong or severe precipitation accompanied by solid ice hydrometeors above the -10 degree C isotherm. Special values are defined as:
0 Missing value

flagAnvil (1-byte integer, array size: nray x nscan):

```
flagAnvil is 1 when anvil is detected by the Ku-band radar,
0 when anvil is not detected, and
-99 when the data is missing.

Note that Ka-band decision is not made because of a lower
sensitivity of Ka-band radar (therefore, there does not
exist any Ka-band flagAnvil; only Ku-band flagAnvil
is available in Ku-only and DPR FS).
```

flagHail (1-byte integer, array size: nray x nscan):

```
0 Hail not detected
1 Fail detected
-99 missing.
```

SRT (Group in FS)

pathAtten (4-byte float, array size: nfreq x nray x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAalt (4-byte float, array size: nfreq x method x nray x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAdw (4-byte float, array size: nfreq x nray x nscan):
The 2-way attenuation.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhb (4-byte float, array size: nfreq x nray x nscan):
The 2-way attenuation of HB.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhybrid (4-byte float, array size: nfreq x nray x nscan):
The 2-way attenuation from a weighted combination of HB and SRT.

Values are in dB. Special values are defined as:
-9999.9 Missing value

piaExp (4-byte float, array size: nfreq x nray x nscan):
TBD.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweightHY (4-byte float, array size: three x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nray x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

reliabFactor (4-byte float, array size: nray x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nray x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

reliabFactorHY (4-byte float, array size: nray x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nray x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff $>$ 3 ; PIAeff estimate is considered reliable
= 2 if 3 $\geq$ Rel_eff $>$ 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff $\leq$ 1 ; PIAeff is unreliable
= 4 if SNR_at surface $<$ 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

reliabFlagHY (2-byte integer, array size: nray x nscan):
TBD.

Special values are defined as:
-9999 Missing value

stddevEff (4-byte float, array size: nfreq x nsdew x nray x nscan):
The effective standard deviation of PIA-SRT computed 3 ways.

Special values are defined as:
-9999.9 Missing value

stddevHY (4-byte float, array size: nfreq x nray x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

zeta (4-byte float, array size: nfreq x nray x nscan):
The term in the HB estimate of path attenuation.

Special values are defined as:
-9999.9 Missing value

DSD (Group in FS)

phase (1-byte char, array size: nbin x nray x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                       the top and peak of bright band
phase = 175 is used for the range bins between
```

```
                    the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nray x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

paramRDm (4-byte float, array size: nNode x nray x nscan):
TBD Special values are defined as:
-9999.9 Missing value

Experimental (Group in FS)

precipRateESurface2 (4-byte float, array size: nray x nscan):
Estimates Surface Precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Values are in mm/hr. Special values are

defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nray x nscan):
Status of the estimated surface precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nfreq x nbinSZP x nray x nscan):
Surface backscattering cross section profile around the current ifov. For information on this experimental field contact the Joint DPR Team. Values are in dB. Special values are defined as:
-9999.9 Missing value

seaIceConcentration (4-byte float, array size: nray x nscan):
Sea ice concentration estimated by Ku. For information on this experimental field contact the Joint DPR Team. Values range from 30 to 100 percent. Special values are defined as:
-9999.9 Missing value

flagSurfaceSnowfall (1-byte char, array size: nray x nscan):
Flag indicating snowfall on the surface, not aloft. 1 for snow, 0 for not snow. Special values are defined as:
255 Missing value

flagGraupelHail (1-byte char, array size: nray x nscan):
Graupel or Hail flag. Special values are defined as:
255 Missing value

binMixedPhaseTop (2-byte integer, array size: nray x nscan):
The range bin of the mixed phase top. Special values are defined as:
-9999 Missing value

surfaceSnowfallIndex (4-byte float, array size: nray x nscan):
Housekeeping product for test purposes. Special values are defined as:
-9999.9 Missing value

SLV (Group in FS)

flagSLV (1-byte integer, array size: nbin x nray x nscan):
Special values are defined as:
-99 Missing value

paramDSD (4-byte float, array size: nDSD x nbin x nray x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

binEchoBottom (2-byte integer, array size: nray x nscan):
For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nfreq x nray x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nfreq x nray x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorFinal (4-byte float, array size: nfreq x nbin x nray x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (4-byte float, array size: nfreq x nray x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (4-byte float, array size: nfreq x nray x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramNUBF (4-byte float, array size: nNUBF x nray x nscan):
TBD. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbin x nray x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWater (4-byte float, array size: nbin x nray x nscan):
The amount of precipitable water. Values are in kg/m^3. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nray x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nray x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are

defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nray x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nray x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nray x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nray x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbin x nray x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

DFRforward1 (4-byte float, array size: nbin x nray x nscan):
TBD Special values are defined as:
-9999.9 Missing value

piaOffset (4-byte float, array size: nfreq x nray x nscan):
TBD. Values are in dB. Special values are defined as:
-9999.9 Missing value

FLG (Group in FS)

flagEcho (1-byte integer, array size: nbin x nray x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nray x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
```

```
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

qualityFlag (1-byte integer, array size: nfreq x nray x nscan):
Flag derived from qualityData with the following values: Special values are defined as:
-99 Missing value

```
Value    Meaning
0        High quality.  No issues.
1        Low quality (DPR modules had warnings but still made a retrieval)
2        Bad (DPR modules had errors or dataQuality is bad and
         retrieval is missing)
```

flagSensor (1-byte integer, array size: nfreq x nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

flagScanPattern (2-byte integer, array size: nfreq x nscan):

```
Flag of scan pattern.

Value  Meaning
1      TBD
-9999  Missing
```

TRG (Group in FS)

This is an experimental part of the retrieval algorithm. Currently all fields within this group are set to zero.

NUBFindex (4-byte float, array size: nray x nscan):
Qualitative index for presence of NUBF. Not to be used, just for our development and debugging. Values range from 0 to 100. Special values are defined as:
-9999.9 Missing value

MSindex (4-byte integer, array size: nray x nscan):

```
                                        Index for presence of MS based on Ku and Ka re
                                        Values [0,50,100]
```

MSindexKu (4-byte integer, array size: nray x nscan):

```
Index for presence of MS based on Ku return signal only.
                                        Values [0,50,100]
```

MSindexKa (4-byte integer, array size: nray x nscan):

```
.Index for presence of MS based on Ka return signal only.
                                        Values [0,50,100]
```

MSsurfPeakIndexKu (4-byte integer, array size: nray x nscan):

```
Index for detection of surface peak for Ku return signal.
                                        Values [0,50,100]
```

MSsurfPeakIndexKa (4-byte integer, array size: nray x nscan):

```
Index for detection of surface peak for Ka return signal.
                                        Values [0,50,100]
```

MSkneeDFRindex (4-byte integer, array size: nray x nscan):

```
Index for detection of knee feature in DFR (see GPM\_dfr\_knee fig).
                                        Values[0,50,100]
```

MSslopesKu (4-byte float, array size: four x nray x nscan):

```
Slope values in different portion of the Ku signal
                                        around the surface peak (see GPM\_slopes fig).
                                        Values [0,50,100]
```

MSslopesKa (4-byte float, array size: four x nray x nscan):

```
Slope values in different portion of the Ka signal
                                        around the surface peak (see GPM\_slopes fig).
                                        Values [0,50,100]
```

HS (Swath)

HS_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in HS)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nrayHS x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nrayHS x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nrayHS x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in HS)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
```

```
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
```

```
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
```

```
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in HS)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time.

Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values

range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group in HS)

elevation (4-byte float, array size: nrayHS x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product.

Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nrayHS x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nrayHS x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nrayHS x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nrayHS x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:
```

```
0  : normal (under saturated level)
1  : possible saturated level at real surface
2  : saturated level at real surface
99 : missing
```

binRealSurface (2-byte integer, array size: nrayHS x nscan):
Range bin number for real surface. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for the storm top. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nrayHS x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

height (4-byte float, array size: nbinHS x nrayHS x nscan):
Height. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nrayHS x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nrayHS x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
```

```
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nrayHS x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

adjustFactor (4-byte float, array size: nrayHS x nscan):
Adjustment factor (dB) for zFactorMeasured (dBZm') and sigmaZeroMeasured (dBs0m'). dBZm' and dBs0m' are used and stored as follows:

```
dBZm' = dBZm - adjustFactor
dBs0m' = dBs0m - adjustFactor
The adjustment factor is the sum of 3 components:
base adjustment for instrument dependency,
angle-bin adjustment for angle-bin dependency, and
temporal adjustment for orbit number dependency.
```

snowIceCover (1-byte integer, array size: nrayHS x nscan):
TBD. Special values are defined as:
-99 Missing value

binMirrorImageL2 (2-byte integer, array size: nrayHS x nscan):
Range bin number of the mirror image.

echoCountRealSurface (1-byte char, array size: nrayHS x nscan):
Echo count at a surface position (binRealSurface). Missing value = 0.

VER (Group in HS)

airTemperature (4-byte float, array size: nbinHS x nrayHS x nscan):
Air Temperature. Values are in K. Special values are defined as:
-9999.9 Missing value

binZeroDeg (2-byte integer, array size: nrayHS x nscan):

```
Range bin number with 0 degrees C level.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(FS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nrayHS x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

piaNPrainFree (4-byte float, array size: nNP x nrayHS x nscan):
TBD Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nrayHS x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nrayHS x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

flagInversion (2-byte integer, array size: nrayHS x nscan):

```
TBD
```

binZeroDegSecondary (2-byte integer, array size: nrayHS x nscan):
TBD Special values are defined as:
-9999 Missing value

CSF (Group in HS)

flagBB (4-byte integer, array size: nrayHS x nscan):
Bright band (BB) exists or not. The definition is different for L2 DPR on the one hand and L2 Ku and L2 Ka on the other.

```
L2 DPR:
0      no Bright Band
1      Bright Band detected by Ku and DFRm
2      Bright Band detected by Ku only
3      Bright Band detected by DFRm only
-1111  No rain value
-9999  Missing value

L2 Ku and L2 Ka:
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nrayHS x nscan):
Range bin number for the peak of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for the top of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binDFRmMLBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for melting layer bottom detected by the DFRm method.

```
Value  Meaning
   >0  Range bin number when ML bottom is detected
    0  ML bottom not detected
-1111  Value for no rain in MS(HS) mode at Ka band
-9999  Missing
```

binDFRmMLTop (2-byte integer, array size: nrayHS x nscan):
Range bin number for melting layer top detected by the DFRm method.

```
Value  Meaning
   >0  Range bin number when ML top is detected
    0  ML top not detected
-1111  Value for no rain in MS(HS) mode at Ka band
-9999  Missing
```

binBBBottom (2-byte integer, array size: nrayHS x nscan):
Range bin number for the bottom of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

flagMLquality (1-byte char, array size: nrayHS x nscan):
ML quality flag. Special values are defined as:
255 Missing value

heightBB (4-byte float, array size: nrayHS x nscan):
Height of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nrayHS x nscan):
The width of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nrayHS x nscan):

```
Quality of the bright band.
When the bright band is detected,
a larger positive number indicates lower
confidence in the detection.

The Ku detection is clear, but
the Ka and DPR detection is
somewhat doubtful.

The meaning of qualityBB has not
been finalized.

3      Smeared bright band
```

```
2      Not so clear bright band
1      Clear bright band
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nrayHS x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value

Let abcdefgh be the 8 digit number,

  abcdefgh

then
   a: Main rain type. (a=1,2,3),
   b: 0,
   c: 0,
   d: V rain type,
   e: H rain type,
   f: BB,
   g: Shallow rain,
   h: Small size cell.
----------------------------------------------------
The following numbers appear as Ku and Ka (MS/HS) rain types:
   ---- stratiform
   1001H100
   10031000
   ---- convective
   2001H1xy (x>0 or y>0)
   2002Hbxy
   200310xy (x>0 or y>0)
   200320xy
   ---- other
   300330xy
```

```
where H is the rain type by H-method, and b depends on BB,
x on shallow rain and y on small size cell:
  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  b = 0: BB not detected,
      1: BB detected.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
=============================================================
```

In the DPR product, rain type by the DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 8    DFRm method cannot be applicable at Part B (in this case
       the conventional method determines the major rain type)
     = 9    DFRm method cannot be applicable at Part A (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value

 If dual frequency data is not available
 but Ku-only or Ka-olny is available,
 rain type is expressed by the following 8 digit number:
   10xxxxxx --- stratiform,
   20xxxxxx --- convective,
   30xxxxxx --- other,
 wihch is a copy of Ku-only module or Ka-only module.
```

```
If dual frequency data is available, rain type is
expressed by
  1qxxxxxx --- stratiform,
  2qxxxxxx --- convective,
  3qxxxxxx --- other,
where q>0.
Thus, by examining q, users can understand whether
data is processed by dual frequency algorithm or
single frequency algorithm.
=======================================
For MS and HS, DFRm method is used.
=======================================
DFRm decision classifies rain type into
   stratiform,
   convective,
and
   transition.
----------------------------------------------------------
The DPR numbering rule can be summarized as follows:
Let opqrstuv be the 8 digit number, then
   o: Main rain type. (o=1,2,3),
   p: DFRm rain type. (p=0,1,2,4,8,9, with p=0 for single frequency data only),
   q: DFRm BB. (q=0,1),
   r: V rain type (by conventional V-method).
      Basically r=0 for inner swath and r>0 for outer swath.
      However, r>0 when only single frequency data is available,
   s: H rain type,
   t: = 0 for innner swath,
        1 when BB is detected in the outer swath.
   u: Shallow rain,
   v: Small size cell.
============================
============================
DFRm type can be obtained by examining p
============================
The meaning of p is as follows:
 p = 0: single frequency data only (dual frequncy data not available),
     1: stratiform by DFRm method,
     2: convective by DFRm method,
     4: transition by DFRm method,
     8: DFRm decision not available,
     9: DFRm decision not available.
Note that p>0 always in DPR processing, which is different
```

```
from Ku-only or Ka-only result.
In Ku-only or Ka-only rain type numbering, p=0 always.
-----------------------------------------------------------
================================================
The following numbers appear as DPR rain types:
================================================
**************************
*   For FS outer swath   *
**************************
  --- stratiform
  1901H100
  19031000
  --- convective
  2901H1xy (x>0 or y>0, see R\_type\_classification\_dpr2)
  2902Hwxy
  290310xy (x>0, y>0, see R\_type\_classification\_dpr2)
  290320xy
  --- other
  390330xy

*******************************
*  For FS inner swath and MS  *
*******************************
  --- stratiform
  11B0H0xy
  14B01000
  19001000 --- H decision only
  19011000 --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  19013000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
            or FS rain >0 but no MS rain; FS V and H determine rain type
  19031000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
            or FS rain >0 but no MS rain; FS V and H determine rain type
  --- convective
  2100H0xy (x>0 or y>0)
  2110H00y (y>0)
  2200H0xy
  2210H00y
  2400H0xy
  2410H00y
  290010xy --- H decision only (x>0 or y>0)
  290020xy --- H decision only
  2901H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
```

```
            or FS rain >0 but no MS rain; FS V and H determine rain type
            (x>0 or y>0 for H=1,3)
  2902H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  290310xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            (x>0 or y>0)
  290320xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  --- other
  340030xy
  390030xy --- H decision only
  390330xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type

**************
*   For HS   *
**************
  --- stratiform
  11B0H000
  14B01000
  19001000 --- H decision only
  --- convective
  21B0H0x0 (x>0)
  22B0H0x0
  240010x0 (x>0, 24B010x0 with B=0)
  240020x0
  241010x0 (x>0, 24B010x0 with B=1)
  290010x0 (x>0) --- H decision only
  290020x0 --- H decision only
  --- other
  340030x0
  390030x0 --- H decision only

where w depends on BB by conventional V-method, B on BB
by DFRm method, H on H-method, x on shallow rain
and y on small size cell:
  w = 0: BB not detected by conventional V-method,
      1: BB detected by conventional V-methd.

  B = 0: BB not detected by DFRm method,
      1: BB detected by DFRm methd.

  H = 1: stratiform by H-method,
```

```
      2: convective by H-method,
      3: other by H-method.

   x = 0: No shallow rain,
       1: Shallow isolated,
       3: Shallow non-isolated.

   y = 0: No small size cell,
       1: Single cell,
       2: Small size cell consisting of two adjacent pixels.
 In the above, x>0 and y>0 are taken care of in the function
 R\_type\_classification\_dpr2().
 ==============================================================
```

qualityTypePrecip (4-byte integer, array size: nrayHS x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nrayHS x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

flagHeavyIcePrecip (1-byte integer, array size: nrayHS x nscan):
This flag denotes strong or severe precipitation accompanied by solid ice hydrometeors above the -10 degree C isotherm. Special values are defined as:

0	Missing value

SRT (Group in HS)

pathAtten (4-byte float, array size: nrayHS x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAalt (4-byte float, array size: method x nrayHS x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAdw (4-byte float, array size: nrayHS x nscan):
The 2-way attenuation.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhb (4-byte float, array size: nrayHS x nscan):
The 2-way attenuation of HB.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhybrid (4-byte float, array size: nrayHS x nscan):
The 2-way attenuation from a weighted combination of HB and SRT.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nrayHS x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweightHY (4-byte float, array size: two x nrayHS x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nrayHS x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

reliabFactor (4-byte float, array size: nrayHS x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nrayHS x nscan):
The reliability factors associated with the individual PIA estimates corresponding to PIAalt. Special values are defined as:
-9999.9 Missing value

reliabFactorHY (4-byte float, array size: nrayHS x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nrayHS x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff > 3 ; PIAeff estimate is considered reliable
= 2 if 3 ≥ Rel_eff > 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff ≤ 1 ; PIAeff is unreliable
= 4 if SNR_at surface < 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

reliabFlagHY (2-byte integer, array size: nrayHS x nscan):
TBD.

Special values are defined as:
-9999 Missing value

stddevEff (4-byte float, array size: nsdew x nrayHS x nscan):
The effective standard deviation of PIA-SRT computed 3 ways.

Special values are defined as:
-9999.9 Missing value

stddevHY (4-byte float, array size: nrayHS x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

zeta (4-byte float, array size: nrayHS x nscan):
The term in the HB estimate of path attenuation.

Special values are defined as:
-9999.9 Missing value

DSD (Group in HS)

phase (1-byte char, array size: nbinHS x nrayHS x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                       the top and peak of bright band
phase = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nrayHS x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

paramRDm (4-byte float, array size: nNode x nrayHS x nscan):
TBD Special values are defined as:
-9999.9 Missing value

Experimental (Group in HS)

precipRateESurface2 (4-byte float, array size: nrayHS x nscan):
Estimates Surface Precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nrayHS x nscan):
Status of the estimated surface precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZPHS x nrayHS x nscan):
Surface backscattering cross section profile around the current ifov. For information on this experimental field contact the Joint DPR Team. Values are in dB. Special values are defined as:
-9999.9 Missing value

seaIceConcentration (4-byte float, array size: nrayHS x nscan):
Sea ice concentration estimated by Ku. For information on this experimental field contact the Joint DPR Team. Values range from 30 to 100 percent. Special values are defined as:
-9999.9 Missing value

SLV (Group in HS)

flagSLV (1-byte integer, array size: nbinHS x nrayHS x nscan):
Special values are defined as:
-99 Missing value

paramDSD (4-byte float, array size: nDSD x nbinHS x nrayHS x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

binEchoBottom (2-byte integer, array size: nrayHS x nscan):
For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nrayHS x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nrayHS x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorFinal (4-byte float, array size: nbinHS x nrayHS x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (4-byte float, array size: nrayHS x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (4-byte float, array size: nrayHS x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramNUBF (4-byte float, array size: nNUBF x nrayHS x nscan):
TBD. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbinHS x nrayHS x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWater (4-byte float, array size: nbinHS x nrayHS x nscan):
The amount of precipitable water. Values are in kg/m^3. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nrayHS x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nrayHS x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nrayHS x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nrayHS x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are

defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nrayHS x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nrayHS x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbinHS x nrayHS x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

piaOffset (4-byte float, array size: nrayHS x nscan):
TBD. Values are in dB. Special values are defined as:
-9999.9 Missing value

FLG (Group in HS)

flagEcho (1-byte integer, array size: nbinHS x nrayHS x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.
```

```
Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nrayHS x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

qualityFlag (1-byte integer, array size: nrayHS x nscan):
Flag derived from qualityData with the following values: Special values are defined as:
-99 Missing value

```
Value    Meaning
0        High quality.  No issues.
1        Low quality (DPR modules had warnings but still made a retrieval)
2        Bad (DPR modules had errors or dataQuality is bad and
         retrieval is missing)
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

flagScanPattern (2-byte integer, array size: nscan):

```
Flag of scan pattern.

Value  Meaning
1      TBD
-99    Missing
```

C Structure Header file:

```
#ifndef _TK_2ADPR_H_
#define _TK_2ADPR_H_

#ifndef _L2ADPR_HS_FLG_
#define _L2ADPR_HS_FLG_

typedef struct {
    signed char flagEcho[24][88];
    int qualityData[24];
    signed char qualityFlag[24];
    signed char flagSensor;
    short flagScanPattern;
} L2ADPR_HS_FLG;

#endif

#ifndef _L2ADPR_HS_SLV_
```

```
#define _L2ADPR_HS_SLV_

typedef struct {
    signed char flagSLV[24][88];
    float paramDSD[24][88][2];
    short binEchoBottom[24];
    float piaFinal[24];
    float sigmaZeroCorrected[24];
    float zFactorFinal[24][88];
    float zFactorFinalESurface[24];
    float zFactorFinalNearSurface[24];
    float paramNUBF[24][3];
    float precipRate[24][88];
    float precipWater[24][88];
    float precipWaterIntegrated[24][2];
    int qualitySLV[24];
    float precipRateNearSurface[24];
    float precipRateESurface[24];
    float precipRateAve24[24];
    unsigned char phaseNearSurface[24];
    float epsilon[24][88];
    float piaOffset[24];
} L2ADPR_HS_SLV;

#endif

#ifndef _L2ADPR_HS_EXPERIMENTAL_
#define _L2ADPR_HS_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[24];
    unsigned char precipRateESurface2Status[24];
    float sigmaZeroProfile[24][5];
    float seaIceConcentration[24];
} L2ADPR_HS_EXPERIMENTAL;

#endif

#ifndef _L2ADPR_HS_DSD_
#define _L2ADPR_HS_DSD_

typedef struct {
    unsigned char phase[24][88];
```

```
    short binNode[24][5];
    float paramRDm[24][5];
} L2ADPR_HS_DSD;

#endif

#ifndef _L2ADPR_HS_SRT_
#define _L2ADPR_HS_SRT_

typedef struct {
    float pathAtten[24];
    float PIAalt[24][6];
    float PIAdw[24];
    float PIAhb[24];
    float PIAhybrid[24];
    float PIAweight[24][6];
    float PIAweightHY[24][2];
    short refScanID[24][2][2];
    float reliabFactor[24];
    float RFactorAlt[24][6];
    float reliabFactorHY[24];
    short reliabFlag[24];
    short reliabFlagHY[24];
    float stddevEff[24][3];
    float stddevHY[24];
    float zeta[24];
} L2ADPR_HS_SRT;

#endif

#ifndef _L2ADPR_HS_CSF_
#define _L2ADPR_HS_CSF_

typedef struct {
    int flagBB[24];
    short binBBPeak[24];
    short binBBTop[24];
    short binDFRmMLBottom[24];
    short binDFRmMLTop[24];
    short binBBBottom[24];
    unsigned char flagMLquality[24];
    float heightBB[24];
    float widthBB[24];
```

```
    int qualityBB[24];
    int typePrecip[24];
    int qualityTypePrecip[24];
    int flagShallowRain[24];
    signed char flagHeavyIcePrecip[24];
} L2ADPR_HS_CSF;

#endif

#ifndef _L2ADPR_HS_VER_
#define _L2ADPR_HS_VER_

typedef struct {
    float airTemperature[24][88];
    short binZeroDeg[24];
    float attenuationNP[24][88];
    float piaNP[24][4];
    float piaNPrainFree[24][4];
    float sigmaZeroNPCorrected[24];
    float heightZeroDeg[24];
    short flagInversion[24];
    short binZeroDegSecondary[24];
} L2ADPR_HS_VER;

#endif

#ifndef _L2ADPR_HS_PRE_
#define _L2ADPR_HS_PRE_

typedef struct {
    float elevation[24];
    int landSurfaceType[24];
    float localZenithAngle[24];
    int flagPrecip[24];
    unsigned char flagSigmaZeroSaturation[24];
    short binRealSurface[24];
    short binStormTop[24];
    float heightStormTop[24];
    float height[24][88];
    short binClutterFreeBottom[24];
    float sigmaZeroMeasured[24];
    float zFactorMeasured[24][88];
    float ellipsoidBinOffset[24];
```

```
    float snRatioAtRealSurface[24];
    float adjustFactor[24];
    signed char snowIceCover[24];
    short binMirrorImageL2[24];
    unsigned char echoCountRealSurface[24];
} L2ADPR_HS_PRE;

#endif

#ifndef _L2ADPR_HS_SCANSTATUS_
#define _L2ADPR_HS_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2ADPR_HS_SCANSTATUS;

#endif

#ifndef _L2ADPR_HS_
#define _L2ADPR_HS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[24];
    float Longitude[24];
    float sunLocalTime[24];
    L2ADPR_HS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2ADPR_HS_PRE PRE;
    L2ADPR_HS_VER VER;
    L2ADPR_HS_CSF CSF;
```

```
    L2ADPR_HS_SRT SRT;
    L2ADPR_HS_DSD DSD;
    L2ADPR_HS_EXPERIMENTAL Experimental;
    L2ADPR_HS_SLV SLV;
    L2ADPR_HS_FLG FLG;
} L2ADPR_HS;

#endif

#ifndef _L2ADPR_FS_TRG_
#define _L2ADPR_FS_TRG_

typedef struct {
    float NUBFindex[49];
    int MSindex[49];
    int MSindexKu[49];
    int MSindexKa[49];
    int MSsurfPeakIndexKu[49];
    int MSsurfPeakIndexKa[49];
    int MSkneeDFRindex[49];
    float MSslopesKu[49][4];
    float MSslopesKa[49][4];
} L2ADPR_FS_TRG;

#endif

#ifndef _L2ADPR_FS_FLG_
#define _L2ADPR_FS_FLG_

typedef struct {
    signed char flagEcho[49][176];
    int qualityData[49];
    signed char qualityFlag[49][2];
    signed char flagSensor[2];
    short flagScanPattern[2];
} L2ADPR_FS_FLG;

#endif

#ifndef _L2ADPR_FS_SLV_
#define _L2ADPR_FS_SLV_

typedef struct {
```

```
    signed char flagSLV[49][176];
    float paramDSD[49][176][2];
    short binEchoBottom[49];
    float piaFinal[49][2];
    float sigmaZeroCorrected[49][2];
    float zFactorFinal[49][176][2];
    float zFactorFinalESurface[49][2];
    float zFactorFinalNearSurface[49][2];
    float paramNUBF[49][3];
    float precipRate[49][176];
    float precipWater[49][176];
    float precipWaterIntegrated[49][2];
    int qualitySLV[49];
    float precipRateNearSurface[49];
    float precipRateESurface[49];
    float precipRateAve24[49];
    unsigned char phaseNearSurface[49];
    float epsilon[49][176];
    float DFRforward1[49][176];
    float piaOffset[49][2];
} L2ADPR_FS_SLV;

#endif

#ifndef _L2ADPR_FS_EXPERIMENTAL_
#define _L2ADPR_FS_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[49];
    unsigned char precipRateESurface2Status[49];
    float sigmaZeroProfile[49][7][2];
    float seaIceConcentration[49];
    unsigned char flagSurfaceSnowfall[49];
    unsigned char flagGraupelHail[49];
    short binMixedPhaseTop[49];
    float surfaceSnowfallIndex[49];
} L2ADPR_FS_EXPERIMENTAL;

#endif

#ifndef _L2ADPR_FS_DSD_
#define _L2ADPR_FS_DSD_
```

```
typedef struct {
    unsigned char phase[49][176];
    short binNode[49][5];
    float paramRDm[49][5];
} L2ADPR_FS_DSD;

#endif

#ifndef _L2ADPR_FS_SRT_
#define _L2ADPR_FS_SRT_

typedef struct {
    float pathAtten[49][2];
    float PIAalt[49][6][2];
    float PIAdw[49][2];
    float PIAhb[49][2];
    float PIAhybrid[49][2];
    float piaExp[49][2];
    float PIAweight[49][6];
    float PIAweightHY[49][3];
    short refScanID[49][2][2];
    float reliabFactor[49];
    float RFactorAlt[49][6];
    float reliabFactorHY[49];
    short reliabFlag[49];
    short reliabFlagHY[49];
    float stddevEff[49][3][2];
    float stddevHY[49][2];
    float zeta[49][2];
} L2ADPR_FS_SRT;

#endif

#ifndef _L2ADPR_FS_CSF_
#define _L2ADPR_FS_CSF_

typedef struct {
    int flagBB[49];
    short binBBPeak[49];
    short binBBTop[49];
    short binDFRmMLBottom[49];
    short binDFRmMLTop[49];
    short binBBBottom[49];
```

```
    short binHeavyIcePrecipTop[49][3];
    short binHeavyIcePrecipBottom[49][3];
    unsigned char nHeavyIcePrecip[49][3];
    unsigned char flagMLquality[49];
    float heightBB[49];
    float widthBB[49];
    int qualityBB[49];
    int typePrecip[49];
    int qualityTypePrecip[49];
    int flagShallowRain[49];
    signed char flagHeavyIcePrecip[49];
    signed char flagAnvil[49];
    signed char flagHail[49];
} L2ADPR_FS_CSF;

#endif

#ifndef _L2ADPR_FS_VER_
#define _L2ADPR_FS_VER_

typedef struct {
    float airTemperature[49][176];
    short binZeroDeg[49];
    float attenuationNP[49][176][2];
    float piaNP[49][4][2];
    float piaNPrainFree[49][4][2];
    float sigmaZeroNPCorrected[49][2];
    float heightZeroDeg[49];
    short flagInversion[49];
    short binZeroDegSecondary[49];
} L2ADPR_FS_VER;

#endif

#ifndef _L2ADPR_FS_PRE_
#define _L2ADPR_FS_PRE_

typedef struct {
    float elevation[49];
    int landSurfaceType[49];
    float localZenithAngle[49][2];
    int flagPrecip[49];
    unsigned char flagSigmaZeroSaturation[49][2];
```

```
    short binRealSurface[49][2];
    short binStormTop[49];
    float heightStormTop[49];
    float height[49][176];
    short binClutterFreeBottom[49];
    float sigmaZeroMeasured[49][2];
    float zFactorMeasured[49][176][2];
    float ellipsoidBinOffset[49];
    float snRatioAtRealSurface[49][2];
    float adjustFactor[49][2];
    signed char snowIceCover[49];
    short binMirrorImageL2[49];
    unsigned char echoCountRealSurface[49][2];
} L2ADPR_FS_PRE;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2ADPR_FS_SCANSTATUS_
```

```
#define _L2ADPR_FS_SCANSTATUS_

typedef struct {
    signed char dataQuality[2];
    signed char dataWarning[2];
    signed char missing[2];
    signed char modeStatus[2];
    short geoError[2];
    short geoWarning[2];
    short SCorientation;
    short pointingStatus[2];
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode[2];
    signed char limitErrorFlag[2];
    double FractionalGranuleNumber;
} L2ADPR_FS_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2ADPR_FS_
#define _L2ADPR_FS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
```

```
    float Longitude[49];
    float sunLocalTime[49];
    L2ADPR_FS_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2ADPR_FS_PRE PRE;
    L2ADPR_FS_VER VER;
    L2ADPR_FS_CSF CSF;
    L2ADPR_FS_SRT SRT;
    L2ADPR_FS_DSD DSD;
    L2ADPR_FS_EXPERIMENTAL Experimental;
    L2ADPR_FS_SLV SLV;
    L2ADPR_FS_FLG FLG;
    L2ADPR_FS_TRG TRG;
} L2ADPR_FS;

#endif

#ifndef _L2ADPR_SWATHS_
#define _L2ADPR_SWATHS_

typedef struct {
    L2ADPR_FS FS;
    L2ADPR_HS HS;
} L2ADPR_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2ADPR_HS_FLG/
    BYTE flagEcho(88,24)
    INTEGER*4 qualityData(24)
    BYTE qualityFlag(24)
    BYTE flagSensor
    INTEGER*2 flagScanPattern
END STRUCTURE

STRUCTURE /L2ADPR_HS_SLV/
    BYTE flagSLV(88,24)
    REAL*4 paramDSD(2,88,24)
    INTEGER*2 binEchoBottom(24)
```

```
    REAL*4 piaFinal(24)
    REAL*4 sigmaZeroCorrected(24)
    REAL*4 zFactorFinal(88,24)
    REAL*4 zFactorFinalESurface(24)
    REAL*4 zFactorFinalNearSurface(24)
    REAL*4 paramNUBF(3,24)
    REAL*4 precipRate(88,24)
    REAL*4 precipWater(88,24)
    REAL*4 precipWaterIntegrated(2,24)
    INTEGER*4 qualitySLV(24)
    REAL*4 precipRateNearSurface(24)
    REAL*4 precipRateESurface(24)
    REAL*4 precipRateAve24(24)
    CHARACTER phaseNearSurface(24)
    REAL*4 epsilon(88,24)
    REAL*4 piaOffset(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_EXPERIMENTAL/
    REAL*4 precipRateESurface2(24)
    CHARACTER precipRateESurface2Status(24)
    REAL*4 sigmaZeroProfile(5,24)
    REAL*4 seaIceConcentration(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_DSD/
    CHARACTER phase(88,24)
    INTEGER*2 binNode(5,24)
    REAL*4 paramRDm(5,24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_SRT/
    REAL*4 pathAtten(24)
    REAL*4 PIAalt(6,24)
    REAL*4 PIAdw(24)
    REAL*4 PIAhb(24)
    REAL*4 PIAhybrid(24)
    REAL*4 PIAweight(6,24)
    REAL*4 PIAweightHY(2,24)
    INTEGER*2 refScanID(2,2,24)
    REAL*4 reliabFactor(24)
    REAL*4 RFactorAlt(6,24)
    REAL*4 reliabFactorHY(24)
```

```
    INTEGER*2 reliabFlag(24)
    INTEGER*2 reliabFlagHY(24)
    REAL*4 stddevEff(3,24)
    REAL*4 stddevHY(24)
    REAL*4 zeta(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_CSF/
    INTEGER*4 flagBB(24)
    INTEGER*2 binBBPeak(24)
    INTEGER*2 binBBTop(24)
    INTEGER*2 binDFRmMLBottom(24)
    INTEGER*2 binDFRmMLTop(24)
    INTEGER*2 binBBBottom(24)
    CHARACTER flagMLquality(24)
    REAL*4 heightBB(24)
    REAL*4 widthBB(24)
    INTEGER*4 qualityBB(24)
    INTEGER*4 typePrecip(24)
    INTEGER*4 qualityTypePrecip(24)
    INTEGER*4 flagShallowRain(24)
    BYTE flagHeavyIcePrecip(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_VER/
    REAL*4 airTemperature(88,24)
    INTEGER*2 binZeroDeg(24)
    REAL*4 attenuationNP(88,24)
    REAL*4 piaNP(4,24)
    REAL*4 piaNPrainFree(4,24)
    REAL*4 sigmaZeroNPCorrected(24)
    REAL*4 heightZeroDeg(24)
    INTEGER*2 flagInversion(24)
    INTEGER*2 binZeroDegSecondary(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_PRE/
    REAL*4 elevation(24)
    INTEGER*4 landSurfaceType(24)
    REAL*4 localZenithAngle(24)
    INTEGER*4 flagPrecip(24)
    CHARACTER flagSigmaZeroSaturation(24)
    INTEGER*2 binRealSurface(24)
```

```
    INTEGER*2 binStormTop(24)
    REAL*4 heightStormTop(24)
    REAL*4 height(88,24)
    INTEGER*2 binClutterFreeBottom(24)
    REAL*4 sigmaZeroMeasured(24)
    REAL*4 zFactorMeasured(88,24)
    REAL*4 ellipsoidBinOffset(24)
    REAL*4 snRatioAtRealSurface(24)
    REAL*4 adjustFactor(24)
    BYTE snowIceCover(24)
    INTEGER*2 binMirrorImageL2(24)
    CHARACTER echoCountRealSurface(24)
END STRUCTURE

STRUCTURE /L2ADPR_HS_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L2ADPR_HS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(24)
    REAL*4 Longitude(24)
    REAL*4 sunLocalTime(24)
    RECORD /L2ADPR_HS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2ADPR_HS_PRE/ PRE
    RECORD /L2ADPR_HS_VER/ VER
    RECORD /L2ADPR_HS_CSF/ CSF
    RECORD /L2ADPR_HS_SRT/ SRT
    RECORD /L2ADPR_HS_DSD/ DSD
    RECORD /L2ADPR_HS_EXPERIMENTAL/ Experimental
```

```
    RECORD /L2ADPR_HS_SLV/ SLV
    RECORD /L2ADPR_HS_FLG/ FLG
END STRUCTURE

STRUCTURE /L2ADPR_FS_TRG/
    REAL*4 NUBFindex(49)
    INTEGER*4 MSindex(49)
    INTEGER*4 MSindexKu(49)
    INTEGER*4 MSindexKa(49)
    INTEGER*4 MSsurfPeakIndexKu(49)
    INTEGER*4 MSsurfPeakIndexKa(49)
    INTEGER*4 MSkneeDFRindex(49)
    REAL*4 MSslopesKu(4,49)
    REAL*4 MSslopesKa(4,49)
END STRUCTURE

STRUCTURE /L2ADPR_FS_FLG/
    BYTE flagEcho(176,49)
    INTEGER*4 qualityData(49)
    BYTE qualityFlag(2,49)
    BYTE flagSensor(2)
    INTEGER*2 flagScanPattern(2)
END STRUCTURE

STRUCTURE /L2ADPR_FS_SLV/
    BYTE flagSLV(176,49)
    REAL*4 paramDSD(2,176,49)
    INTEGER*2 binEchoBottom(49)
    REAL*4 piaFinal(2,49)
    REAL*4 sigmaZeroCorrected(2,49)
    REAL*4 zFactorFinal(2,176,49)
    REAL*4 zFactorFinalESurface(2,49)
    REAL*4 zFactorFinalNearSurface(2,49)
    REAL*4 paramNUBF(3,49)
    REAL*4 precipRate(176,49)
    REAL*4 precipWater(176,49)
    REAL*4 precipWaterIntegrated(2,49)
    INTEGER*4 qualitySLV(49)
    REAL*4 precipRateNearSurface(49)
    REAL*4 precipRateESurface(49)
    REAL*4 precipRateAve24(49)
    CHARACTER phaseNearSurface(49)
    REAL*4 epsilon(176,49)
```

```
    REAL*4 DFRforward1(176,49)
    REAL*4 piaOffset(2,49)
END STRUCTURE

STRUCTURE /L2ADPR_FS_EXPERIMENTAL/
    REAL*4 precipRateESurface2(49)
    CHARACTER precipRateESurface2Status(49)
    REAL*4 sigmaZeroProfile(2,7,49)
    REAL*4 seaIceConcentration(49)
    CHARACTER flagSurfaceSnowfall(49)
    CHARACTER flagGraupelHail(49)
    INTEGER*2 binMixedPhaseTop(49)
    REAL*4 surfaceSnowfallIndex(49)
END STRUCTURE

STRUCTURE /L2ADPR_FS_DSD/
    CHARACTER phase(176,49)
    INTEGER*2 binNode(5,49)
    REAL*4 paramRDm(5,49)
END STRUCTURE

STRUCTURE /L2ADPR_FS_SRT/
    REAL*4 pathAtten(2,49)
    REAL*4 PIAalt(2,6,49)
    REAL*4 PIAdw(2,49)
    REAL*4 PIAhb(2,49)
    REAL*4 PIAhybrid(2,49)
    REAL*4 piaExp(2,49)
    REAL*4 PIAweight(6,49)
    REAL*4 PIAweightHY(3,49)
    INTEGER*2 refScanID(2,2,49)
    REAL*4 reliabFactor(49)
    REAL*4 RFactorAlt(6,49)
    REAL*4 reliabFactorHY(49)
    INTEGER*2 reliabFlag(49)
    INTEGER*2 reliabFlagHY(49)
    REAL*4 stddevEff(2,3,49)
    REAL*4 stddevHY(2,49)
    REAL*4 zeta(2,49)
END STRUCTURE

STRUCTURE /L2ADPR_FS_CSF/
    INTEGER*4 flagBB(49)
```

```
    INTEGER*2 binBBPeak(49)
    INTEGER*2 binBBTop(49)
    INTEGER*2 binDFRmMLBottom(49)
    INTEGER*2 binDFRmMLTop(49)
    INTEGER*2 binBBBottom(49)
    INTEGER*2 binHeavyIcePrecipTop(3,49)
    INTEGER*2 binHeavyIcePrecipBottom(3,49)
    CHARACTER nHeavyIcePrecip(3,49)
    CHARACTER flagMLquality(49)
    REAL*4 heightBB(49)
    REAL*4 widthBB(49)
    INTEGER*4 qualityBB(49)
    INTEGER*4 typePrecip(49)
    INTEGER*4 qualityTypePrecip(49)
    INTEGER*4 flagShallowRain(49)
    BYTE flagHeavyIcePrecip(49)
    BYTE flagAnvil(49)
    BYTE flagHail(49)
END STRUCTURE

STRUCTURE /L2ADPR_FS_VER/
    REAL*4 airTemperature(176,49)
    INTEGER*2 binZeroDeg(49)
    REAL*4 attenuationNP(2,176,49)
    REAL*4 piaNP(2,4,49)
    REAL*4 piaNPrainFree(2,4,49)
    REAL*4 sigmaZeroNPCorrected(2,49)
    REAL*4 heightZeroDeg(49)
    INTEGER*2 flagInversion(49)
    INTEGER*2 binZeroDegSecondary(49)
END STRUCTURE

STRUCTURE /L2ADPR_FS_PRE/
    REAL*4 elevation(49)
    INTEGER*4 landSurfaceType(49)
    REAL*4 localZenithAngle(2,49)
    INTEGER*4 flagPrecip(49)
    CHARACTER flagSigmaZeroSaturation(2,49)
    INTEGER*2 binRealSurface(2,49)
    INTEGER*2 binStormTop(49)
    REAL*4 heightStormTop(49)
    REAL*4 height(176,49)
    INTEGER*2 binClutterFreeBottom(49)
```

```
    REAL*4 sigmaZeroMeasured(2,49)
    REAL*4 zFactorMeasured(2,176,49)
    REAL*4 ellipsoidBinOffset(49)
    REAL*4 snRatioAtRealSurface(2,49)
    REAL*4 adjustFactor(2,49)
    BYTE snowIceCover(49)
    INTEGER*2 binMirrorImageL2(49)
    CHARACTER echoCountRealSurface(2,49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2ADPR_FS_SCANSTATUS/
    BYTE dataQuality(2)
    BYTE dataWarning(2)
    BYTE missing(2)
    BYTE modeStatus(2)
    INTEGER*2 geoError(2)
    INTEGER*2 geoWarning(2)
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus(2)
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode(2)
    BYTE limitErrorFlag(2)
```

```
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2ADPR_FS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    RECORD /L2ADPR_FS_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2ADPR_FS_PRE/ PRE
    RECORD /L2ADPR_FS_VER/ VER
    RECORD /L2ADPR_FS_CSF/ CSF
    RECORD /L2ADPR_FS_SRT/ SRT
    RECORD /L2ADPR_FS_DSD/ DSD
    RECORD /L2ADPR_FS_EXPERIMENTAL/ Experimental
    RECORD /L2ADPR_FS_SLV/ SLV
    RECORD /L2ADPR_FS_FLG/ FLG
    RECORD /L2ADPR_FS_TRG/ TRG
END STRUCTURE

STRUCTURE /L2ADPR_SWATHS/
    RECORD /L2ADPR_FS/ FS;
    RECORD /L2ADPR_HS/ HS;
END STRUCTURE
```

5.49 2APR - PR precipitation

The PR Level-2A product, 2APR, "PR precipitation," is written as a 1 swath structure. The swath is FS, Full scans. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each NS scan.
nrayMS	25	Number of angle bins in each MS scan.
nrayHS	24	Number of angle bins in each HS scan.
nbin	176	Number of range bins in each NS and MS ray. Bin interval is 125 m. 0 is at the top. 175 is the bin of the earth ellipsoid.
nbinSZP	7	Number of range bins for sigmaZeroProfile.
nNP	4	Number of NP kinds.
nearFar	2	Near reference, Far reference.
foreBack	2	Foreward, Backward.
method	6	Number of SRT methods.
nsdew	3	Number of standard deviation effective ways.
nNode	5	Number of binNode.
nDSD	2	Number of DSD parameters. Parameters are dBNw and Dm (mm).
LS	2	Liquid, solid.
nNUBF	3	Number of NUBF parameters.
two	2	Two.

Figure 582 through Figure 593 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

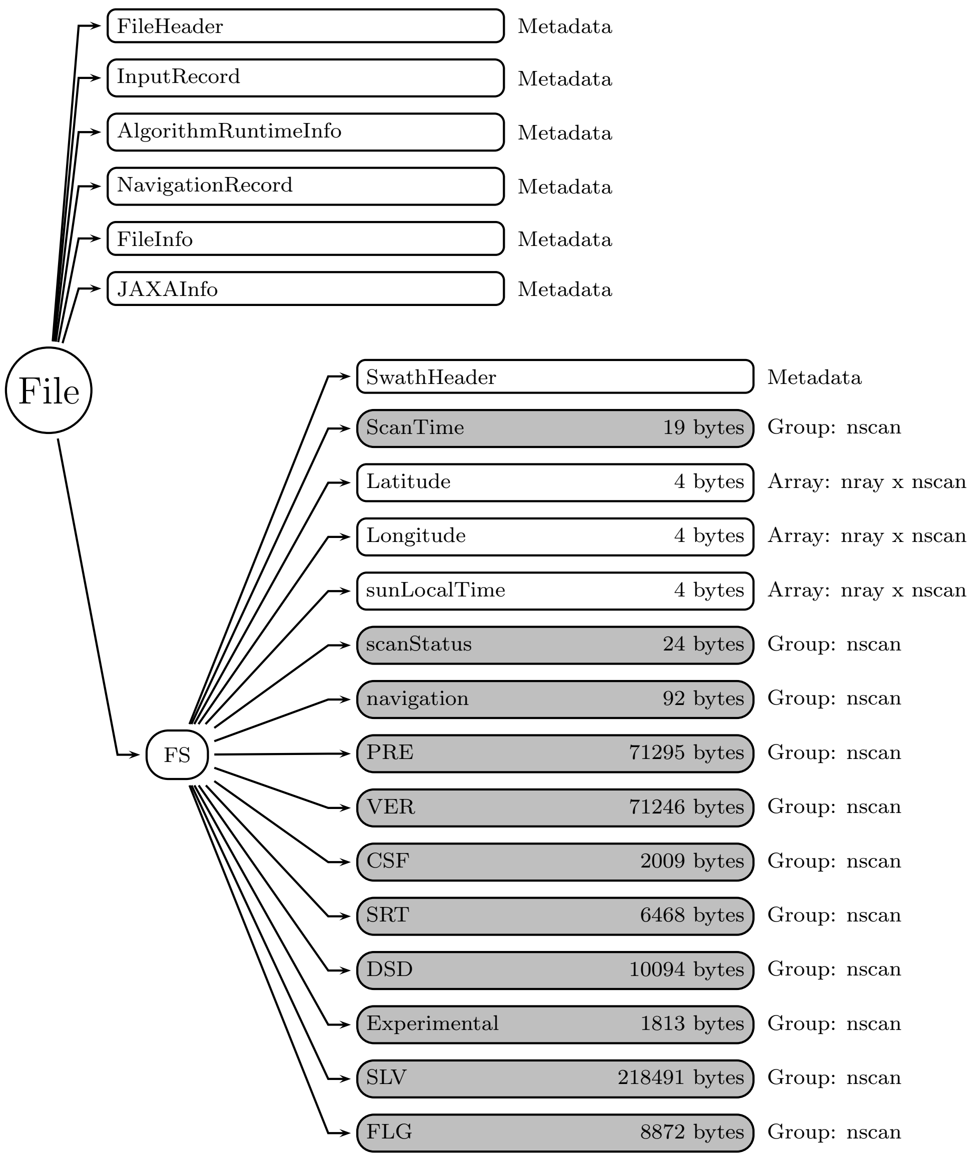


Figure 582: Data Format Structure for 2APR, PR precipitation

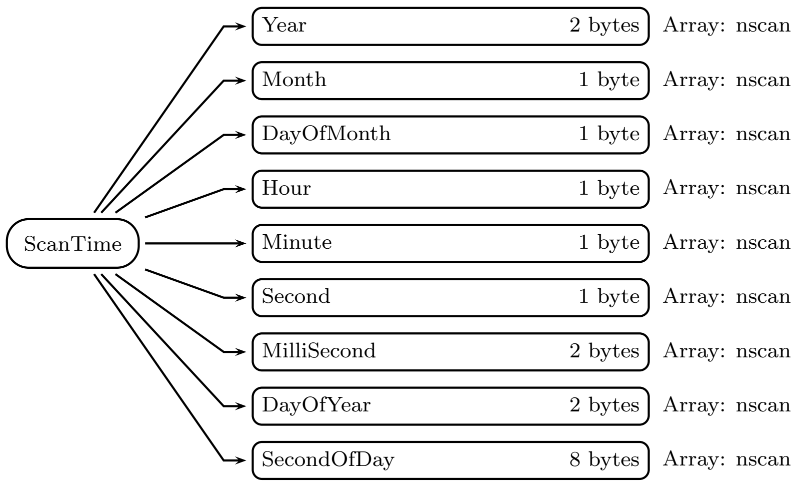


Figure 583: Data Format Structure for 2APR, ScanTime

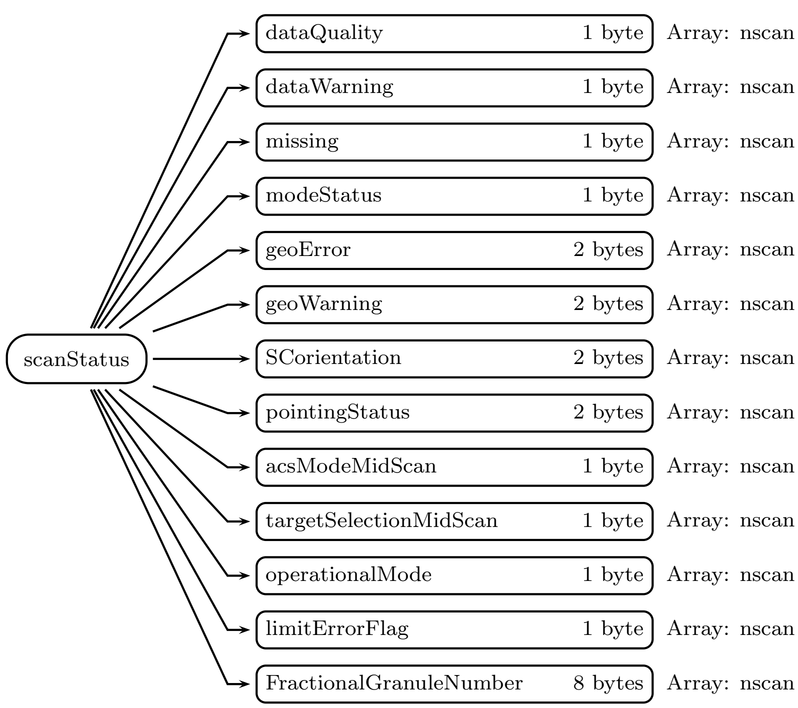


Figure 584: Data Format Structure for 2APR, scanStatus

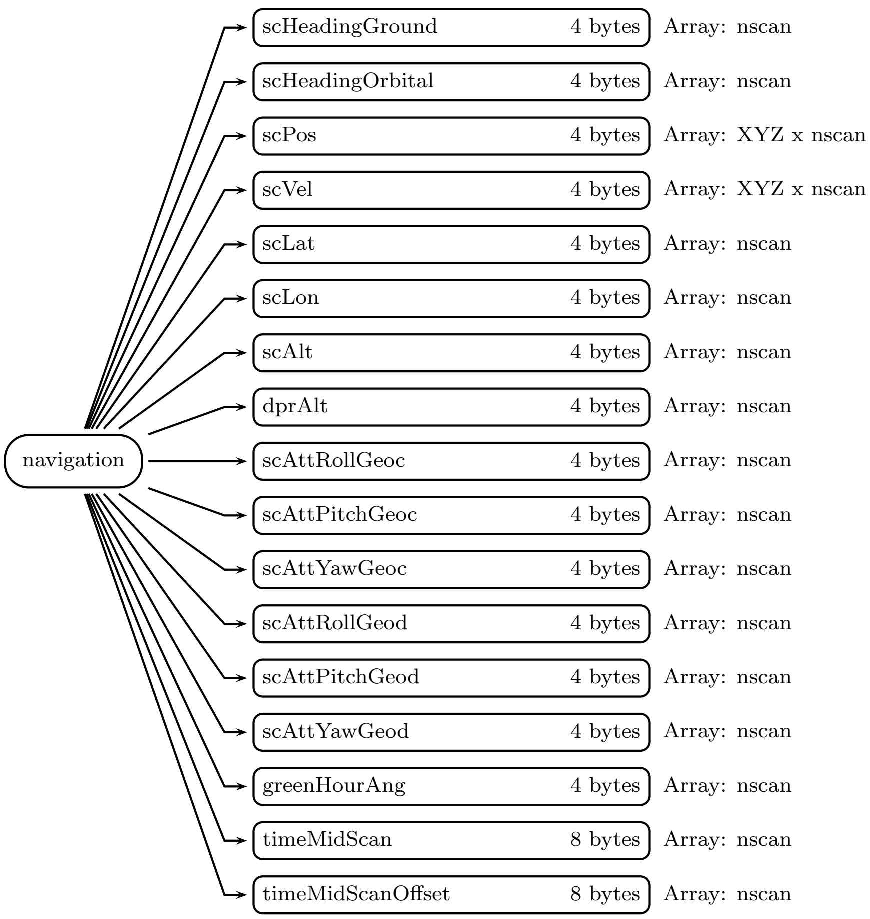


Figure 585: Data Format Structure for 2APR, navigation

PRE		
elevation	4 bytes	Array: nray x nscan
landSurfaceType	4 bytes	Array: nray x nscan
localZenithAngle	4 bytes	Array: nray x nscan
flagPrecip	4 bytes	Array: nray x nscan
flagSigmaZeroSaturation	1 byte	Array: nray x nscan
binRealSurface	2 bytes	Array: nray x nscan
binStormTop	2 bytes	Array: nray x nscan
heightStormTop	4 bytes	Array: nray x nscan
height	4 bytes	Array: nbin x nray x nscan
binClutterFreeBottom	2 bytes	Array: nray x nscan
sigmaZeroMeasured	4 bytes	Array: nray x nscan
zFactorMeasured	4 bytes	Array: nbin x nray x nscan
ellipsoidBinOffset	4 bytes	Array: nray x nscan
snRatioAtRealSurface	4 bytes	Array: nray x nscan
adjustFactor	4 bytes	Array: nray x nscan
snowIceCover	1 byte	Array: nray x nscan
binMirrorImageL2	2 bytes	Array: nray x nscan
echoCountRealSurface	1 byte	Array: nray x nscan

Figure 586: Data Format Structure for 2APR, PRE

VER		
airTemperature	4 bytes	Array: nbin x nray x nscan
binZeroDeg	2 bytes	Array: nray x nscan
attenuationNP	4 bytes	Array: nbin x nray x nscan
piaNP	4 bytes	Array: nNP x nray x nscan
piaNPrainFree	4 bytes	Array: nNP x nray x nscan
sigmaZeroNPCorrected	4 bytes	Array: nray x nscan
heightZeroDeg	4 bytes	Array: nray x nscan
flagInversion	2 bytes	Array: nray x nscan
binZeroDegSecondary	2 bytes	Array: nray x nscan

Figure 587: Data Format Structure for 2APR, VER

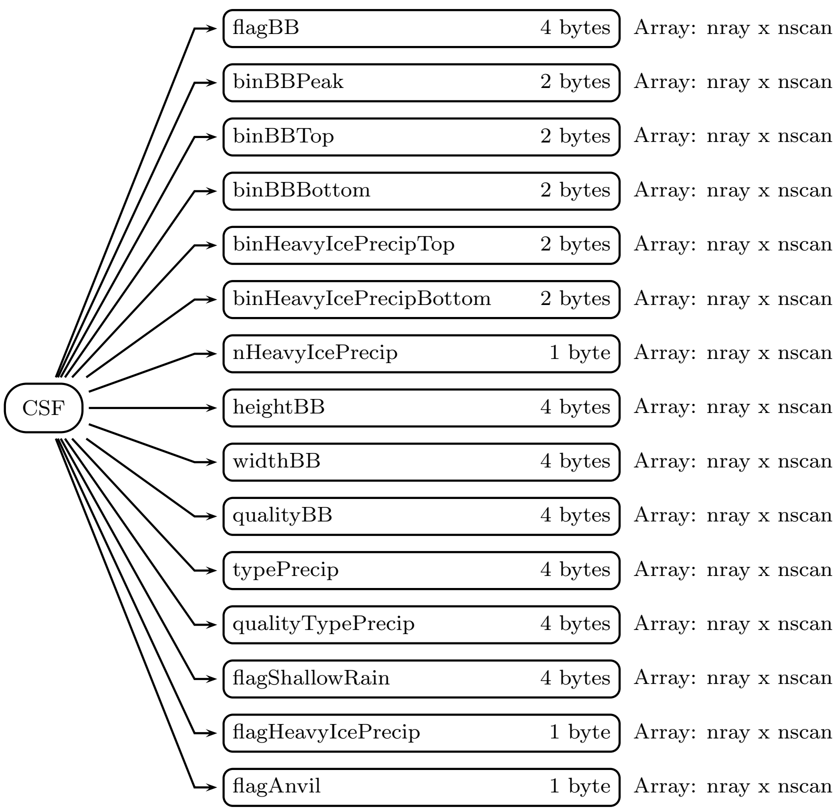


Figure 588: Data Format Structure for 2APR, CSF

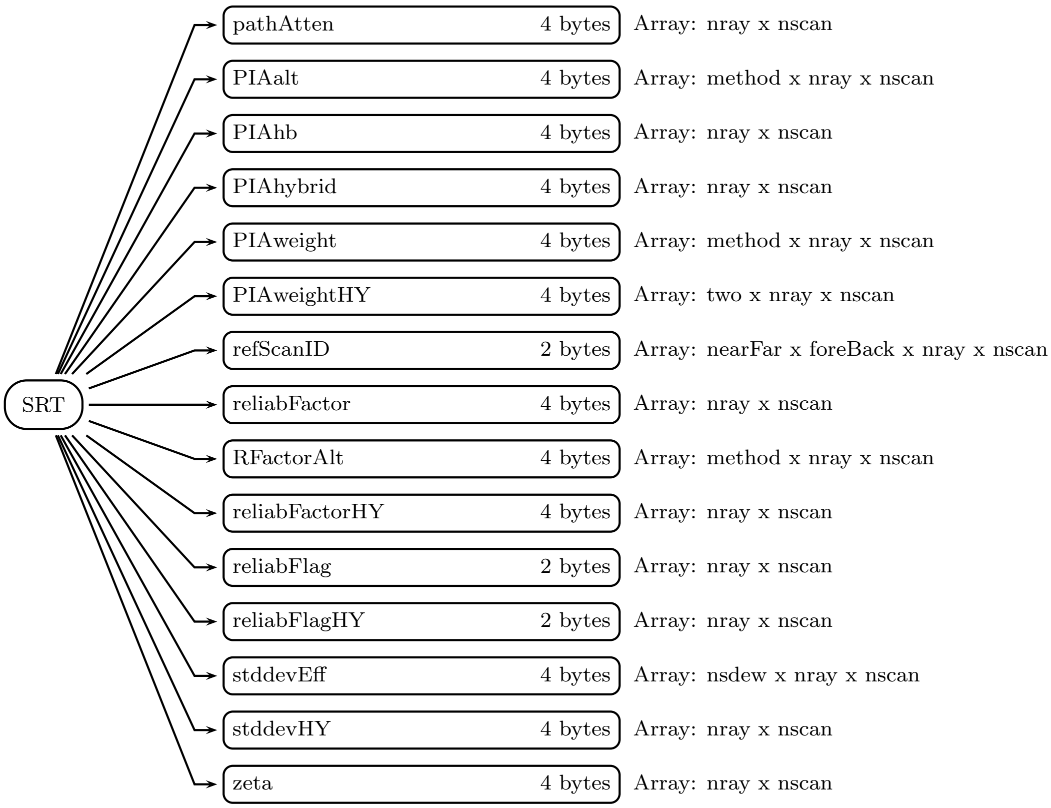


Figure 589: Data Format Structure for 2APR, SRT

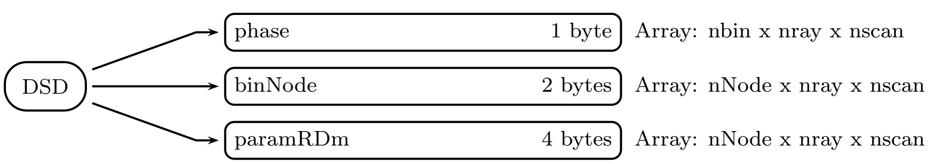


Figure 590: Data Format Structure for 2APR, DSD

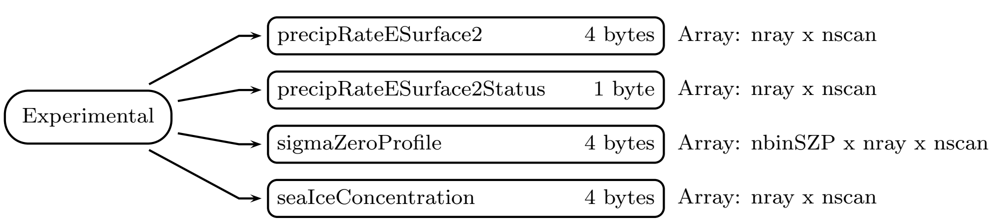


Figure 591: Data Format Structure for 2APR, Experimental

SLV

flagSLV	1 byte	Array: nbin x nray x nscan
paramDSD	4 bytes	Array: nDSD x nbin x nray x nscan
binEchoBottom	2 bytes	Array: nray x nscan
piaFinal	4 bytes	Array: nray x nscan
sigmaZeroCorrected	4 bytes	Array: nray x nscan
zFactorFinal	4 bytes	Array: nbin x nray x nscan
zFactorFinalESurface	4 bytes	Array: nray x nscan
zFactorFinalNearSurface	4 bytes	Array: nray x nscan
paramNUBF	4 bytes	Array: nNUBF x nray x nscan
precipRate	4 bytes	Array: nbin x nray x nscan
precipWater	4 bytes	Array: nbin x nray x nscan
precipWaterIntegrated	4 bytes	Array: LS x nray x nscan
qualitySLV	4 bytes	Array: nray x nscan
precipRateNearSurface	4 bytes	Array: nray x nscan
precipRateESurface	4 bytes	Array: nray x nscan
precipRateAve24	4 bytes	Array: nray x nscan
phaseNearSurface	1 byte	Array: nray x nscan
epsilon	4 bytes	Array: nbin x nray x nscan
piaOffset	4 bytes	Array: nray x nscan

Figure 592: Data Format Structure for 2APR, SLV

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):

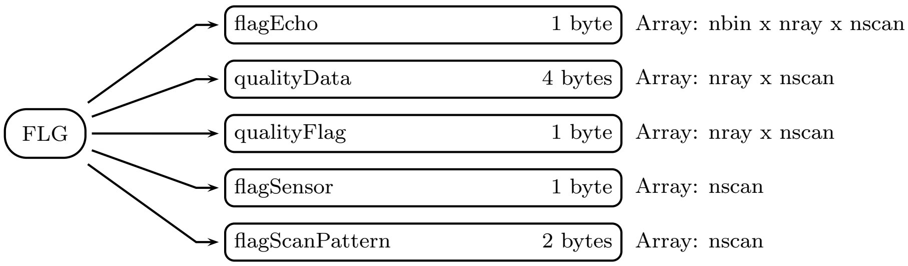


Figure 593: Data Format Structure for 2APR, FLG

NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

FS (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate

bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
```

```
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
```

```
7      Ku/Ka Standby VPRF Table OUT
8      Ku/Ka Standby Phase Out
9      Ku/Ka Standby Dump Out
10     Ku/Ka Standby (No Science Data)
11     Ku/Ka Independent Observation
12     Ku/Ka Independent External Calibration
13     Ku/Ka Independent Internal Calibration
14     Ku/Ka Independent SSPA Analysis
15     Ku/Ka Independent LNA Analysis
16     Ku/Ka Independent Health-Check
17     Ku/Ka Independent Standby VPRF Table OUT
18     Ku/Ka Independent Standby Phase Out
19     Ku/Ka Independent Standby Dump Out
20     Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction

of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in True of Date (TOD) Earth-Centered Inertial (ECI) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (m/s) of the spacecraft in TOD ECI Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the

Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0

to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group)

elevation (4-byte float, array size: nray x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nray x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nray x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nray x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
```

```
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nray x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0  : normal (under saturated level)
1  : possible saturated level at real surface
2  : saturated level at real surface
99 : missing
```

binRealSurface (2-byte integer, array size: nray x nscan):
Range bin number for real surface. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nray x nscan):
Range bin number for the storm top. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nray x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

height (4-byte float, array size: nbin x nray x nscan):
Height. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nray x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nray x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values

are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nray x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

adjustFactor (4-byte float, array size: nray x nscan):
Adjustment factor (dB) for zFactorMeasured (dBZm') and sigmaZeroMeasured (dBs0m'). dBZm' and dBs0m' are used and stored as follows:

```
dBZm' = dBZm - adjustFactor
dBs0m' = dBs0m - adjustFactor
The adjustment factor is the sum of 3 components:
base adjustment for instrument dependency,
angle-bin adjustment for angle-bin dependency, and
temporal adjustment for orbit number dependency.
```

snowIceCover (1-byte integer, array size: nray x nscan):
TBD. Special values are defined as:
-99 Missing value

binMirrorImageL2 (2-byte integer, array size: nray x nscan):
Range bin number of the mirror image.

echoCountRealSurface (1-byte char, array size: nray x nscan):
Echo count at a surface position (binRealSurface). Missing value = 0.

VER (Group)

airTemperature (4-byte float, array size: nbin x nray x nscan):
Air Temperature. Values are in K. Special values are defined as:
-9999.9 Missing value

binZeroDeg (2-byte integer, array size: nray x nscan):

```
Range bin number with 0 degrees C level.
For FS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(FS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbin x nray x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nray x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

piaNPrainFree (4-byte float, array size: nNP x nray x nscan):
TBD Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nray x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nray x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

flagInversion (2-byte integer, array size: nray x nscan):

```
TBD
```

binZeroDegSecondary (2-byte integer, array size: nray x nscan):
TBD Special values are defined as:
-9999 Missing value

CSF (Group)

flagBB (4-byte integer, array size: nray x nscan):
Bright band (BB) exists or not. The definition is different for L2 DPR on the one hand and L2 Ku and L2 Ka on the other.

```
L2 DPR:
0      no Bright Band
1      Bright Band detected by Ku and DFRm
2      Bright Band detected by Ku only
3      Bright Band detected by DFRm only
-1111  No rain value
-9999  Missing value

L2 Ku and L2 Ka:
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nray x nscan):
Range bin number for the peak of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS

swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of bright band. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binHeavyIcePrecipBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of heavy ice precip. For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

nHeavyIcePrecip (1-byte char, array size: nray x nscan):
TBD. Special values are defined as:
0 Missing value

heightBB (4-byte float, array size: nray x nscan):
Height of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nray x nscan):
The width of bright band. A value of -1111.1 denotes no precipitation. Values are in m. Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nray x nscan):

```
Quality of the bright band.
When the bright band is detected,
a larger positive number indicates lower
```

```
confidence in the detection.

The Ku detection is clear, but
the Ka and DPR detection is
somewhat doubtful.

The meaning of qualityBB has not
been finalized.

3      Smeared bright band
2      Not so clear bright band
1      Clear bright band
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nray x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value

Let abcdefgh be the 8 digit number,

  abcdefgh

then
   a: Main rain type. (a=1,2,3),
   b: 0,
   c: 0,
   d: V rain type,
   e: H rain type,
   f: BB,
   g: Shallow rain,
   h: Small size cell.
----------------------------------------------------
The following numbers appear as Ku and Ka (MS/HS) rain types:
```

```
   ---- stratiform
   1001H100
   10031000
   ---- convective
   2001H1xy (x>0 or y>0)
   2002Hbxy
   200310xy (x>0 or y>0)
   200320xy
   ---- other
   300330xy
where H is the rain type by H-method, and b depends on BB,
x on shallow rain and y on small size cell:
  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  b = 0: BB not detected,
      1: BB detected.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
==============================================================
```

In the DPR product, rain type by the DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 8    DFRm method cannot be applicable at Part B (in this case
       the conventional method determines the major rain type)
     = 9    DFRm method cannot be applicable at Part A (in this case
       the conventional method determines the major rain type)

-1111  No rain value
```

```
-9999  Missing value

 If dual frequency data is not available
 but Ku-only or Ka-olny is available,
 rain type is expressed by the following 8 digit number:
   10xxxxxx --- stratiform,
   20xxxxxx --- convective,
   30xxxxxx --- other,
 wihch is a copy of Ku-only module or Ka-only module.

 If dual frequency data is available, rain type is
 expressed by
   1qxxxxxx --- stratiform,
   2qxxxxxx --- convective,
   3qxxxxxx --- other,
 where q>0.
 Thus, by examining q, users can understand whether
 data is processed by dual frequency algorithm or
 single frequency algorithm.
 =======================================
 For MS and HS, DFRm method is used.
 =======================================
 DFRm decision classifies rain type into
    stratiform,
    convective,
 and
    transition.
 ----------------------------------------------------------
 The DPR numbering rule can be summarized as follows:
 Let opqrstuv be the 8 digit number, then
    o: Main rain type. (o=1,2,3),
    p: DFRm rain type. (p=0,1,2,4,8,9, with p=0 for single frequency data only),
    q: DFRm BB. (q=0,1),
    r: V rain type (by conventional V-method).
       Basically r=0 for inner swath and r>0 for outer swath.
       However, r>0 when only single frequency data is available,
    s: H rain type,
    t: = 0 for innner swath,
         1 when BB is detected in the outer swath.
    u: Shallow rain,
    v: Small size cell.
 ============================
 ============================
```

```
DFRm type can be obtained by examining p
============================
The meaning of p is as follows:
 p = 0: single frequency data only (dual frequncy data not available),
     1: stratiform by DFRm method,
     2: convective by DFRm method,
     4: transition by DFRm method,
     8: DFRm decision not available,
     9: DFRm decision not available.
Note that p>0 always in DPR processing, which is different
from Ku-only or Ka-only result.
In Ku-only or Ka-only rain type numbering, p=0 always.
-----------------------------------------------------------
===============================================
The following numbers appear as DPR rain types:
===============================================
**************************
*   For FS outer swath   *
**************************
  --- stratiform
  1901H100
  19031000
  --- convective
  2901H1xy (x>0 or y>0, see R\_type\_classification\_dpr2)
  2902Hwxy
  290310xy (x>0, y>0, see R\_type\_classification\_dpr2)
  290320xy
  --- other
  390330xy

*******************************
*  For FS inner swath and MS  *
*******************************
  --- stratiform
  11B0H0xy
  14B01000
  19001000 --- H decision only
  19011000 --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  19013000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
            or FS rain >0 but no MS rain; FS V and H determine rain type
  19031000 --- MS rain >0 but no FS rain; MS V and H determine rain type.
            or FS rain >0 but no MS rain; FS V and H determine rain type
```

```
  --- convective
  2100H0xy (x>0 or y>0)
  2110H00y (y>0)
  2200H0xy
  2210H00y
  2400H0xy
  2410H00y
  290010xy --- H decision only (x>0 or y>0)
  290020xy --- H decision only
  2901H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
            (x>0 or y>0 for H=1,3)
  2902H0xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  290310xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            (x>0 or y>0)
  290320xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type
  --- other
  340030xy
  390030xy --- H decision only
  390330xy --- MS rain >0 but no FS rain; MS V and H determine rain type
            or FS rain >0 but no MS rain; FS V and H determine rain type

**************
*   For HS   *
**************
  --- stratiform
  11B0H000
  14B01000
  19001000 --- H decision only
  --- convective
  21B0H0x0 (x>0)
  22B0H0x0
  240010x0 (x>0, 24B010x0 with B=0)
  240020x0
  241010x0 (x>0, 24B010x0 with B=1)
  290010x0 (x>0) --- H decision only
  290020x0 --- H decision only
  --- other
  340030x0
  390030x0 --- H decision only
```

```
where w depends on BB by conventional V-method, B on BB
by DFRm method, H on H-method, x on shallow rain
and y on small size cell:
  w = 0: BB not detected by conventional V-method,
      1: BB detected by conventional V-methd.

  B = 0: BB not detected by DFRm method,
      1: BB detected by DFRm methd.

  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
In the above, x>0 and y>0 are taken care of in the function
R\_type\_classification\_dpr2().
==============================================================
```

qualityTypePrecip (4-byte integer, array size: nray x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nray x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

flagHeavyIcePrecip (1-byte integer, array size: nray x nscan):
This flag denotes strong or severe precipitation accompanied by solid ice hydrometeors above the -10 degree C isotherm. Special values are defined as:
0 Missing value

flagAnvil (1-byte integer, array size: nray x nscan):

```
flagAnvil is 1 when anvil is detected by the Ku-band radar,
0 when anvil is not detected, and
-99 when the data is missing.

Note that Ka-band decision is not made because of a lower
sensitivity of Ka-band radar (therefore, there does not
exist any Ka-band flagAnvil; only Ku-band flagAnvil
is available in Ku-only and DPR FS).
```

SRT (Group)

pathAtten (4-byte float, array size: nray x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAalt (4-byte float, array size: method x nray x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhb (4-byte float, array size: nray x nscan):
The 2-way attenuation of HB.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAhybrid (4-byte float, array size: nray x nscan):
The 2-way attenuation from a weighted combination of HB and SRT.

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

PIAweightHY (4-byte float, array size: two x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Values are in dB. Special values are defined as:
-9999.9 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nray x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

reliabFactor (4-byte float, array size: nray x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nray x nscan):
The reliability factors associated with the individual PIA estimates corresponding to

PIAalt. Special values are defined as:
-9999.9 Missing value

reliabFactorHY (4-byte float, array size: nray x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nray x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff $>$ 3 ; PIAeff estimate is considered reliable
= 2 if 3 $\geq$ Rel_eff $>$ 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff $\leq$ 1 ; PIAeff is unreliable
= 4 if SNR_at surface $<$ 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

reliabFlagHY (2-byte integer, array size: nray x nscan):
TBD.

Special values are defined as:
-9999 Missing value

stddevEff (4-byte float, array size: nsdew x nray x nscan):
The effective standard deviation of PIA-SRT computed 3 ways.

Special values are defined as:
-9999.9 Missing value

stddevHY (4-byte float, array size: nray x nscan):
TBD.

Special values are defined as:
-9999.9 Missing value

zeta (4-byte float, array size: nray x nscan):
The term in the HB estimate of path attenuation.

Special values are defined as:
-9999.9 Missing value

DSD (Group)

phase (1-byte char, array size: nbin x nray x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                       the top and peak of bright band
phase = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nray x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For FS and MS swaths,
bin numbers are 1-based ranging
```

```
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing
```

paramRDm (4-byte float, array size: nNode x nray x nscan):
TBD Special values are defined as:
-9999.9 Missing value

Experimental (Group)

precipRateESurface2 (4-byte float, array size: nray x nscan):
Estimates Surface Precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nray x nscan):
Status of the estimated surface precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZP x nray x nscan):
Surface backscattering cross section profile around the current ifov. For information on this experimental field contact the Joint DPR Team. Values are in dB. Special values are defined as:
-9999.9 Missing value

seaIceConcentration (4-byte float, array size: nray x nscan):
Sea ice concentration estimated by Ku. For information on this experimental field contact the Joint DPR Team. Values range from 30 to 100 percent. Special values are defined as:
-9999.9 Missing value

SLV (Group)

flagSLV (1-byte integer, array size: nbin x nray x nscan):
Special values are defined as:
-99 Missing value

paramDSD (4-byte float, array size: nDSD x nbin x nray x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

binEchoBottom (2-byte integer, array size: nray x nscan):
For FS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nray x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nray x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorFinal (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramNUBF (4-byte float, array size: nNUBF x nray x nscan):
TBD. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbin x nray x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWater (4-byte float, array size: nbin x nray x nscan):
The amount of precipitable water. Values are in kg/m^3. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nray x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined

as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nray x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nray x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nray x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nray x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nray x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbin x nray x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

piaOffset (4-byte float, array size: nray x nscan):
TBD. Values are in dB. Special values are defined as:
-9999.9 Missing value

FLG (Group)

flagEcho (1-byte integer, array size: nbin x nray x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nray x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
```

```
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

qualityFlag (1-byte integer, array size: nray x nscan):
Flag derived from qualityData with the following values: Special values are defined as:
-99 Missing value

```
Value    Meaning
0        High quality.  No issues.
1        Low quality (DPR modules had warnings but still made a retrieval)
2        Bad (DPR modules had errors or dataQuality is bad and
         retrieval is missing)
```

flagSensor (1-byte integer, array size: nscan):

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

flagScanPattern (2-byte integer, array size: nscan):

```
Flag of scan pattern.

Value  Meaning
1      TBD
-99    Missing
```

C Structure Header file:

```
#ifndef _TK_2APR_H_
#define _TK_2APR_H_
```

```
#ifndef _L2APR_FLG_
#define _L2APR_FLG_

typedef struct {
    signed char flagEcho[49][176];
    int qualityData[49];
    signed char qualityFlag[49];
    signed char flagSensor;
    short flagScanPattern;
} L2APR_FLG;

#endif

#ifndef _L2APR_SLV_
#define _L2APR_SLV_

typedef struct {
    signed char flagSLV[49][176];
    float paramDSD[49][176][2];
    short binEchoBottom[49];
    float piaFinal[49];
    float sigmaZeroCorrected[49];
    float zFactorFinal[49][176];
    float zFactorFinalESurface[49];
    float zFactorFinalNearSurface[49];
    float paramNUBF[49][3];
    float precipRate[49][176];
    float precipWater[49][176];
    float precipWaterIntegrated[49][2];
    int qualitySLV[49];
    float precipRateNearSurface[49];
    float precipRateESurface[49];
    float precipRateAve24[49];
    unsigned char phaseNearSurface[49];
    float epsilon[49][176];
    float piaOffset[49];
} L2APR_SLV;

#endif

#ifndef _L2APR_EXPERIMENTAL_
#define _L2APR_EXPERIMENTAL_
```

```
typedef struct {
    float precipRateESurface2[49];
    unsigned char precipRateESurface2Status[49];
    float sigmaZeroProfile[49][7];
    float seaIceConcentration[49];
} L2APR_EXPERIMENTAL;

#endif

#ifndef _L2APR_DSD_
#define _L2APR_DSD_

typedef struct {
    unsigned char phase[49][176];
    short binNode[49][5];
    float paramRDm[49][5];
} L2APR_DSD;

#endif

#ifndef _L2APR_SRT_
#define _L2APR_SRT_

typedef struct {
    float pathAtten[49];
    float PIAalt[49][6];
    float PIAhb[49];
    float PIAhybrid[49];
    float PIAweight[49][6];
    float PIAweightHY[49][2];
    short refScanID[49][2][2];
    float reliabFactor[49];
    float RFactorAlt[49][6];
    float reliabFactorHY[49];
    short reliabFlag[49];
    short reliabFlagHY[49];
    float stddevEff[49][3];
    float stddevHY[49];
    float zeta[49];
} L2APR_SRT;

#endif
```

```
#ifndef _L2APR_CSF_
#define _L2APR_CSF_

typedef struct {
    int flagBB[49];
    short binBBPeak[49];
    short binBBTop[49];
    short binBBBottom[49];
    short binHeavyIcePrecipTop[49];
    short binHeavyIcePrecipBottom[49];
    unsigned char nHeavyIcePrecip[49];
    float heightBB[49];
    float widthBB[49];
    int qualityBB[49];
    int typePrecip[49];
    int qualityTypePrecip[49];
    int flagShallowRain[49];
    signed char flagHeavyIcePrecip[49];
    signed char flagAnvil[49];
} L2APR_CSF;

#endif

#ifndef _L2APR_VER_
#define _L2APR_VER_

typedef struct {
    float airTemperature[49][176];
    short binZeroDeg[49];
    float attenuationNP[49][176];
    float piaNP[49][4];
    float piaNPrainFree[49][4];
    float sigmaZeroNPCorrected[49];
    float heightZeroDeg[49];
    short flagInversion[49];
    short binZeroDegSecondary[49];
} L2APR_VER;

#endif

#ifndef _L2APR_PRE_
#define _L2APR_PRE_
```

```
typedef struct {
    float elevation[49];
    int landSurfaceType[49];
    float localZenithAngle[49];
    int flagPrecip[49];
    unsigned char flagSigmaZeroSaturation[49];
    short binRealSurface[49];
    short binStormTop[49];
    float heightStormTop[49];
    float height[49][176];
    short binClutterFreeBottom[49];
    float sigmaZeroMeasured[49];
    float zFactorMeasured[49][176];
    float ellipsoidBinOffset[49];
    float snRatioAtRealSurface[49];
    float adjustFactor[49];
    signed char snowIceCover[49];
    short binMirrorImageL2[49];
    unsigned char echoCountRealSurface[49];
} L2APR_PRE;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
```

```
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2APR_SCANSTATUS_
#define _L2APR_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2APR_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif
```

```
#ifndef _L2APR_FS_
#define _L2APR_FS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float sunLocalTime[49];
    L2APR_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2APR_PRE PRE;
    L2APR_VER VER;
    L2APR_CSF CSF;
    L2APR_SRT SRT;
    L2APR_DSD DSD;
    L2APR_EXPERIMENTAL Experimental;
    L2APR_SLV SLV;
    L2APR_FLG FLG;
} L2APR_FS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2APR_FLG/
    BYTE flagEcho(176,49)
    INTEGER*4 qualityData(49)
    BYTE qualityFlag(49)
    BYTE flagSensor
    INTEGER*2 flagScanPattern
END STRUCTURE

STRUCTURE /L2APR_SLV/
    BYTE flagSLV(176,49)
    REAL*4 paramDSD(2,176,49)
    INTEGER*2 binEchoBottom(49)
    REAL*4 piaFinal(49)
    REAL*4 sigmaZeroCorrected(49)
    REAL*4 zFactorFinal(176,49)
    REAL*4 zFactorFinalESurface(49)
```

```
    REAL*4 zFactorFinalNearSurface(49)
    REAL*4 paramNUBF(3,49)
    REAL*4 precipRate(176,49)
    REAL*4 precipWater(176,49)
    REAL*4 precipWaterIntegrated(2,49)
    INTEGER*4 qualitySLV(49)
    REAL*4 precipRateNearSurface(49)
    REAL*4 precipRateESurface(49)
    REAL*4 precipRateAve24(49)
    CHARACTER phaseNearSurface(49)
    REAL*4 epsilon(176,49)
    REAL*4 piaOffset(49)
END STRUCTURE

STRUCTURE /L2APR_EXPERIMENTAL/
    REAL*4 precipRateESurface2(49)
    CHARACTER precipRateESurface2Status(49)
    REAL*4 sigmaZeroProfile(7,49)
    REAL*4 seaIceConcentration(49)
END STRUCTURE

STRUCTURE /L2APR_DSD/
    CHARACTER phase(176,49)
    INTEGER*2 binNode(5,49)
    REAL*4 paramRDm(5,49)
END STRUCTURE

STRUCTURE /L2APR_SRT/
    REAL*4 pathAtten(49)
    REAL*4 PIAalt(6,49)
    REAL*4 PIAhb(49)
    REAL*4 PIAhybrid(49)
    REAL*4 PIAweight(6,49)
    REAL*4 PIAweightHY(2,49)
    INTEGER*2 refScanID(2,2,49)
    REAL*4 reliabFactor(49)
    REAL*4 RFactorAlt(6,49)
    REAL*4 reliabFactorHY(49)
    INTEGER*2 reliabFlag(49)
    INTEGER*2 reliabFlagHY(49)
    REAL*4 stddevEff(3,49)
    REAL*4 stddevHY(49)
    REAL*4 zeta(49)
```

```
END STRUCTURE

STRUCTURE /L2APR_CSF/
    INTEGER*4 flagBB(49)
    INTEGER*2 binBBPeak(49)
    INTEGER*2 binBBTop(49)
    INTEGER*2 binBBBottom(49)
    INTEGER*2 binHeavyIcePrecipTop(49)
    INTEGER*2 binHeavyIcePrecipBottom(49)
    CHARACTER nHeavyIcePrecip(49)
    REAL*4 heightBB(49)
    REAL*4 widthBB(49)
    INTEGER*4 qualityBB(49)
    INTEGER*4 typePrecip(49)
    INTEGER*4 qualityTypePrecip(49)
    INTEGER*4 flagShallowRain(49)
    BYTE flagHeavyIcePrecip(49)
    BYTE flagAnvil(49)
END STRUCTURE

STRUCTURE /L2APR_VER/
    REAL*4 airTemperature(176,49)
    INTEGER*2 binZeroDeg(49)
    REAL*4 attenuationNP(176,49)
    REAL*4 piaNP(4,49)
    REAL*4 piaNPrainFree(4,49)
    REAL*4 sigmaZeroNPCorrected(49)
    REAL*4 heightZeroDeg(49)
    INTEGER*2 flagInversion(49)
    INTEGER*2 binZeroDegSecondary(49)
END STRUCTURE

STRUCTURE /L2APR_PRE/
    REAL*4 elevation(49)
    INTEGER*4 landSurfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 flagPrecip(49)
    CHARACTER flagSigmaZeroSaturation(49)
    INTEGER*2 binRealSurface(49)
    INTEGER*2 binStormTop(49)
    REAL*4 heightStormTop(49)
    REAL*4 height(176,49)
    INTEGER*2 binClutterFreeBottom(49)
```

```
    REAL*4 sigmaZeroMeasured(49)
    REAL*4 zFactorMeasured(176,49)
    REAL*4 ellipsoidBinOffset(49)
    REAL*4 snRatioAtRealSurface(49)
    REAL*4 adjustFactor(49)
    BYTE snowIceCover(49)
    INTEGER*2 binMirrorImageL2(49)
    CHARACTER echoCountRealSurface(49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2APR_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
```

```
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2APR_FS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    RECORD /L2APR_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2APR_PRE/ PRE
    RECORD /L2APR_VER/ VER
    RECORD /L2APR_CSF/ CSF
    RECORD /L2APR_SRT/ SRT
    RECORD /L2APR_DSD/ DSD
    RECORD /L2APR_EXPERIMENTAL/ Experimental
    RECORD /L2APR_SLV/ SLV
    RECORD /L2APR_FLG/ FLG
END STRUCTURE
```

5.50 3DPR - DPR Full Product

3DPR, "DPR Full Product", computes statistics of the DPR measurements at both a low horizontal resolution (G1, 5^o x 5^o latitude/longitude) and a high horizontal resolution (G2, 0.25^o x 0.25^o latitude/longitude). The product can be monthly or daily.

```
Histograms have the following category thresholds, where
histbin(i) =  cat(i) less than x less than or equal to cat(i+1)
cat rain = [ 0.01,    ! mm/h  (logarithmic steps)
```

```
        0.10,   0.13,   0.17,   0.23,   0.30,   0.40,
        0.52,   0.69,   0.91,   1.20,   1.58,   2.08,
        2.75,   3.62,   4.77,   6.29,   8.29,  10.92,
       14.40,  18.97,  25.00,  32.95,  43.43,  57.24,
       75.44,  99.43, 131.04, 172.71, 227.63, 300.00 ],

cat Z = [ 0.01,       ! dBZ
       6.0,    8.0,   10.0,   12.0,   14.0,   16.0,
       18.0,   20.0,   22.0,   24.0,   26.0,   28.0,
       30.0,   32.0,   34.0,   36.0,   38.0,   40.0,
       42.0,   44.0,   46.0,   48.0,   50.0,   52.0,
       54.0,   56.0,   58.0,   60.0,   62.0,   64.0 ],

cat integratedWater = [ 0.0,      ! kg/m^2
     200.0,  400.0,  600.0,  800.0, 1000.0, 1200.0,
     1400.0, 1600.0, 1800.0, 2000.0, 2200.0, 2400.0,
     2600.0, 2800.0, 3000.0, 3200.0, 3400.0, 3600.0,
     3800.0, 4000.0, 4200.0, 4400.0, 4600.0, 4800.0,
     5000.0, 5200.0, 5400.0, 5600.0, 5800.0, 6000.0 ],

cat bbhgt = [ 10.0,    ! meters
     250.0,  500.0,  750.0, 1000.0, 1250.0, 1500.0,
     1750.0, 2000.0, 2250.0, 2500.0, 2750.0, 3000.0,
     3250.0, 3500.0, 3750.0, 4000.0, 4250.0, 4500.0,
     4750.0, 5000.0, 5250.0, 5500.0, 5750.0, 6000.0,
     6250.0, 6500.0, 6750.0, 7000.0, 7500.0,20000.0 ],

cat bbwdth = [ 0.0,    ! meters
      125.0,  250.0,  375.0,  500.0,  625.0,  750.0,
      875.0, 1000.0, 1125.0, 1250.0, 1375.0, 1500.0,
     1625.0, 1750.0, 1875.0, 2000.0, 2125.0, 2250.0,
     2375.0, 2500.0, 2625.0, 2750.0, 2875.0, 3000.0,
     3125.0, 3250.0, 3375.0, 3500.0, 3625.0, 3750.0 ],

cat stormh = 1000.0*[ 0.01,   ! km  (convert m > km)
        0.5,    1.0,    1.5,    2.0,    2.5,    3.0,
        3.5,    4.0,    4.5,    5.0,    5.5,    6.0,
        6.5,    7.0,    7.5,    8.0,    8.5,    9.0,
        9.5,   10.0,   10.5,   11.0,   11.5,   12.0,
       12.5,   13.0,   14.0,   15.0,   16.0,   20.0 ],

cat epsilon = [ 0.0,
        0.1,    0.2,    0.3,    0.4,    0.5,    0.6,
```

```
        0.7,    0.8,    0.9,    1.0,    1.1,    1.2,
        1.3,    1.4,    1.5,    1.6,    1.7,    1.8,
        1.9,    2.0,    2.1,    2.2,    2.3,    2.4,
        2.5,    2.6,    2.7,    2.8,    2.9,    3.0 ],

cat nubf = [ 1.0,
        1.05,   1.1,    1.15,   1.2,    1.25,   1.3,
        1.35,   1.4,    1.45,   1.5,    1.55,   1.6,
        1.65,   1.7,    1.75,   1.8,    1.85,   1.9,
        1.95,   2.0,    2.1,    2.2,    2.3,    2.4,
        2.5,    2.6,    2.7,    2.8,    2.9,    3.0 ],

cat pia = [ 0.01,
        0.1,    0.2,    0.3,    0.4,    0.5,    0.6,
        0.8,    1.0,    1.2,    1.4,    1.6,    1.8,
        2.0,    2.5,    3.0,    3.5,    4.0,    4.5,
        5.0,    5.5,    6.0,    7.0,    8.0,    9.0,
       10.0,   15.0,   20.0,   25.0,   30.0,  100.0 ],

cat dBNw = [ 0.1,
       1.0,    2.0,    4.0,    6.0,    8.0,   10.0,
       12.0,   14.0,   16.0,   18.0,   20.0,   22.0,
       24.0,   26.0,   28.0,   30.0,   32.0,   34.0,
       36.0,   38.0,   40.0,   42.0,   44.0,   46.0,
       48.0,   50.0,   52.0,   54.0,   56.0,   60.0 ],

cat Dm = [ 0.1,         ! mm
        0.2,    0.3,    0.4,    0.5,    0.6,    0.7,
        0.8,    0.9,    1.0,    1.1,    1.2,    1.3,
        1.4,    1.5,    1.6,    1.7,    1.8,    1.9,
        2.0,    2.1,    2.2,    2.3,    2.4,    2.5,
        2.6,    2.7,    2.8,    2.9,    3.0,    4.0 ]
```

Dimension definitions:

ltL	28	Number of low resolution 5^o grid intervals of latitude from 70^oS to 70^oN.
lnL	72	Number of low resolution 5^o grid intervals of longitude from 180^oW to 180^oE.
ltH	536	Number of high resolution 0.25^o grid intervals of latitude from 67^oS to 67^oN.
lnH	1440	Number of high resolution 0.25^o grid intervals of longitude from 180^oW to 180^oE.
chn3	3	Number of channels. For FS: KuFS(49), KaFS(49), DPRFS(49) For MS: KuMS(25), KaMS(25), DPRMS(25)
chn4	4	Number of channels. For FS: KuFS(49), KaFS(49), DPRKuFS(49), DPRKaFS(49) For MS: KuMS(25), KaMS(25), DPRKuMS(49), DPRKaMS(49)
hgt	5	Number of heights above the earth ellipsoid: 2, 4, 6, 10, and 15 km.
tim	24	Number of hours (local time).
ang7	7	Number of angles. Indeces are used with the meaning 0, 1, 2,...,6 = angle bins 24, (20,28), (16,32), (12,36), (8,40), (4,44), and (0,48).
ang4	4	Number of angles. Indeces are used with the meaning 0, 1, 2, 3 = angle bins 24, (20,28), (16,32), (12,36).
rt	3	Number of rain types: all, stratiform, convective.
st	3	Number of surface types: all, ocean, land.
bin	30	Number of bins in histogram. The thresholds are different for different variables. See the introduction to this algorithm.

Figure 594 through Figure 824 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

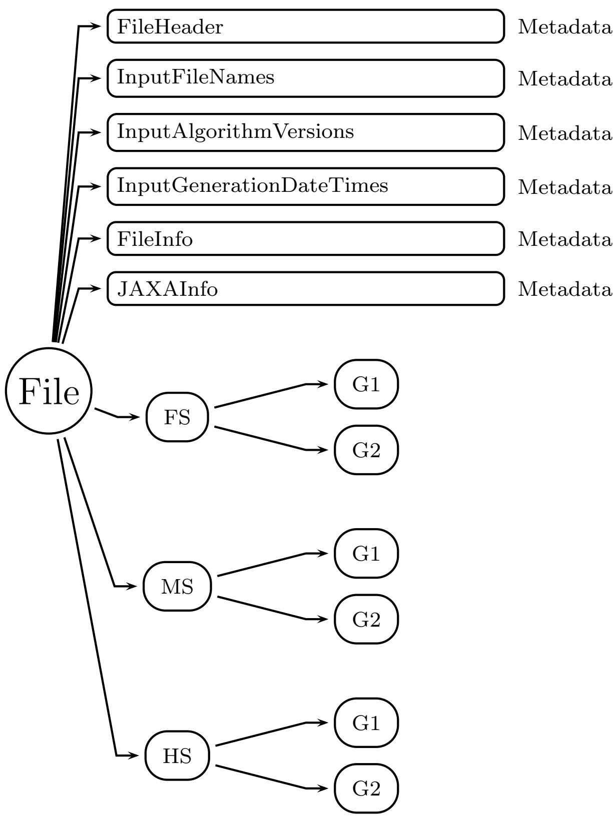


Figure 594: Data Format Structure for 3DPR, , DPR Full Product

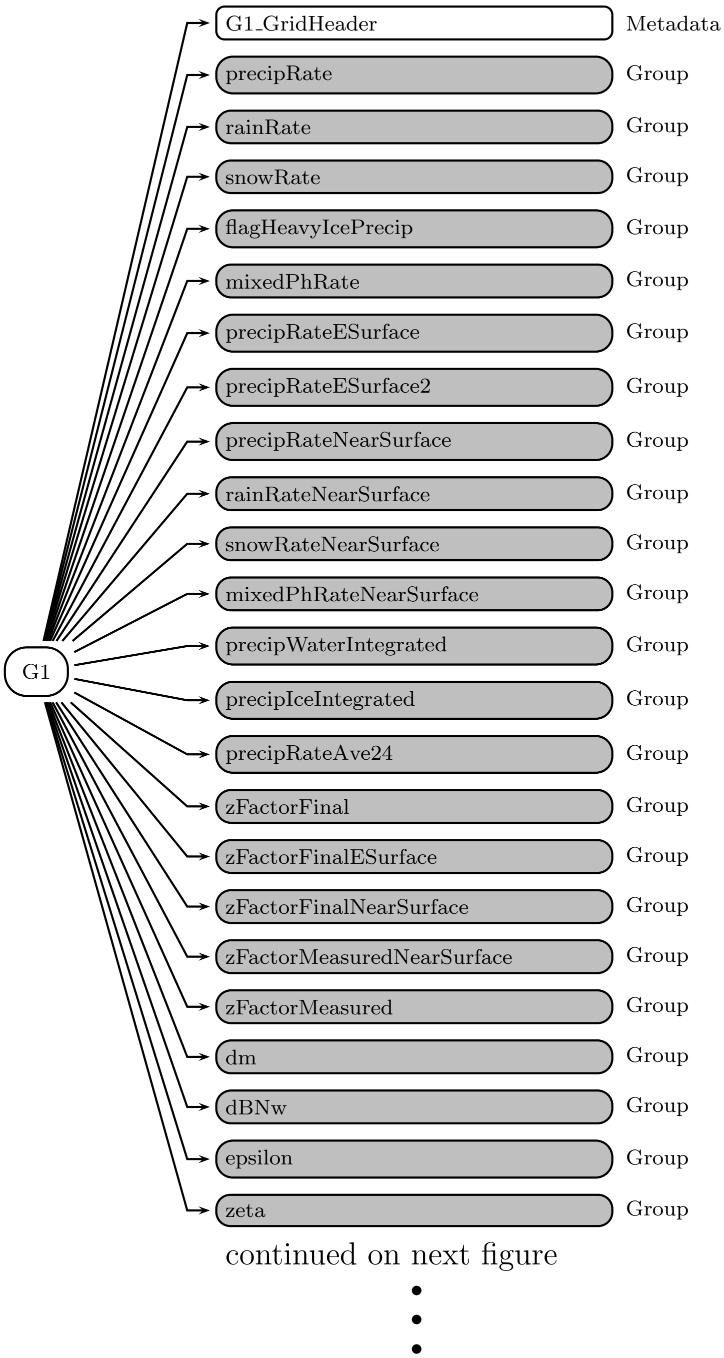


Figure 595: Data Format Structure for 3DPR, FS, G1,

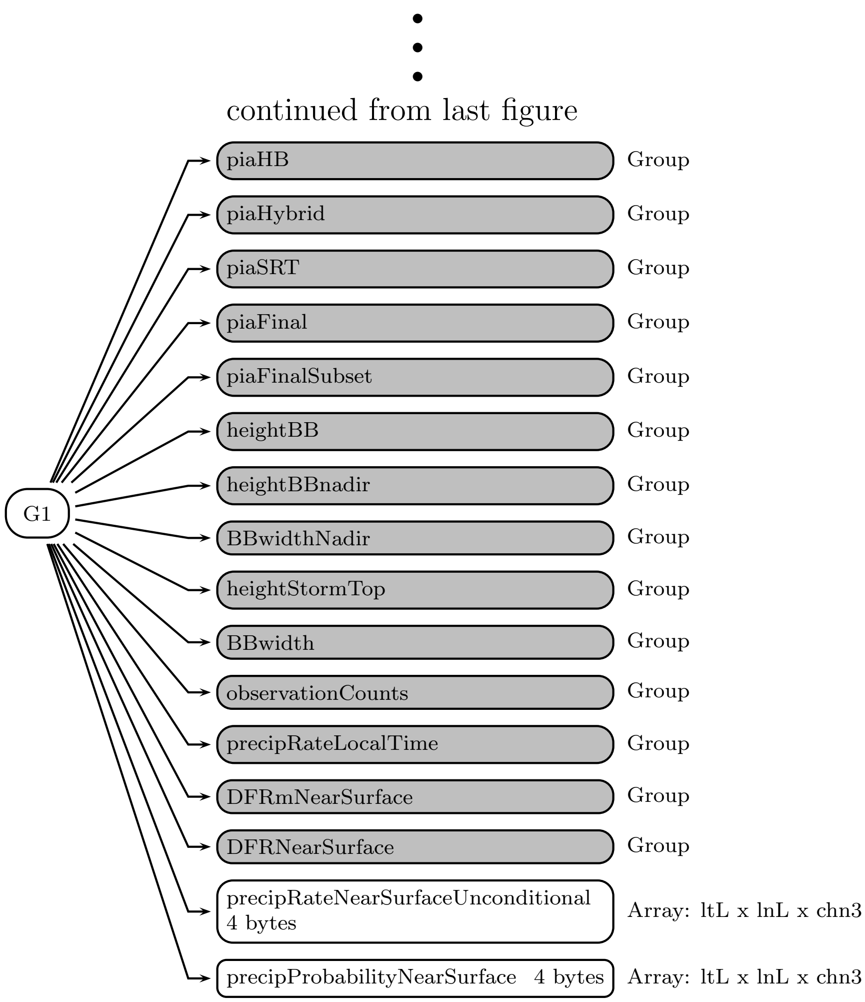


Figure 596: Data Format Structure for 3DPR, FS, G1

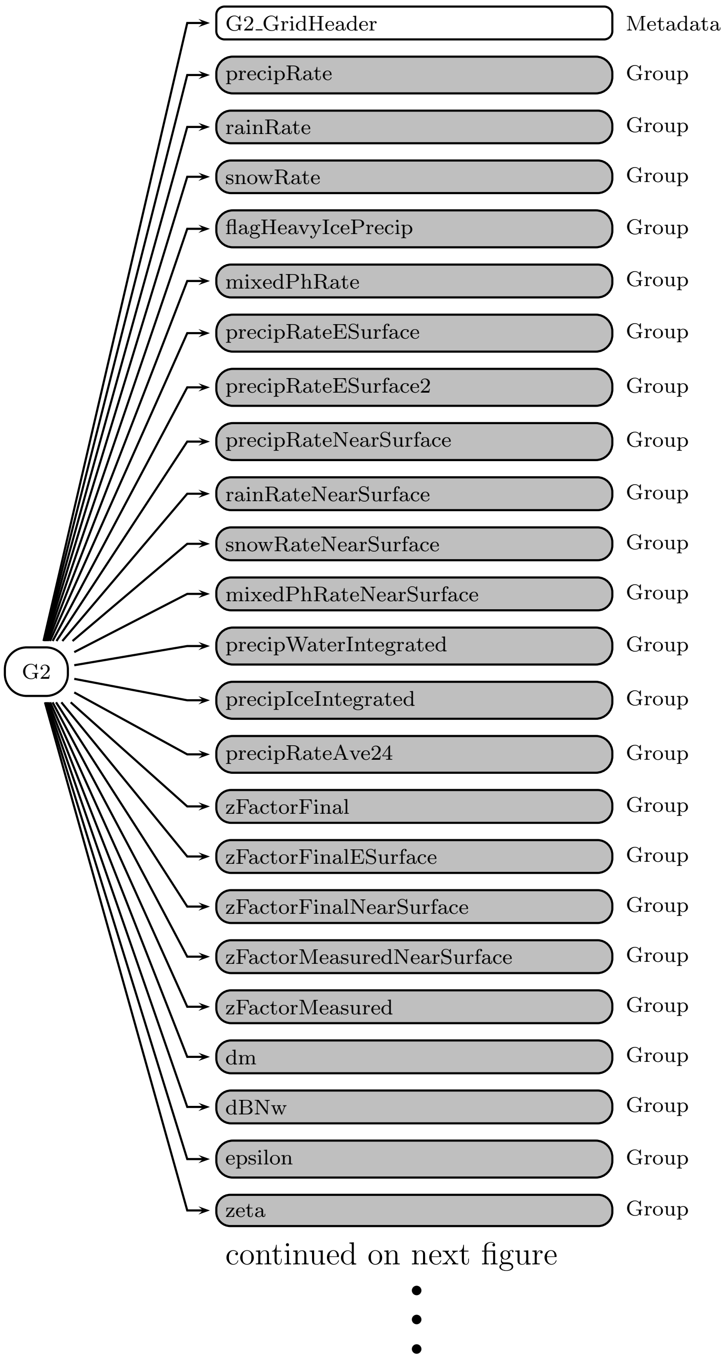


Figure 597: Data Format Structure for 3DPR, FS, G2,

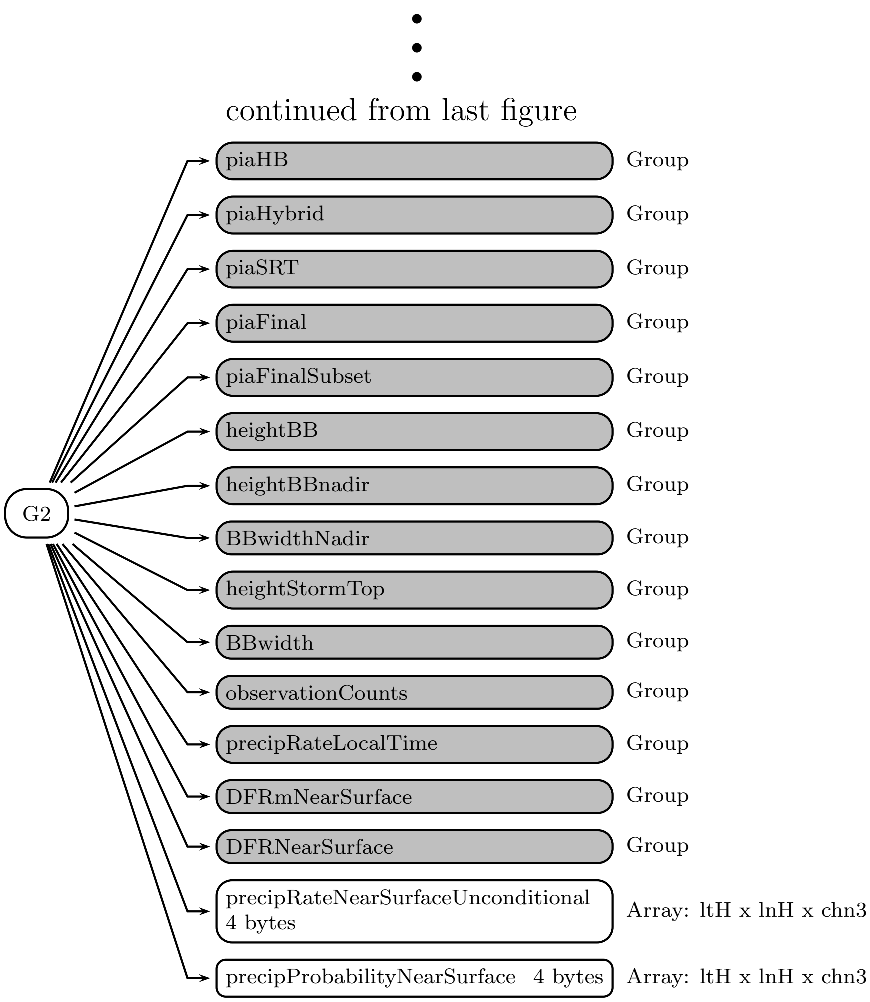


Figure 598: Data Format Structure for 3DPR, FS, G2

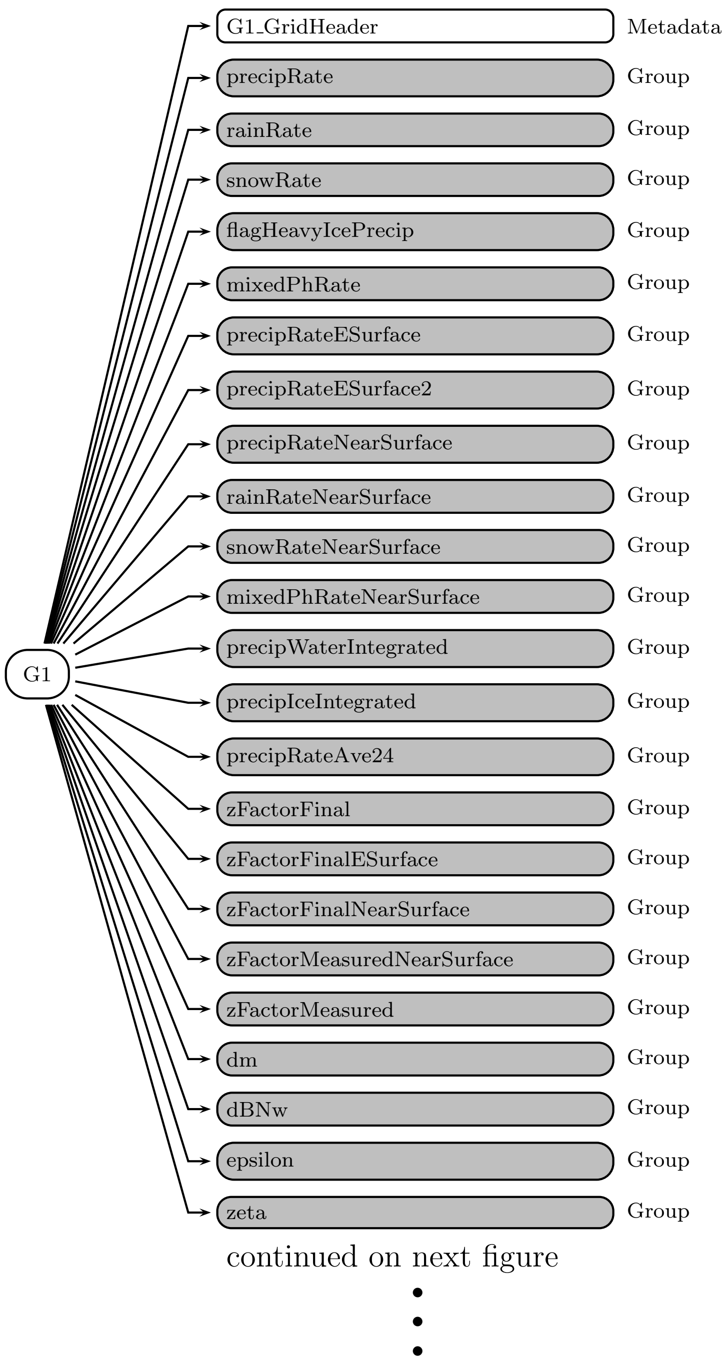


Figure 599: Data Format Structure for 3DPR, MS, G1,

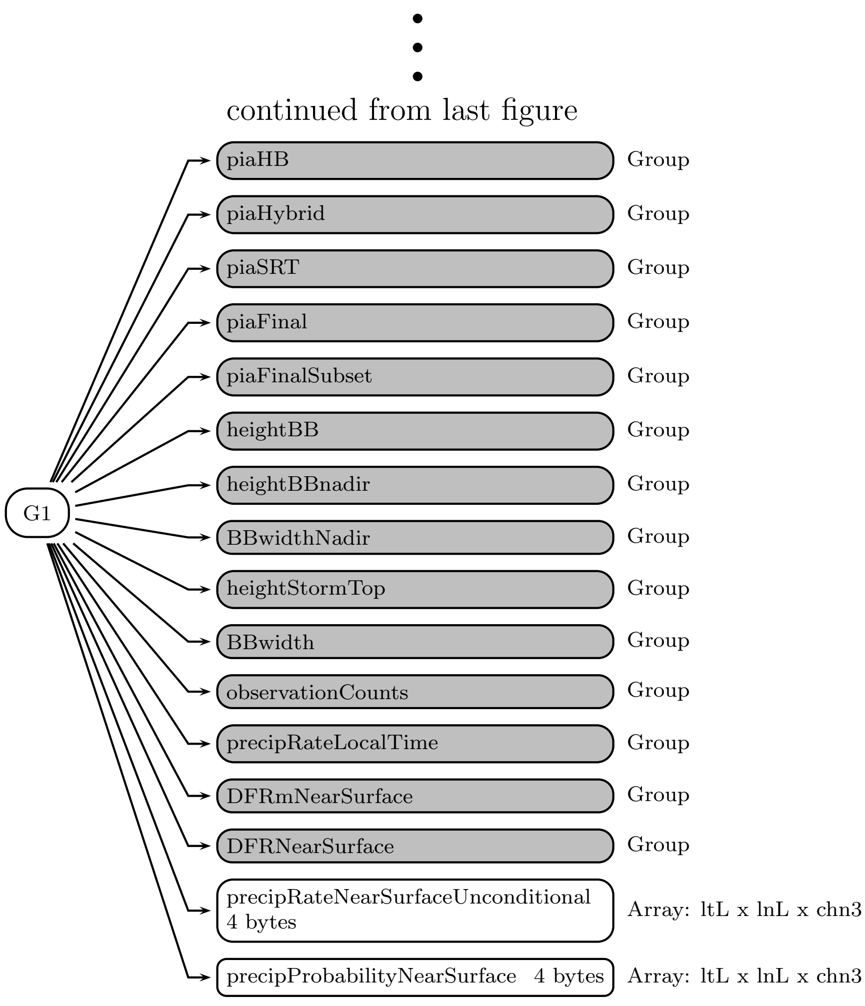
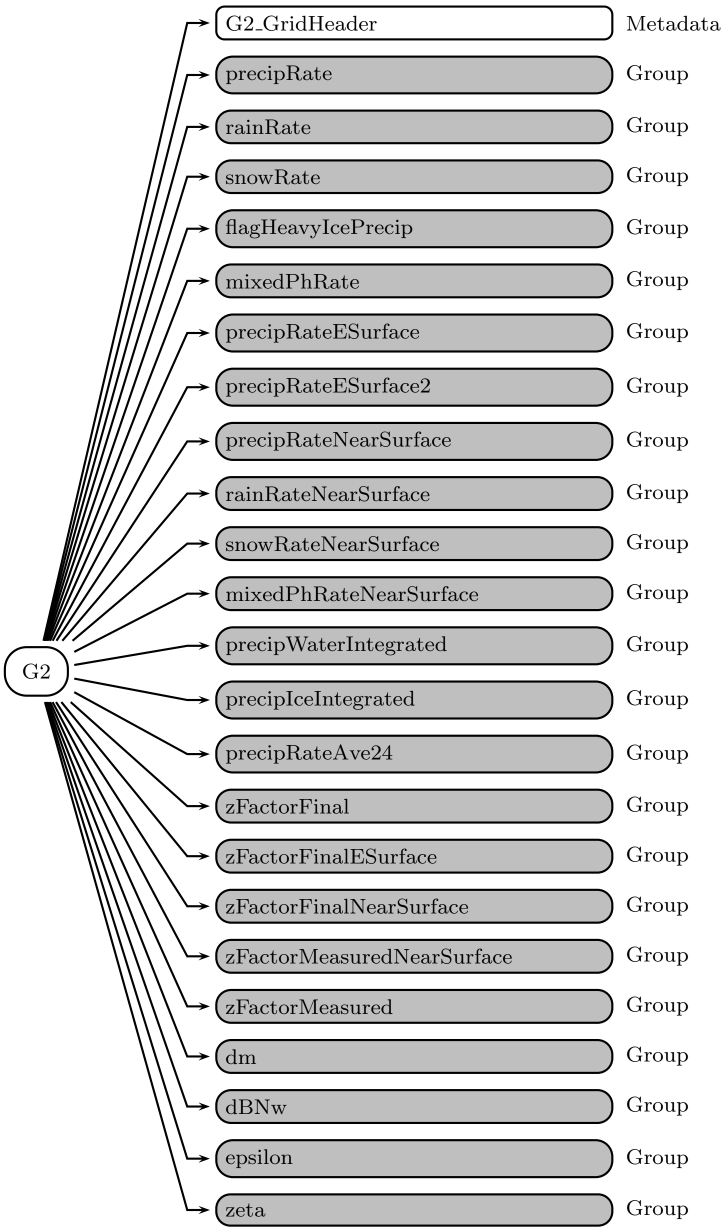


Figure 600: Data Format Structure for 3DPR, MS, G1



continued on next figure

Figure 601: Data Format Structure for 3DPR, MS, G2,

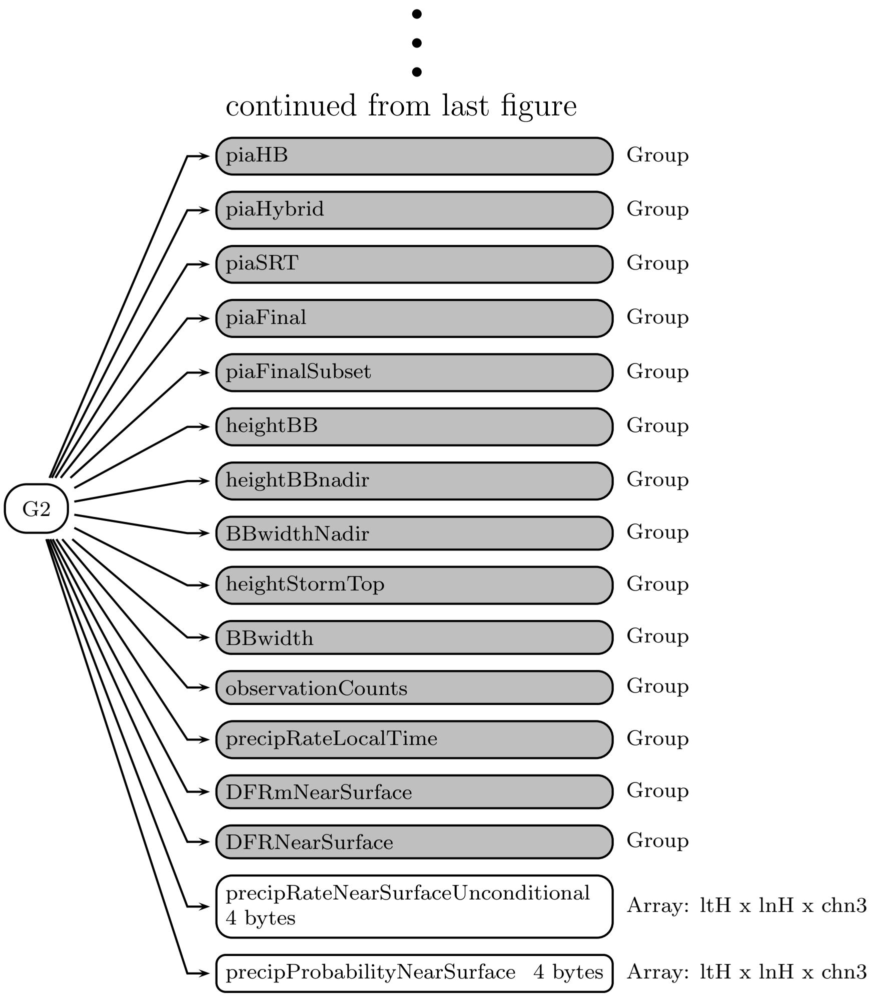


Figure 602: Data Format Structure for 3DPR, MS, G2

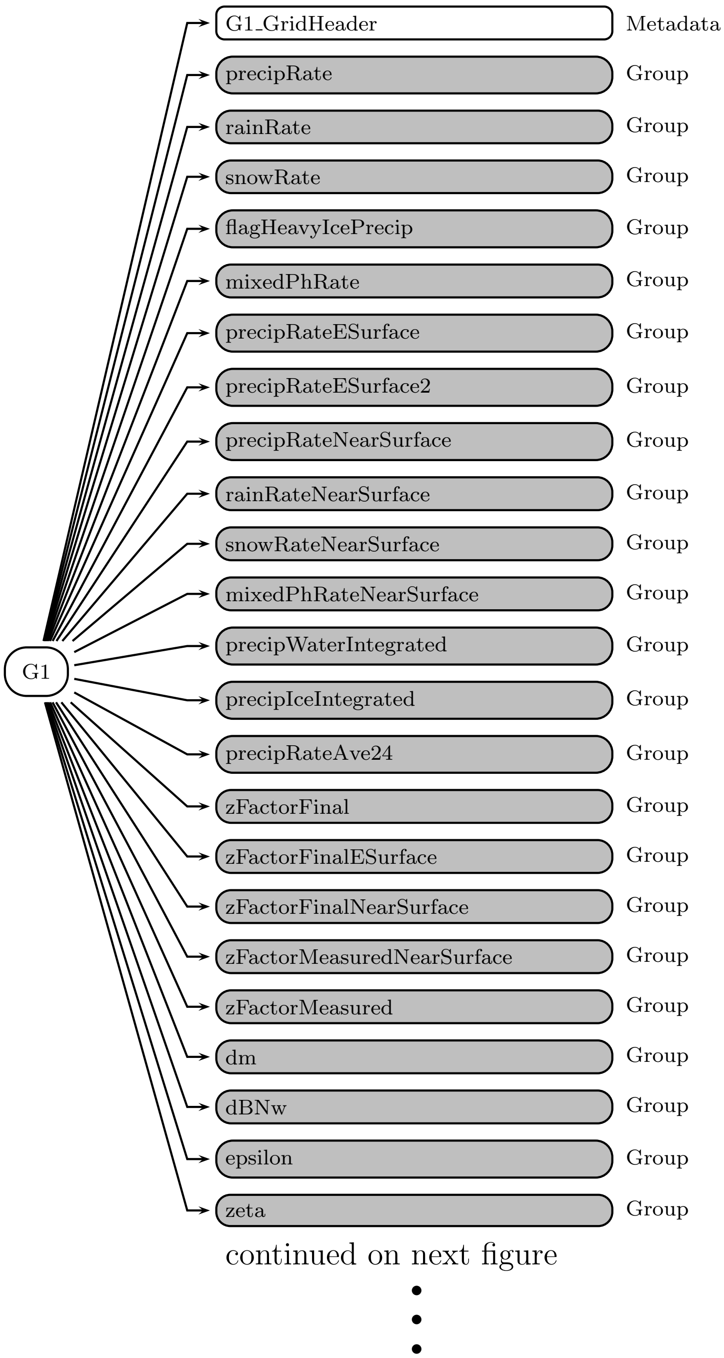


Figure 603: Data Format Structure for 3DPR, HS, G1,

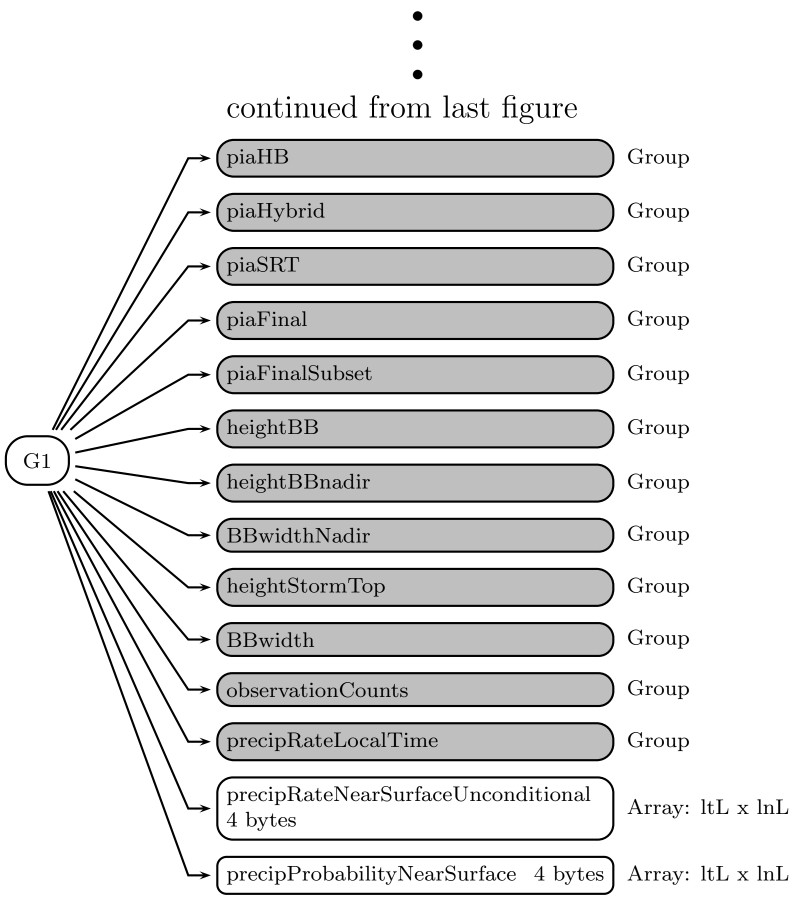
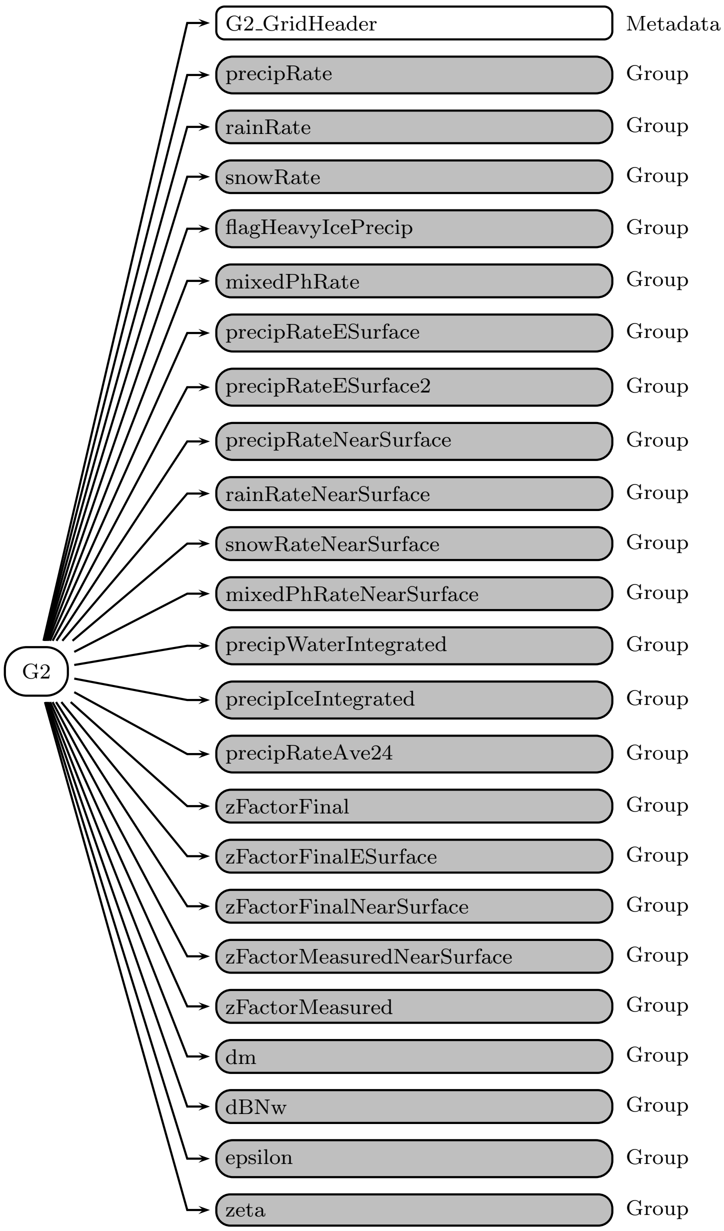


Figure 604: Data Format Structure for 3DPR, HS, G1



continued on next figure

Figure 605: Data Format Structure for 3DPR, HS, G2,

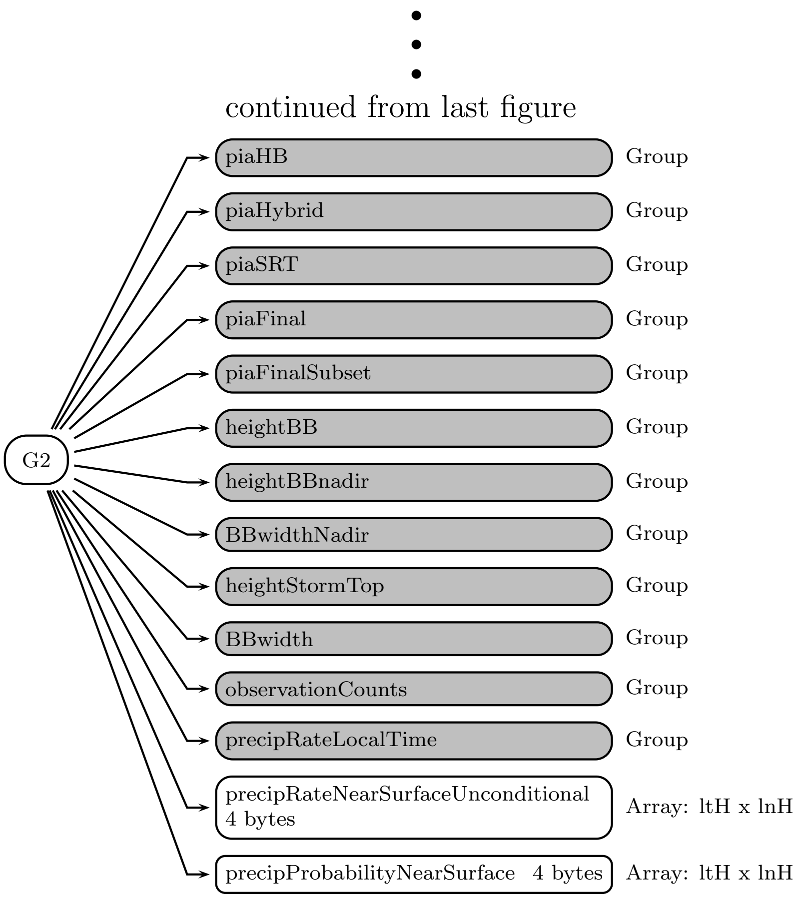


Figure 606: Data Format Structure for 3DPR, HS, G2

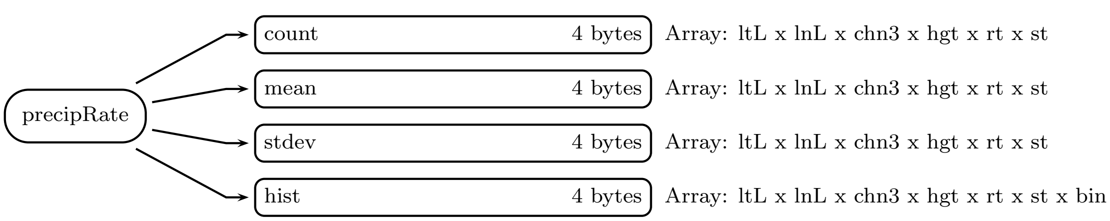


Figure 607: Data Format Structure for 3DPR, FS, G1, precipRate

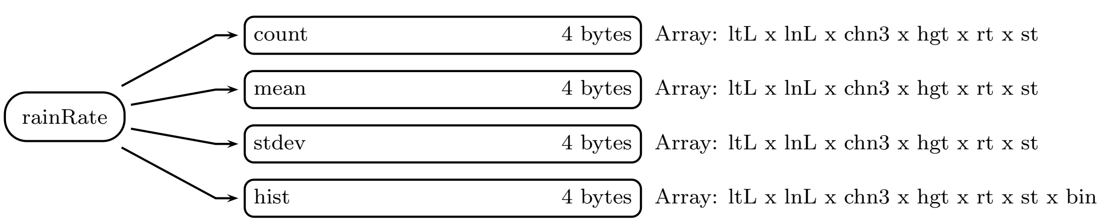


Figure 608: Data Format Structure for 3DPR, FS, G1, rainRate

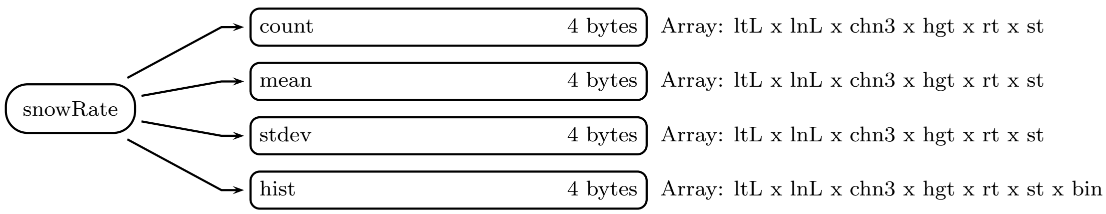


Figure 609: Data Format Structure for 3DPR, FS, G1, snowRate

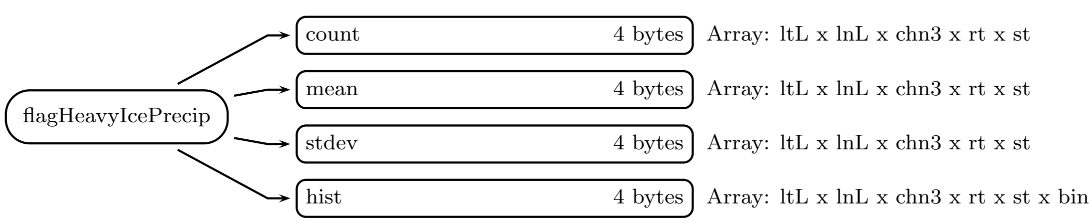


Figure 610: Data Format Structure for 3DPR, FS, G1, flagHeavyIcePrecip

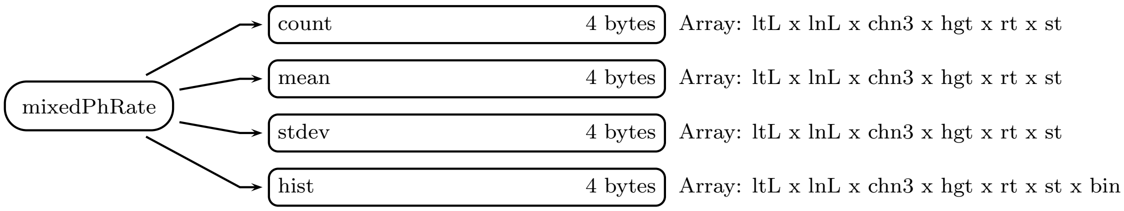


Figure 611: Data Format Structure for 3DPR, FS, G1, mixedPhRate

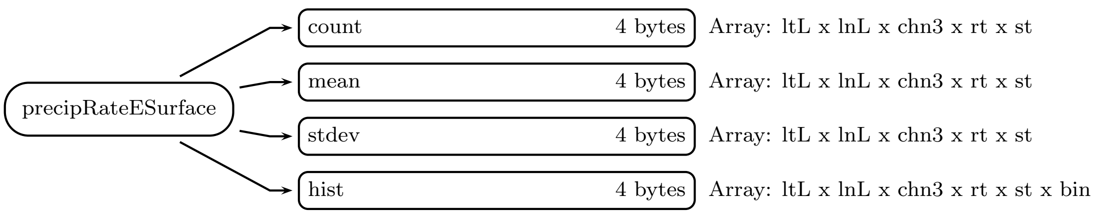


Figure 612: Data Format Structure for 3DPR, FS, G1, precipRateESurface

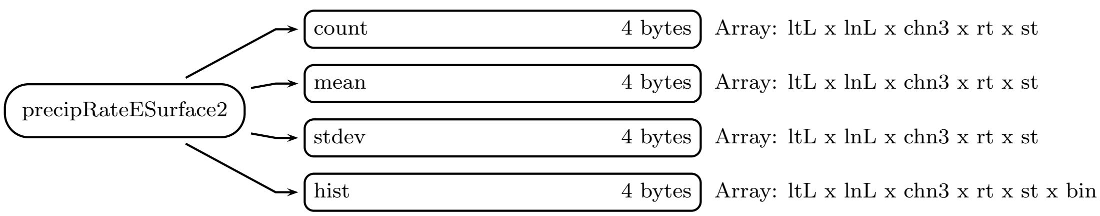


Figure 613: Data Format Structure for 3DPR, FS, G1, precipRateESurface2

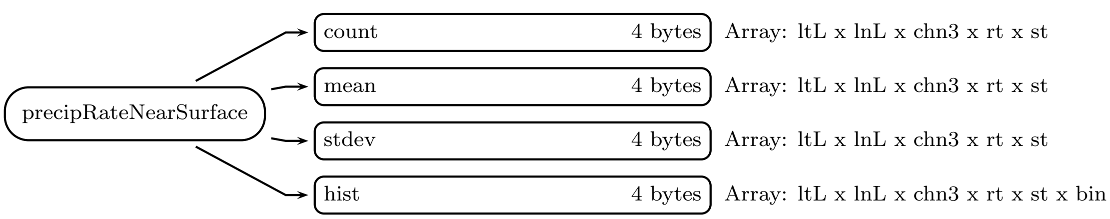


Figure 614: Data Format Structure for 3DPR, FS, G1, precipRateNearSurface

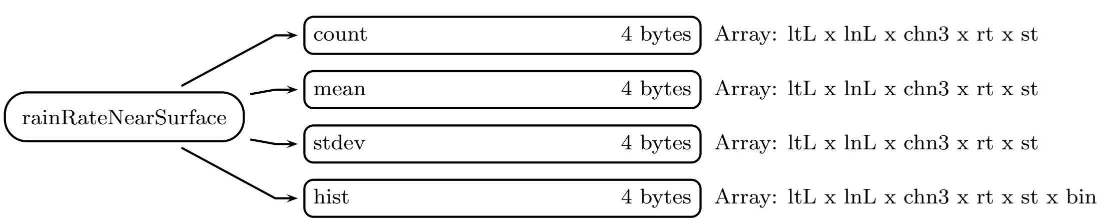


Figure 615: Data Format Structure for 3DPR, FS, G1, rainRateNearSurface

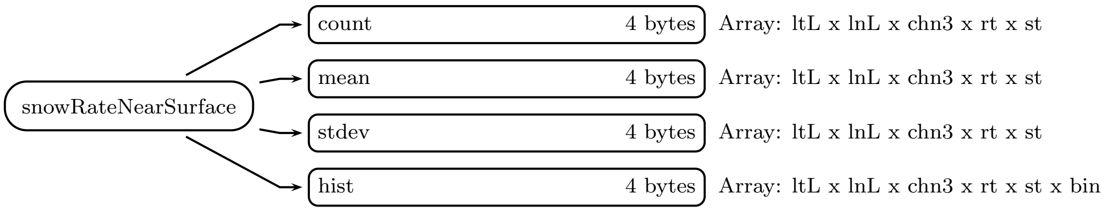


Figure 616: Data Format Structure for 3DPR, FS, G1, snowRateNearSurface

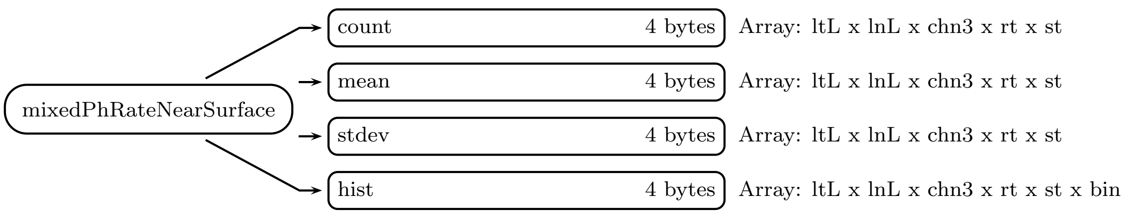


Figure 617: Data Format Structure for 3DPR, FS, G1, mixedPhRateNearSurface

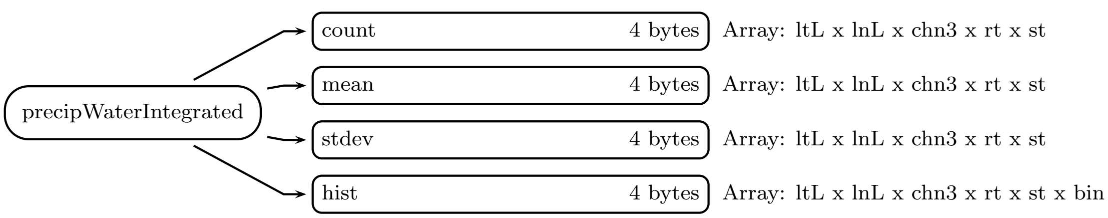


Figure 618: Data Format Structure for 3DPR, FS, G1, precipWaterIntegrated

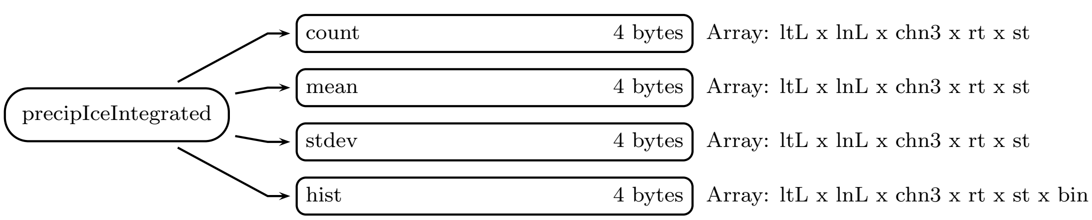


Figure 619: Data Format Structure for 3DPR, FS, G1, precipIceIntegrated

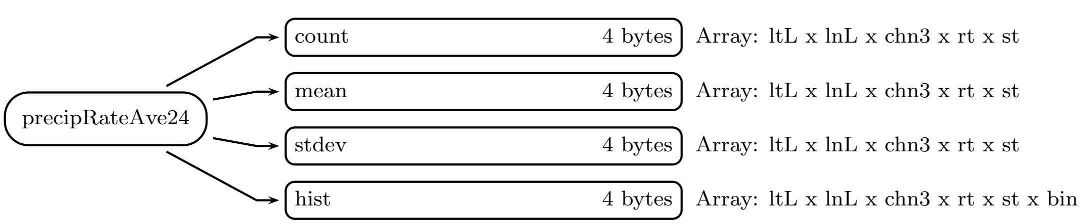


Figure 620: Data Format Structure for 3DPR, FS, G1, precipRateAve24

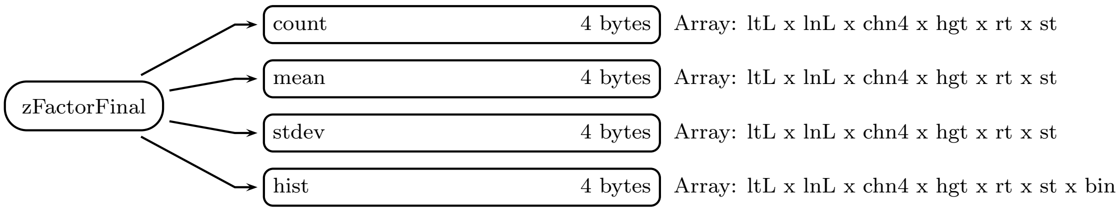


Figure 621: Data Format Structure for 3DPR, FS, G1, zFactorFinal

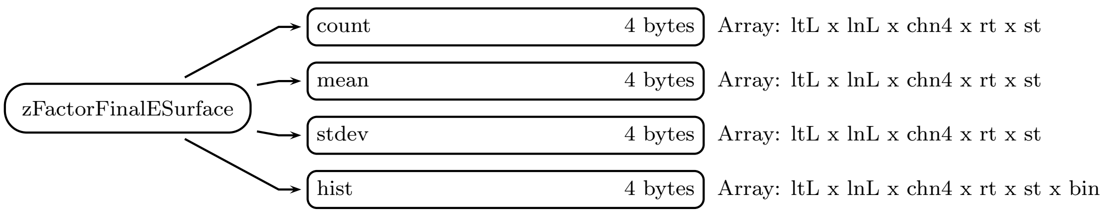


Figure 622: Data Format Structure for 3DPR, FS, G1, zFactorFinalESurface

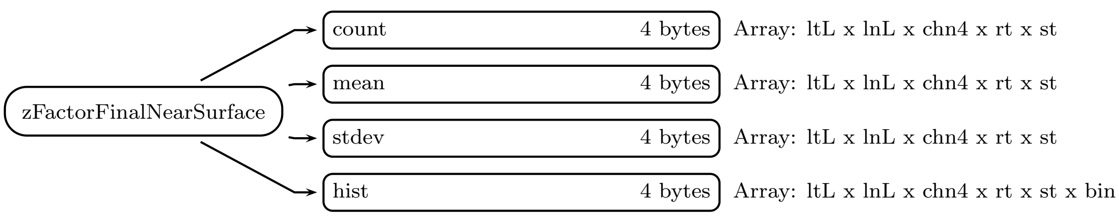


Figure 623: Data Format Structure for 3DPR, FS, G1, zFactorFinalNearSurface

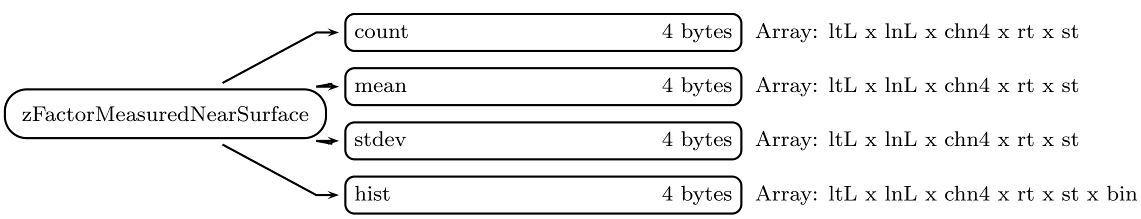


Figure 624: Data Format Structure for 3DPR, FS, G1, zFactorMeasuredNearSurface

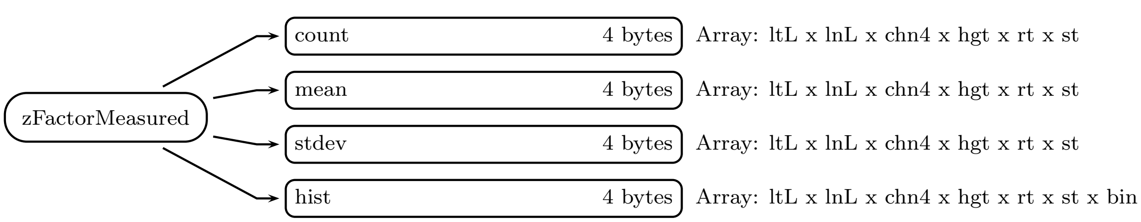


Figure 625: Data Format Structure for 3DPR, FS, G1, zFactorMeasured

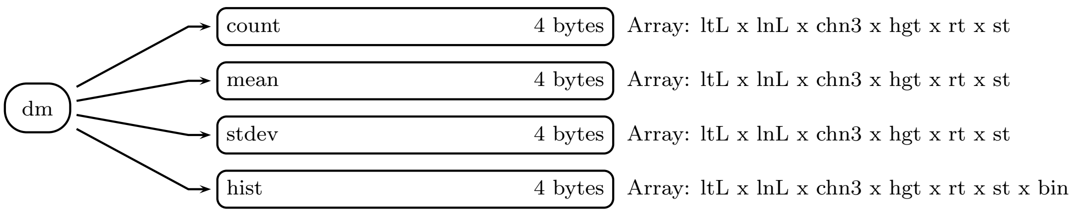


Figure 626: Data Format Structure for 3DPR, FS, G1, dm

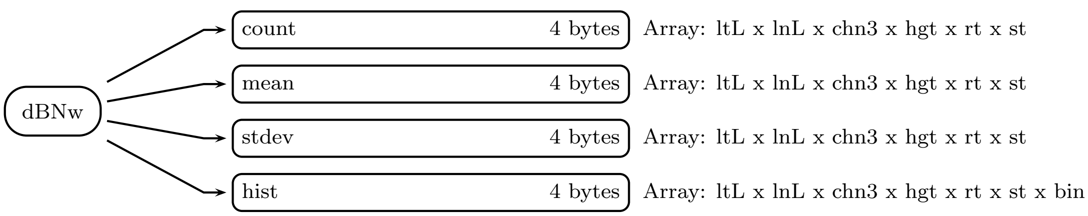


Figure 627: Data Format Structure for 3DPR, FS, G1, dBNw

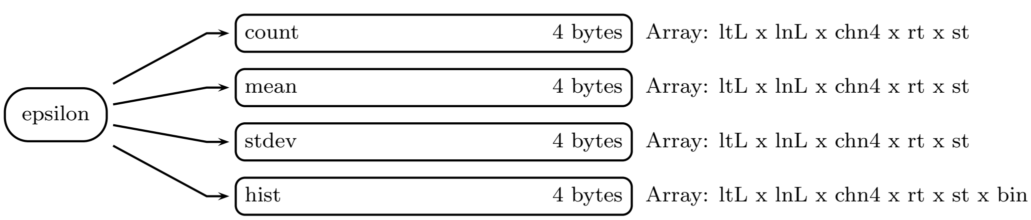


Figure 628: Data Format Structure for 3DPR, FS, G1, epsilon

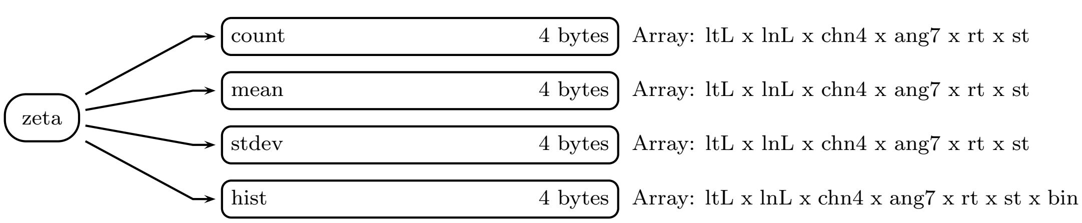


Figure 629: Data Format Structure for 3DPR, FS, G1, zeta

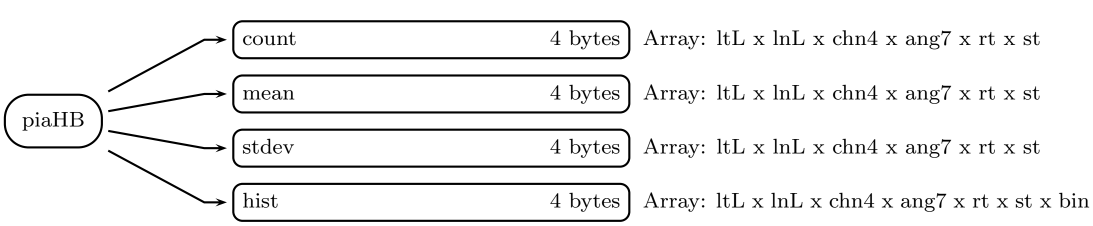


Figure 630: Data Format Structure for 3DPR, FS, G1, piaHB

piaHybrid	count	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	mean	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	stdev	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	hist	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st x bin

Figure 631: Data Format Structure for 3DPR, FS, G1, piaHybrid

piaSRT	count	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	mean	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	stdev	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	hist	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st x bin

Figure 632: Data Format Structure for 3DPR, FS, G1, piaSRT

piaFinal	count	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	mean	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	stdev	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	hist	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st x bin

Figure 633: Data Format Structure for 3DPR, FS, G1, piaFinal

piaFinalSubset	count	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	mean	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	stdev	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st
	hist	4 bytes	Array: ltL x lnL x chn4 x ang7 x rt x st x bin

Figure 634: Data Format Structure for 3DPR, FS, G1, piaFinalSubset

heightBB	count	4 bytes	Array: ltL x lnL x chn3 x rt x st
	mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
	stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
	hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 635: Data Format Structure for 3DPR, FS, G1, heightBB

heightBBnadir			
	count	4 bytes	Array: ltL x lnL x chn3 x rt x st
	mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
	stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
	hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 636: Data Format Structure for 3DPR, FS, G1, heightBBnadir

BBwidthNadir			
	count	4 bytes	Array: ltL x lnL x chn3 x rt x st
	mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
	stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
	hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 637: Data Format Structure for 3DPR, FS, G1, BBwidthNadir

heightStormTop			
	count	4 bytes	Array: ltL x lnL x chn3 x rt x st
	mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
	stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
	hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 638: Data Format Structure for 3DPR, FS, G1, heightStormTop

BBwidth			
	count	4 bytes	Array: ltL x lnL x chn3 x rt x st
	mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
	stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
	hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 639: Data Format Structure for 3DPR, FS, G1, BBwidth

observationCounts			
	total	4 bytes	Array: ltL x lnL x chn3 x st
	localTime	4 bytes	Array: ltL x lnL x chn3 x tim x st
	pia	4 bytes	Array: ltL x lnL x chn3 x ang7 x st
	shallowRain	4 bytes	Array: ltL x lnL x chn3 x st

Figure 640: Data Format Structure for 3DPR, FS, G1, observationCounts

precipRateLocalTime	count	4 bytes	Array: ltL x lnL x chn3 x tim x st
	mean	4 bytes	Array: ltL x lnL x chn3 x tim x st
	stdev	4 bytes	Array: ltL x lnL x chn3 x tim x st

Figure 641: Data Format Structure for 3DPR, FS, G1, precipRateLocalTime

DFRmNearSurface	count	4 bytes	Array: ltL x lnL x rt x st
	mean	4 bytes	Array: ltL x lnL x rt x st
	stdev	4 bytes	Array: ltL x lnL x rt x st
	hist	4 bytes	Array: ltL x lnL x rt x st x bin

Figure 642: Data Format Structure for 3DPR, FS, G1, DFRmNearSurface

DFRNearSurface	count	4 bytes	Array: ltL x lnL x rt x st
	mean	4 bytes	Array: ltL x lnL x rt x st
	stdev	4 bytes	Array: ltL x lnL x rt x st
	hist	4 bytes	Array: ltL x lnL x rt x st x bin

Figure 643: Data Format Structure for 3DPR, FS, G1, DFRNearSurface

precipRate	count	4 bytes	Array: ltH x lnH x chn3 x hgt x rt
	mean	4 bytes	Array: ltH x lnH x chn3 x hgt x rt
	stdev	4 bytes	Array: ltH x lnH x chn3 x hgt x rt

Figure 644: Data Format Structure for 3DPR, FS, G2, precipRate

rainRate	count	4 bytes	Array: ltH x lnH x chn3 x hgt x rt
	mean	4 bytes	Array: ltH x lnH x chn3 x hgt x rt
	stdev	4 bytes	Array: ltH x lnH x chn3 x hgt x rt

Figure 645: Data Format Structure for 3DPR, FS, G2, rainRate

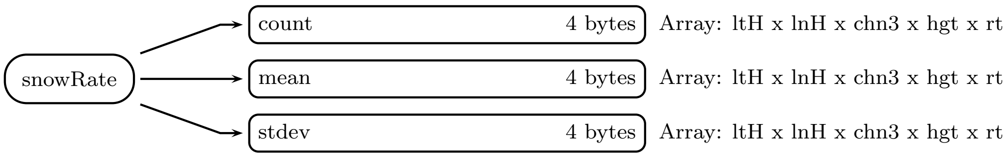


Figure 646: Data Format Structure for 3DPR, FS, G2, snowRate

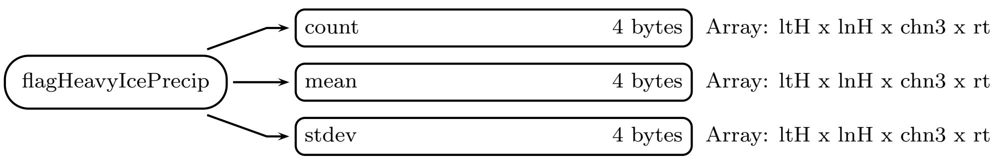


Figure 647: Data Format Structure for 3DPR, FS, G2, flagHeavyIcePrecip

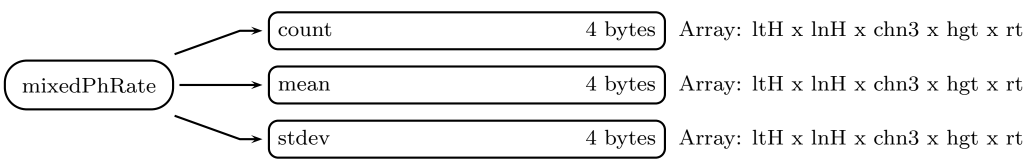


Figure 648: Data Format Structure for 3DPR, FS, G2, mixedPhRate

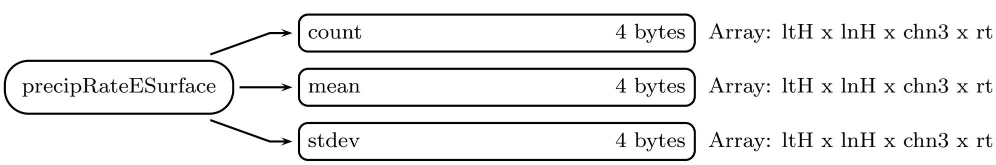


Figure 649: Data Format Structure for 3DPR, FS, G2, precipRateESurface

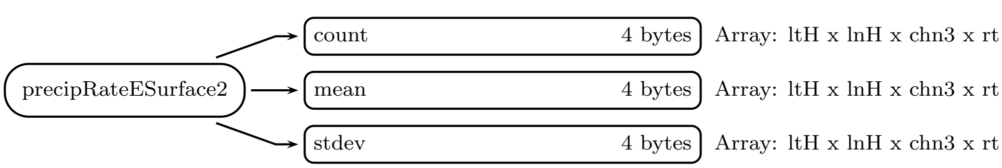


Figure 650: Data Format Structure for 3DPR, FS, G2, precipRateESurface2

precipRateNearSurface			
	count	4 bytes	Array: ltH x lnH x chn3 x rt
	mean	4 bytes	Array: ltH x lnH x chn3 x rt
	stdev	4 bytes	Array: ltH x lnH x chn3 x rt

Figure 651: Data Format Structure for 3DPR, FS, G2, precipRateNearSurface

rainRateNearSurface			
	count	4 bytes	Array: ltH x lnH x chn3 x rt
	mean	4 bytes	Array: ltH x lnH x chn3 x rt
	stdev	4 bytes	Array: ltH x lnH x chn3 x rt

Figure 652: Data Format Structure for 3DPR, FS, G2, rainRateNearSurface

snowRateNearSurface			
	count	4 bytes	Array: ltH x lnH x chn3 x rt
	mean	4 bytes	Array: ltH x lnH x chn3 x rt
	stdev	4 bytes	Array: ltH x lnH x chn3 x rt

Figure 653: Data Format Structure for 3DPR, FS, G2, snowRateNearSurface

mixedPhRateNearSurface			
	count	4 bytes	Array: ltH x lnH x chn3 x rt
	mean	4 bytes	Array: ltH x lnH x chn3 x rt
	stdev	4 bytes	Array: ltH x lnH x chn3 x rt

Figure 654: Data Format Structure for 3DPR, FS, G2, mixedPhRateNearSurface

precipWaterIntegrated			
	count	4 bytes	Array: ltH x lnH x chn3 x rt
	mean	4 bytes	Array: ltH x lnH x chn3 x rt
	stdev	4 bytes	Array: ltH x lnH x chn3 x rt

Figure 655: Data Format Structure for 3DPR, FS, G2, precipWaterIntegrated

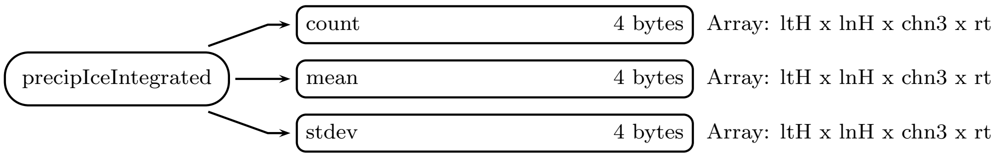


Figure 656: Data Format Structure for 3DPR, FS, G2, precipIceIntegrated

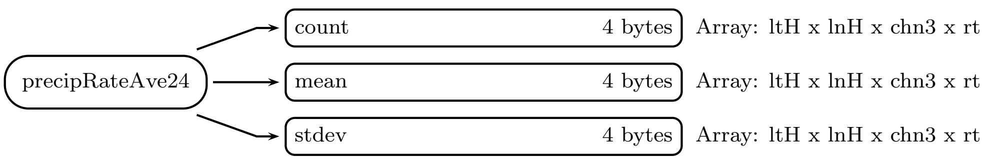


Figure 657: Data Format Structure for 3DPR, FS, G2, precipRateAve24

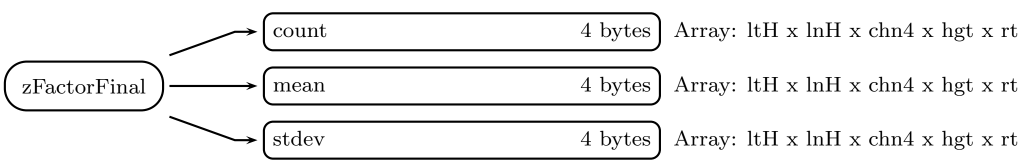


Figure 658: Data Format Structure for 3DPR, FS, G2, zFactorFinal

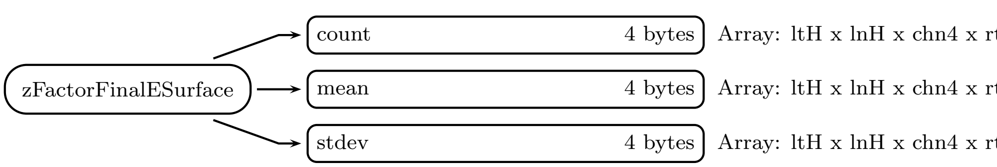


Figure 659: Data Format Structure for 3DPR, FS, G2, zFactorFinalESurface

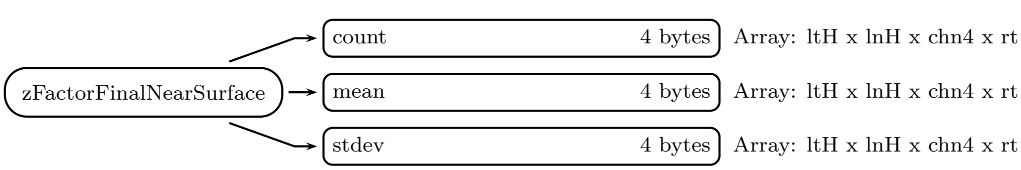


Figure 660: Data Format Structure for 3DPR, FS, G2, zFactorFinalNearSurface

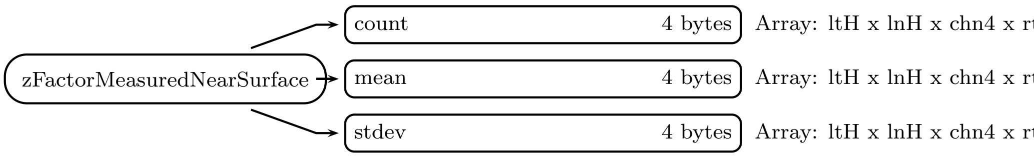


Figure 661: Data Format Structure for 3DPR, FS, G2, zFactorMeasuredNearSurface

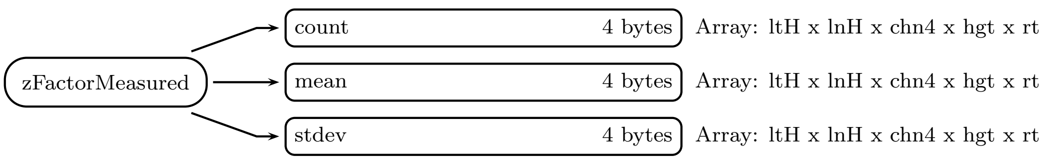


Figure 662: Data Format Structure for 3DPR, FS, G2, zFactorMeasured

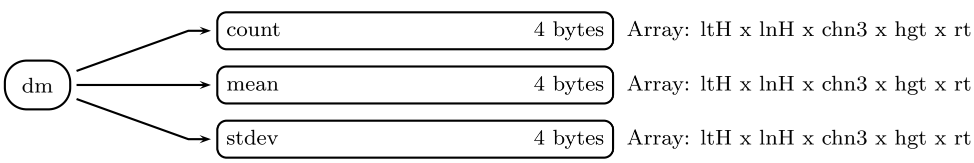


Figure 663: Data Format Structure for 3DPR, FS, G2, dm

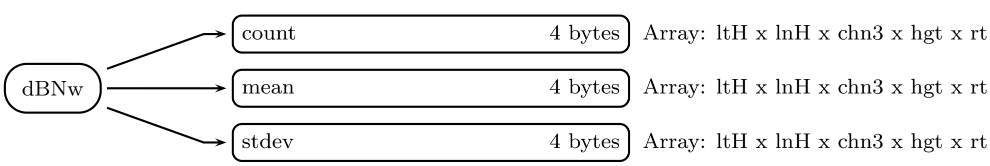


Figure 664: Data Format Structure for 3DPR, FS, G2, dBNw

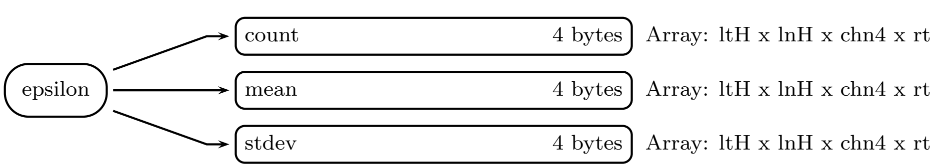


Figure 665: Data Format Structure for 3DPR, FS, G2, epsilon

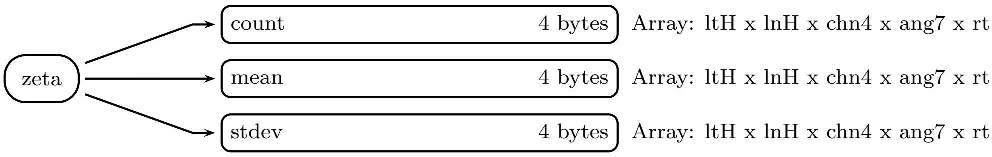


Figure 666: Data Format Structure for 3DPR, FS, G2, zeta

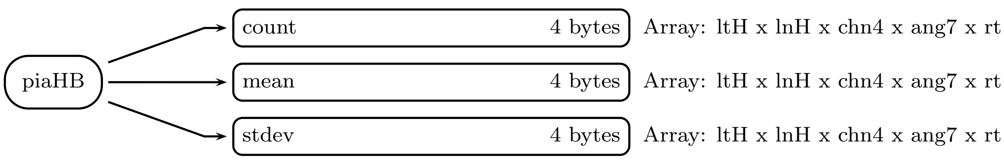


Figure 667: Data Format Structure for 3DPR, FS, G2, piaHB

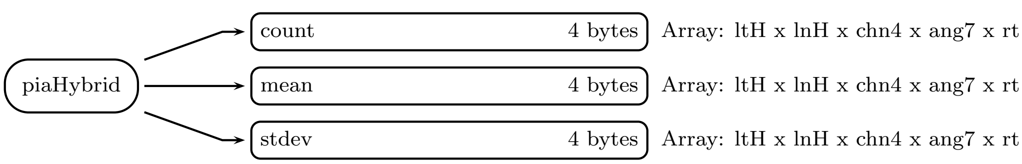


Figure 668: Data Format Structure for 3DPR, FS, G2, piaHybrid

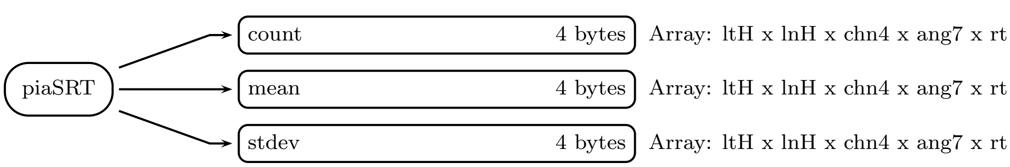


Figure 669: Data Format Structure for 3DPR, FS, G2, piaSRT

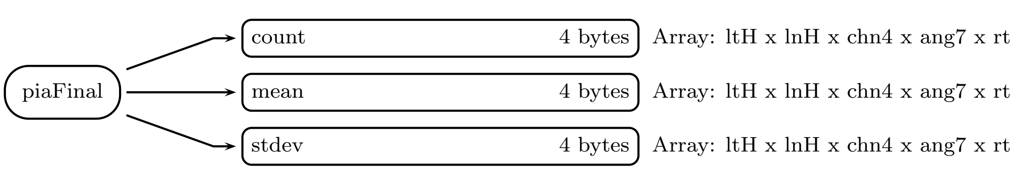


Figure 670: Data Format Structure for 3DPR, FS, G2, piaFinal

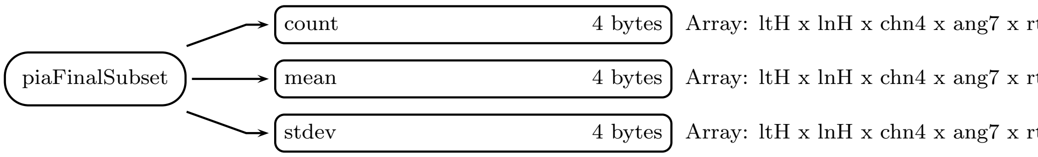


Figure 671: Data Format Structure for 3DPR, FS, G2, piaFinalSubset

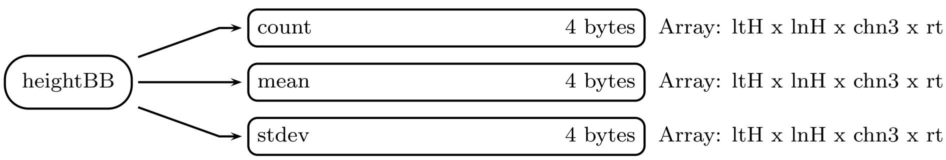


Figure 672: Data Format Structure for 3DPR, FS, G2, heightBB

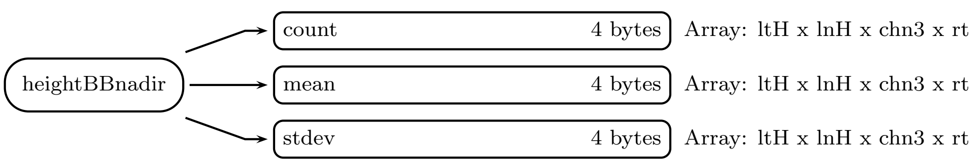


Figure 673: Data Format Structure for 3DPR, FS, G2, heightBBnadir

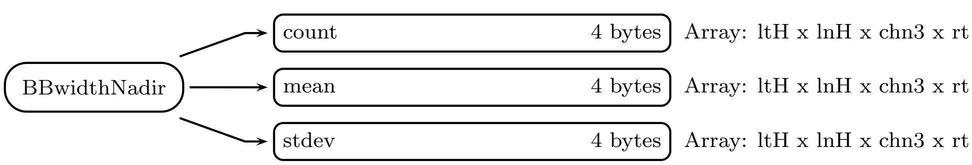


Figure 674: Data Format Structure for 3DPR, FS, G2, BBwidthNadir

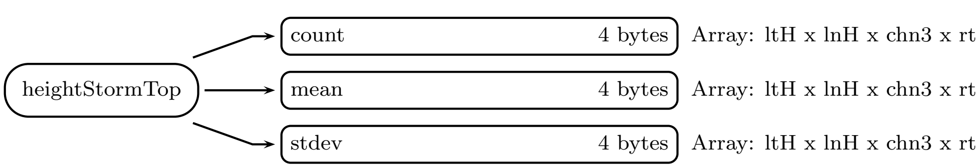


Figure 675: Data Format Structure for 3DPR, FS, G2, heightStormTop

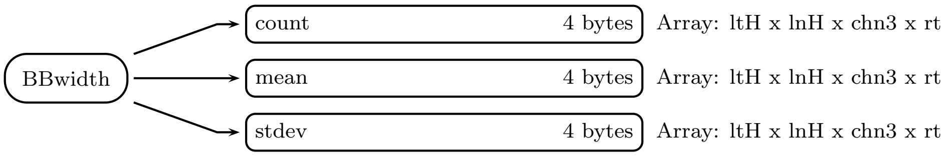


Figure 676: Data Format Structure for 3DPR, FS, G2, BBwidth

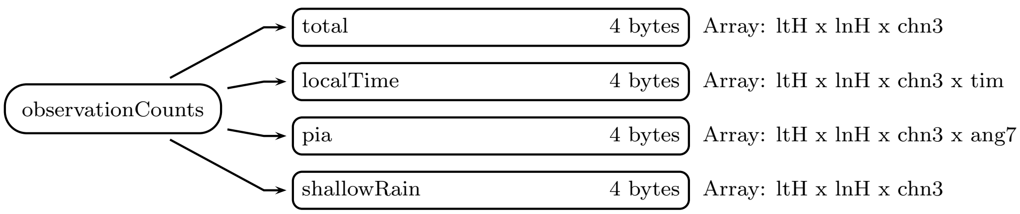


Figure 677: Data Format Structure for 3DPR, FS, G2, observationCounts

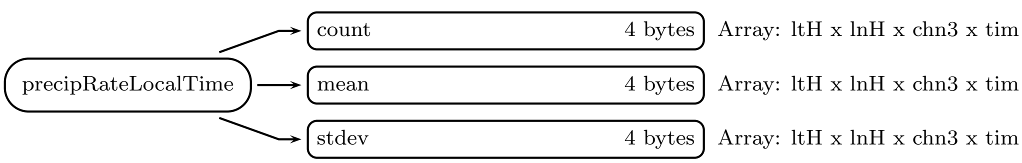


Figure 678: Data Format Structure for 3DPR, FS, G2, precipRateLocalTime

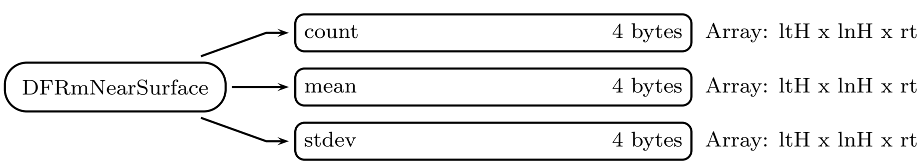


Figure 679: Data Format Structure for 3DPR, FS, G2, DFRmNearSurface

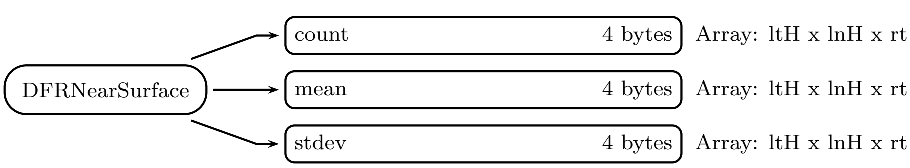


Figure 680: Data Format Structure for 3DPR, FS, G2, DFRNearSurface

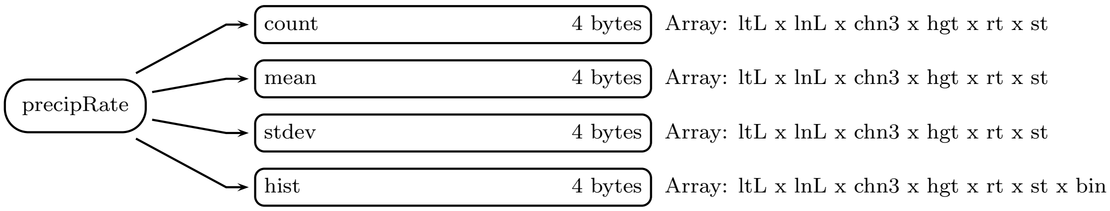


Figure 681: Data Format Structure for 3DPR, MS, G1, precipRate

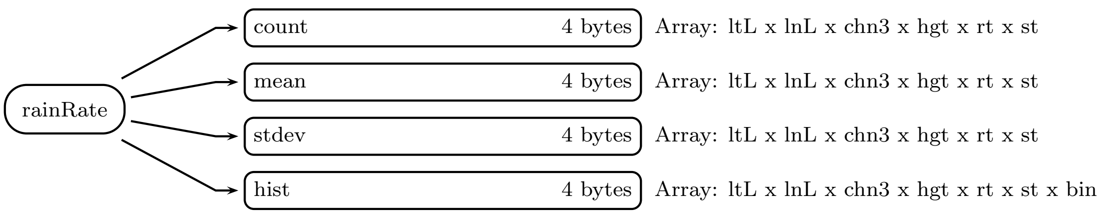


Figure 682: Data Format Structure for 3DPR, MS, G1, rainRate

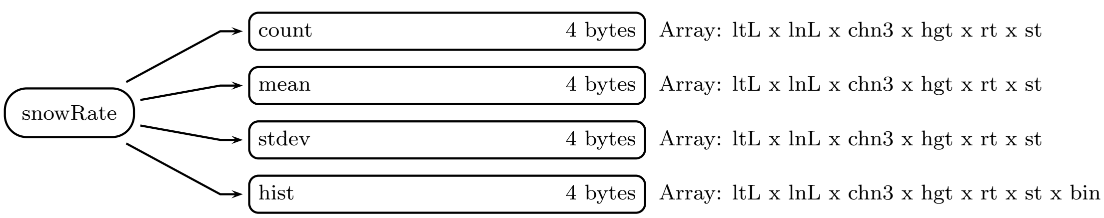


Figure 683: Data Format Structure for 3DPR, MS, G1, snowRate

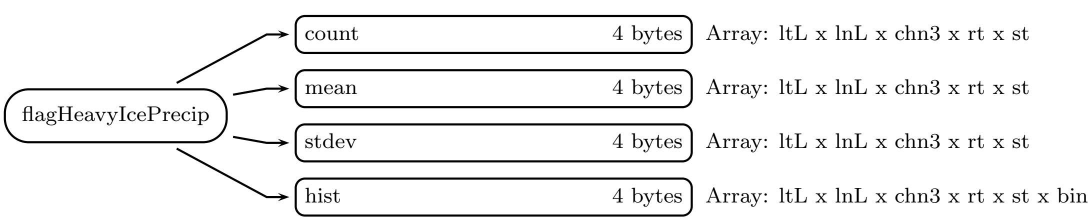


Figure 684: Data Format Structure for 3DPR, MS, G1, flagHeavyIcePrecip

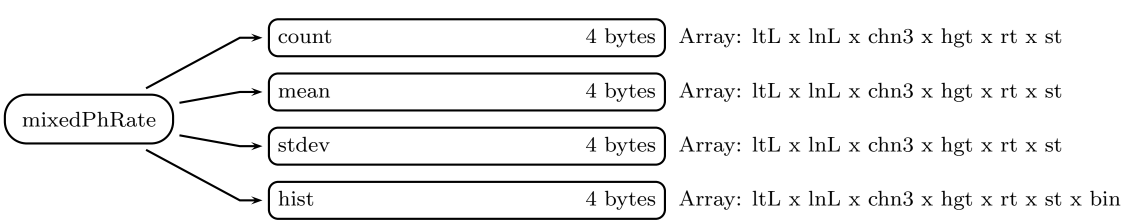


Figure 685: Data Format Structure for 3DPR, MS, G1, mixedPhRate

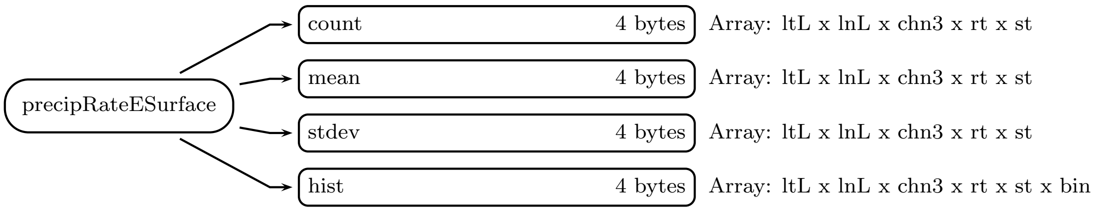


Figure 686: Data Format Structure for 3DPR, MS, G1, precipRateESurface

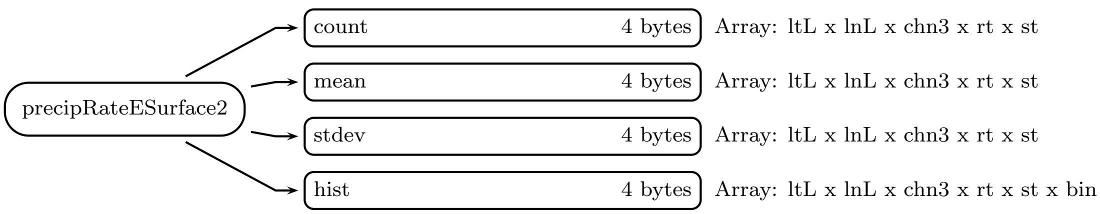


Figure 687: Data Format Structure for 3DPR, MS, G1, precipRateESurface2

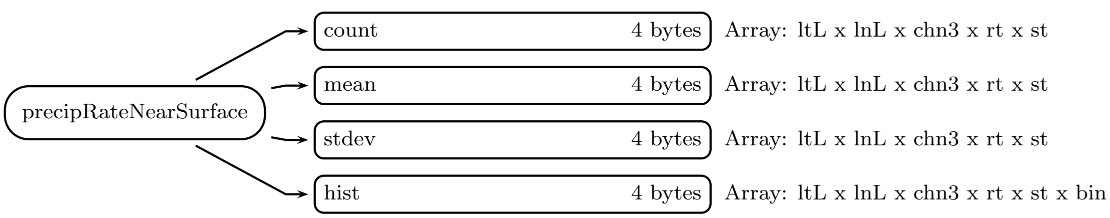


Figure 688: Data Format Structure for 3DPR, MS, G1, precipRateNearSurface

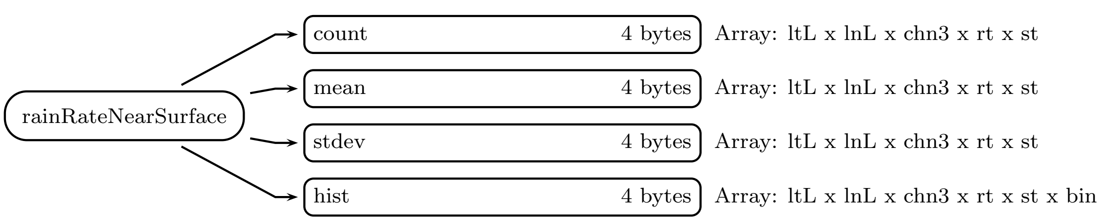


Figure 689: Data Format Structure for 3DPR, MS, G1, rainRateNearSurface

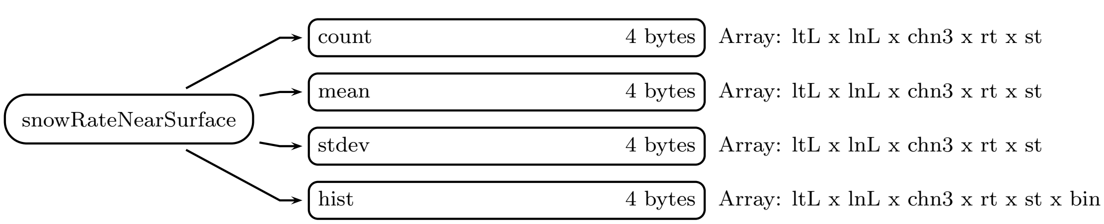


Figure 690: Data Format Structure for 3DPR, MS, G1, snowRateNearSurface

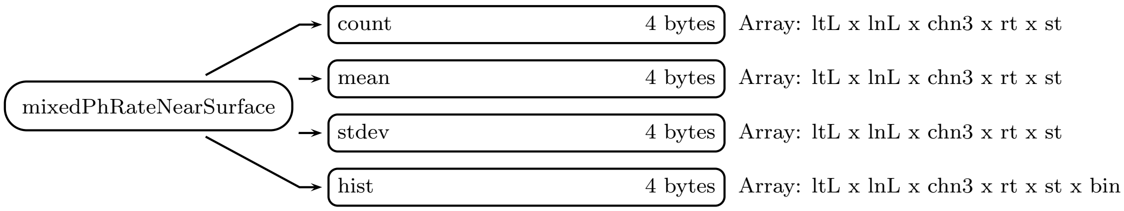


Figure 691: Data Format Structure for 3DPR, MS, G1, mixedPhRateNearSurface

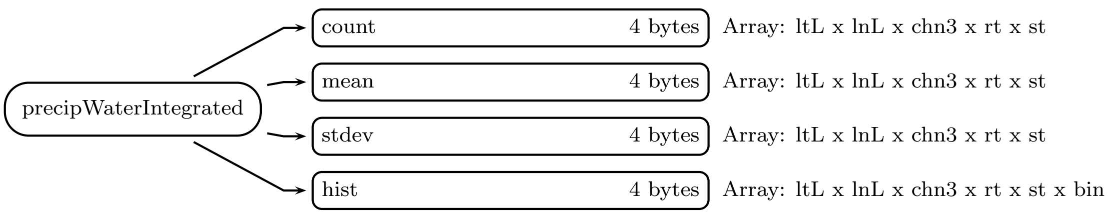


Figure 692: Data Format Structure for 3DPR, MS, G1, precipWaterIntegrated

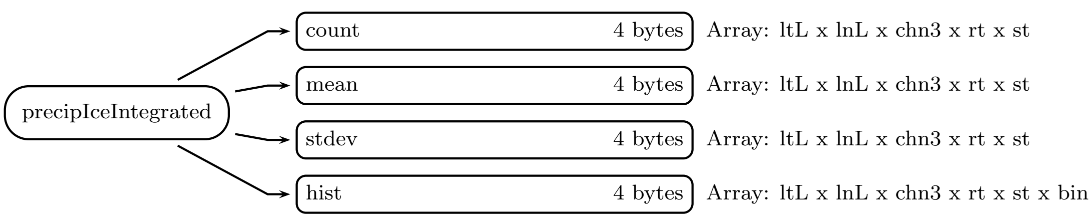


Figure 693: Data Format Structure for 3DPR, MS, G1, precipIceIntegrated

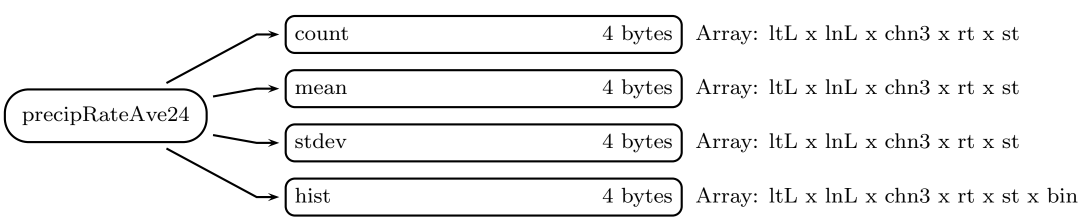


Figure 694: Data Format Structure for 3DPR, MS, G1, precipRateAve24

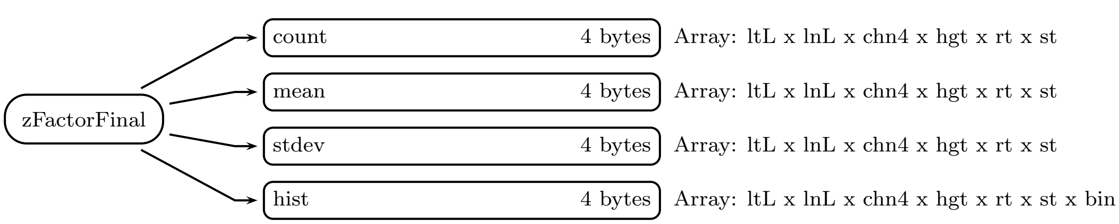


Figure 695: Data Format Structure for 3DPR, MS, G1, zFactorFinal

zFactorFinalESurface

count	4 bytes	Array: ltL x lnL x chn4 x rt x st
mean	4 bytes	Array: ltL x lnL x chn4 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn4 x rt x st
hist	4 bytes	Array: ltL x lnL x chn4 x rt x st x bin

Figure 696: Data Format Structure for 3DPR, MS, G1, zFactorFinalESurface

zFactorFinalNearSurface

count	4 bytes	Array: ltL x lnL x chn4 x rt x st
mean	4 bytes	Array: ltL x lnL x chn4 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn4 x rt x st
hist	4 bytes	Array: ltL x lnL x chn4 x rt x st x bin

Figure 697: Data Format Structure for 3DPR, MS, G1, zFactorFinalNearSurface

zFactorMeasuredNearSurface

count	4 bytes	Array: ltL x lnL x chn4 x rt x st
mean	4 bytes	Array: ltL x lnL x chn4 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn4 x rt x st
hist	4 bytes	Array: ltL x lnL x chn4 x rt x st x bin

Figure 698: Data Format Structure for 3DPR, MS, G1, zFactorMeasuredNearSurface

zFactorMeasured

count	4 bytes	Array: ltL x lnL x chn4 x hgt x rt x st
mean	4 bytes	Array: ltL x lnL x chn4 x hgt x rt x st
stdev	4 bytes	Array: ltL x lnL x chn4 x hgt x rt x st
hist	4 bytes	Array: ltL x lnL x chn4 x hgt x rt x st x bin

Figure 699: Data Format Structure for 3DPR, MS, G1, zFactorMeasured

dm

count	4 bytes	Array: ltL x lnL x chn3 x hgt x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x hgt x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x hgt x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x hgt x rt x st x bin

Figure 700: Data Format Structure for 3DPR, MS, G1, dm

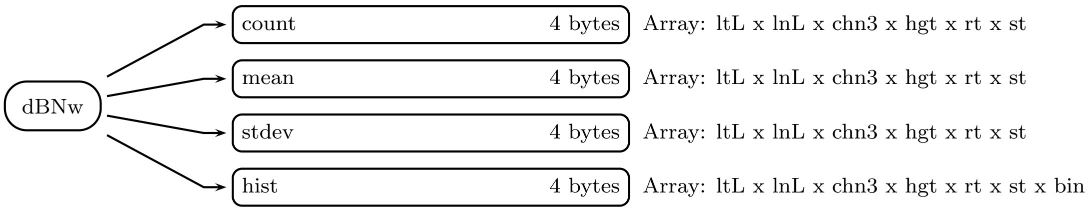


Figure 701: Data Format Structure for 3DPR, MS, G1, dBNw

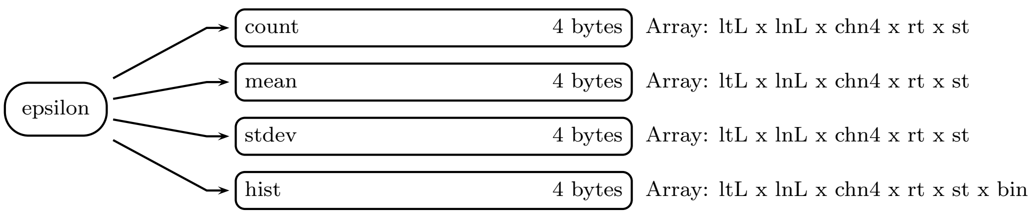


Figure 702: Data Format Structure for 3DPR, MS, G1, epsilon

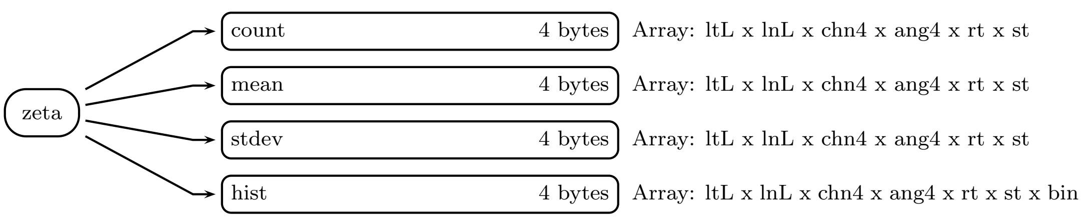


Figure 703: Data Format Structure for 3DPR, MS, G1, zeta

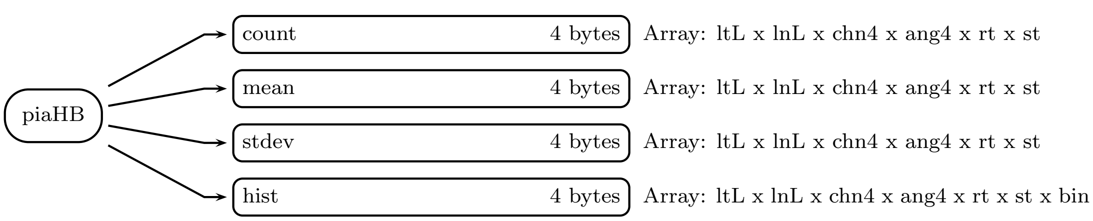


Figure 704: Data Format Structure for 3DPR, MS, G1, piaHB

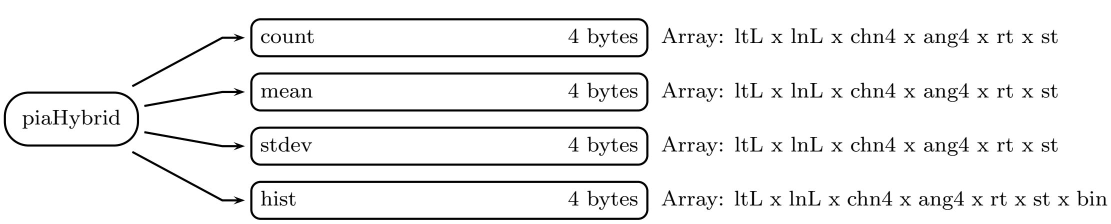


Figure 705: Data Format Structure for 3DPR, MS, G1, piaHybrid

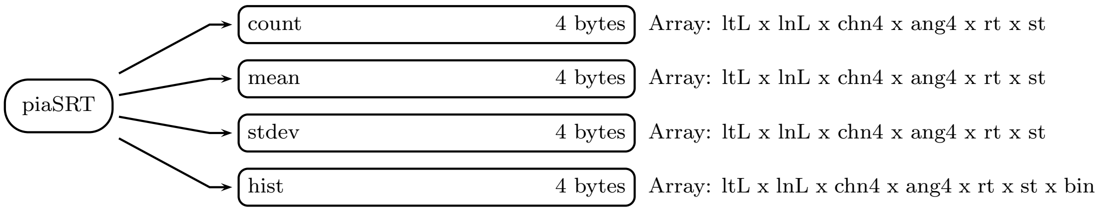


Figure 706: Data Format Structure for 3DPR, MS, G1, piaSRT

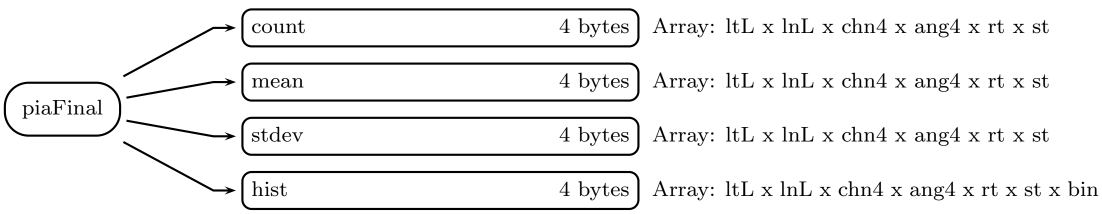


Figure 707: Data Format Structure for 3DPR, MS, G1, piaFinal

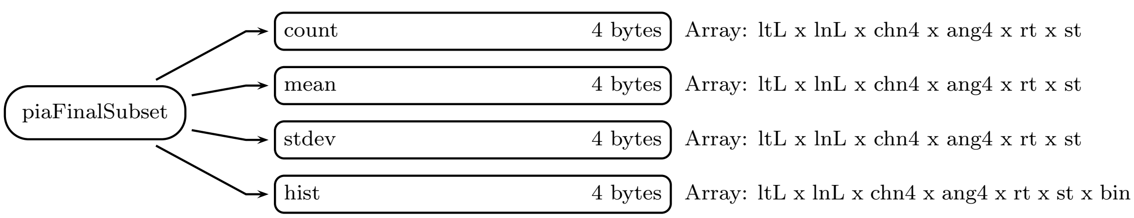


Figure 708: Data Format Structure for 3DPR, MS, G1, piaFinalSubset

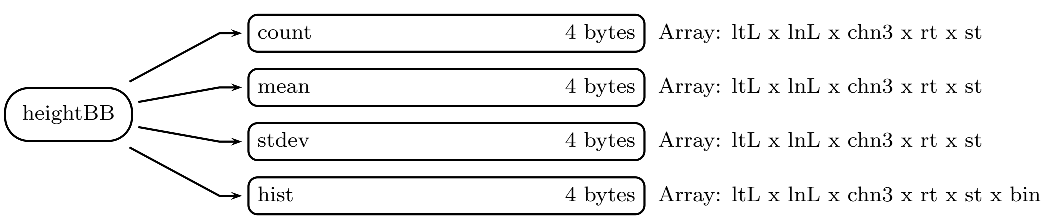


Figure 709: Data Format Structure for 3DPR, MS, G1, heightBB

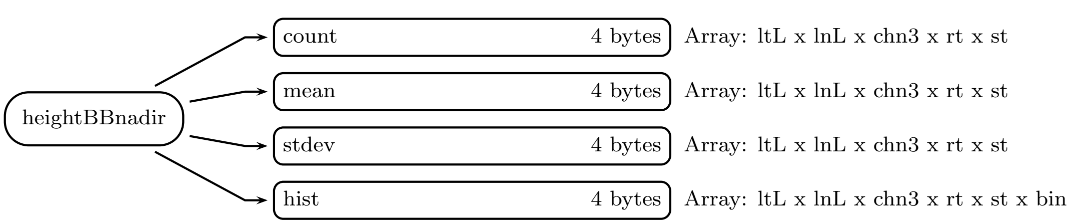


Figure 710: Data Format Structure for 3DPR, MS, G1, heightBBnadir

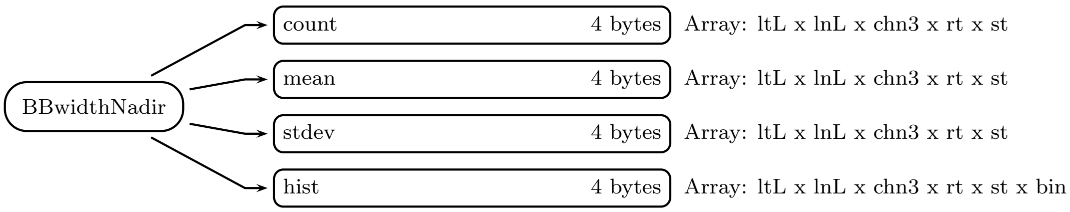


Figure 711: Data Format Structure for 3DPR, MS, G1, BBwidthNadir

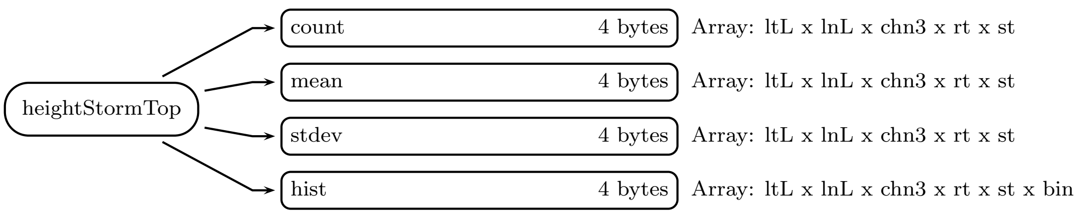


Figure 712: Data Format Structure for 3DPR, MS, G1, heightStormTop

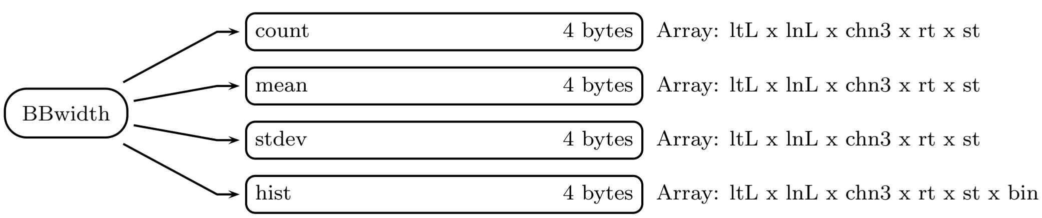


Figure 713: Data Format Structure for 3DPR, MS, G1, BBwidth

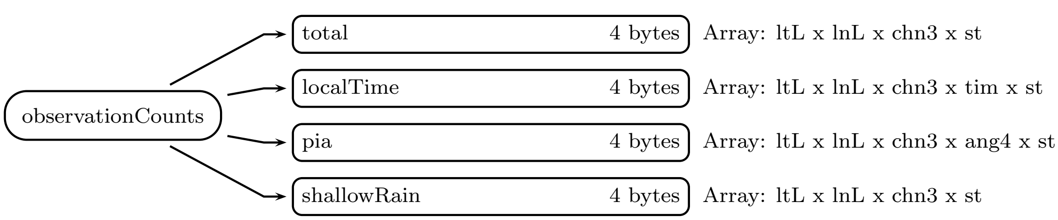


Figure 714: Data Format Structure for 3DPR, MS, G1, observationCounts

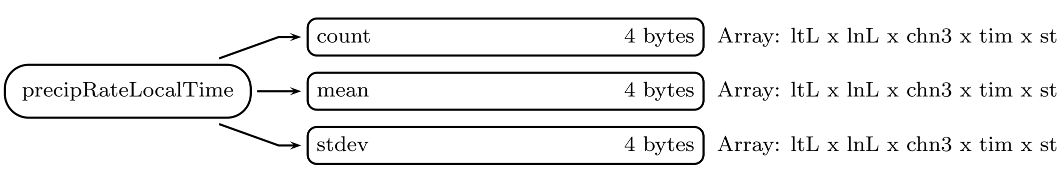


Figure 715: Data Format Structure for 3DPR, MS, G1, precipRateLocalTime

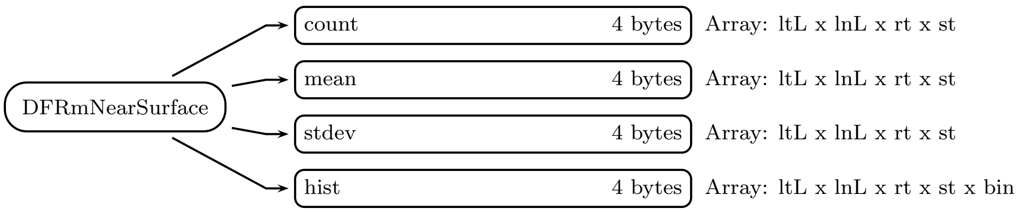


Figure 716: Data Format Structure for 3DPR, MS, G1, DFRmNearSurface

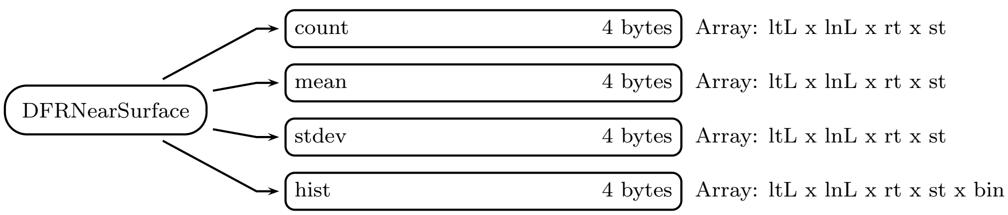


Figure 717: Data Format Structure for 3DPR, MS, G1, DFRNearSurface

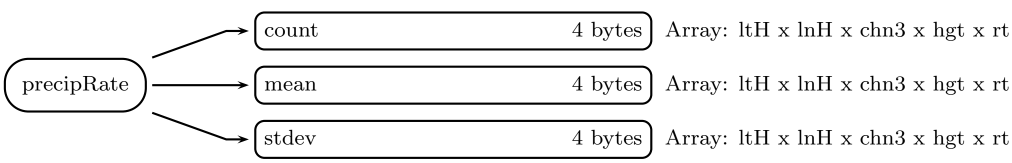


Figure 718: Data Format Structure for 3DPR, MS, G2, precipRate

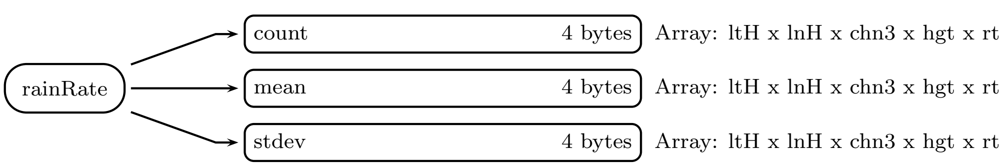


Figure 719: Data Format Structure for 3DPR, MS, G2, rainRate

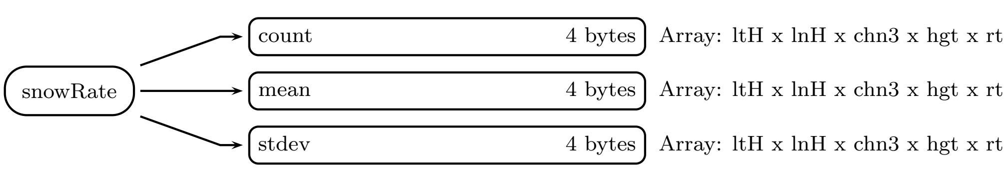


Figure 720: Data Format Structure for 3DPR, MS, G2, snowRate

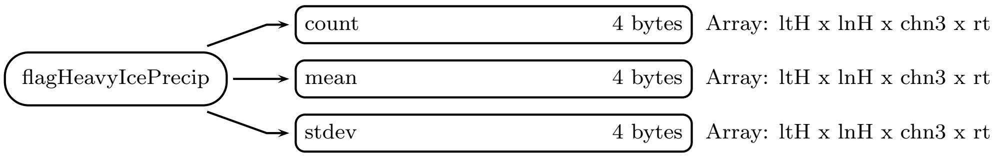


Figure 721: Data Format Structure for 3DPR, MS, G2, flagHeavyIcePrecip

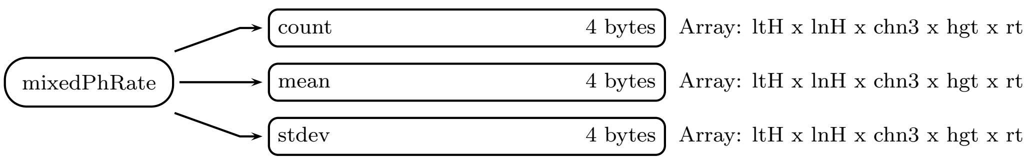


Figure 722: Data Format Structure for 3DPR, MS, G2, mixedPhRate

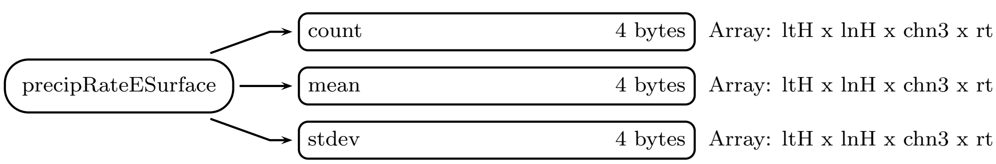


Figure 723: Data Format Structure for 3DPR, MS, G2, precipRateESurface

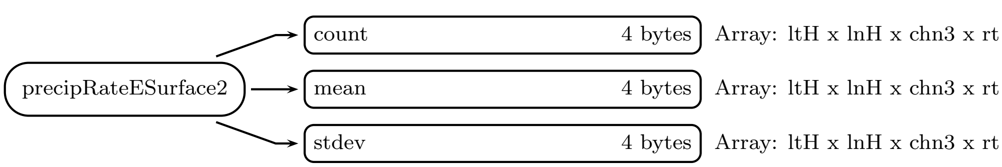


Figure 724: Data Format Structure for 3DPR, MS, G2, precipRateESurface2

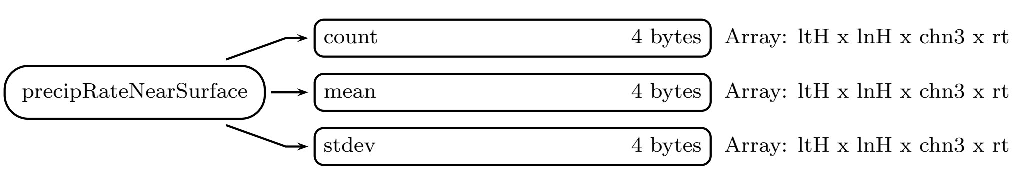


Figure 725: Data Format Structure for 3DPR, MS, G2, precipRateNearSurface

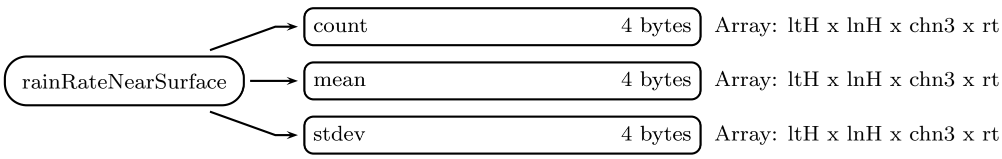


Figure 726: Data Format Structure for 3DPR, MS, G2, rainRateNearSurface

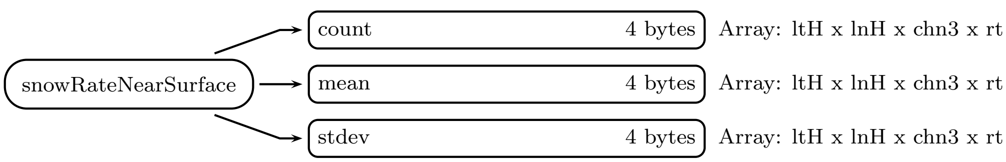


Figure 727: Data Format Structure for 3DPR, MS, G2, snowRateNearSurface

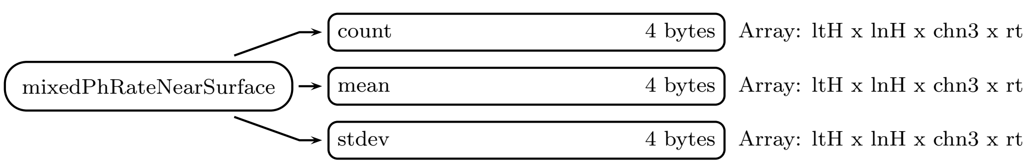


Figure 728: Data Format Structure for 3DPR, MS, G2, mixedPhRateNearSurface

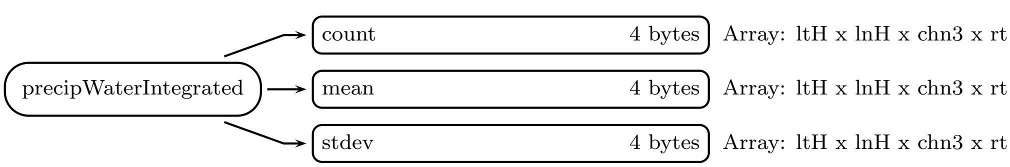


Figure 729: Data Format Structure for 3DPR, MS, G2, precipWaterIntegrated

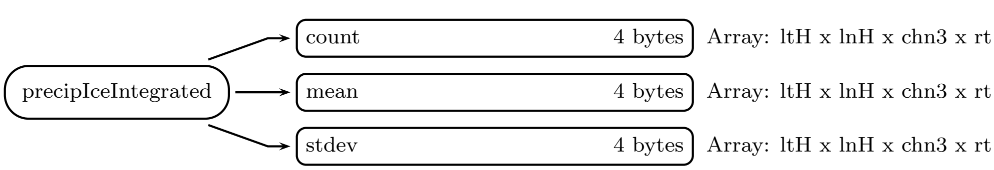


Figure 730: Data Format Structure for 3DPR, MS, G2, precipIceIntegrated

precipRateAve24

count	4 bytes	Array: ltH x lnH x chn3 x rt
mean	4 bytes	Array: ltH x lnH x chn3 x rt
stdev	4 bytes	Array: ltH x lnH x chn3 x rt

Figure 731: Data Format Structure for 3DPR, MS, G2, precipRateAve24

zFactorFinal

count	4 bytes	Array: ltH x lnH x chn4 x hgt x rt
mean	4 bytes	Array: ltH x lnH x chn4 x hgt x rt
stdev	4 bytes	Array: ltH x lnH x chn4 x hgt x rt

Figure 732: Data Format Structure for 3DPR, MS, G2, zFactorFinal

zFactorFinalESurface

count	4 bytes	Array: ltH x lnH x chn4 x rt
mean	4 bytes	Array: ltH x lnH x chn4 x rt
stdev	4 bytes	Array: ltH x lnH x chn4 x rt

Figure 733: Data Format Structure for 3DPR, MS, G2, zFactorFinalESurface

zFactorFinalNearSurface

count	4 bytes	Array: ltH x lnH x chn4 x rt
mean	4 bytes	Array: ltH x lnH x chn4 x rt
stdev	4 bytes	Array: ltH x lnH x chn4 x rt

Figure 734: Data Format Structure for 3DPR, MS, G2, zFactorFinalNearSurface

zFactorMeasuredNearSurface

count	4 bytes	Array: ltH x lnH x chn4 x rt
mean	4 bytes	Array: ltH x lnH x chn4 x rt
stdev	4 bytes	Array: ltH x lnH x chn4 x rt

Figure 735: Data Format Structure for 3DPR, MS, G2, zFactorMeasuredNearSurface

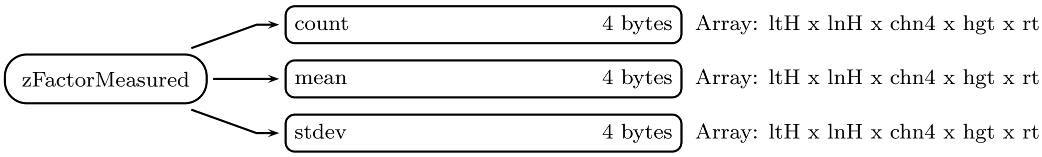


Figure 736: Data Format Structure for 3DPR, MS, G2, zFactorMeasured

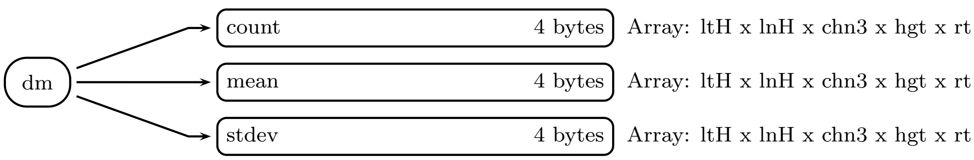


Figure 737: Data Format Structure for 3DPR, MS, G2, dm

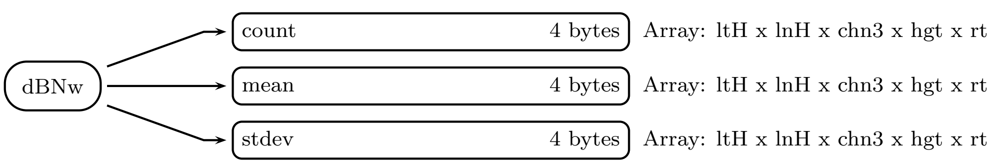


Figure 738: Data Format Structure for 3DPR, MS, G2, dBNw

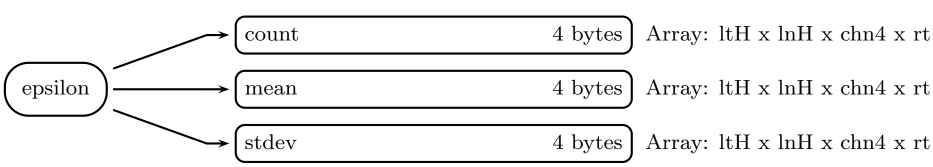


Figure 739: Data Format Structure for 3DPR, MS, G2, epsilon

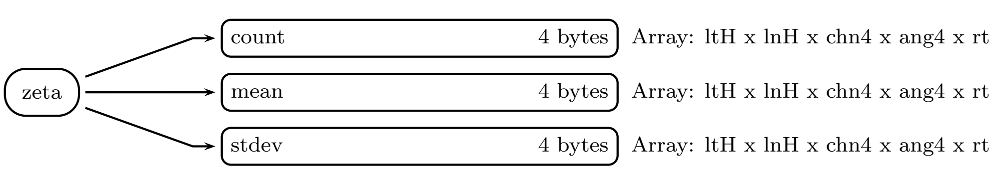


Figure 740: Data Format Structure for 3DPR, MS, G2, zeta

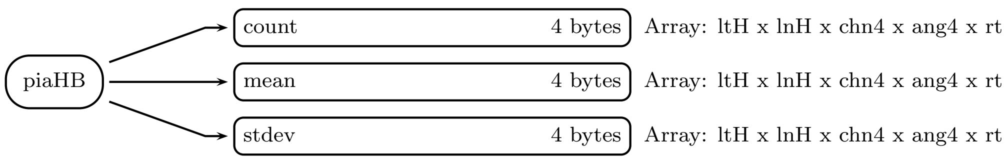


Figure 741: Data Format Structure for 3DPR, MS, G2, piaHB

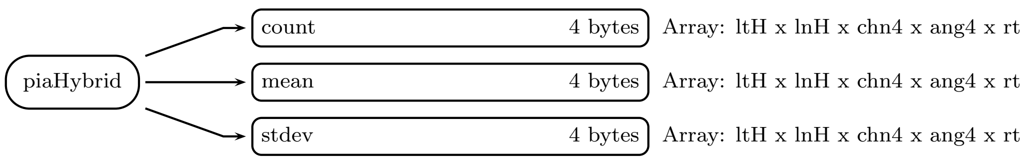


Figure 742: Data Format Structure for 3DPR, MS, G2, piaHybrid

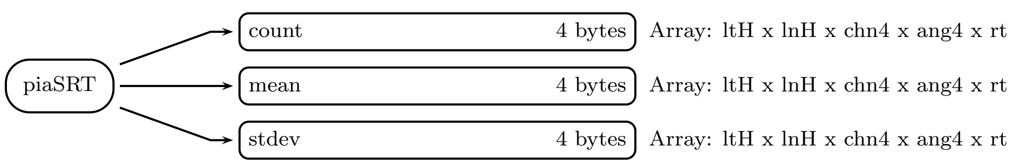


Figure 743: Data Format Structure for 3DPR, MS, G2, piaSRT

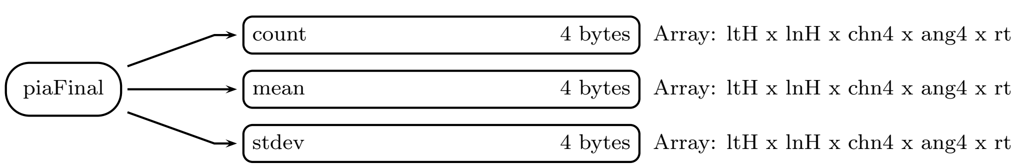


Figure 744: Data Format Structure for 3DPR, MS, G2, piaFinal

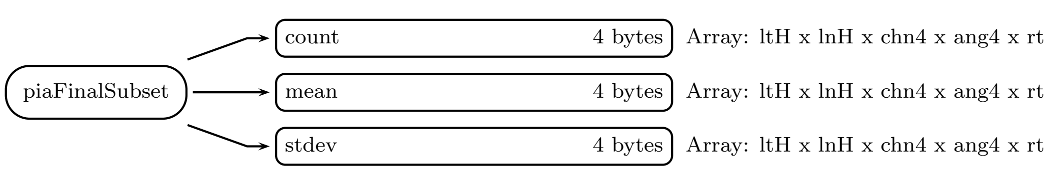


Figure 745: Data Format Structure for 3DPR, MS, G2, piaFinalSubset

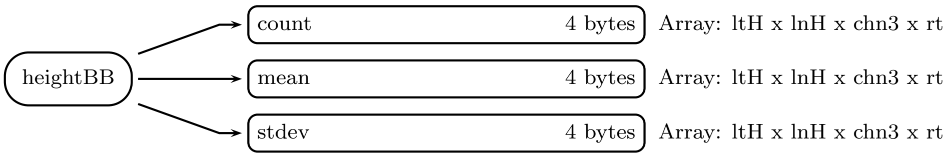


Figure 746: Data Format Structure for 3DPR, MS, G2, heightBB

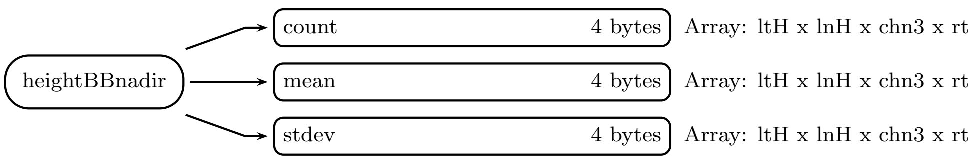


Figure 747: Data Format Structure for 3DPR, MS, G2, heightBBnadir

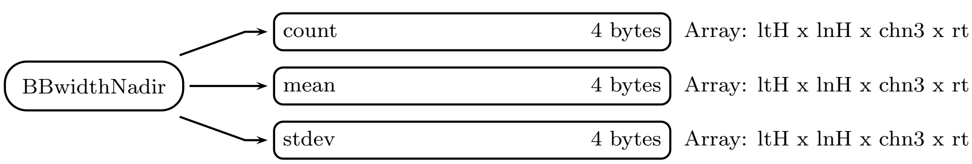


Figure 748: Data Format Structure for 3DPR, MS, G2, BBwidthNadir

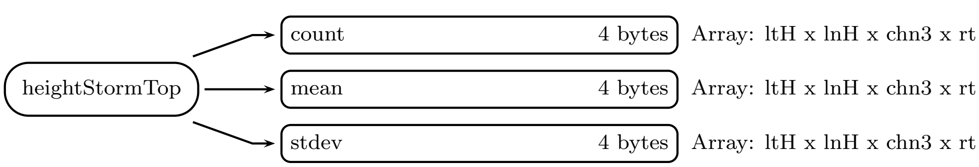


Figure 749: Data Format Structure for 3DPR, MS, G2, heightStormTop

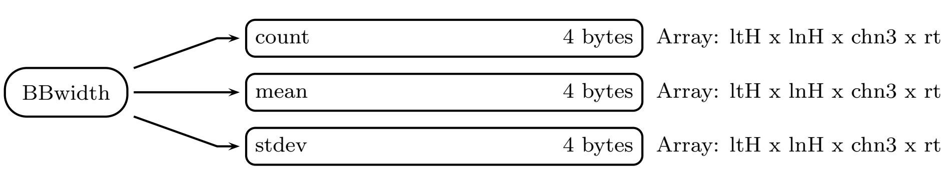


Figure 750: Data Format Structure for 3DPR, MS, G2, BBwidth

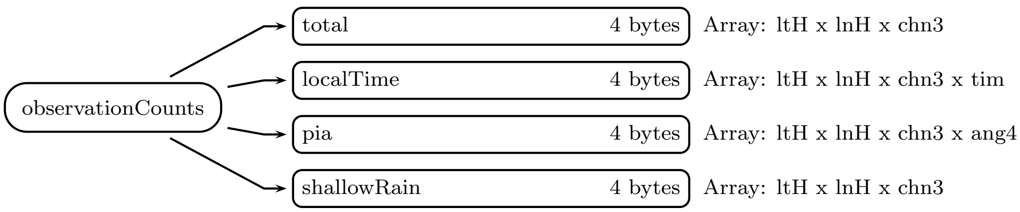


Figure 751: Data Format Structure for 3DPR, MS, G2, observationCounts

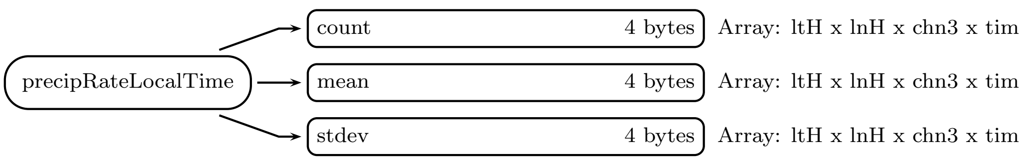


Figure 752: Data Format Structure for 3DPR, MS, G2, precipRateLocalTime

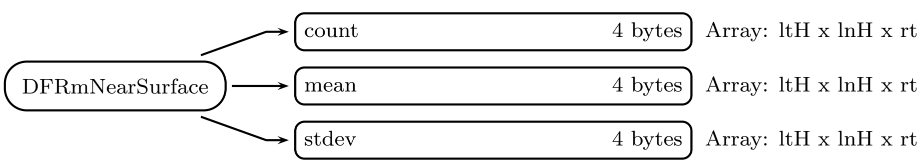


Figure 753: Data Format Structure for 3DPR, MS, G2, DFRmNearSurface

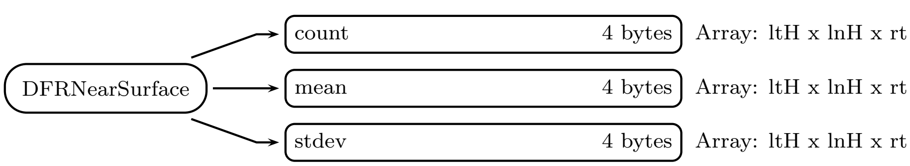


Figure 754: Data Format Structure for 3DPR, MS, G2, DFRNearSurface

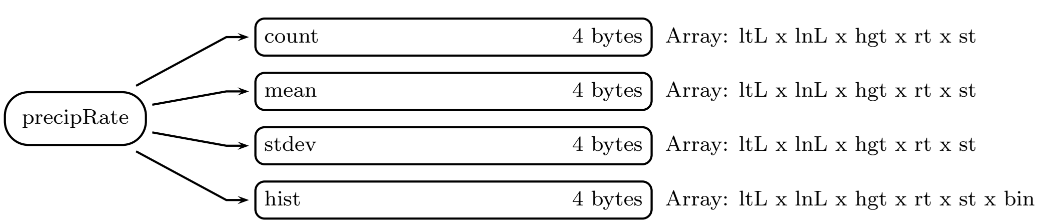


Figure 755: Data Format Structure for 3DPR, HS, G1, precipRate

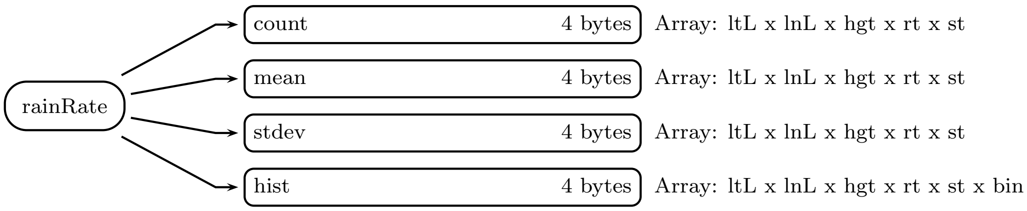


Figure 756: Data Format Structure for 3DPR, HS, G1, rainRate

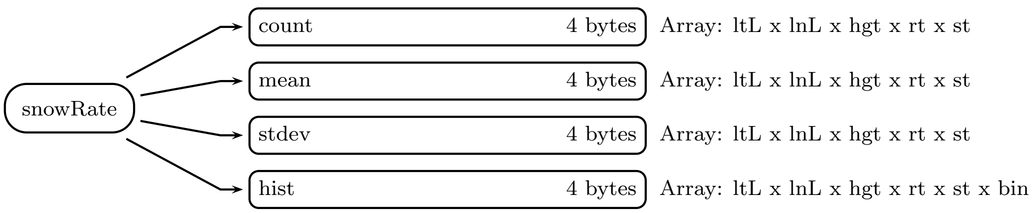


Figure 757: Data Format Structure for 3DPR, HS, G1, snowRate

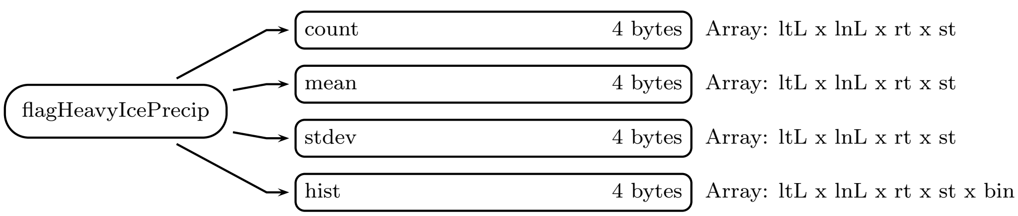


Figure 758: Data Format Structure for 3DPR, HS, G1, flagHeavyIcePrecip

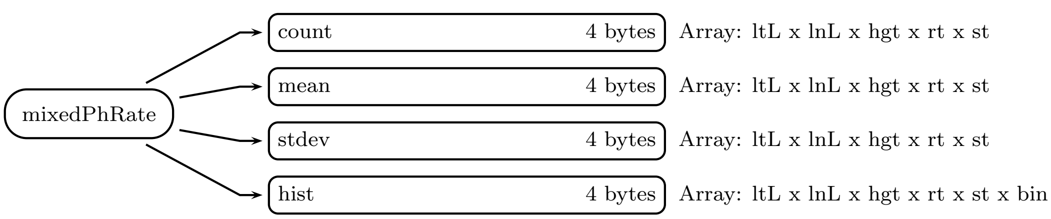


Figure 759: Data Format Structure for 3DPR, HS, G1, mixedPhRate

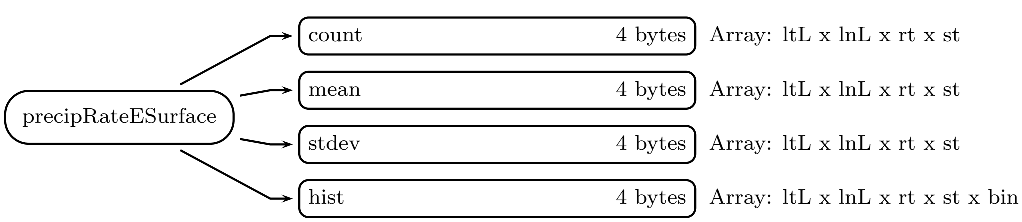


Figure 760: Data Format Structure for 3DPR, HS, G1, precipRateESurface

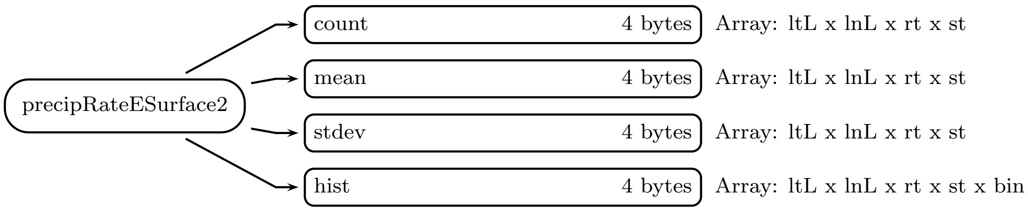


Figure 761: Data Format Structure for 3DPR, HS, G1, precipRateESurface2

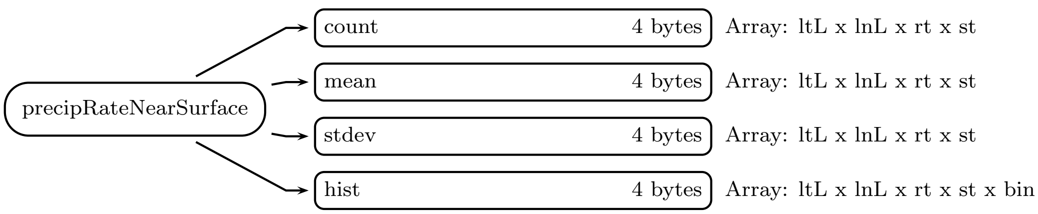


Figure 762: Data Format Structure for 3DPR, HS, G1, precipRateNearSurface

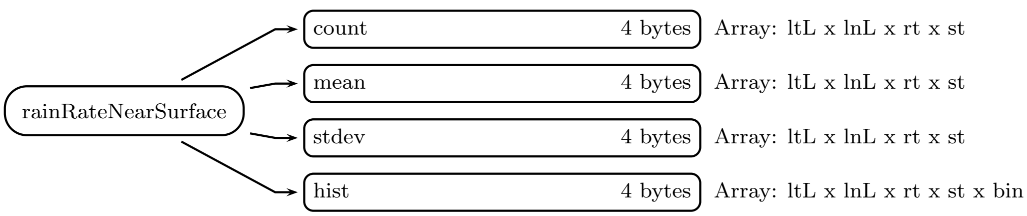


Figure 763: Data Format Structure for 3DPR, HS, G1, rainRateNearSurface

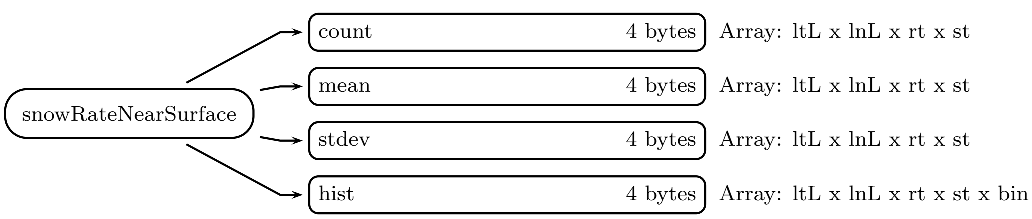


Figure 764: Data Format Structure for 3DPR, HS, G1, snowRateNearSurface

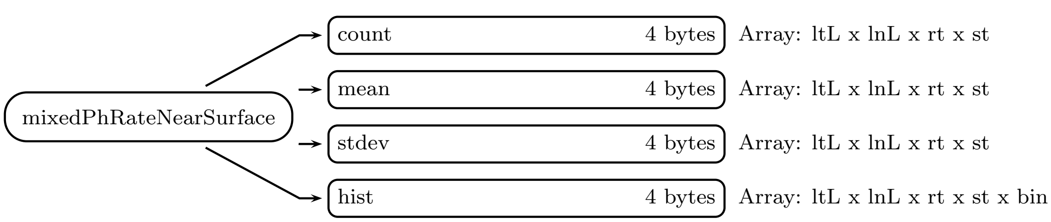


Figure 765: Data Format Structure for 3DPR, HS, G1, mixedPhRateNearSurface

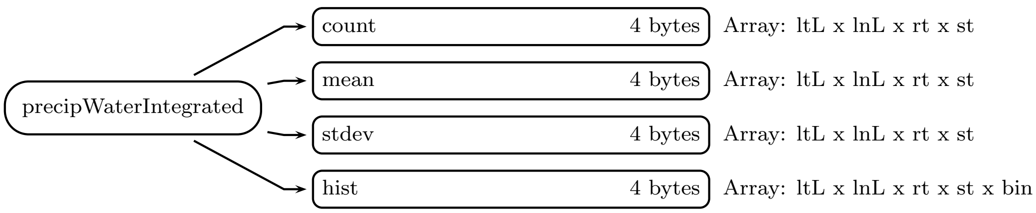


Figure 766: Data Format Structure for 3DPR, HS, G1, precipWaterIntegrated

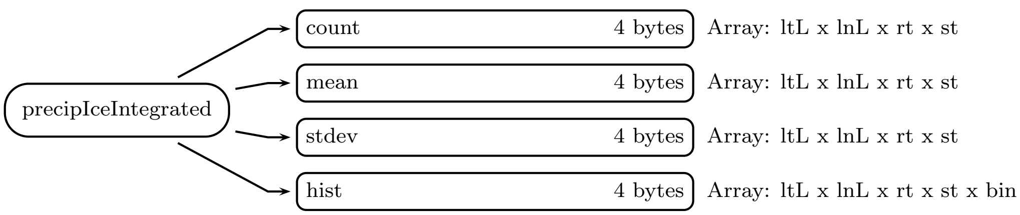


Figure 767: Data Format Structure for 3DPR, HS, G1, precipIceIntegrated

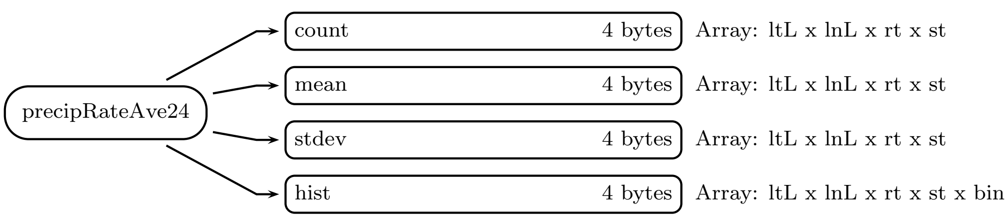


Figure 768: Data Format Structure for 3DPR, HS, G1, precipRateAve24

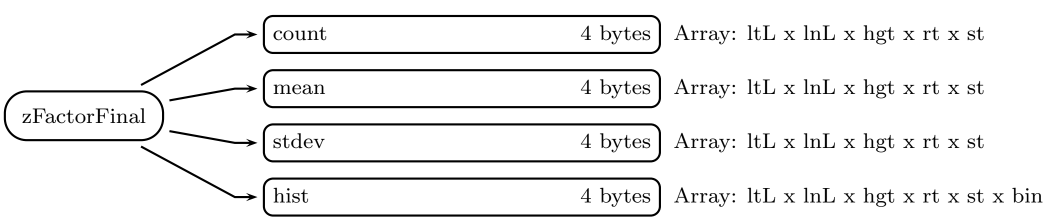


Figure 769: Data Format Structure for 3DPR, HS, G1, zFactorFinal

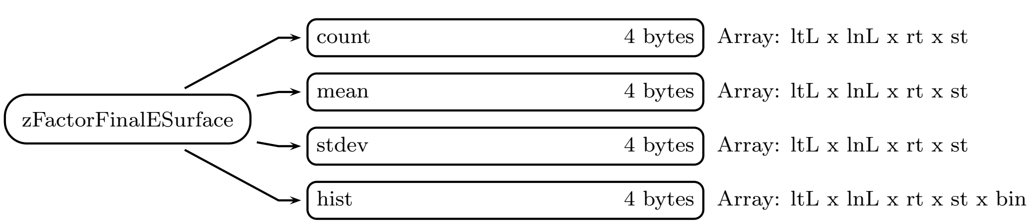


Figure 770: Data Format Structure for 3DPR, HS, G1, zFactorFinalESurface

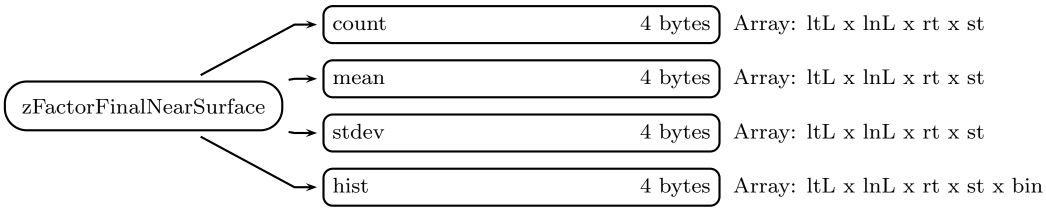


Figure 771: Data Format Structure for 3DPR, HS, G1, zFactorFinalNearSurface

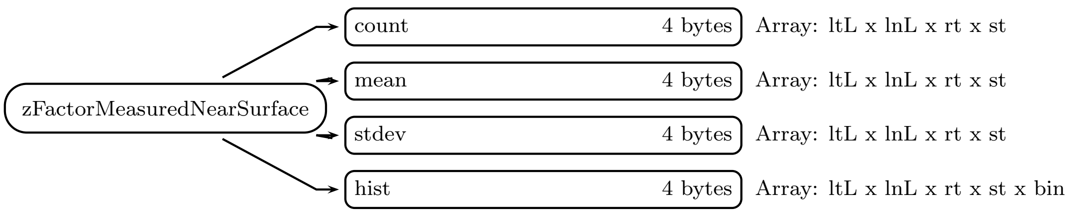


Figure 772: Data Format Structure for 3DPR, HS, G1, zFactorMeasuredNearSurface

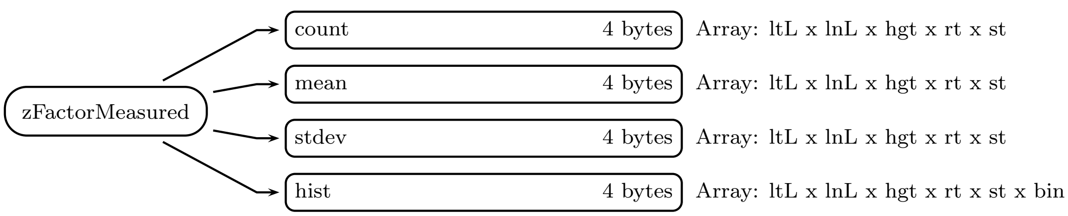


Figure 773: Data Format Structure for 3DPR, HS, G1, zFactorMeasured

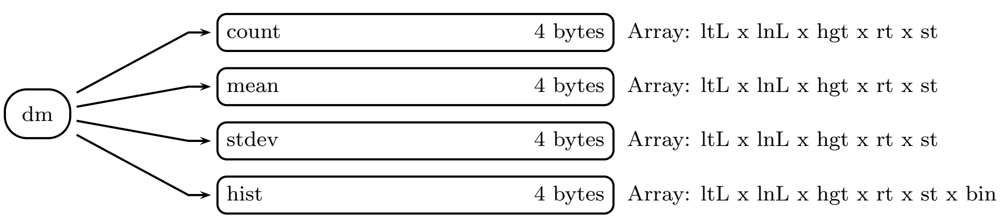


Figure 774: Data Format Structure for 3DPR, HS, G1, dm

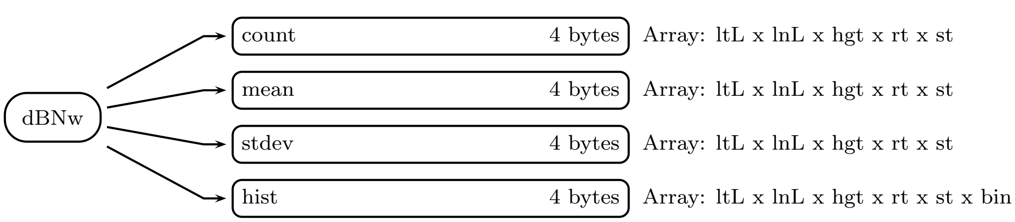


Figure 775: Data Format Structure for 3DPR, HS, G1, dBNw

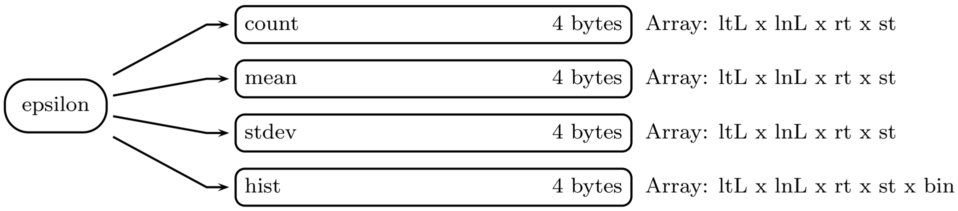


Figure 776: Data Format Structure for 3DPR, HS, G1, epsilon

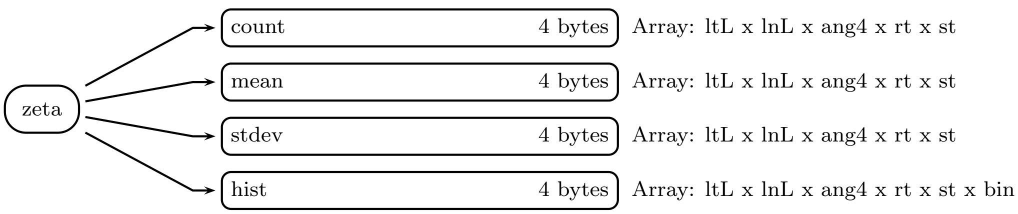


Figure 777: Data Format Structure for 3DPR, HS, G1, zeta

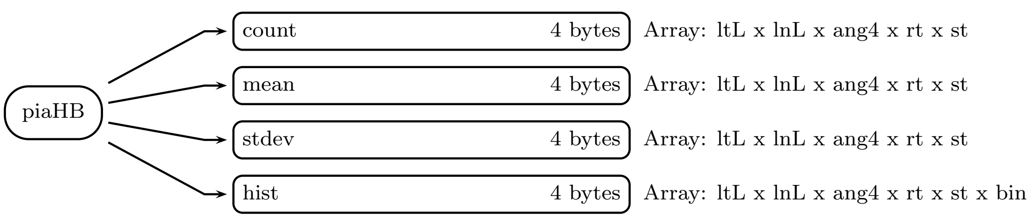


Figure 778: Data Format Structure for 3DPR, HS, G1, piaHB

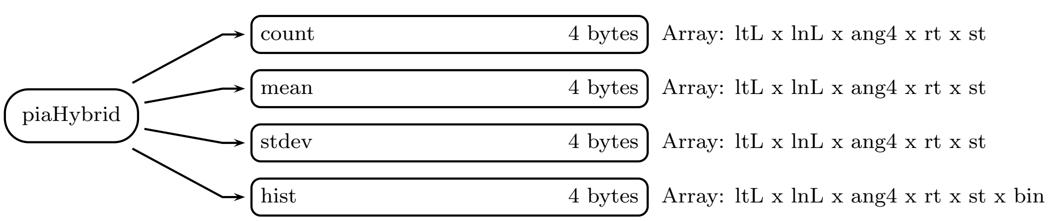


Figure 779: Data Format Structure for 3DPR, HS, G1, piaHybrid

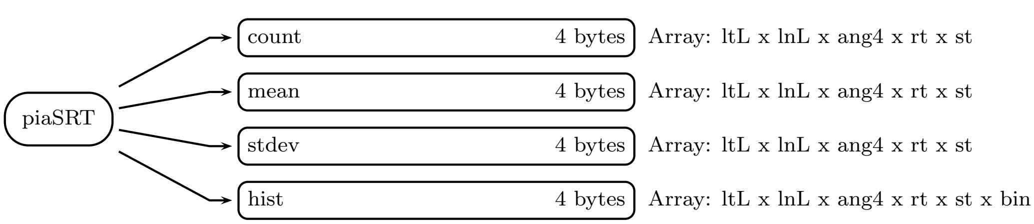


Figure 780: Data Format Structure for 3DPR, HS, G1, piaSRT

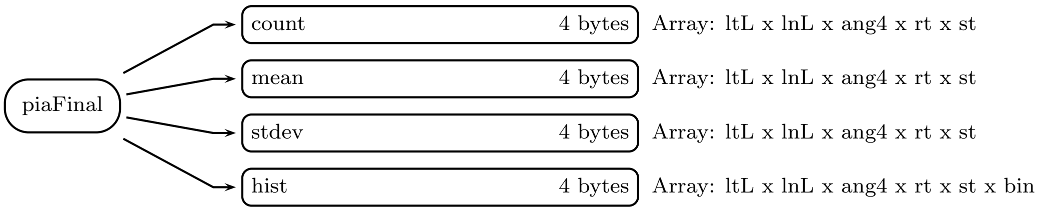


Figure 781: Data Format Structure for 3DPR, HS, G1, piaFinal

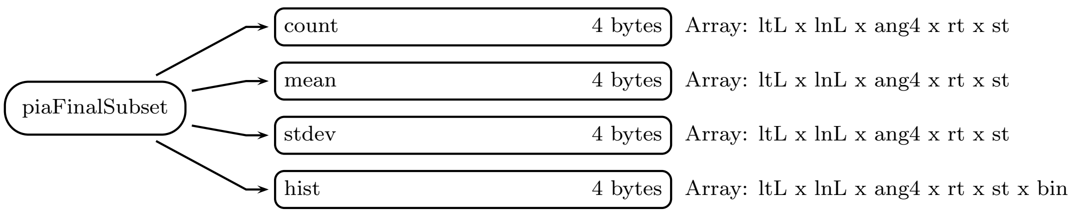


Figure 782: Data Format Structure for 3DPR, HS, G1, piaFinalSubset

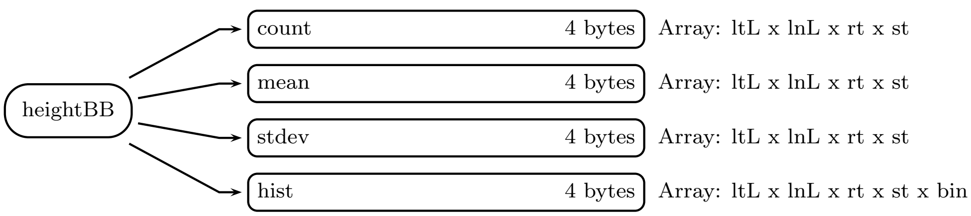


Figure 783: Data Format Structure for 3DPR, HS, G1, heightBB

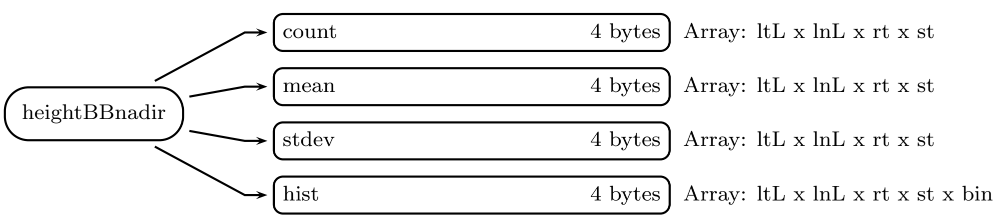


Figure 784: Data Format Structure for 3DPR, HS, G1, heightBBnadir

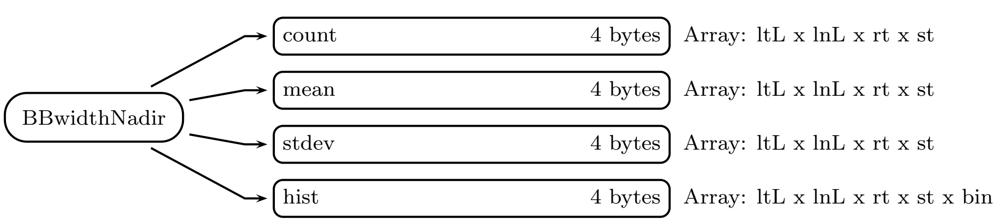


Figure 785: Data Format Structure for 3DPR, HS, G1, BBwidthNadir

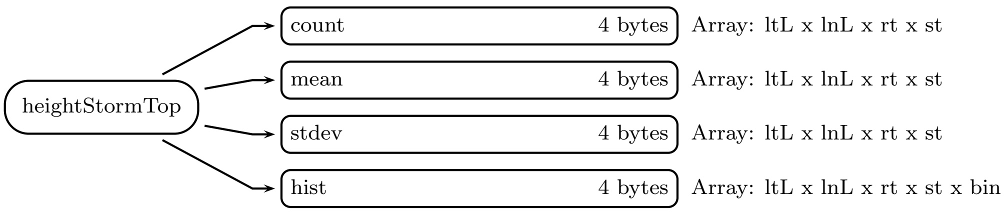


Figure 786: Data Format Structure for 3DPR, HS, G1, heightStormTop

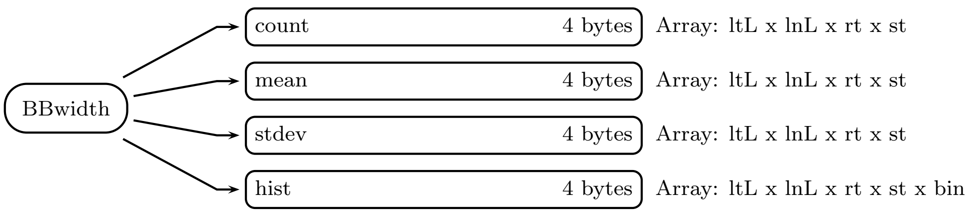


Figure 787: Data Format Structure for 3DPR, HS, G1, BBwidth

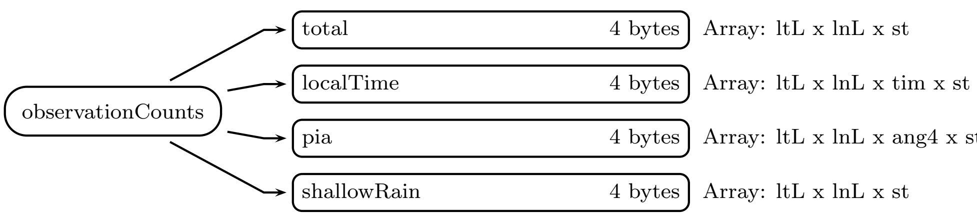


Figure 788: Data Format Structure for 3DPR, HS, G1, observationCounts

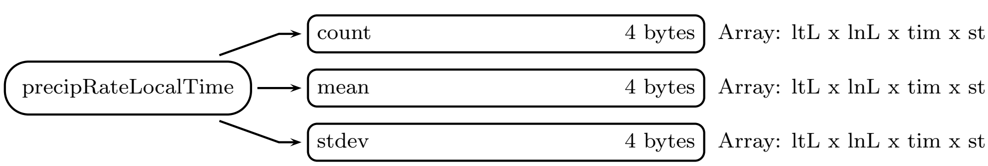


Figure 789: Data Format Structure for 3DPR, HS, G1, precipRateLocalTime

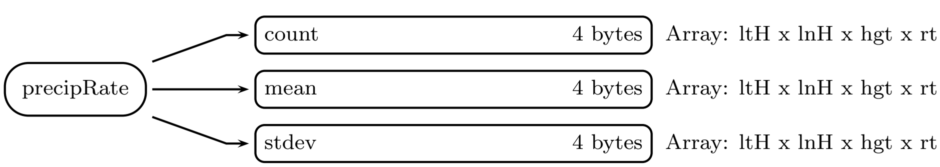


Figure 790: Data Format Structure for 3DPR, HS, G2, precipRate

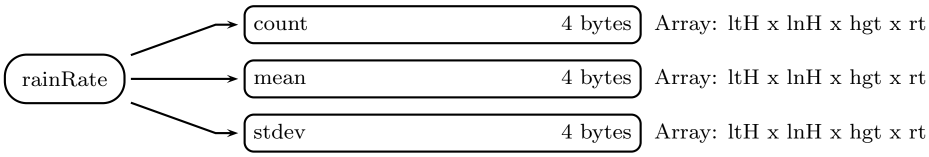


Figure 791: Data Format Structure for 3DPR, HS, G2, rainRate

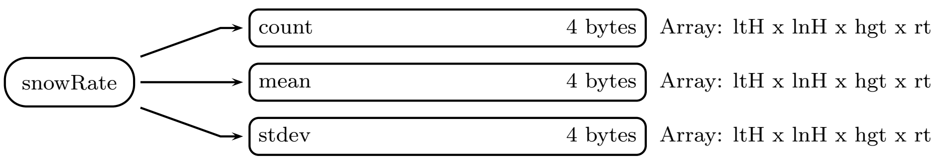


Figure 792: Data Format Structure for 3DPR, HS, G2, snowRate

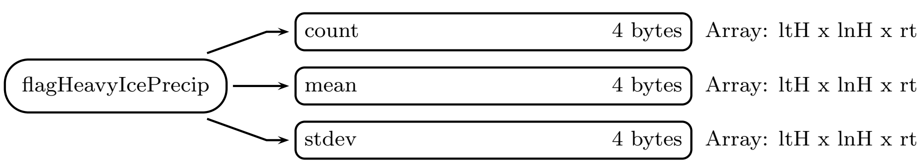


Figure 793: Data Format Structure for 3DPR, HS, G2, flagHeavyIcePrecip

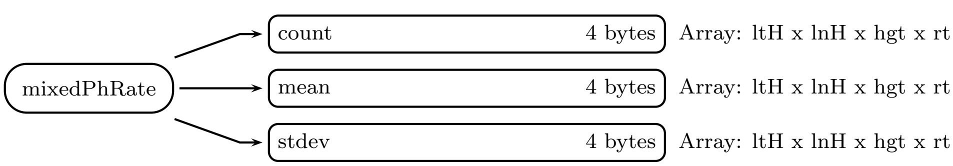


Figure 794: Data Format Structure for 3DPR, HS, G2, mixedPhRate

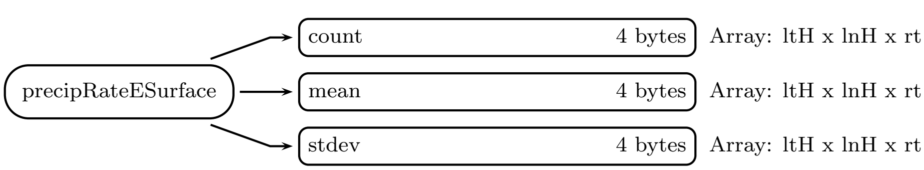


Figure 795: Data Format Structure for 3DPR, HS, G2, precipRateESurface

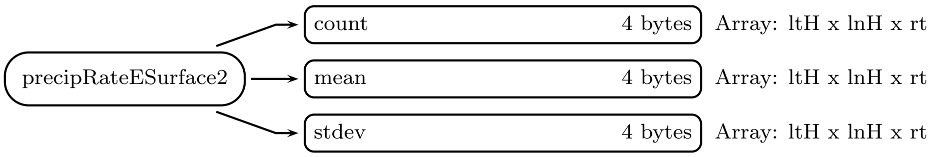


Figure 796: Data Format Structure for 3DPR, HS, G2, precipRateESurface2

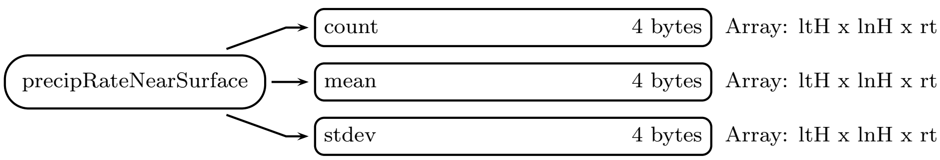


Figure 797: Data Format Structure for 3DPR, HS, G2, precipRateNearSurface

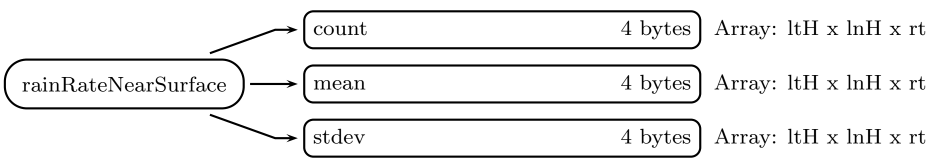


Figure 798: Data Format Structure for 3DPR, HS, G2, rainRateNearSurface

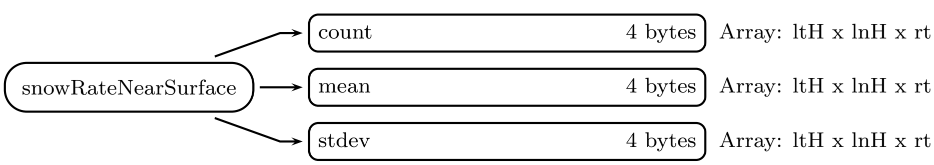


Figure 799: Data Format Structure for 3DPR, HS, G2, snowRateNearSurface

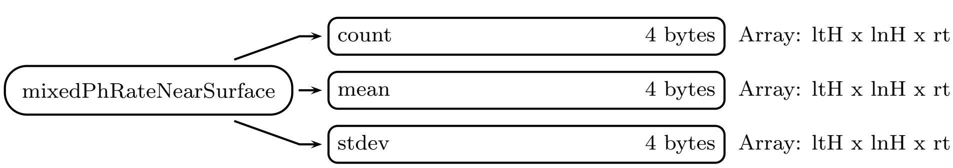


Figure 800: Data Format Structure for 3DPR, HS, G2, mixedPhRateNearSurface

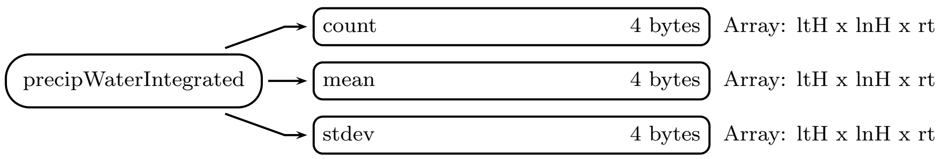


Figure 801: Data Format Structure for 3DPR, HS, G2, precipWaterIntegrated

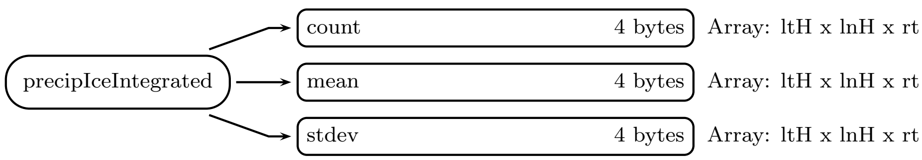


Figure 802: Data Format Structure for 3DPR, HS, G2, precipIceIntegrated

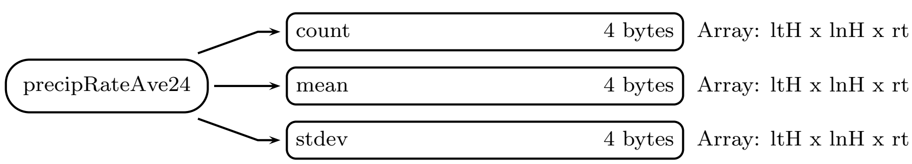


Figure 803: Data Format Structure for 3DPR, HS, G2, precipRateAve24

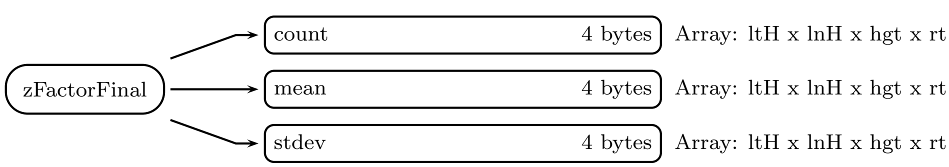


Figure 804: Data Format Structure for 3DPR, HS, G2, zFactorFinal

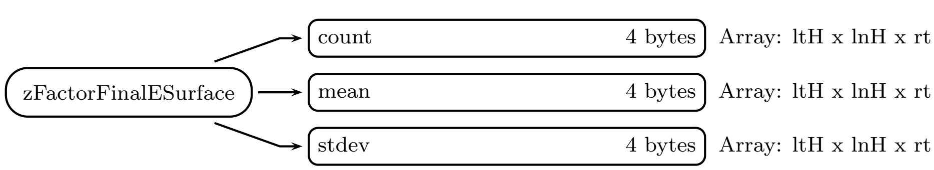


Figure 805: Data Format Structure for 3DPR, HS, G2, zFactorFinalESurface

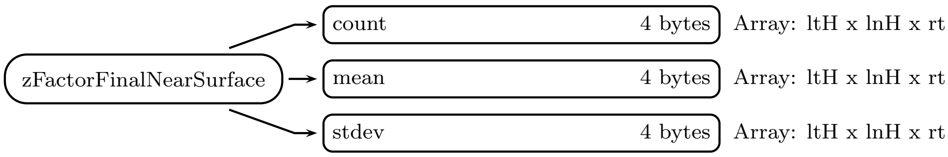


Figure 806: Data Format Structure for 3DPR, HS, G2, zFactorFinalNearSurface

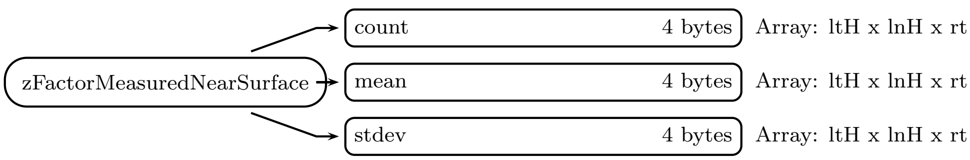


Figure 807: Data Format Structure for 3DPR, HS, G2, zFactorMeasuredNearSurface

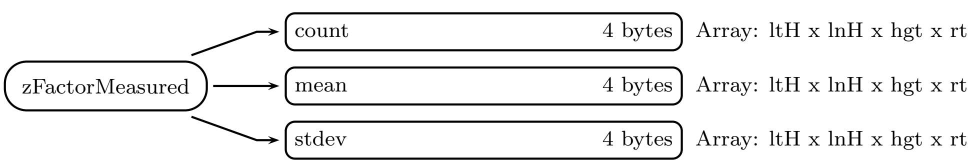


Figure 808: Data Format Structure for 3DPR, HS, G2, zFactorMeasured

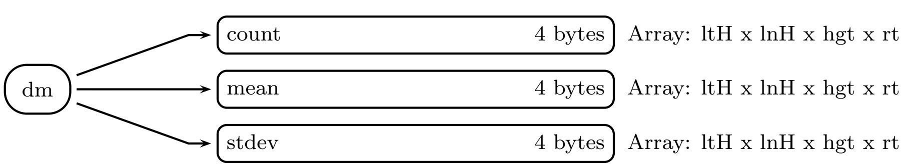


Figure 809: Data Format Structure for 3DPR, HS, G2, dm

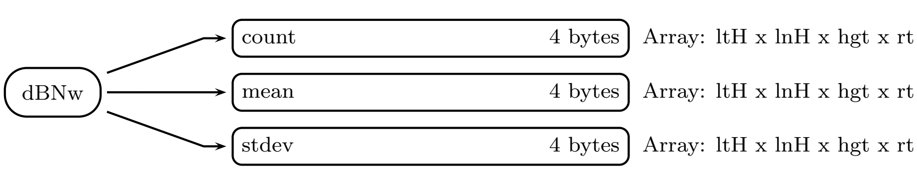


Figure 810: Data Format Structure for 3DPR, HS, G2, dBNw

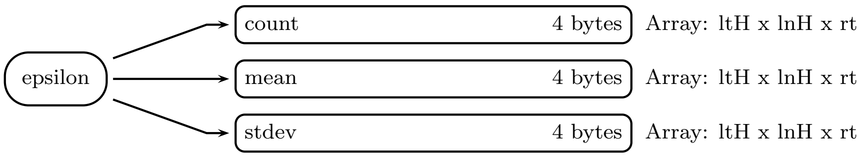


Figure 811: Data Format Structure for 3DPR, HS, G2, epsilon

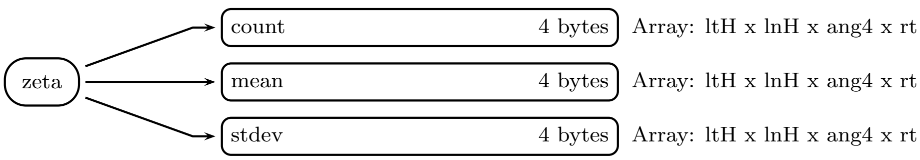


Figure 812: Data Format Structure for 3DPR, HS, G2, zeta

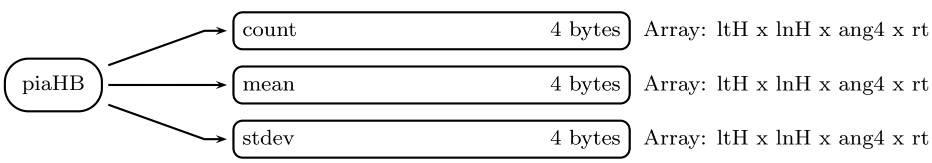


Figure 813: Data Format Structure for 3DPR, HS, G2, piaHB

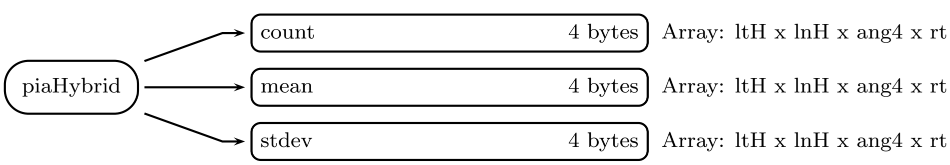


Figure 814: Data Format Structure for 3DPR, HS, G2, piaHybrid

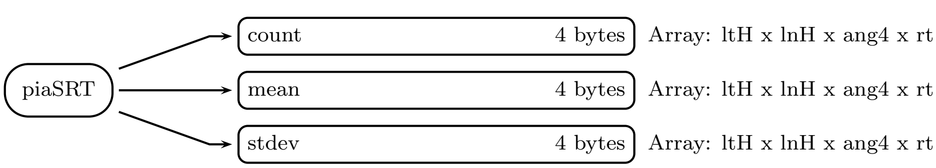


Figure 815: Data Format Structure for 3DPR, HS, G2, piaSRT

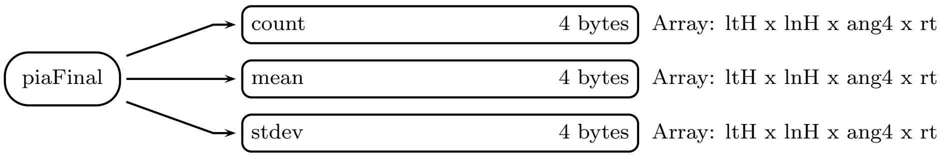


Figure 816: Data Format Structure for 3DPR, HS, G2, piaFinal

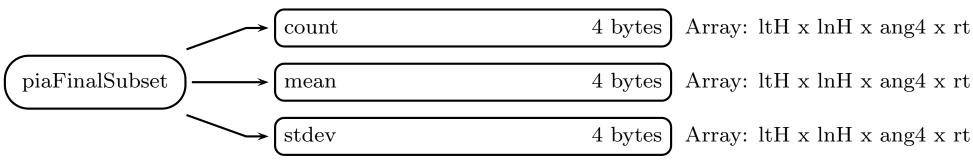


Figure 817: Data Format Structure for 3DPR, HS, G2, piaFinalSubset

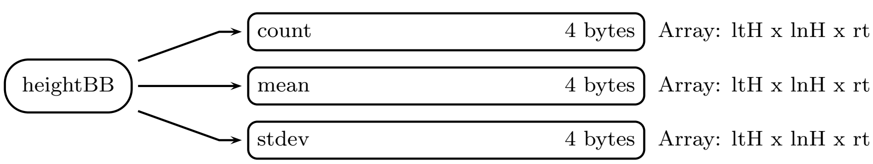


Figure 818: Data Format Structure for 3DPR, HS, G2, heightBB

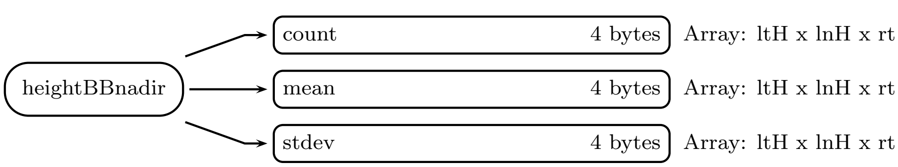


Figure 819: Data Format Structure for 3DPR, HS, G2, heightBBnadir

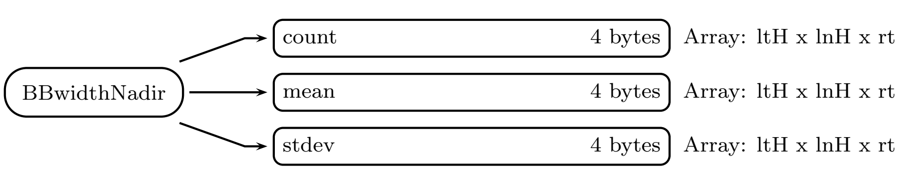


Figure 820: Data Format Structure for 3DPR, HS, G2, BBwidthNadir

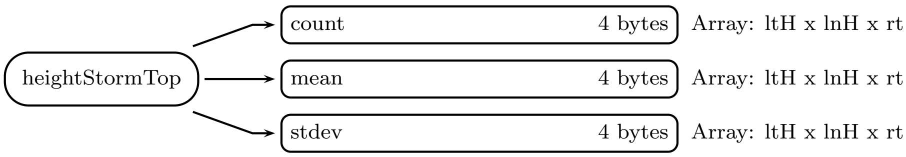


Figure 821: Data Format Structure for 3DPR, HS, G2, heightStormTop

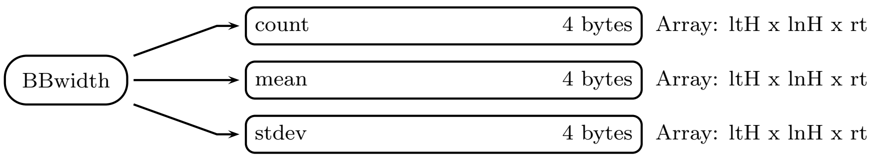


Figure 822: Data Format Structure for 3DPR, HS, G2, BBwidth

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

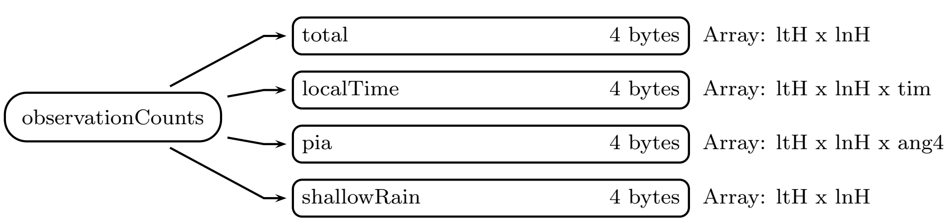


Figure 823: Data Format Structure for 3DPR, HS, G2, observationCounts

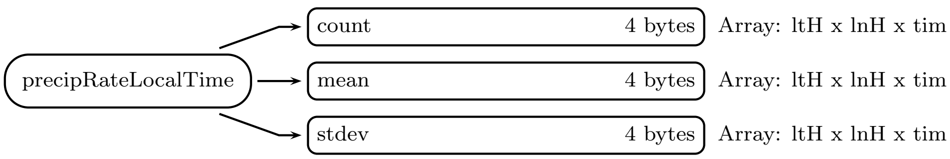


Figure 824: Data Format Structure for 3DPR, HS, G2, precipRateLocalTime

FS (Group)

G1 (Grid in FS)

G1_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in FS, G1)

Conditional Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRate (Group in FS, G1)

Conditional liquid water Rain Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRate (Group in FS, G1)

Conditional Snowfall Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

flagHeavyIcePrecip (Group in FS, G1)

Counts of the occurrence of flagHeavyIcePrecip. Mean and std. dev. are set to missing. The histogram contains counts of the integer flag values, with bins from 1 to 30.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRate (Group in FS, G1)

Conditional Mixed Phase Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface (Group in FS, G1)

Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface2 (Group in FS, G1)

Alternate Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateNearSurface (Group in FS, G1)

Conditional Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRateNearSurface (Group in FS, G1)

Unconditional liquid Rain Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRateNearSurface (Group in FS, G1)

Conditional Snow Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRateNearSurface (Group in FS, G1)

Conditional Mixed Phase Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipWaterIntegrated (Group in FS, G1)
Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipIceIntegrated (Group in FS, G1)
Integrated Precipitable Ice

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateAve24 (Group in FS, G1)
Average Precipitation Rate in 24hrs.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinal (Group in FS, G1)
Corrected Reflectivity

count (4-byte integer, array size: ltL x lnL x chn4 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinalESurface (Group in FS, G1)
Corrected Reflectivity at the Estimated Surface

count (4-byte integer, array size: ltL x lnL x chn4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinalNearSurface (Group in FS, G1)

Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorMeasuredNearSurface (Group in FS, G1)

Measured Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorMeasured (Group in FS, G1)

Measured Reflectivity

count (4-byte integer, array size: ltL x lnL x chn4 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dm (Group in FS, G1)

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dBNw (Group in FS, G1)

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

epsilon (Group in FS, G1)

count (4-byte integer, array size: ltL x lnL x chn4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zeta (Group in FS, G1)

Integral of 0.2*ln(10)*alpha*Zm^{beta} over the slant range path where alpha and Zm are functions of range.

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaHB (Group in FS, G1)
Hitchfield-Bordan Path Integrated Attenuation for the slant range path.

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaHybrid (Group in FS, G1)
Weighted Hybrid PIA between the HB solution and the SRT PIA.

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaSRT (Group in FS, G1)
Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinal (Group in FS, G1)
Final Path Integrated Attenuation

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinalSubset (Group in FS, G1)
Final Path Integrated Attenuation Subset

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBB (Group in FS, G1)
Height of Bright Band.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBBnadir (Group in FS, G1)
Height of Bright Band from Nadir.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidthNadir (Group in FS, G1)
Width of Bright Band at Nadir

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightStormTop (Group in FS, G1)
Storm Top Height

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidth (Group in FS, G1)
Bright Band Width

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

observationCounts (Group in FS, G1)

Observation Counts

total (4-byte integer, array size: ltL x lnL x chn3 x st):
Total obs. Special values are defined as:
-9999 Missing value

localTime (4-byte integer, array size: ltL x lnL x chn3 x tim x st):
obs time. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltL x lnL x chn3 x ang7 x st):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltL x lnL x chn3 x st):
obs time. Special values are defined as:
-9999 Missing value

precipRateLocalTime (Group in FS, G1)

Precipitation Rate by Local Time

count (4-byte integer, array size: ltL x lnL x chn3 x tim x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x tim x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x tim x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

DFRmNearSurface (Group in FS, G1)

DFRm at the Near Surface level

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

DFRNearSurface (Group in FS, G1)

DFR at the Near Surface level

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltL x lnL x chn3):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltL x lnL x chn3):
Probability of rain. Special values are defined as:
-9999.9 Missing value

G2 (Grid in FS)

G2_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in FS, G2)

Conditional Precipitation Rate

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRate (Group in FS, G2)

Conditional Liquid Rain Rate

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRate (Group in FS, G2)

Conditional Snow Rate

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

flagHeavyIcePrecip (Group in FS, G2)

Counts of the occurrence of flagHeavyIcePrecip. Mean and std. dev. are set to missing. The histogram contains counts of the integer flag values, with bins from 1 to 30.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRate (Group in FS, G2)

Conditional Preciptiation Rate of Mixed Phase

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface (Group in FS, G2)

Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface2 (Group in FS, G2)

Alternate Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurface (Group in FS, G2)

Conditional Precipitation Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRateNearSurface (Group in FS, G2)

Conditional Liquid Rain Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRateNearSurface (Group in FS, G2)

Conditional Snow Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRateNearSurface (Group in FS, G2)

Conditional Precipitation Rate of Mixed Phase at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (Group in FS, G2)

Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipIceIntegrated (Group in FS, G2)

Integrated Precipitable Ice

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (Group in FS, G2)

Conditional Precipitation Rate Averaged for 24hrs.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinal (Group in FS, G2)

Corrected Reflectivity.

count (4-byte integer, array size: ltH x lnH x chn4 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (Group in FS, G2)

Corrected Reflectivity Estimate at the Surface

count (4-byte integer, array size: ltH x lnH x chn4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (Group in FS, G2)

Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorMeasuredNearSurface (Group in FS, G2)

Measured Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (Group in FS, G2)

Corrected Reflectivity

count (4-byte integer, array size: ltH x lnH x chn4 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dm (Group in FS, G2)

Mean Mass-Weighted Drop Diameter

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dBNw (Group in FS, G2)

Normalized Drop Concentration Parameter

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

epsilon (Group in FS, G2)

count (4-byte integer, array size: ltH x lnH x chn4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zeta (Group in FS, G2)

Integral of 0.2*ln(10)*alpha*Zm^{beta} over the slant range path where alpha and Zm are functions of range.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaHB (Group in FS, G2)

Hitchfield-Bordan Path Integrated Attenuation for the slant range path.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaHybrid (Group in FS, G2)

Weighted Hybrid PIA between the HB solution and the SRT PIA.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaSRT (Group in FS, G2)

Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinal (Group in FS, G2)

Final Path Integrated Attenuation Estimate.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinalSubset (Group in FS, G2)

Final Path Integrated Attenuation Subset

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightBB (Group in FS, G2)

Height Of the Bright Band.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightBBnadir (Group in FS, G2)

Height of Bright Band from Nadir.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

BBwidthNadir (Group in FS, G2)
Width of Bright Band at Nadir

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightStormTop (Group in FS, G2)
Height of the Storm Top.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

BBwidth (Group in FS, G2)
Bright Band Width

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

observationCounts (Group in FS, G2)

Observation Counts.

total (4-byte integer, array size: ltH x lnH x chn3):
Total obs. Special values are defined as:
-9999 Missing value

localTime (4-byte integer, array size: ltH x lnH x chn3 x tim):
obs time. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltH x lnH x chn3 x ang7):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltH x lnH x chn3):
obs time. Special values are defined as:
-9999 Missing value

precipRateLocalTime (Group in FS, G2)

Precipitation Rate by Local Time

count (4-byte integer, array size: ltH x lnH x chn3 x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x tim):
Standard deviation. Special values are defined as:
-9999.9 Missing value

DFRmNearSurface (Group in FS, G2)

DFRm at the Near Surface level

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

DFRNearSurface (Group in FS, G2)

DFR at the Near Surface level

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltH x lnH x chn3):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltH x lnH x chn3):
Probability of rain. Special values are defined as:
-9999.9 Missing value

MS (Group)

G1 (Grid in MS)

Same as FS/G1 except all ang7 dimensions repaced by ang4

G2 (Grid in MS)

Same as FS/G2 except all ang7 dimensions repaced by ang4

HS (Group)

G1 (Grid in HS)

G1_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in HS, G1)

Conditional Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRate (Group in HS, G1)

Conditional liquid water Rain Rate.

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRate (Group in HS, G1)

Conditional Snowfall Rate.

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

flagHeavyIcePrecip (Group in HS, G1)

Counts of the occurrence of flagHeavyIcePrecip. Mean and std. dev. are set to missing. The histogram contains counts of the integer flag values, with bins from 1 to 30.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRate (Group in HS, G1)
Conditional Mixed Phase Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface (Group in HS, G1)
Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface2 (Group in HS, G1)
Alternate Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateNearSurface (Group in HS, G1)

Conditional Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRateNearSurface (Group in HS, G1)

Unconditional liquid Rain Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRateNearSurface (Group in HS, G1)
Conditional Snow Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRateNearSurface (Group in HS, G1)
Conditional Mixed Phase Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipWaterIntegrated (Group in HS, G1)
Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipIceIntegrated (Group in HS, G1)

Integrated Precipitable Ice

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateAve24 (Group in HS, G1)

Average Precipitation Rate in 24hrs.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinal (Group in HS, G1)

Corrected Reflectivity

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinalESurface (Group in HS, G1)

Corrected Reflectivity at the Estimated Surface

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinalNearSurface (Group in HS, G1)
Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorMeasuredNearSurface (Group in HS, G1)
Measured Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorMeasured (Group in HS, G1)
Measured Reflectivity

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dm (Group in HS, G1)

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dBNw (Group in HS, G1)

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

epsilon (Group in HS, G1)

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zeta (Group in HS, G1)

Integral of 0.2*ln(10)*alpha*Zm^{beta} over the slant range path where alpha and Zm are functions of range.

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaHB (Group in HS, G1)

Hitchfield-Bordan Path Integrated Attenuation for the slant range path.

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaHybrid (Group in HS, G1)
Weighted Hybrid PIA between the HB solution and the SRT PIA.

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaSRT (Group in HS, G1)
Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinal (Group in HS, G1)

Final Path Integrated Attenuation

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinalSubset (Group in HS, G1)

Final Path Integrated Attenuation Subset

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBB (Group in HS, G1)
Height of Bright Band.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBBnadir (Group in HS, G1)
Height of Bright Band from Nadir.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidthNadir (Group in HS, G1)
Width of Bright Band at Nadir

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightStormTop (Group in HS, G1)

Storm Top Height

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidth (Group in HS, G1)

Bright Band Width

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

observationCounts (Group in HS, G1)

Observation Counts

total (4-byte integer, array size: ltL x lnL x st):
Total obs. Special values are defined as:
-9999 Missing value

localTime (4-byte integer, array size: ltL x lnL x tim x st):
obs time. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltL x lnL x ang4 x st):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltL x lnL x st):
obs time. Special values are defined as:
-9999 Missing value

precipRateLocalTime (Group in HS, G1)

Precipitation Rate by Local Time

count (4-byte integer, array size: ltL x lnL x tim x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x tim x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x tim x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltL x lnL):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltL x lnL):
Probability of rain. Special values are defined as:
-9999.9 Missing value

G2 (Grid in HS)

G2_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in HS, G2)
Conditional Precipitation Rate

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRate (Group in HS, G2)
Conditional Liquid Rain Rate

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRate (Group in HS, G2)
Conditional Snow Rate

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

flagHeavyIcePrecip (Group in HS, G2)

Counts of the occurrence of flagHeavyIcePrecip. Mean and std. dev. are set to missing. The histogram contains counts of the integer flag values, with bins from 1 to 30.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRate (Group in HS, G2)

Conditional Preciptiation Rate of Mixed Phase

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface (Group in HS, G2)

Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface2 (Group in HS, G2)

Alternate Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurface (Group in HS, G2)

Conditional Precipitation Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRateNearSurface (Group in HS, G2)

Conditional Liquid Rain Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRateNearSurface (Group in HS, G2)

Conditional Snow Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRateNearSurface (Group in HS, G2)

Conditional Precipitation Rate of Mixed Phase at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (Group in HS, G2)

Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipIceIntegrated (Group in HS, G2)

Integrated Precipitable Ice

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (Group in HS, G2)

Conditional Precipitation Rate Averaged for 24hrs.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinal (Group in HS, G2)

Corrected Reflectivity.

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (Group in HS, G2)

Corrected Reflectivity Estimate at the Surface

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (Group in HS, G2)

Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorMeasuredNearSurface (Group in HS, G2)

Measured Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (Group in HS, G2)

Corrected Reflectivity

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dm (Group in HS, G2)

Mean Mass-Weighted Drop Diameter

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dBNw (Group in HS, G2)

Normalized Drop Concentration Parameter

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

epsilon (Group in HS, G2)

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zeta (Group in HS, G2)

Integral of 0.2*ln(10)*alpha*Zm^{beta} over the slant range path where alpha and Zm are functions of range.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaHB (Group in HS, G2)

Hitchfield-Bordan Path Integrated Attenuation for the slant range path.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaHybrid (Group in HS, G2)

Weighted Hybrid PIA between the HB solution and the SRT PIA.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaSRT (Group in HS, G2)

Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinal (Group in HS, G2)

Final Path Integrated Attenuation Estimate.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinalSubset (Group in HS, G2)
Final Path Integrated Attenuation Subset

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightBB (Group in HS, G2)
Height Of the Bright Band.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightBBnadir (Group in HS, G2)
Height of Bright Band from Nadir.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

BBwidthNadir (Group in HS, G2)

Width of Bright Band at Nadir

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightStormTop (Group in HS, G2)

Height of the Storm Top.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

BBwidth (Group in HS, G2)

Bright Band Width

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

observationCounts (Group in HS, G2)
Observation Counts.

total (4-byte integer, array size: ltH x lnH):
Total obs. Special values are defined as:
-9999 Missing value

localTime (4-byte integer, array size: ltH x lnH x tim):
obs time. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltH x lnH x ang4):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltH x lnH):
obs time. Special values are defined as:
-9999 Missing value

precipRateLocalTime (Group in HS, G2)
Precipitation Rate by Local Time

count (4-byte integer, array size: ltH x lnH x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x tim):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltH x lnH):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltH x lnH):
Probability of rain. Special values are defined as:

-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3DPR_H_
#define _TK_3DPR_H_

#ifndef _L3DPR_HS_G2_PRECIPRATELOCALTIME_
#define _L3DPR_HS_G2_PRECIPRATELOCALTIME_

typedef struct {
    int count[24][1440][536];
    float mean[24][1440][536];
    float stdev[24][1440][536];
} L3DPR_HS_G2_PRECIPRATELOCALTIME;

#endif

#ifndef _L3DPR_HS_G2_OBSERVATIONCOUNTS_
#define _L3DPR_HS_G2_OBSERVATIONCOUNTS_

typedef struct {
    int total[1440][536];
    int localTime[24][1440][536];
    int pia[4][1440][536];
    int shallowRain[1440][536];
} L3DPR_HS_G2_OBSERVATIONCOUNTS;

#endif

#ifndef _L3DPR_HS_G2_BBWIDTH_
#define _L3DPR_HS_G2_BBWIDTH_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_BBWIDTH;

#endif

#ifndef _L3DPR_HS_G2_HEIGHTSTORMTOP_
```

```
#define _L3DPR_HS_G2_HEIGHTSTORMTOP_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_HEIGHTSTORMTOP;

#endif

#ifndef _L3DPR_HS_G2_BBWIDTHNADIR_
#define _L3DPR_HS_G2_BBWIDTHNADIR_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_BBWIDTHNADIR;

#endif

#ifndef _L3DPR_HS_G2_HEIGHTBBNADIR_
#define _L3DPR_HS_G2_HEIGHTBBNADIR_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_HEIGHTBBNADIR;

#endif

#ifndef _L3DPR_HS_G2_HEIGHTBB_
#define _L3DPR_HS_G2_HEIGHTBB_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_HEIGHTBB;

#endif
```

```
#ifndef _L3DPR_HS_G2_PIAFINALSUBSET_
#define _L3DPR_HS_G2_PIAFINALSUBSET_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_HS_G2_PIAFINALSUBSET;

#endif

#ifndef _L3DPR_HS_G2_PIAFINAL_
#define _L3DPR_HS_G2_PIAFINAL_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_HS_G2_PIAFINAL;

#endif

#ifndef _L3DPR_HS_G2_PIASRT_
#define _L3DPR_HS_G2_PIASRT_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_HS_G2_PIASRT;

#endif

#ifndef _L3DPR_HS_G2_PIAHYBRID_
#define _L3DPR_HS_G2_PIAHYBRID_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_HS_G2_PIAHYBRID;

#endif
```

```
#ifndef _L3DPR_HS_G2_PIAHB_
#define _L3DPR_HS_G2_PIAHB_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_HS_G2_PIAHB;

#endif

#ifndef _L3DPR_HS_G2_ZETA_
#define _L3DPR_HS_G2_ZETA_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_HS_G2_ZETA;

#endif

#ifndef _L3DPR_HS_G2_EPSILON_
#define _L3DPR_HS_G2_EPSILON_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_EPSILON;

#endif

#ifndef _L3DPR_HS_G2_DBNW_
#define _L3DPR_HS_G2_DBNW_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_HS_G2_DBNW;
```

```
#endif

#ifndef _L3DPR_HS_G2_DM_
#define _L3DPR_HS_G2_DM_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_HS_G2_DM;

#endif

#ifndef _L3DPR_HS_G2_ZFACTORMEASURED_
#define _L3DPR_HS_G2_ZFACTORMEASURED_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_HS_G2_ZFACTORMEASURED;

#endif

#ifndef _L3DPR_HS_G2_ZFACTORMEASUREDNEARSURFACE_
#define _L3DPR_HS_G2_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3DPR_HS_G2_ZFACTORFINALNEARSURFACE_
#define _L3DPR_HS_G2_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_ZFACTORFINALNEARSURFACE;
```

```
#endif

#ifndef _L3DPR_HS_G2_ZFACTORFINALESURFACE_
#define _L3DPR_HS_G2_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_ZFACTORFINALESURFACE;

#endif

#ifndef _L3DPR_HS_G2_ZFACTORFINAL_
#define _L3DPR_HS_G2_ZFACTORFINAL_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_HS_G2_ZFACTORFINAL;

#endif

#ifndef _L3DPR_HS_G2_PRECIPRATEAVE24_
#define _L3DPR_HS_G2_PRECIPRATEAVE24_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_PRECIPRATEAVE24;

#endif

#ifndef _L3DPR_HS_G2_PRECIPICEINTEGRATED_
#define _L3DPR_HS_G2_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
```

```
} L3DPR_HS_G2_PRECIPICEINTEGRATED;

#endif

#ifndef _L3DPR_HS_G2_PRECIPWATERINTEGRATED_
#define _L3DPR_HS_G2_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3DPR_HS_G2_MIXEDPHRATENEARSURFACE_
#define _L3DPR_HS_G2_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3DPR_HS_G2_SNOWRATENEARSURFACE_
#define _L3DPR_HS_G2_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_SNOWRATENEARSURFACE;

#endif

#ifndef _L3DPR_HS_G2_RAINRATENEARSURFACE_
#define _L3DPR_HS_G2_RAINRATENEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
```

```
    float stdev[3][1440][536];
} L3DPR_HS_G2_RAINRATENEARSURFACE;

#endif

#ifndef _L3DPR_HS_G2_PRECIPRATENEARSURFACE_
#define _L3DPR_HS_G2_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3DPR_HS_G2_PRECIPRATEESURFACE2_
#define _L3DPR_HS_G2_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_PRECIPRATEESURFACE2;

#endif

#ifndef _L3DPR_HS_G2_PRECIPRATEESURFACE_
#define _L3DPR_HS_G2_PRECIPRATEESURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_PRECIPRATEESURFACE;

#endif

#ifndef _L3DPR_HS_G2_MIXEDPHRATE_
#define _L3DPR_HS_G2_MIXEDPHRATE_

typedef struct {
    int count[3][5][1440][536];
```

```
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_HS_G2_MIXEDPHRATE;

#endif

#ifndef _L3DPR_HS_G2_FLAGHEAVYICEPRECIP_
#define _L3DPR_HS_G2_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_HS_G2_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3DPR_HS_G2_SNOWRATE_
#define _L3DPR_HS_G2_SNOWRATE_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_HS_G2_SNOWRATE;

#endif

#ifndef _L3DPR_HS_G2_RAINRATE_
#define _L3DPR_HS_G2_RAINRATE_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_HS_G2_RAINRATE;

#endif

#ifndef _L3DPR_HS_G2_PRECIPRATE_
#define _L3DPR_HS_G2_PRECIPRATE_

typedef struct {
```

```
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3DPR_HS_G2_PRECIPRATE;

#endif

#ifndef _L3DPR_HS_G2_
#define _L3DPR_HS_G2_

typedef struct {
    L3DPR_HS_G2_PRECIPRATE precipRate;
    L3DPR_HS_G2_RAINRATE rainRate;
    L3DPR_HS_G2_SNOWRATE snowRate;
    L3DPR_HS_G2_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3DPR_HS_G2_MIXEDPHRATE mixedPhRate;
    L3DPR_HS_G2_PRECIPRATEESURFACE precipRateESurface;
    L3DPR_HS_G2_PRECIPRATEESURFACE2 precipRateESurface2;
    L3DPR_HS_G2_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3DPR_HS_G2_RAINRATENEARSURFACE rainRateNearSurface;
    L3DPR_HS_G2_SNOWRATENEARSURFACE snowRateNearSurface;
    L3DPR_HS_G2_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3DPR_HS_G2_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3DPR_HS_G2_PRECIPICEINTEGRATED precipIceIntegrated;
    L3DPR_HS_G2_PRECIPRATEAVE24 precipRateAve24;
    L3DPR_HS_G2_ZFACTORFINAL zFactorFinal;
    L3DPR_HS_G2_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3DPR_HS_G2_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3DPR_HS_G2_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3DPR_HS_G2_ZFACTORMEASURED zFactorMeasured;
    L3DPR_HS_G2_DM dm;
    L3DPR_HS_G2_DBNW dBNw;
    L3DPR_HS_G2_EPSILON epsilon;
    L3DPR_HS_G2_ZETA zeta;
    L3DPR_HS_G2_PIAHB piaHB;
    L3DPR_HS_G2_PIAHYBRID piaHybrid;
    L3DPR_HS_G2_PIASRT piaSRT;
    L3DPR_HS_G2_PIAFINAL piaFinal;
    L3DPR_HS_G2_PIAFINALSUBSET piaFinalSubset;
    L3DPR_HS_G2_HEIGHTBB heightBB;
    L3DPR_HS_G2_HEIGHTBBNADIR heightBBnadir;
    L3DPR_HS_G2_BBWIDTHNADIR BBwidthNadir;
    L3DPR_HS_G2_HEIGHTSTORMTOP heightStormTop;
```

```
    L3DPR_HS_G2_BBWIDTH BBwidth;
    L3DPR_HS_G2_OBSERVATIONCOUNTS observationCounts;
    L3DPR_HS_G2_PRECIPRATELOCALTIME precipRateLocalTime;
    float precipRateNearSurfaceUnconditional[1440][536];
    float precipProbabilityNearSurface[1440][536];
} L3DPR_HS_G2;

#endif

#ifndef _L3DPR_HS_G1_PRECIPRATELOCALTIME_
#define _L3DPR_HS_G1_PRECIPRATELOCALTIME_

typedef struct {
    int count[3][24][72][28];
    float mean[3][24][72][28];
    float stdev[3][24][72][28];
} L3DPR_HS_G1_PRECIPRATELOCALTIME;

#endif

#ifndef _L3DPR_HS_G1_OBSERVATIONCOUNTS_
#define _L3DPR_HS_G1_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][72][28];
    int localTime[3][24][72][28];
    int pia[3][4][72][28];
    int shallowRain[3][72][28];
} L3DPR_HS_G1_OBSERVATIONCOUNTS;

#endif

#ifndef _L3DPR_HS_G1_BBWIDTH_
#define _L3DPR_HS_G1_BBWIDTH_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_BBWIDTH;

#endif
```

```
#ifndef _L3DPR_HS_G1_HEIGHTSTORMTOP_
#define _L3DPR_HS_G1_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_HEIGHTSTORMTOP;

#endif

#ifndef _L3DPR_HS_G1_BBWIDTHNADIR_
#define _L3DPR_HS_G1_BBWIDTHNADIR_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_BBWIDTHNADIR;

#endif

#ifndef _L3DPR_HS_G1_HEIGHTBBNADIR_
#define _L3DPR_HS_G1_HEIGHTBBNADIR_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_HEIGHTBBNADIR;

#endif

#ifndef _L3DPR_HS_G1_HEIGHTBB_
#define _L3DPR_HS_G1_HEIGHTBB_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
```

```
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_HEIGHTBB;

#endif

#ifndef _L3DPR_HS_G1_PIAFINALSUBSET_
#define _L3DPR_HS_G1_PIAFINALSUBSET_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_HS_G1_PIAFINALSUBSET;

#endif

#ifndef _L3DPR_HS_G1_PIAFINAL_
#define _L3DPR_HS_G1_PIAFINAL_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_HS_G1_PIAFINAL;

#endif

#ifndef _L3DPR_HS_G1_PIASRT_
#define _L3DPR_HS_G1_PIASRT_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_HS_G1_PIASRT;

#endif

#ifndef _L3DPR_HS_G1_PIAHYBRID_
```

```
#define _L3DPR_HS_G1_PIAHYBRID_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_HS_G1_PIAHYBRID;

#endif

#ifndef _L3DPR_HS_G1_PIAHB_
#define _L3DPR_HS_G1_PIAHB_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_HS_G1_PIAHB;

#endif

#ifndef _L3DPR_HS_G1_ZETA_
#define _L3DPR_HS_G1_ZETA_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_HS_G1_ZETA;

#endif

#ifndef _L3DPR_HS_G1_EPSILON_
#define _L3DPR_HS_G1_EPSILON_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
```

```
} L3DPR_HS_G1_EPSILON;

#endif

#ifndef _L3DPR_HS_G1_DBNW_
#define _L3DPR_HS_G1_DBNW_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_HS_G1_DBNW;

#endif

#ifndef _L3DPR_HS_G1_DM_
#define _L3DPR_HS_G1_DM_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_HS_G1_DM;

#endif

#ifndef _L3DPR_HS_G1_ZFACTORMEASURED_
#define _L3DPR_HS_G1_ZFACTORMEASURED_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_HS_G1_ZFACTORMEASURED;

#endif

#ifndef _L3DPR_HS_G1_ZFACTORMEASUREDNEARSURFACE_
#define _L3DPR_HS_G1_ZFACTORMEASUREDNEARSURFACE_
```

```
typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3DPR_HS_G1_ZFACTORFINALNEARSURFACE_
#define _L3DPR_HS_G1_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3DPR_HS_G1_ZFACTORFINALESURFACE_
#define _L3DPR_HS_G1_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_ZFACTORFINALESURFACE;

#endif

#ifndef _L3DPR_HS_G1_ZFACTORFINAL_
#define _L3DPR_HS_G1_ZFACTORFINAL_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_HS_G1_ZFACTORFINAL;
```

```
#endif

#ifndef _L3DPR_HS_G1_PRECIPRATEAVE24_
#define _L3DPR_HS_G1_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_PRECIPRATEAVE24;

#endif

#ifndef _L3DPR_HS_G1_PRECIPICEINTEGRATED_
#define _L3DPR_HS_G1_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_PRECIPICEINTEGRATED;

#endif

#ifndef _L3DPR_HS_G1_PRECIPWATERINTEGRATED_
#define _L3DPR_HS_G1_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3DPR_HS_G1_MIXEDPHRATENEARSURFACE_
#define _L3DPR_HS_G1_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][3][72][28];
```

```
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3DPR_HS_G1_SNOWRATENEARSURFACE_
#define _L3DPR_HS_G1_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_SNOWRATENEARSURFACE;

#endif

#ifndef _L3DPR_HS_G1_RAINRATENEARSURFACE_
#define _L3DPR_HS_G1_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_RAINRATENEARSURFACE;

#endif

#ifndef _L3DPR_HS_G1_PRECIPRATENEARSURFACE_
#define _L3DPR_HS_G1_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_PRECIPRATENEARSURFACE;

#endif
```

```
#ifndef _L3DPR_HS_G1_PRECIPRATEESURFACE2_
#define _L3DPR_HS_G1_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_PRECIPRATEESURFACE2;

#endif

#ifndef _L3DPR_HS_G1_PRECIPRATEESURFACE_
#define _L3DPR_HS_G1_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_PRECIPRATEESURFACE;

#endif

#ifndef _L3DPR_HS_G1_MIXEDPHRATE_
#define _L3DPR_HS_G1_MIXEDPHRATE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_HS_G1_MIXEDPHRATE;

#endif

#ifndef _L3DPR_HS_G1_FLAGHEAVYICEPRECIP_
#define _L3DPR_HS_G1_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
```

```
    int hist[30][3][3][72][28];
} L3DPR_HS_G1_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3DPR_HS_G1_SNOWRATE_
#define _L3DPR_HS_G1_SNOWRATE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_HS_G1_SNOWRATE;

#endif

#ifndef _L3DPR_HS_G1_RAINRATE_
#define _L3DPR_HS_G1_RAINRATE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_HS_G1_RAINRATE;

#endif

#ifndef _L3DPR_HS_G1_PRECIPRATE_
#define _L3DPR_HS_G1_PRECIPRATE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3DPR_HS_G1_PRECIPRATE;

#endif

#ifndef _L3DPR_HS_G1_
#define _L3DPR_HS_G1_
```

```
typedef struct {
    L3DPR_HS_G1_PRECIPRATE precipRate;
    L3DPR_HS_G1_RAINRATE rainRate;
    L3DPR_HS_G1_SNOWRATE snowRate;
    L3DPR_HS_G1_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3DPR_HS_G1_MIXEDPHRATE mixedPhRate;
    L3DPR_HS_G1_PRECIPRATEESURFACE precipRateESurface;
    L3DPR_HS_G1_PRECIPRATEESURFACE2 precipRateESurface2;
    L3DPR_HS_G1_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3DPR_HS_G1_RAINRATENEARSURFACE rainRateNearSurface;
    L3DPR_HS_G1_SNOWRATENEARSURFACE snowRateNearSurface;
    L3DPR_HS_G1_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3DPR_HS_G1_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3DPR_HS_G1_PRECIPICEINTEGRATED precipIceIntegrated;
    L3DPR_HS_G1_PRECIPRATEAVE24 precipRateAve24;
    L3DPR_HS_G1_ZFACTORFINAL zFactorFinal;
    L3DPR_HS_G1_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3DPR_HS_G1_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3DPR_HS_G1_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3DPR_HS_G1_ZFACTORMEASURED zFactorMeasured;
    L3DPR_HS_G1_DM dm;
    L3DPR_HS_G1_DBNW dBNw;
    L3DPR_HS_G1_EPSILON epsilon;
    L3DPR_HS_G1_ZETA zeta;
    L3DPR_HS_G1_PIAHB piaHB;
    L3DPR_HS_G1_PIAHYBRID piaHybrid;
    L3DPR_HS_G1_PIASRT piaSRT;
    L3DPR_HS_G1_PIAFINAL piaFinal;
    L3DPR_HS_G1_PIAFINALSUBSET piaFinalSubset;
    L3DPR_HS_G1_HEIGHTBB heightBB;
    L3DPR_HS_G1_HEIGHTBBNADIR heightBBnadir;
    L3DPR_HS_G1_BBWIDTHNADIR BBwidthNadir;
    L3DPR_HS_G1_HEIGHTSTORMTOP heightStormTop;
    L3DPR_HS_G1_BBWIDTH BBwidth;
    L3DPR_HS_G1_OBSERVATIONCOUNTS observationCounts;
    L3DPR_HS_G1_PRECIPRATELOCALTIME precipRateLocalTime;
    float precipRateNearSurfaceUnconditional[72][28];
    float precipProbabilityNearSurface[72][28];
} L3DPR_HS_G1;

#endif
```

```
#ifndef _L3DPR_HS_
#define _L3DPR_HS_

typedef struct {
    L3DPR_HS_G1 G1;
    L3DPR_HS_G2 G2;
} L3DPR_HS;

#endif

#ifndef _L3DPR_MS_G2_DFRNEARSURFACE_
#define _L3DPR_MS_G2_DFRNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_MS_G2_DFRNEARSURFACE;

#endif

#ifndef _L3DPR_MS_G2_DFRMNEARSURFACE_
#define _L3DPR_MS_G2_DFRMNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_MS_G2_DFRMNEARSURFACE;

#endif

#ifndef _L3DPR_MS_G2_PRECIPRATELOCALTIME_
#define _L3DPR_MS_G2_PRECIPRATELOCALTIME_

typedef struct {
    int count[24][3][1440][536];
    float mean[24][3][1440][536];
    float stdev[24][3][1440][536];
} L3DPR_MS_G2_PRECIPRATELOCALTIME;

#endif
```

```
#ifndef _L3DPR_MS_G2_OBSERVATIONCOUNTS_
#define _L3DPR_MS_G2_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][1440][536];
    int localTime[24][3][1440][536];
    int pia[4][3][1440][536];
    int shallowRain[3][1440][536];
} L3DPR_MS_G2_OBSERVATIONCOUNTS;

#endif

#ifndef _L3DPR_MS_G2_BBWIDTH_
#define _L3DPR_MS_G2_BBWIDTH_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_BBWIDTH;

#endif

#ifndef _L3DPR_MS_G2_HEIGHTSTORMTOP_
#define _L3DPR_MS_G2_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_HEIGHTSTORMTOP;

#endif

#ifndef _L3DPR_MS_G2_BBWIDTHNADIR_
#define _L3DPR_MS_G2_BBWIDTHNADIR_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_BBWIDTHNADIR;
```

```
#endif

#ifndef _L3DPR_MS_G2_HEIGHTBBNADIR_
#define _L3DPR_MS_G2_HEIGHTBBNADIR_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_HEIGHTBBNADIR;

#endif

#ifndef _L3DPR_MS_G2_HEIGHTBB_
#define _L3DPR_MS_G2_HEIGHTBB_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_HEIGHTBB;

#endif

#ifndef _L3DPR_MS_G2_PIAFINALSUBSET_
#define _L3DPR_MS_G2_PIAFINALSUBSET_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3DPR_MS_G2_PIAFINALSUBSET;

#endif

#ifndef _L3DPR_MS_G2_PIAFINAL_
#define _L3DPR_MS_G2_PIAFINAL_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3DPR_MS_G2_PIAFINAL;
```

```
#endif

#ifndef _L3DPR_MS_G2_PIASRT_
#define _L3DPR_MS_G2_PIASRT_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3DPR_MS_G2_PIASRT;

#endif

#ifndef _L3DPR_MS_G2_PIAHYBRID_
#define _L3DPR_MS_G2_PIAHYBRID_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3DPR_MS_G2_PIAHYBRID;

#endif

#ifndef _L3DPR_MS_G2_PIAHB_
#define _L3DPR_MS_G2_PIAHB_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3DPR_MS_G2_PIAHB;

#endif

#ifndef _L3DPR_MS_G2_ZETA_
#define _L3DPR_MS_G2_ZETA_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
```

```
} L3DPR_MS_G2_ZETA;

#endif

#ifndef _L3DPR_MS_G2_EPSILON_
#define _L3DPR_MS_G2_EPSILON_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_MS_G2_EPSILON;

#endif

#ifndef _L3DPR_MS_G2_DBNW_
#define _L3DPR_MS_G2_DBNW_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_MS_G2_DBNW;

#endif

#ifndef _L3DPR_MS_G2_DM_
#define _L3DPR_MS_G2_DM_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_MS_G2_DM;

#endif

#ifndef _L3DPR_MS_G2_ZFACTORMEASURED_
#define _L3DPR_MS_G2_ZFACTORMEASURED_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
```

```
    float stdev[3][5][4][1440][536];
} L3DPR_MS_G2_ZFACTORMEASURED;

#endif

#ifndef _L3DPR_MS_G2_ZFACTORMEASUREDNEARSURFACE_
#define _L3DPR_MS_G2_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_MS_G2_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3DPR_MS_G2_ZFACTORFINALNEARSURFACE_
#define _L3DPR_MS_G2_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_MS_G2_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3DPR_MS_G2_ZFACTORFINALESURFACE_
#define _L3DPR_MS_G2_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_MS_G2_ZFACTORFINALESURFACE;

#endif

#ifndef _L3DPR_MS_G2_ZFACTORFINAL_
#define _L3DPR_MS_G2_ZFACTORFINAL_

typedef struct {
    int count[3][5][4][1440][536];
```

```
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
} L3DPR_MS_G2_ZFACTORFINAL;

#endif

#ifndef _L3DPR_MS_G2_PRECIPRATEAVE24_
#define _L3DPR_MS_G2_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_PRECIPRATEAVE24;

#endif

#ifndef _L3DPR_MS_G2_PRECIPICEINTEGRATED_
#define _L3DPR_MS_G2_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_PRECIPICEINTEGRATED;

#endif

#ifndef _L3DPR_MS_G2_PRECIPWATERINTEGRATED_
#define _L3DPR_MS_G2_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3DPR_MS_G2_MIXEDPHRATENEARSURFACE_
#define _L3DPR_MS_G2_MIXEDPHRATENEARSURFACE_

typedef struct {
```

```
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3DPR_MS_G2_SNOWRATENEARSURFACE_
#define _L3DPR_MS_G2_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_SNOWRATENEARSURFACE;

#endif

#ifndef _L3DPR_MS_G2_RAINRATENEARSURFACE_
#define _L3DPR_MS_G2_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_RAINRATENEARSURFACE;

#endif

#ifndef _L3DPR_MS_G2_PRECIPRATENEARSURFACE_
#define _L3DPR_MS_G2_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3DPR_MS_G2_PRECIPRATEESURFACE2_
#define _L3DPR_MS_G2_PRECIPRATEESURFACE2_
```

```
typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_PRECIPRATEESURFACE2;

#endif

#ifndef _L3DPR_MS_G2_PRECIPRATEESURFACE_
#define _L3DPR_MS_G2_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_PRECIPRATEESURFACE;

#endif

#ifndef _L3DPR_MS_G2_MIXEDPHRATE_
#define _L3DPR_MS_G2_MIXEDPHRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_MS_G2_MIXEDPHRATE;

#endif

#ifndef _L3DPR_MS_G2_FLAGHEAVYICEPRECIP_
#define _L3DPR_MS_G2_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_MS_G2_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3DPR_MS_G2_SNOWRATE_
#define _L3DPR_MS_G2_SNOWRATE_
```

```
typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_MS_G2_SNOWRATE;

#endif

#ifndef _L3DPR_MS_G2_RAINRATE_
#define _L3DPR_MS_G2_RAINRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_MS_G2_RAINRATE;

#endif

#ifndef _L3DPR_MS_G2_PRECIPRATE_
#define _L3DPR_MS_G2_PRECIPRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_MS_G2_PRECIPRATE;

#endif

#ifndef _L3DPR_MS_G2_
#define _L3DPR_MS_G2_

typedef struct {
    L3DPR_MS_G2_PRECIPRATE precipRate;
    L3DPR_MS_G2_RAINRATE rainRate;
    L3DPR_MS_G2_SNOWRATE snowRate;
    L3DPR_MS_G2_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3DPR_MS_G2_MIXEDPHRATE mixedPhRate;
    L3DPR_MS_G2_PRECIPRATEESURFACE precipRateESurface;
    L3DPR_MS_G2_PRECIPRATEESURFACE2 precipRateESurface2;
    L3DPR_MS_G2_PRECIPRATENEARSURFACE precipRateNearSurface;
```

```
    L3DPR_MS_G2_RAINRATENEARSURFACE rainRateNearSurface;
    L3DPR_MS_G2_SNOWRATENEARSURFACE snowRateNearSurface;
    L3DPR_MS_G2_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3DPR_MS_G2_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3DPR_MS_G2_PRECIPICEINTEGRATED precipIceIntegrated;
    L3DPR_MS_G2_PRECIPRATEAVE24 precipRateAve24;
    L3DPR_MS_G2_ZFACTORFINAL zFactorFinal;
    L3DPR_MS_G2_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3DPR_MS_G2_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3DPR_MS_G2_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3DPR_MS_G2_ZFACTORMEASURED zFactorMeasured;
    L3DPR_MS_G2_DM dm;
    L3DPR_MS_G2_DBNW dBNw;
    L3DPR_MS_G2_EPSILON epsilon;
    L3DPR_MS_G2_ZETA zeta;
    L3DPR_MS_G2_PIAHB piaHB;
    L3DPR_MS_G2_PIAHYBRID piaHybrid;
    L3DPR_MS_G2_PIASRT piaSRT;
    L3DPR_MS_G2_PIAFINAL piaFinal;
    L3DPR_MS_G2_PIAFINALSUBSET piaFinalSubset;
    L3DPR_MS_G2_HEIGHTBB heightBB;
    L3DPR_MS_G2_HEIGHTBBNADIR heightBBnadir;
    L3DPR_MS_G2_BBWIDTHNADIR BBwidthNadir;
    L3DPR_MS_G2_HEIGHTSTORMTOP heightStormTop;
    L3DPR_MS_G2_BBWIDTH BBwidth;
    L3DPR_MS_G2_OBSERVATIONCOUNTS observationCounts;
    L3DPR_MS_G2_PRECIPRATELOCALTIME precipRateLocalTime;
    L3DPR_MS_G2_DFRMNEARSURFACE DFRmNearSurface;
    L3DPR_MS_G2_DFRNEARSURFACE DFRNearSurface;
    float precipRateNearSurfaceUnconditional[3][1440][536];
    float precipProbabilityNearSurface[3][1440][536];
} L3DPR_MS_G2;

#endif

#ifndef _L3DPR_MS_G1_DFRNEARSURFACE_
#define _L3DPR_MS_G1_DFRNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
```

```
} L3DPR_MS_G1_DFRNEARSURFACE;

#endif

#ifndef _L3DPR_MS_G1_DFRMNEARSURFACE_
#define _L3DPR_MS_G1_DFRMNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_MS_G1_DFRMNEARSURFACE;

#endif

#ifndef _L3DPR_MS_G1_PRECIPRATELOCALTIME_
#define _L3DPR_MS_G1_PRECIPRATELOCALTIME_

typedef struct {
    int count[3][24][3][72][28];
    float mean[3][24][3][72][28];
    float stdev[3][24][3][72][28];
} L3DPR_MS_G1_PRECIPRATELOCALTIME;

#endif

#ifndef _L3DPR_MS_G1_OBSERVATIONCOUNTS_
#define _L3DPR_MS_G1_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][3][72][28];
    int localTime[3][24][3][72][28];
    int pia[3][4][3][72][28];
    int shallowRain[3][3][72][28];
} L3DPR_MS_G1_OBSERVATIONCOUNTS;

#endif

#ifndef _L3DPR_MS_G1_BBWIDTH_
#define _L3DPR_MS_G1_BBWIDTH_

typedef struct {
```

```
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_BBWIDTH;

#endif

#ifndef _L3DPR_MS_G1_HEIGHTSTORMTOP_
#define _L3DPR_MS_G1_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_HEIGHTSTORMTOP;

#endif

#ifndef _L3DPR_MS_G1_BBWIDTHNADIR_
#define _L3DPR_MS_G1_BBWIDTHNADIR_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_BBWIDTHNADIR;

#endif

#ifndef _L3DPR_MS_G1_HEIGHTBBNADIR_
#define _L3DPR_MS_G1_HEIGHTBBNADIR_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_HEIGHTBBNADIR;

#endif
```

```
#ifndef _L3DPR_MS_G1_HEIGHTBB_
#define _L3DPR_MS_G1_HEIGHTBB_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_HEIGHTBB;

#endif

#ifndef _L3DPR_MS_G1_PIAFINALSUBSET_
#define _L3DPR_MS_G1_PIAFINALSUBSET_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3DPR_MS_G1_PIAFINALSUBSET;

#endif

#ifndef _L3DPR_MS_G1_PIAFINAL_
#define _L3DPR_MS_G1_PIAFINAL_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3DPR_MS_G1_PIAFINAL;

#endif

#ifndef _L3DPR_MS_G1_PIASRT_
#define _L3DPR_MS_G1_PIASRT_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
```

```
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3DPR_MS_G1_PIASRT;

#endif

#ifndef _L3DPR_MS_G1_PIAHYBRID_
#define _L3DPR_MS_G1_PIAHYBRID_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3DPR_MS_G1_PIAHYBRID;

#endif

#ifndef _L3DPR_MS_G1_PIAHB_
#define _L3DPR_MS_G1_PIAHB_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3DPR_MS_G1_PIAHB;

#endif

#ifndef _L3DPR_MS_G1_ZETA_
#define _L3DPR_MS_G1_ZETA_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3DPR_MS_G1_ZETA;

#endif

#ifndef _L3DPR_MS_G1_EPSILON_
```

```
#define _L3DPR_MS_G1_EPSILON_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_MS_G1_EPSILON;

#endif

#ifndef _L3DPR_MS_G1_DBNW_
#define _L3DPR_MS_G1_DBNW_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_MS_G1_DBNW;

#endif

#ifndef _L3DPR_MS_G1_DM_
#define _L3DPR_MS_G1_DM_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_MS_G1_DM;

#endif

#ifndef _L3DPR_MS_G1_ZFACTORMEASURED_
#define _L3DPR_MS_G1_ZFACTORMEASURED_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
```

```
} L3DPR_MS_G1_ZFACTORMEASURED;

#endif

#ifndef _L3DPR_MS_G1_ZFACTORMEASUREDNEARSURFACE_
#define _L3DPR_MS_G1_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_MS_G1_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3DPR_MS_G1_ZFACTORFINALNEARSURFACE_
#define _L3DPR_MS_G1_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_MS_G1_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3DPR_MS_G1_ZFACTORFINALESURFACE_
#define _L3DPR_MS_G1_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_MS_G1_ZFACTORFINALESURFACE;

#endif

#ifndef _L3DPR_MS_G1_ZFACTORFINAL_
#define _L3DPR_MS_G1_ZFACTORFINAL_
```

```
typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
} L3DPR_MS_G1_ZFACTORFINAL;

#endif

#ifndef _L3DPR_MS_G1_PRECIPRATEAVE24_
#define _L3DPR_MS_G1_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_PRECIPRATEAVE24;

#endif

#ifndef _L3DPR_MS_G1_PRECIPICEINTEGRATED_
#define _L3DPR_MS_G1_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_PRECIPICEINTEGRATED;

#endif

#ifndef _L3DPR_MS_G1_PRECIPWATERINTEGRATED_
#define _L3DPR_MS_G1_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_PRECIPWATERINTEGRATED;
```

```
#endif

#ifndef _L3DPR_MS_G1_MIXEDPHRATENEARSURFACE_
#define _L3DPR_MS_G1_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3DPR_MS_G1_SNOWRATENEARSURFACE_
#define _L3DPR_MS_G1_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_SNOWRATENEARSURFACE;

#endif

#ifndef _L3DPR_MS_G1_RAINRATENEARSURFACE_
#define _L3DPR_MS_G1_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_RAINRATENEARSURFACE;

#endif

#ifndef _L3DPR_MS_G1_PRECIPRATENEARSURFACE_
#define _L3DPR_MS_G1_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
```

```
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3DPR_MS_G1_PRECIPRATEESURFACE2_
#define _L3DPR_MS_G1_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_PRECIPRATEESURFACE2;

#endif

#ifndef _L3DPR_MS_G1_PRECIPRATEESURFACE_
#define _L3DPR_MS_G1_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_PRECIPRATEESURFACE;

#endif

#ifndef _L3DPR_MS_G1_MIXEDPHRATE_
#define _L3DPR_MS_G1_MIXEDPHRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_MS_G1_MIXEDPHRATE;

#endif
```

```
#ifndef _L3DPR_MS_G1_FLAGHEAVYICEPRECIP_
#define _L3DPR_MS_G1_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_MS_G1_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3DPR_MS_G1_SNOWRATE_
#define _L3DPR_MS_G1_SNOWRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_MS_G1_SNOWRATE;

#endif

#ifndef _L3DPR_MS_G1_RAINRATE_
#define _L3DPR_MS_G1_RAINRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_MS_G1_RAINRATE;

#endif

#ifndef _L3DPR_MS_G1_PRECIPRATE_
#define _L3DPR_MS_G1_PRECIPRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
```

```
    int hist[30][3][3][5][3][72][28];
} L3DPR_MS_G1_PRECIPRATE;

#endif

#ifndef _L3DPR_MS_G1_
#define _L3DPR_MS_G1_

typedef struct {
    L3DPR_MS_G1_PRECIPRATE precipRate;
    L3DPR_MS_G1_RAINRATE rainRate;
    L3DPR_MS_G1_SNOWRATE snowRate;
    L3DPR_MS_G1_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3DPR_MS_G1_MIXEDPHRATE mixedPhRate;
    L3DPR_MS_G1_PRECIPRATEESURFACE precipRateESurface;
    L3DPR_MS_G1_PRECIPRATEESURFACE2 precipRateESurface2;
    L3DPR_MS_G1_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3DPR_MS_G1_RAINRATENEARSURFACE rainRateNearSurface;
    L3DPR_MS_G1_SNOWRATENEARSURFACE snowRateNearSurface;
    L3DPR_MS_G1_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3DPR_MS_G1_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3DPR_MS_G1_PRECIPICEINTEGRATED precipIceIntegrated;
    L3DPR_MS_G1_PRECIPRATEAVE24 precipRateAve24;
    L3DPR_MS_G1_ZFACTORFINAL zFactorFinal;
    L3DPR_MS_G1_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3DPR_MS_G1_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3DPR_MS_G1_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3DPR_MS_G1_ZFACTORMEASURED zFactorMeasured;
    L3DPR_MS_G1_DM dm;
    L3DPR_MS_G1_DBNW dBNw;
    L3DPR_MS_G1_EPSILON epsilon;
    L3DPR_MS_G1_ZETA zeta;
    L3DPR_MS_G1_PIAHB piaHB;
    L3DPR_MS_G1_PIAHYBRID piaHybrid;
    L3DPR_MS_G1_PIASRT piaSRT;
    L3DPR_MS_G1_PIAFINAL piaFinal;
    L3DPR_MS_G1_PIAFINALSUBSET piaFinalSubset;
    L3DPR_MS_G1_HEIGHTBB heightBB;
    L3DPR_MS_G1_HEIGHTBBNADIR heightBBnadir;
    L3DPR_MS_G1_BBWIDTHNADIR BBwidthNadir;
    L3DPR_MS_G1_HEIGHTSTORMTOP heightStormTop;
    L3DPR_MS_G1_BBWIDTH BBwidth;
    L3DPR_MS_G1_OBSERVATIONCOUNTS observationCounts;
```

```
    L3DPR_MS_G1_PRECIPRATELOCALTIME precipRateLocalTime;
    L3DPR_MS_G1_DFRMNEARSURFACE DFRmNearSurface;
    L3DPR_MS_G1_DFRNEARSURFACE DFRNearSurface;
    float precipRateNearSurfaceUnconditional[3][72][28];
    float precipProbabilityNearSurface[3][72][28];
} L3DPR_MS_G1;

#endif

#ifndef _L3DPR_MS_
#define _L3DPR_MS_

typedef struct {
    L3DPR_MS_G1 G1;
    L3DPR_MS_G2 G2;
} L3DPR_MS;

#endif

#ifndef _L3DPR_FS_G2_DFRNEARSURFACE_
#define _L3DPR_FS_G2_DFRNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_FS_G2_DFRNEARSURFACE;

#endif

#ifndef _L3DPR_FS_G2_DFRMNEARSURFACE_
#define _L3DPR_FS_G2_DFRMNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3DPR_FS_G2_DFRMNEARSURFACE;

#endif

#ifndef _L3DPR_FS_G2_PRECIPRATELOCALTIME_
#define _L3DPR_FS_G2_PRECIPRATELOCALTIME_
```

```
typedef struct {
    int count[24][3][1440][536];
    float mean[24][3][1440][536];
    float stdev[24][3][1440][536];
} L3DPR_FS_G2_PRECIPRATELOCALTIME;

#endif

#ifndef _L3DPR_FS_G2_OBSERVATIONCOUNTS_
#define _L3DPR_FS_G2_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][1440][536];
    int localTime[24][3][1440][536];
    int pia[7][3][1440][536];
    int shallowRain[3][1440][536];
} L3DPR_FS_G2_OBSERVATIONCOUNTS;

#endif

#ifndef _L3DPR_FS_G2_BBWIDTH_
#define _L3DPR_FS_G2_BBWIDTH_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_BBWIDTH;

#endif

#ifndef _L3DPR_FS_G2_HEIGHTSTORMTOP_
#define _L3DPR_FS_G2_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_HEIGHTSTORMTOP;

#endif
```

```
#ifndef _L3DPR_FS_G2_BBWIDTHNADIR_
#define _L3DPR_FS_G2_BBWIDTHNADIR_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_BBWIDTHNADIR;

#endif

#ifndef _L3DPR_FS_G2_HEIGHTBBNADIR_
#define _L3DPR_FS_G2_HEIGHTBBNADIR_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_HEIGHTBBNADIR;

#endif

#ifndef _L3DPR_FS_G2_HEIGHTBB_
#define _L3DPR_FS_G2_HEIGHTBB_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_HEIGHTBB;

#endif

#ifndef _L3DPR_FS_G2_PIAFINALSUBSET_
#define _L3DPR_FS_G2_PIAFINALSUBSET_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_FS_G2_PIAFINALSUBSET;

#endif
```

```
#ifndef _L3DPR_FS_G2_PIAFINAL_
#define _L3DPR_FS_G2_PIAFINAL_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_FS_G2_PIAFINAL;

#endif

#ifndef _L3DPR_FS_G2_PIASRT_
#define _L3DPR_FS_G2_PIASRT_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_FS_G2_PIASRT;

#endif

#ifndef _L3DPR_FS_G2_PIAHYBRID_
#define _L3DPR_FS_G2_PIAHYBRID_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_FS_G2_PIAHYBRID;

#endif

#ifndef _L3DPR_FS_G2_PIAHB_
#define _L3DPR_FS_G2_PIAHB_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_FS_G2_PIAHB;
```

```
#endif

#ifndef _L3DPR_FS_G2_ZETA_
#define _L3DPR_FS_G2_ZETA_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3DPR_FS_G2_ZETA;

#endif

#ifndef _L3DPR_FS_G2_EPSILON_
#define _L3DPR_FS_G2_EPSILON_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_FS_G2_EPSILON;

#endif

#ifndef _L3DPR_FS_G2_DBNW_
#define _L3DPR_FS_G2_DBNW_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_FS_G2_DBNW;

#endif

#ifndef _L3DPR_FS_G2_DM_
#define _L3DPR_FS_G2_DM_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_FS_G2_DM;
```

```
#endif

#ifndef _L3DPR_FS_G2_ZFACTORMEASURED_
#define _L3DPR_FS_G2_ZFACTORMEASURED_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
} L3DPR_FS_G2_ZFACTORMEASURED;

#endif

#ifndef _L3DPR_FS_G2_ZFACTORMEASUREDNEARSURFACE_
#define _L3DPR_FS_G2_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_FS_G2_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3DPR_FS_G2_ZFACTORFINALNEARSURFACE_
#define _L3DPR_FS_G2_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3DPR_FS_G2_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3DPR_FS_G2_ZFACTORFINALESURFACE_
#define _L3DPR_FS_G2_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
```

```
} L3DPR_FS_G2_ZFACTORFINALESURFACE;

#endif

#ifndef _L3DPR_FS_G2_ZFACTORFINAL_
#define _L3DPR_FS_G2_ZFACTORFINAL_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
} L3DPR_FS_G2_ZFACTORFINAL;

#endif

#ifndef _L3DPR_FS_G2_PRECIPRATEAVE24_
#define _L3DPR_FS_G2_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_PRECIPRATEAVE24;

#endif

#ifndef _L3DPR_FS_G2_PRECIPICEINTEGRATED_
#define _L3DPR_FS_G2_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_PRECIPICEINTEGRATED;

#endif

#ifndef _L3DPR_FS_G2_PRECIPWATERINTEGRATED_
#define _L3DPR_FS_G2_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
```

```
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3DPR_FS_G2_MIXEDPHRATENEARSURFACE_
#define _L3DPR_FS_G2_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3DPR_FS_G2_SNOWRATENEARSURFACE_
#define _L3DPR_FS_G2_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_SNOWRATENEARSURFACE;

#endif

#ifndef _L3DPR_FS_G2_RAINRATENEARSURFACE_
#define _L3DPR_FS_G2_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_RAINRATENEARSURFACE;

#endif

#ifndef _L3DPR_FS_G2_PRECIPRATENEARSURFACE_
#define _L3DPR_FS_G2_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
```

```
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3DPR_FS_G2_PRECIPRATEESURFACE2_
#define _L3DPR_FS_G2_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_PRECIPRATEESURFACE2;

#endif

#ifndef _L3DPR_FS_G2_PRECIPRATEESURFACE_
#define _L3DPR_FS_G2_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_PRECIPRATEESURFACE;

#endif

#ifndef _L3DPR_FS_G2_MIXEDPHRATE_
#define _L3DPR_FS_G2_MIXEDPHRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_FS_G2_MIXEDPHRATE;

#endif

#ifndef _L3DPR_FS_G2_FLAGHEAVYICEPRECIP_
#define _L3DPR_FS_G2_FLAGHEAVYICEPRECIP_

typedef struct {
```

```
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3DPR_FS_G2_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3DPR_FS_G2_SNOWRATE_
#define _L3DPR_FS_G2_SNOWRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_FS_G2_SNOWRATE;

#endif

#ifndef _L3DPR_FS_G2_RAINRATE_
#define _L3DPR_FS_G2_RAINRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_FS_G2_RAINRATE;

#endif

#ifndef _L3DPR_FS_G2_PRECIPRATE_
#define _L3DPR_FS_G2_PRECIPRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3DPR_FS_G2_PRECIPRATE;

#endif

#ifndef _L3DPR_FS_G2_
#define _L3DPR_FS_G2_
```

```
typedef struct {
    L3DPR_FS_G2_PRECIPRATE precipRate;
    L3DPR_FS_G2_RAINRATE rainRate;
    L3DPR_FS_G2_SNOWRATE snowRate;
    L3DPR_FS_G2_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3DPR_FS_G2_MIXEDPHRATE mixedPhRate;
    L3DPR_FS_G2_PRECIPRATEESURFACE precipRateESurface;
    L3DPR_FS_G2_PRECIPRATEESURFACE2 precipRateESurface2;
    L3DPR_FS_G2_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3DPR_FS_G2_RAINRATENEARSURFACE rainRateNearSurface;
    L3DPR_FS_G2_SNOWRATENEARSURFACE snowRateNearSurface;
    L3DPR_FS_G2_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3DPR_FS_G2_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3DPR_FS_G2_PRECIPICEINTEGRATED precipIceIntegrated;
    L3DPR_FS_G2_PRECIPRATEAVE24 precipRateAve24;
    L3DPR_FS_G2_ZFACTORFINAL zFactorFinal;
    L3DPR_FS_G2_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3DPR_FS_G2_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3DPR_FS_G2_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3DPR_FS_G2_ZFACTORMEASURED zFactorMeasured;
    L3DPR_FS_G2_DM dm;
    L3DPR_FS_G2_DBNW dBNw;
    L3DPR_FS_G2_EPSILON epsilon;
    L3DPR_FS_G2_ZETA zeta;
    L3DPR_FS_G2_PIAHB piaHB;
    L3DPR_FS_G2_PIAHYBRID piaHybrid;
    L3DPR_FS_G2_PIASRT piaSRT;
    L3DPR_FS_G2_PIAFINAL piaFinal;
    L3DPR_FS_G2_PIAFINALSUBSET piaFinalSubset;
    L3DPR_FS_G2_HEIGHTBB heightBB;
    L3DPR_FS_G2_HEIGHTBBNADIR heightBBnadir;
    L3DPR_FS_G2_BBWIDTHNADIR BBwidthNadir;
    L3DPR_FS_G2_HEIGHTSTORMTOP heightStormTop;
    L3DPR_FS_G2_BBWIDTH BBwidth;
    L3DPR_FS_G2_OBSERVATIONCOUNTS observationCounts;
    L3DPR_FS_G2_PRECIPRATELOCALTIME precipRateLocalTime;
    L3DPR_FS_G2_DFRMNEARSURFACE DFRmNearSurface;
    L3DPR_FS_G2_DFRNEARSURFACE DFRNearSurface;
    float precipRateNearSurfaceUnconditional[3][1440][536];
    float precipProbabilityNearSurface[3][1440][536];
} L3DPR_FS_G2;

#endif
```

```
#ifndef _L3DPR_FS_G1_DFRNEARSURFACE_
#define _L3DPR_FS_G1_DFRNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_FS_G1_DFRNEARSURFACE;

#endif

#ifndef _L3DPR_FS_G1_DFRMNEARSURFACE_
#define _L3DPR_FS_G1_DFRMNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3DPR_FS_G1_DFRMNEARSURFACE;

#endif

#ifndef _L3DPR_FS_G1_PRECIPRATELOCALTIME_
#define _L3DPR_FS_G1_PRECIPRATELOCALTIME_

typedef struct {
    int count[3][24][3][72][28];
    float mean[3][24][3][72][28];
    float stdev[3][24][3][72][28];
} L3DPR_FS_G1_PRECIPRATELOCALTIME;

#endif

#ifndef _L3DPR_FS_G1_OBSERVATIONCOUNTS_
#define _L3DPR_FS_G1_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][3][72][28];
    int localTime[3][24][3][72][28];
    int pia[3][7][3][72][28];
```

```
    int shallowRain[3][3][72][28];
} L3DPR_FS_G1_OBSERVATIONCOUNTS;

#endif

#ifndef _L3DPR_FS_G1_BBWIDTH_
#define _L3DPR_FS_G1_BBWIDTH_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_BBWIDTH;

#endif

#ifndef _L3DPR_FS_G1_HEIGHTSTORMTOP_
#define _L3DPR_FS_G1_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_HEIGHTSTORMTOP;

#endif

#ifndef _L3DPR_FS_G1_BBWIDTHNADIR_
#define _L3DPR_FS_G1_BBWIDTHNADIR_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_BBWIDTHNADIR;

#endif

#ifndef _L3DPR_FS_G1_HEIGHTBBNADIR_
#define _L3DPR_FS_G1_HEIGHTBBNADIR_
```

```
typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_HEIGHTBBNADIR;

#endif

#ifndef _L3DPR_FS_G1_HEIGHTBB_
#define _L3DPR_FS_G1_HEIGHTBB_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_HEIGHTBB;

#endif

#ifndef _L3DPR_FS_G1_PIAFINALSUBSET_
#define _L3DPR_FS_G1_PIAFINALSUBSET_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_FS_G1_PIAFINALSUBSET;

#endif

#ifndef _L3DPR_FS_G1_PIAFINAL_
#define _L3DPR_FS_G1_PIAFINAL_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_FS_G1_PIAFINAL;
```

```
#endif

#ifndef _L3DPR_FS_G1_PIASRT_
#define _L3DPR_FS_G1_PIASRT_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_FS_G1_PIASRT;

#endif

#ifndef _L3DPR_FS_G1_PIAHYBRID_
#define _L3DPR_FS_G1_PIAHYBRID_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_FS_G1_PIAHYBRID;

#endif

#ifndef _L3DPR_FS_G1_PIAHB_
#define _L3DPR_FS_G1_PIAHB_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_FS_G1_PIAHB;

#endif

#ifndef _L3DPR_FS_G1_ZETA_
#define _L3DPR_FS_G1_ZETA_

typedef struct {
```

```
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3DPR_FS_G1_ZETA;

#endif

#ifndef _L3DPR_FS_G1_EPSILON_
#define _L3DPR_FS_G1_EPSILON_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_FS_G1_EPSILON;

#endif

#ifndef _L3DPR_FS_G1_DBNW_
#define _L3DPR_FS_G1_DBNW_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_FS_G1_DBNW;

#endif

#ifndef _L3DPR_FS_G1_DM_
#define _L3DPR_FS_G1_DM_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_FS_G1_DM;

#endif
```

```
#ifndef _L3DPR_FS_G1_ZFACTORMEASURED_
#define _L3DPR_FS_G1_ZFACTORMEASURED_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
} L3DPR_FS_G1_ZFACTORMEASURED;

#endif

#ifndef _L3DPR_FS_G1_ZFACTORMEASUREDNEARSURFACE_
#define _L3DPR_FS_G1_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_FS_G1_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3DPR_FS_G1_ZFACTORFINALNEARSURFACE_
#define _L3DPR_FS_G1_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_FS_G1_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3DPR_FS_G1_ZFACTORFINALESURFACE_
#define _L3DPR_FS_G1_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
```

```
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3DPR_FS_G1_ZFACTORFINALESURFACE;

#endif

#ifndef _L3DPR_FS_G1_ZFACTORFINAL_
#define _L3DPR_FS_G1_ZFACTORFINAL_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
} L3DPR_FS_G1_ZFACTORFINAL;

#endif

#ifndef _L3DPR_FS_G1_PRECIPRATEAVE24_
#define _L3DPR_FS_G1_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_PRECIPRATEAVE24;

#endif

#ifndef _L3DPR_FS_G1_PRECIPICEINTEGRATED_
#define _L3DPR_FS_G1_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_PRECIPICEINTEGRATED;

#endif

#ifndef _L3DPR_FS_G1_PRECIPWATERINTEGRATED_
```

```
#define _L3DPR_FS_G1_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3DPR_FS_G1_MIXEDPHRATENEARSURFACE_
#define _L3DPR_FS_G1_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3DPR_FS_G1_SNOWRATENEARSURFACE_
#define _L3DPR_FS_G1_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_SNOWRATENEARSURFACE;

#endif

#ifndef _L3DPR_FS_G1_RAINRATENEARSURFACE_
#define _L3DPR_FS_G1_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
```

```
} L3DPR_FS_G1_RAINRATENEARSURFACE;

#endif

#ifndef _L3DPR_FS_G1_PRECIPRATENEARSURFACE_
#define _L3DPR_FS_G1_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3DPR_FS_G1_PRECIPRATEESURFACE2_
#define _L3DPR_FS_G1_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_PRECIPRATEESURFACE2;

#endif

#ifndef _L3DPR_FS_G1_PRECIPRATEESURFACE_
#define _L3DPR_FS_G1_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_PRECIPRATEESURFACE;

#endif

#ifndef _L3DPR_FS_G1_MIXEDPHRATE_
#define _L3DPR_FS_G1_MIXEDPHRATE_
```

```
typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_FS_G1_MIXEDPHRATE;

#endif

#ifndef _L3DPR_FS_G1_FLAGHEAVYICEPRECIP_
#define _L3DPR_FS_G1_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3DPR_FS_G1_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3DPR_FS_G1_SNOWRATE_
#define _L3DPR_FS_G1_SNOWRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_FS_G1_SNOWRATE;

#endif

#ifndef _L3DPR_FS_G1_RAINRATE_
#define _L3DPR_FS_G1_RAINRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_FS_G1_RAINRATE;
```

```
#endif

#ifndef _L3DPR_FS_G1_PRECIPRATE_
#define _L3DPR_FS_G1_PRECIPRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3DPR_FS_G1_PRECIPRATE;

#endif

#ifndef _L3DPR_FS_G1_
#define _L3DPR_FS_G1_

typedef struct {
    L3DPR_FS_G1_PRECIPRATE precipRate;
    L3DPR_FS_G1_RAINRATE rainRate;
    L3DPR_FS_G1_SNOWRATE snowRate;
    L3DPR_FS_G1_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3DPR_FS_G1_MIXEDPHRATE mixedPhRate;
    L3DPR_FS_G1_PRECIPRATEESURFACE precipRateESurface;
    L3DPR_FS_G1_PRECIPRATEESURFACE2 precipRateESurface2;
    L3DPR_FS_G1_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3DPR_FS_G1_RAINRATENEARSURFACE rainRateNearSurface;
    L3DPR_FS_G1_SNOWRATENEARSURFACE snowRateNearSurface;
    L3DPR_FS_G1_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3DPR_FS_G1_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3DPR_FS_G1_PRECIPICEINTEGRATED precipIceIntegrated;
    L3DPR_FS_G1_PRECIPRATEAVE24 precipRateAve24;
    L3DPR_FS_G1_ZFACTORFINAL zFactorFinal;
    L3DPR_FS_G1_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3DPR_FS_G1_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3DPR_FS_G1_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3DPR_FS_G1_ZFACTORMEASURED zFactorMeasured;
    L3DPR_FS_G1_DM dm;
    L3DPR_FS_G1_DBNW dBNw;
    L3DPR_FS_G1_EPSILON epsilon;
    L3DPR_FS_G1_ZETA zeta;
    L3DPR_FS_G1_PIAHB piaHB;
    L3DPR_FS_G1_PIAHYBRID piaHybrid;
```

```
    L3DPR_FS_G1_PIASRT piaSRT;
    L3DPR_FS_G1_PIAFINAL piaFinal;
    L3DPR_FS_G1_PIAFINALSUBSET piaFinalSubset;
    L3DPR_FS_G1_HEIGHTBB heightBB;
    L3DPR_FS_G1_HEIGHTBBNADIR heightBBnadir;
    L3DPR_FS_G1_BBWIDTHNADIR BBwidthNadir;
    L3DPR_FS_G1_HEIGHTSTORMTOP heightStormTop;
    L3DPR_FS_G1_BBWIDTH BBwidth;
    L3DPR_FS_G1_OBSERVATIONCOUNTS observationCounts;
    L3DPR_FS_G1_PRECIPRATELOCALTIME precipRateLocalTime;
    L3DPR_FS_G1_DFRMNEARSURFACE DFRmNearSurface;
    L3DPR_FS_G1_DFRNEARSURFACE DFRNearSurface;
    float precipRateNearSurfaceUnconditional[3][72][28];
    float precipProbabilityNearSurface[3][72][28];
} L3DPR_FS_G1;

#endif

#ifndef _L3DPR_FS_
#define _L3DPR_FS_

typedef struct {
    L3DPR_FS_G1 G1;
    L3DPR_FS_G2 G2;
} L3DPR_FS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3DPR_HS_G2_PRECIPRATELOCALTIME/
    INTEGER*4 count(536,1440,24)
    REAL*4 mean(536,1440,24)
    REAL*4 stdev(536,1440,24)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_OBSERVATIONCOUNTS/
    INTEGER*4 total(536,1440)
    INTEGER*4 localTime(536,1440,24)
    INTEGER*4 pia(536,1440,4)
    INTEGER*4 shallowRain(536,1440)
```

```
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_BBWIDTH/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_HEIGHTSTORMTOP/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_BBWIDTHNADIR/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_HEIGHTBBNADIR/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_HEIGHTBB/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PIAFINALSUBSET/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PIAFINAL/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE
```

```
STRUCTURE /L3DPR_HS_G2_PIASRT/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PIAHYBRID/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PIAHB/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_ZETA/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_EPSILON/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_DBNW/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_DM/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE
```

```
STRUCTURE /L3DPR_HS_G2_ZFACTORMEASURED/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_ZFACTORFINALESURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_ZFACTORFINAL/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PRECIPRATEAVE24/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PRECIPICEINTEGRATED/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PRECIPWATERINTEGRATED/
```

```
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_SNOWRATENEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_RAINRATENEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PRECIPRATENEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PRECIPRATEESURFACE2/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PRECIPRATEESURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_MIXEDPHRATE/
    INTEGER*4 count(536,1440,5,3)
```

```
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_SNOWRATE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_RAINRATE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2_PRECIPRATE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G2/
    RECORD /L3DPR_HS_G2_PRECIPRATE/ precipRate
    RECORD /L3DPR_HS_G2_RAINRATE/ rainRate
    RECORD /L3DPR_HS_G2_SNOWRATE/ snowRate
    RECORD /L3DPR_HS_G2_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3DPR_HS_G2_MIXEDPHRATE/ mixedPhRate
    RECORD /L3DPR_HS_G2_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3DPR_HS_G2_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3DPR_HS_G2_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3DPR_HS_G2_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3DPR_HS_G2_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3DPR_HS_G2_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3DPR_HS_G2_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3DPR_HS_G2_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3DPR_HS_G2_PRECIPRATEAVE24/ precipRateAve24
```

```
    RECORD /L3DPR_HS_G2_ZFACTORFINAL/ zFactorFinal
    RECORD /L3DPR_HS_G2_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3DPR_HS_G2_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3DPR_HS_G2_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3DPR_HS_G2_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3DPR_HS_G2_DM/ dm
    RECORD /L3DPR_HS_G2_DBNW/ dBNw
    RECORD /L3DPR_HS_G2_EPSILON/ epsilon
    RECORD /L3DPR_HS_G2_ZETA/ zeta
    RECORD /L3DPR_HS_G2_PIAHB/ piaHB
    RECORD /L3DPR_HS_G2_PIAHYBRID/ piaHybrid
    RECORD /L3DPR_HS_G2_PIASRT/ piaSRT
    RECORD /L3DPR_HS_G2_PIAFINAL/ piaFinal
    RECORD /L3DPR_HS_G2_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3DPR_HS_G2_HEIGHTBB/ heightBB
    RECORD /L3DPR_HS_G2_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3DPR_HS_G2_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3DPR_HS_G2_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3DPR_HS_G2_BBWIDTH/ BBwidth
    RECORD /L3DPR_HS_G2_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3DPR_HS_G2_PRECIPRATELOCALTIME/ precipRateLocalTime
    REAL*4 precipRateNearSurfaceUnconditional(536,1440)
    REAL*4 precipProbabilityNearSurface(536,1440)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PRECIPRATELOCALTIME/
    INTEGER*4 count(28,72,24,3)
    REAL*4 mean(28,72,24,3)
    REAL*4 stdev(28,72,24,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_OBSERVATIONCOUNTS/
    INTEGER*4 total(28,72,3)
    INTEGER*4 localTime(28,72,24,3)
    INTEGER*4 pia(28,72,4,3)
    INTEGER*4 shallowRain(28,72,3)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_BBWIDTH/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
```

```
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_HEIGHTSTORMTOP/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_BBWIDTHNADIR/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_HEIGHTBBNADIR/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_HEIGHTBB/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PIAFINALSUBSET/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PIAFINAL/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3DPR_HS_G1_PIASRT/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PIAHYBRID/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PIAHB/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_ZETA/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_EPSILON/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_DBNW/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3DPR_HS_G1_DM/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_ZFACTORMEASURED/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_ZFACTORFINALESURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_ZFACTORFINAL/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PRECIPRATEAVE24/
```

```
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PRECIPICEINTEGRATED/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PRECIPWATERINTEGRATED/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_SNOWRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_RAINRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PRECIPRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3)
```

```
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PRECIPRATEESURFACE2/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PRECIPRATEESURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_MIXEDPHRATE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_SNOWRATE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_RAINRATE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
```

```
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1_PRECIPRATE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_HS_G1/
    RECORD /L3DPR_HS_G1_PRECIPRATE/ precipRate
    RECORD /L3DPR_HS_G1_RAINRATE/ rainRate
    RECORD /L3DPR_HS_G1_SNOWRATE/ snowRate
    RECORD /L3DPR_HS_G1_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3DPR_HS_G1_MIXEDPHRATE/ mixedPhRate
    RECORD /L3DPR_HS_G1_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3DPR_HS_G1_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3DPR_HS_G1_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3DPR_HS_G1_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3DPR_HS_G1_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3DPR_HS_G1_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3DPR_HS_G1_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3DPR_HS_G1_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3DPR_HS_G1_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3DPR_HS_G1_ZFACTORFINAL/ zFactorFinal
    RECORD /L3DPR_HS_G1_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3DPR_HS_G1_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3DPR_HS_G1_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3DPR_HS_G1_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3DPR_HS_G1_DM/ dm
    RECORD /L3DPR_HS_G1_DBNW/ dBNw
    RECORD /L3DPR_HS_G1_EPSILON/ epsilon
    RECORD /L3DPR_HS_G1_ZETA/ zeta
    RECORD /L3DPR_HS_G1_PIAHB/ piaHB
    RECORD /L3DPR_HS_G1_PIAHYBRID/ piaHybrid
    RECORD /L3DPR_HS_G1_PIASRT/ piaSRT
    RECORD /L3DPR_HS_G1_PIAFINAL/ piaFinal
    RECORD /L3DPR_HS_G1_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3DPR_HS_G1_HEIGHTBB/ heightBB
    RECORD /L3DPR_HS_G1_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3DPR_HS_G1_BBWIDTHNADIR/ BBwidthNadir
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    RECORD /L3DPR_HS_G1_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3DPR_HS_G1_BBWIDTH/ BBwidth
    RECORD /L3DPR_HS_G1_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3DPR_HS_G1_PRECIPRATELOCALTIME/ precipRateLocalTime
    REAL*4 precipRateNearSurfaceUnconditional(28,72)
    REAL*4 precipProbabilityNearSurface(28,72)
END STRUCTURE

STRUCTURE /L3DPR_HS/
    RECORD /L3DPR_HS_G1/ G1
    RECORD /L3DPR_HS_G2/ G2
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_DFRNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_DFRMNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PRECIPRATELOCALTIME/
    INTEGER*4 count(536,1440,3,24)
    REAL*4 mean(536,1440,3,24)
    REAL*4 stdev(536,1440,3,24)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_OBSERVATIONCOUNTS/
    INTEGER*4 total(536,1440,3)
    INTEGER*4 localTime(536,1440,3,24)
    INTEGER*4 pia(536,1440,3,4)
    INTEGER*4 shallowRain(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_BBWIDTH/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE
```

```
STRUCTURE /L3DPR_MS_G2_HEIGHTSTORMTOP/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_BBWIDTHNADIR/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_HEIGHTBBNADIR/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_HEIGHTBB/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PIAFINALSUBSET/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PIAFINAL/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PIASRT/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE
```

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STRUCTURE /L3DPR_MS_G2_PIAHYBRID/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PIAHB/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_ZETA/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_EPSILON/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_DBNW/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_DM/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_ZFACTORMEASURED/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_ZFACTORMEASUREDNEARSURFACE/
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```
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_ZFACTORFINALESURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_ZFACTORFINAL/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PRECIPRATEAVE24/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PRECIPICEINTEGRATED/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PRECIPWATERINTEGRATED/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
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    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_SNOWRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_RAINRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PRECIPRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PRECIPRATEESURFACE2/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PRECIPRATEESURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_MIXEDPHRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
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    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_SNOWRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_RAINRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2_PRECIPRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G2/
    RECORD /L3DPR_MS_G2_PRECIPRATE/ precipRate
    RECORD /L3DPR_MS_G2_RAINRATE/ rainRate
    RECORD /L3DPR_MS_G2_SNOWRATE/ snowRate
    RECORD /L3DPR_MS_G2_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3DPR_MS_G2_MIXEDPHRATE/ mixedPhRate
    RECORD /L3DPR_MS_G2_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3DPR_MS_G2_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3DPR_MS_G2_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3DPR_MS_G2_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3DPR_MS_G2_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3DPR_MS_G2_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3DPR_MS_G2_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3DPR_MS_G2_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3DPR_MS_G2_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3DPR_MS_G2_ZFACTORFINAL/ zFactorFinal
    RECORD /L3DPR_MS_G2_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3DPR_MS_G2_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3DPR_MS_G2_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3DPR_MS_G2_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3DPR_MS_G2_DM/ dm
    RECORD /L3DPR_MS_G2_DBNW/ dBNw
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    RECORD /L3DPR_MS_G2_EPSILON/ epsilon
    RECORD /L3DPR_MS_G2_ZETA/ zeta
    RECORD /L3DPR_MS_G2_PIAHB/ piaHB
    RECORD /L3DPR_MS_G2_PIAHYBRID/ piaHybrid
    RECORD /L3DPR_MS_G2_PIASRT/ piaSRT
    RECORD /L3DPR_MS_G2_PIAFINAL/ piaFinal
    RECORD /L3DPR_MS_G2_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3DPR_MS_G2_HEIGHTBB/ heightBB
    RECORD /L3DPR_MS_G2_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3DPR_MS_G2_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3DPR_MS_G2_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3DPR_MS_G2_BBWIDTH/ BBwidth
    RECORD /L3DPR_MS_G2_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3DPR_MS_G2_PRECIPRATELOCALTIME/ precipRateLocalTime
    RECORD /L3DPR_MS_G2_DFRMNEARSURFACE/ DFRmNearSurface
    RECORD /L3DPR_MS_G2_DFRNEARSURFACE/ DFRNearSurface
    REAL*4 precipRateNearSurfaceUnconditional(536,1440,3)
    REAL*4 precipProbabilityNearSurface(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_DFRNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_DFRMNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PRECIPRATELOCALTIME/
    INTEGER*4 count(28,72,3,24,3)
    REAL*4 mean(28,72,3,24,3)
    REAL*4 stdev(28,72,3,24,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_OBSERVATIONCOUNTS/
    INTEGER*4 total(28,72,3,3)
    INTEGER*4 localTime(28,72,3,24,3)
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    INTEGER*4 pia(28,72,3,4,3)
    INTEGER*4 shallowRain(28,72,3,3)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_BBWIDTH/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_HEIGHTSTORMTOP/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_BBWIDTHNADIR/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_HEIGHTBBNADIR/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_HEIGHTBB/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PIAFINALSUBSET/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
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    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PIAFINAL/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PIASRT/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PIAHYBRID/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PIAHB/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_ZETA/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_EPSILON/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
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```
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_DBNW/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_DM/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_ZFACTORMEASURED/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_ZFACTORFINALESURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE
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STRUCTURE /L3DPR_MS_G1_ZFACTORFINAL/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PRECIPRATEAVE24/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PRECIPICEINTEGRATED/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PRECIPWATERINTEGRATED/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_SNOWRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3DPR_MS_G1_RAINRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PRECIPRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PRECIPRATEESURFACE2/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PRECIPRATEESURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_MIXEDPHRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_SNOWRATE/
```

```
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_RAINRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1_PRECIPRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_MS_G1/
    RECORD /L3DPR_MS_G1_PRECIPRATE/ precipRate
    RECORD /L3DPR_MS_G1_RAINRATE/ rainRate
    RECORD /L3DPR_MS_G1_SNOWRATE/ snowRate
    RECORD /L3DPR_MS_G1_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3DPR_MS_G1_MIXEDPHRATE/ mixedPhRate
    RECORD /L3DPR_MS_G1_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3DPR_MS_G1_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3DPR_MS_G1_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3DPR_MS_G1_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3DPR_MS_G1_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3DPR_MS_G1_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3DPR_MS_G1_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3DPR_MS_G1_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3DPR_MS_G1_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3DPR_MS_G1_ZFACTORFINAL/ zFactorFinal
    RECORD /L3DPR_MS_G1_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3DPR_MS_G1_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3DPR_MS_G1_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3DPR_MS_G1_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3DPR_MS_G1_DM/ dm
    RECORD /L3DPR_MS_G1_DBNW/ dBNw
    RECORD /L3DPR_MS_G1_EPSILON/ epsilon
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    RECORD /L3DPR_MS_G1_ZETA/ zeta
    RECORD /L3DPR_MS_G1_PIAHB/ piaHB
    RECORD /L3DPR_MS_G1_PIAHYBRID/ piaHybrid
    RECORD /L3DPR_MS_G1_PIASRT/ piaSRT
    RECORD /L3DPR_MS_G1_PIAFINAL/ piaFinal
    RECORD /L3DPR_MS_G1_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3DPR_MS_G1_HEIGHTBB/ heightBB
    RECORD /L3DPR_MS_G1_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3DPR_MS_G1_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3DPR_MS_G1_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3DPR_MS_G1_BBWIDTH/ BBwidth
    RECORD /L3DPR_MS_G1_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3DPR_MS_G1_PRECIPRATELOCALTIME/ precipRateLocalTime
    RECORD /L3DPR_MS_G1_DFRMNEARSURFACE/ DFRmNearSurface
    RECORD /L3DPR_MS_G1_DFRNEARSURFACE/ DFRNearSurface
    REAL*4 precipRateNearSurfaceUnconditional(28,72,3)
    REAL*4 precipProbabilityNearSurface(28,72,3)
END STRUCTURE

STRUCTURE /L3DPR_MS/
    RECORD /L3DPR_MS_G1/ G1
    RECORD /L3DPR_MS_G2/ G2
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_DFRNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_DFRMNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PRECIPRATELOCALTIME/
    INTEGER*4 count(536,1440,3,24)
    REAL*4 mean(536,1440,3,24)
    REAL*4 stdev(536,1440,3,24)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_OBSERVATIONCOUNTS/
```

```
    INTEGER*4 total(536,1440,3)
    INTEGER*4 localTime(536,1440,3,24)
    INTEGER*4 pia(536,1440,3,7)
    INTEGER*4 shallowRain(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_BBWIDTH/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_HEIGHTSTORMTOP/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_BBWIDTHNADIR/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_HEIGHTBBNADIR/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_HEIGHTBB/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PIAFINALSUBSET/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PIAFINAL/
```

```
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PIASRT/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PIAHYBRID/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PIAHB/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_ZETA/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_EPSILON/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_DBNW/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_DM/
    INTEGER*4 count(536,1440,3,5,3)
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```
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_ZFACTORMEASURED/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_ZFACTORFINALESURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_ZFACTORFINAL/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PRECIPRATEAVE24/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PRECIPICEINTEGRATED/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
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    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PRECIPWATERINTEGRATED/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_SNOWRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_RAINRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PRECIPRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PRECIPRATEESURFACE2/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PRECIPRATEESURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
```

```
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_MIXEDPHRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_SNOWRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_RAINRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2_PRECIPRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G2/
    RECORD /L3DPR_FS_G2_PRECIPRATE/ precipRate
    RECORD /L3DPR_FS_G2_RAINRATE/ rainRate
    RECORD /L3DPR_FS_G2_SNOWRATE/ snowRate
    RECORD /L3DPR_FS_G2_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3DPR_FS_G2_MIXEDPHRATE/ mixedPhRate
    RECORD /L3DPR_FS_G2_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3DPR_FS_G2_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3DPR_FS_G2_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3DPR_FS_G2_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3DPR_FS_G2_SNOWRATENEARSURFACE/ snowRateNearSurface
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    RECORD /L3DPR_FS_G2_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3DPR_FS_G2_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3DPR_FS_G2_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3DPR_FS_G2_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3DPR_FS_G2_ZFACTORFINAL/ zFactorFinal
    RECORD /L3DPR_FS_G2_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3DPR_FS_G2_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3DPR_FS_G2_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3DPR_FS_G2_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3DPR_FS_G2_DM/ dm
    RECORD /L3DPR_FS_G2_DBNW/ dBNw
    RECORD /L3DPR_FS_G2_EPSILON/ epsilon
    RECORD /L3DPR_FS_G2_ZETA/ zeta
    RECORD /L3DPR_FS_G2_PIAHB/ piaHB
    RECORD /L3DPR_FS_G2_PIAHYBRID/ piaHybrid
    RECORD /L3DPR_FS_G2_PIASRT/ piaSRT
    RECORD /L3DPR_FS_G2_PIAFINAL/ piaFinal
    RECORD /L3DPR_FS_G2_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3DPR_FS_G2_HEIGHTBB/ heightBB
    RECORD /L3DPR_FS_G2_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3DPR_FS_G2_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3DPR_FS_G2_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3DPR_FS_G2_BBWIDTH/ BBwidth
    RECORD /L3DPR_FS_G2_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3DPR_FS_G2_PRECIPRATELOCALTIME/ precipRateLocalTime
    RECORD /L3DPR_FS_G2_DFRMNEARSURFACE/ DFRmNearSurface
    RECORD /L3DPR_FS_G2_DFRNEARSURFACE/ DFRNearSurface
    REAL*4 precipRateNearSurfaceUnconditional(536,1440,3)
    REAL*4 precipProbabilityNearSurface(536,1440,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_DFRNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_DFRMNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
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```
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PRECIPRATELOCALTIME/
    INTEGER*4 count(28,72,3,24,3)
    REAL*4 mean(28,72,3,24,3)
    REAL*4 stdev(28,72,3,24,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_OBSERVATIONCOUNTS/
    INTEGER*4 total(28,72,3,3)
    INTEGER*4 localTime(28,72,3,24,3)
    INTEGER*4 pia(28,72,3,7,3)
    INTEGER*4 shallowRain(28,72,3,3)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_BBWIDTH/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_HEIGHTSTORMTOP/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_BBWIDTHNADIR/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_HEIGHTBBNADIR/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE
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```
STRUCTURE /L3DPR_FS_G1_HEIGHTBB/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PIAFINALSUBSET/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PIAFINAL/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PIASRT/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PIAHYBRID/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PIAHB/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_ZETA/
```

```
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_EPSILON/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_DBNW/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_DM/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_ZFACTORMEASURED/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(28,72,4,3,3)
```

```
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_ZFACTORFINALESURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_ZFACTORFINAL/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PRECIPRATEAVE24/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PRECIPICEINTEGRATED/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PRECIPWATERINTEGRATED/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
```

```
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_SNOWRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_RAINRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PRECIPRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PRECIPRATEESURFACE2/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PRECIPRATEESURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_MIXEDPHRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
```

```
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_SNOWRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_RAINRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1_PRECIPRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3DPR_FS_G1/
    RECORD /L3DPR_FS_G1_PRECIPRATE/ precipRate
    RECORD /L3DPR_FS_G1_RAINRATE/ rainRate
    RECORD /L3DPR_FS_G1_SNOWRATE/ snowRate
    RECORD /L3DPR_FS_G1_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3DPR_FS_G1_MIXEDPHRATE/ mixedPhRate
    RECORD /L3DPR_FS_G1_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3DPR_FS_G1_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3DPR_FS_G1_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3DPR_FS_G1_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3DPR_FS_G1_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3DPR_FS_G1_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
```

```
    RECORD /L3DPR_FS_G1_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3DPR_FS_G1_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3DPR_FS_G1_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3DPR_FS_G1_ZFACTORFINAL/ zFactorFinal
    RECORD /L3DPR_FS_G1_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3DPR_FS_G1_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3DPR_FS_G1_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3DPR_FS_G1_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3DPR_FS_G1_DM/ dm
    RECORD /L3DPR_FS_G1_DBNW/ dBNw
    RECORD /L3DPR_FS_G1_EPSILON/ epsilon
    RECORD /L3DPR_FS_G1_ZETA/ zeta
    RECORD /L3DPR_FS_G1_PIAHB/ piaHB
    RECORD /L3DPR_FS_G1_PIAHYBRID/ piaHybrid
    RECORD /L3DPR_FS_G1_PIASRT/ piaSRT
    RECORD /L3DPR_FS_G1_PIAFINAL/ piaFinal
    RECORD /L3DPR_FS_G1_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3DPR_FS_G1_HEIGHTBB/ heightBB
    RECORD /L3DPR_FS_G1_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3DPR_FS_G1_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3DPR_FS_G1_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3DPR_FS_G1_BBWIDTH/ BBwidth
    RECORD /L3DPR_FS_G1_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3DPR_FS_G1_PRECIPRATELOCALTIME/ precipRateLocalTime
    RECORD /L3DPR_FS_G1_DFRMNEARSURFACE/ DFRmNearSurface
    RECORD /L3DPR_FS_G1_DFRNEARSURFACE/ DFRNearSurface
    REAL*4 precipRateNearSurfaceUnconditional(28,72,3)
    REAL*4 precipProbabilityNearSurface(28,72,3)
END STRUCTURE

STRUCTURE /L3DPR_FS/
    RECORD /L3DPR_FS_G1/ G1
    RECORD /L3DPR_FS_G2/ G2
END STRUCTURE
```

5.51 3PR - PR Full Product

3PR, "PR Full Product", computes statistics of the PR measurements at both a low horizontal resolution (G1, 5^o x 5^o latitude/longitude) and a high horizontal resolution (G2, 0.25^o x 0.25^o latitude/longitude). The product can be monthly or daily. The arrays in the format are the same as the arrays in the 3DPR format. Only KuFS and KuMS information is present in the arrays. Other channels are filled with the missing value.

```
Histograms have the following category thresholds, where
histbin(i) =  cat(i) less than x less than or equal to cat(i+1)
cat rain = [ 0.01,    ! mm/h  (logarithmic steps)
        0.10,   0.13,   0.17,   0.23,   0.30,   0.40,
        0.52,   0.69,   0.91,   1.20,   1.58,   2.08,
        2.75,   3.62,   4.77,   6.29,   8.29,  10.92,
       14.40,  18.97,  25.00,  32.95,  43.43,  57.24,
       75.44,  99.43, 131.04, 172.71, 227.63, 300.00 ],

cat Z = [ 0.01,       ! dBZ
       6.0,    8.0,   10.0,   12.0,   14.0,   16.0,
       18.0,   20.0,   22.0,   24.0,   26.0,   28.0,
       30.0,   32.0,   34.0,   36.0,   38.0,   40.0,
       42.0,   44.0,   46.0,   48.0,   50.0,   52.0,
       54.0,   56.0,   58.0,   60.0,   62.0,   64.0 ],

cat integratedWater = [ 0.0,      ! kg/m^2
     200.0,  400.0,  600.0,  800.0, 1000.0, 1200.0,
     1400.0, 1600.0, 1800.0, 2000.0, 2200.0, 2400.0,
     2600.0, 2800.0, 3000.0, 3200.0, 3400.0, 3600.0,
     3800.0, 4000.0, 4200.0, 4400.0, 4600.0, 4800.0,
     5000.0, 5200.0, 5400.0, 5600.0, 5800.0, 6000.0 ],

cat bbhgt = [ 10.0,    ! meters
     250.0,  500.0,  750.0, 1000.0, 1250.0, 1500.0,
     1750.0, 2000.0, 2250.0, 2500.0, 2750.0, 3000.0,
     3250.0, 3500.0, 3750.0, 4000.0, 4250.0, 4500.0,
     4750.0, 5000.0, 5250.0, 5500.0, 5750.0, 6000.0,
     6250.0, 6500.0, 6750.0, 7000.0, 7500.0,20000.0 ],

cat bbwdth = [ 0.0,    ! meters
      125.0,  250.0,  375.0,  500.0,  625.0,  750.0,
      875.0, 1000.0, 1125.0, 1250.0, 1375.0, 1500.0,
     1625.0, 1750.0, 1875.0, 2000.0, 2125.0, 2250.0,
     2375.0, 2500.0, 2625.0, 2750.0, 2875.0, 3000.0,
     3125.0, 3250.0, 3375.0, 3500.0, 3625.0, 3750.0 ],

cat stormh = 1000.0*[ 0.01,   ! km  (convert m > km)
        0.5,    1.0,    1.5,    2.0,    2.5,    3.0,
        3.5,    4.0,    4.5,    5.0,    5.5,    6.0,
        6.5,    7.0,    7.5,    8.0,    8.5,    9.0,
        9.5,   10.0,   10.5,   11.0,   11.5,   12.0,
```

```
        12.5,   13.0,   14.0,   15.0,   16.0,   20.0 ],

 cat epsilon = [ 0.0,
         0.1,    0.2,    0.3,    0.4,    0.5,    0.6,
         0.7,    0.8,    0.9,    1.0,    1.1,    1.2,
         1.3,    1.4,    1.5,    1.6,    1.7,    1.8,
         1.9,    2.0,    2.1,    2.2,    2.3,    2.4,
         2.5,    2.6,    2.7,    2.8,    2.9,    3.0 ],

 cat nubf = [ 1.0,
         1.05,   1.1,    1.15,   1.2,    1.25,   1.3,
         1.35,   1.4,    1.45,   1.5,    1.55,   1.6,
         1.65,   1.7,    1.75,   1.8,    1.85,   1.9,
         1.95,   2.0,    2.1,    2.2,    2.3,    2.4,
         2.5,    2.6,    2.7,    2.8,    2.9,    3.0 ],

 cat pia = [ 0.01,
         0.1,    0.2,    0.3,    0.4,    0.5,    0.6,
         0.8,    1.0,    1.2,    1.4,    1.6,    1.8,
         2.0,    2.5,    3.0,    3.5,    4.0,    4.5,
         5.0,    5.5,    6.0,    7.0,    8.0,    9.0,
        10.0,   15.0,   20.0,   25.0,   30.0,  100.0 ],

 cat dBNw = [ 0.1,
        1.0,    2.0,    4.0,    6.0,    8.0,   10.0,
        12.0,   14.0,   16.0,   18.0,   20.0,   22.0,
        24.0,   26.0,   28.0,   30.0,   32.0,   34.0,
        36.0,   38.0,   40.0,   42.0,   44.0,   46.0,
        48.0,   50.0,   52.0,   54.0,   56.0,   60.0 ],

 cat Dm = [ 0.1,        ! mm
         0.2,    0.3,    0.4,    0.5,    0.6,    0.7,
         0.8,    0.9,    1.0,    1.1,    1.2,    1.3,
         1.4,    1.5,    1.6,    1.7,    1.8,    1.9,
         2.0,    2.1,    2.2,    2.3,    2.4,    2.5,
         2.6,    2.7,    2.8,    2.9,    3.0,    4.0 ]
```

Dimension definitions:

ltL	28	Number of low resolution 5^o grid intervals of latitude from 70^oS to 70^oN.
lnL	72	Number of low resolution 5^o grid intervals of longitude from 180^oW to 180^oE.
ltH	536	Number of high resolution 0.25^o grid intervals of latitude from 67^oS to 67^oN.
lnH	1440	Number of high resolution 0.25^o grid intervals of longitude from 180^oW to 180^oE.
chn3	3	Number of channels. For FS: KuFS(49), KaFS(49), DPRFS(49) For MS: KuMS(25), KaMS(25), DPRMS(25)
chn4	4	Number of channels. For FS: KuFS(49), KaFS(49), DPRKuFS(49), DPRKaFS(49) For MS: KuMS(25), KaMS(25), DPRKuMS(49), DPRKaMS(49)
hgt	5	Number of heights above the earth ellipsoid: 2, 4, 6, 10, and 15 km.
tim	24	Number of hours (local time).
ang7	7	Number of angles. Indeces are used with the meaning 0, 1, 2,...,6 = angle bins 24, (20,28), (16,32), (12,36), (8,40), (4,44), and (0,48).
ang4	4	Number of angles. Indeces are used with the meaning 0, 1, 2, 3 = angle bins 24, (20,28), (16,32), (12,36).
rt	3	Number of rain types: stratiform, convective, all.
st	3	Number of surface types: ocean, land, all.
bin	30	Number of bins in histogram. The thresholds are different for different variables. See the introduction to this algorithm.

Figure 825 through Figure 1055 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

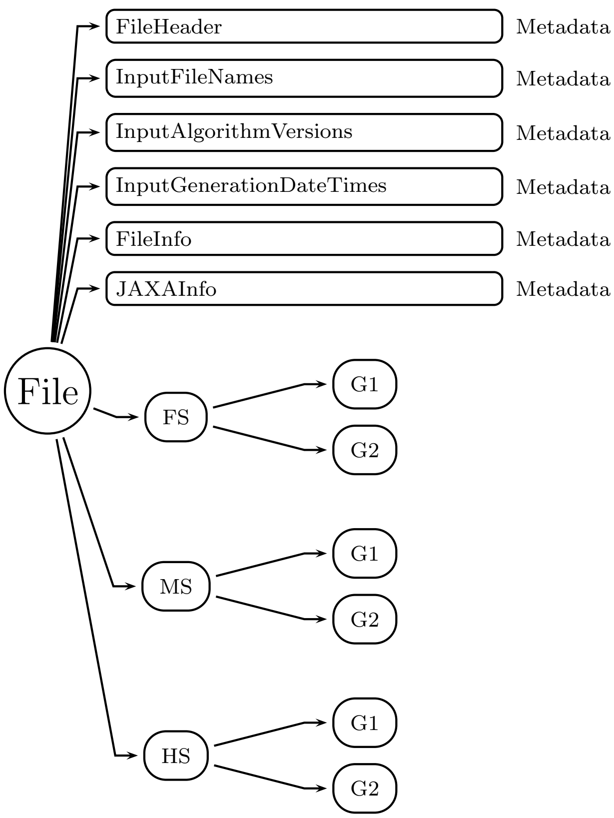
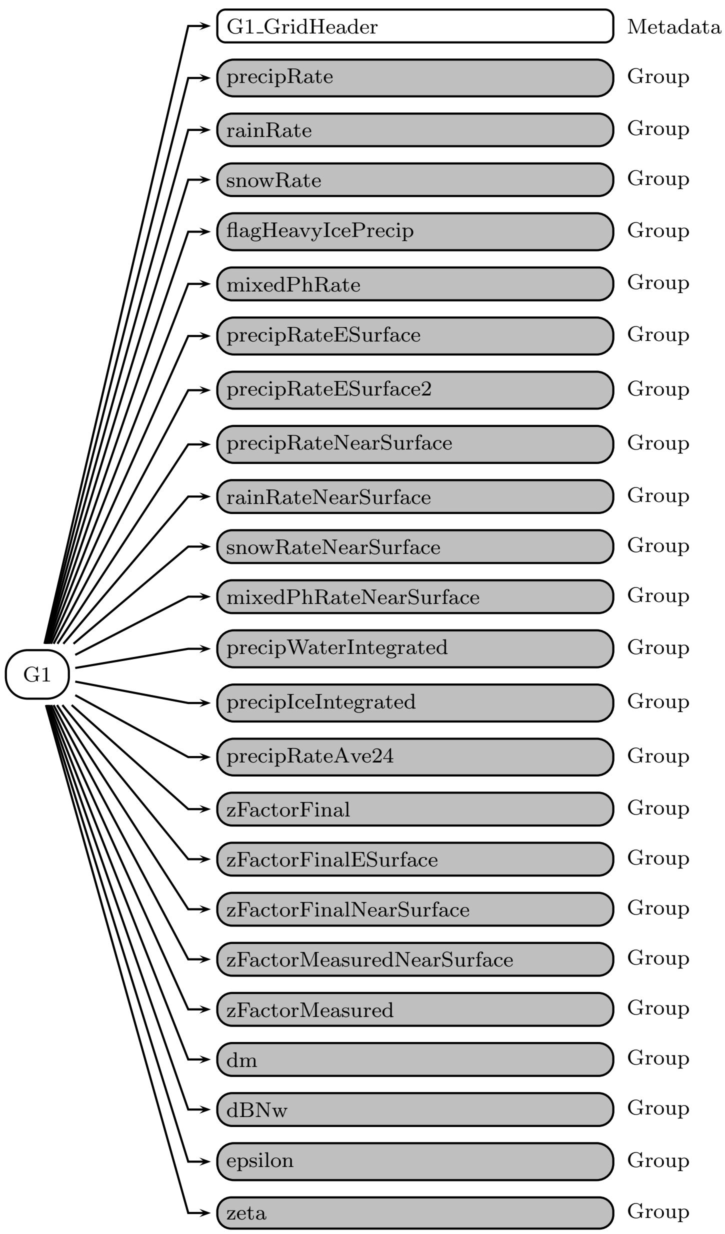


Figure 825: Data Format Structure for 3PR, , PR Full Product



continued on next figure

Figure 826: Data Format Structure for 3PR, FS, G1,

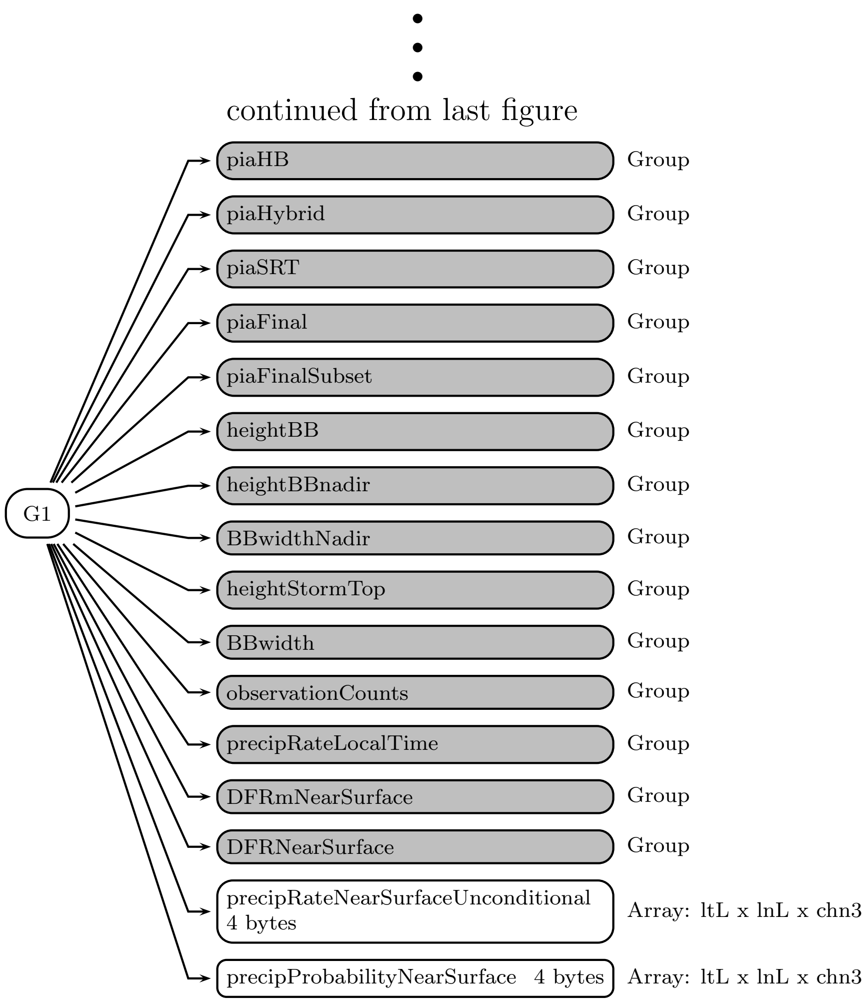
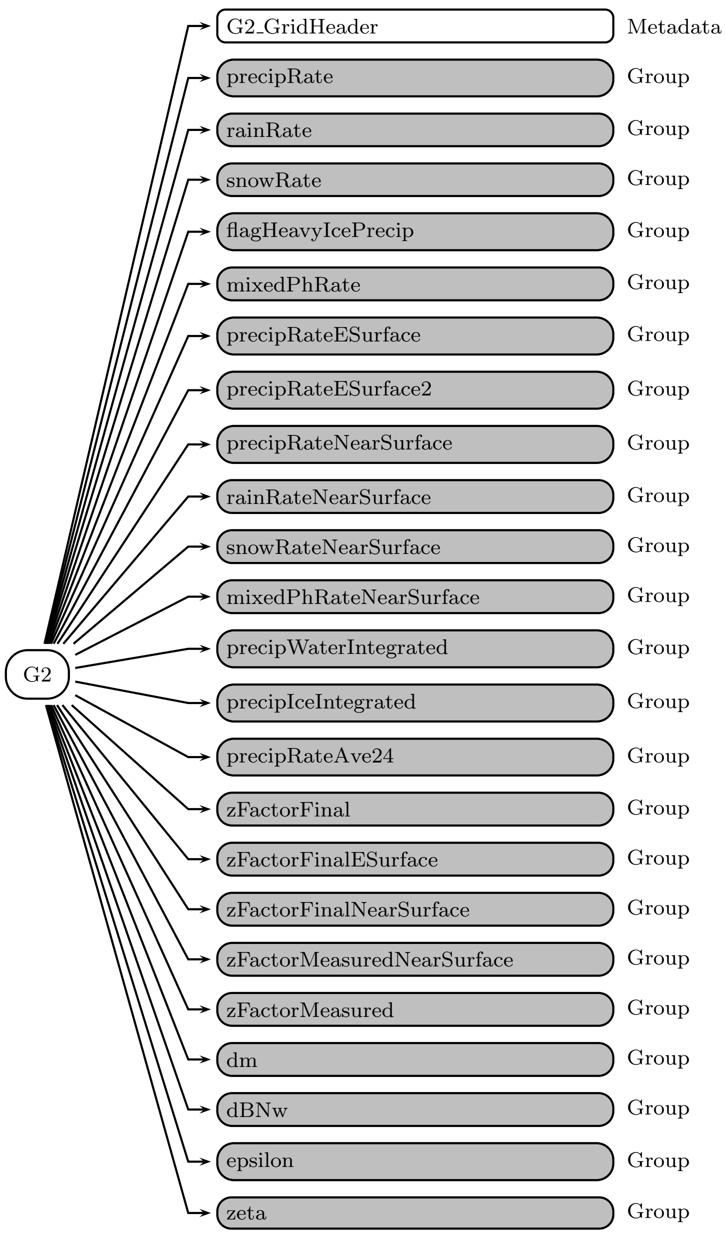


Figure 827: Data Format Structure for 3PR, FS, G1



continued on next figure

Figure 828: Data Format Structure for 3PR, FS, G2,

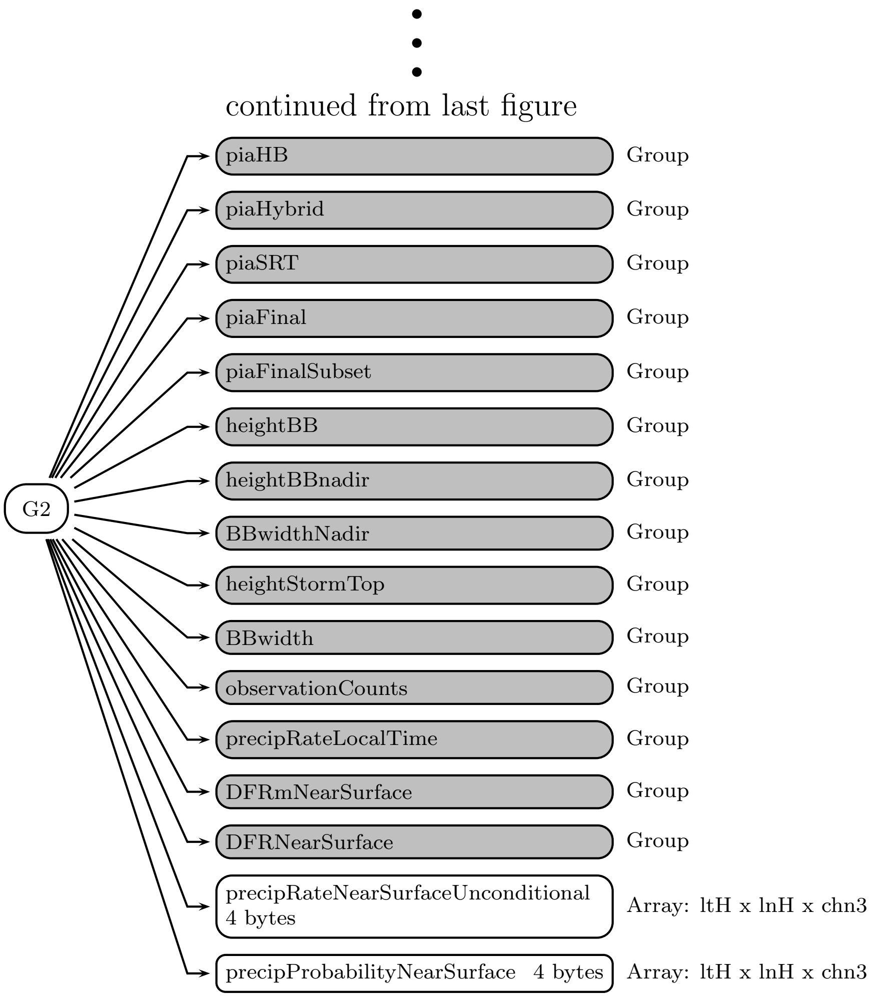


Figure 829: Data Format Structure for 3PR, FS, G2

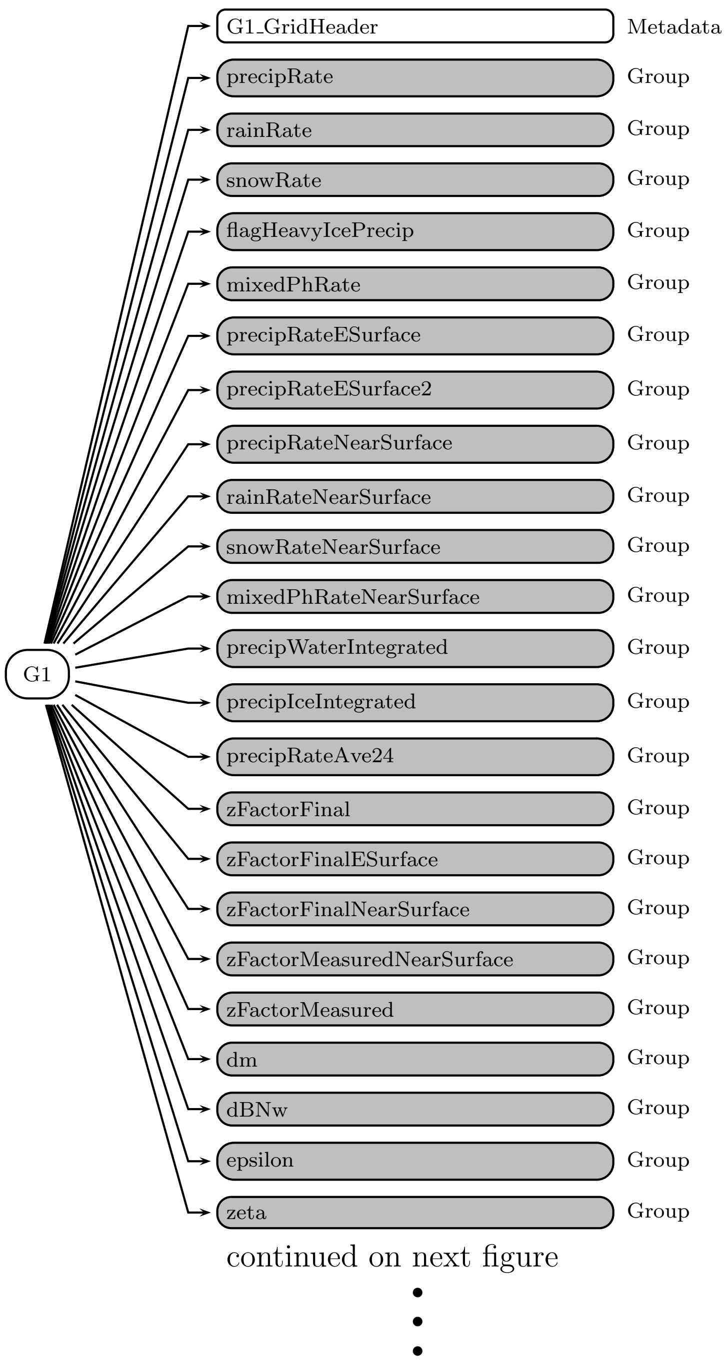


Figure 830: Data Format Structure for 3PR, MS, G1,

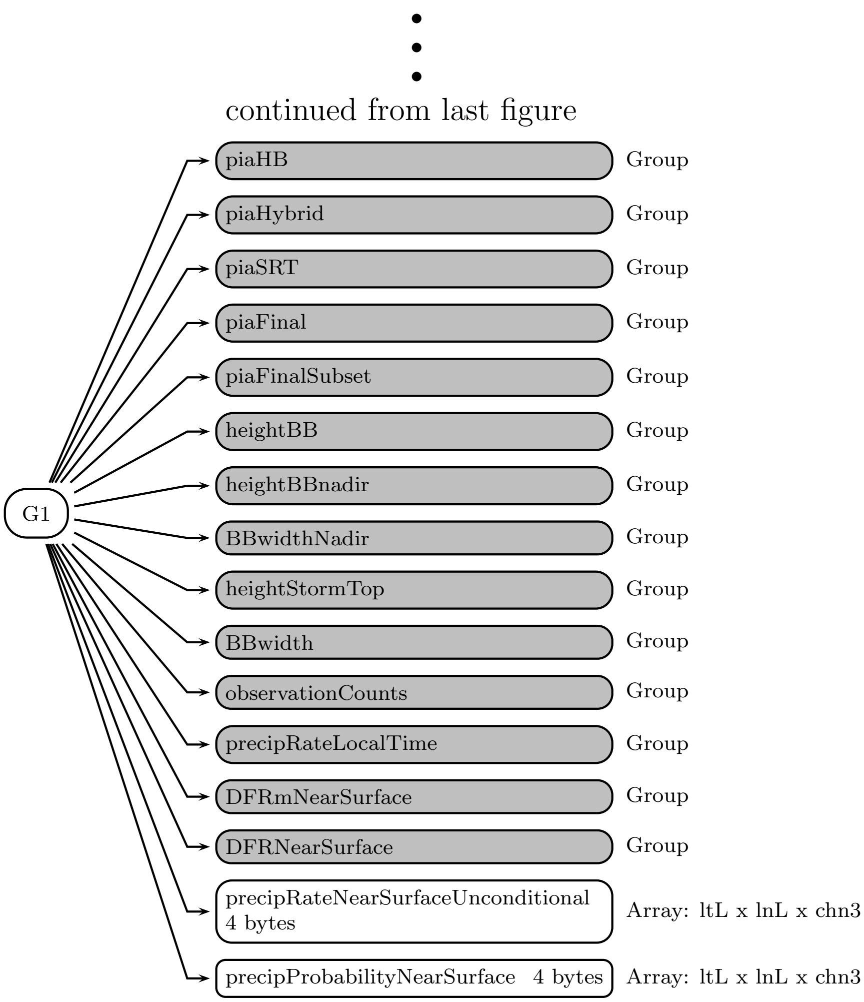
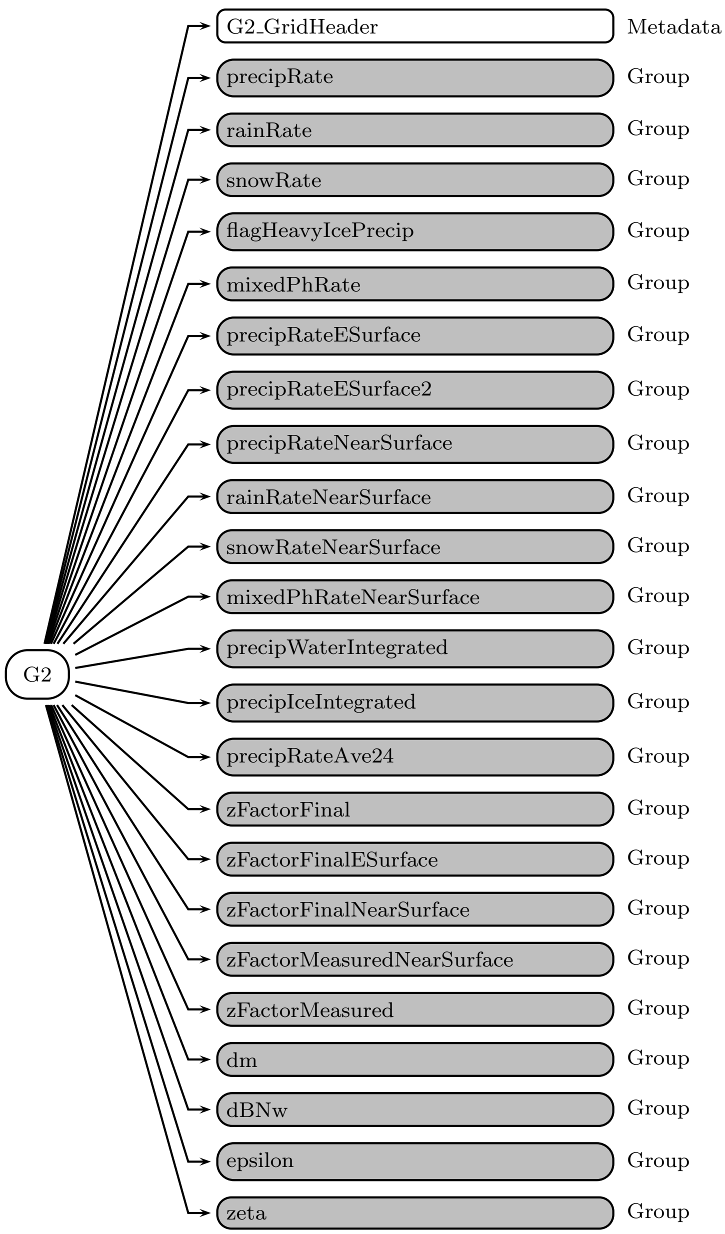


Figure 831: Data Format Structure for 3PR, MS, G1



continued on next figure

Figure 832: Data Format Structure for 3PR, MS, G2,

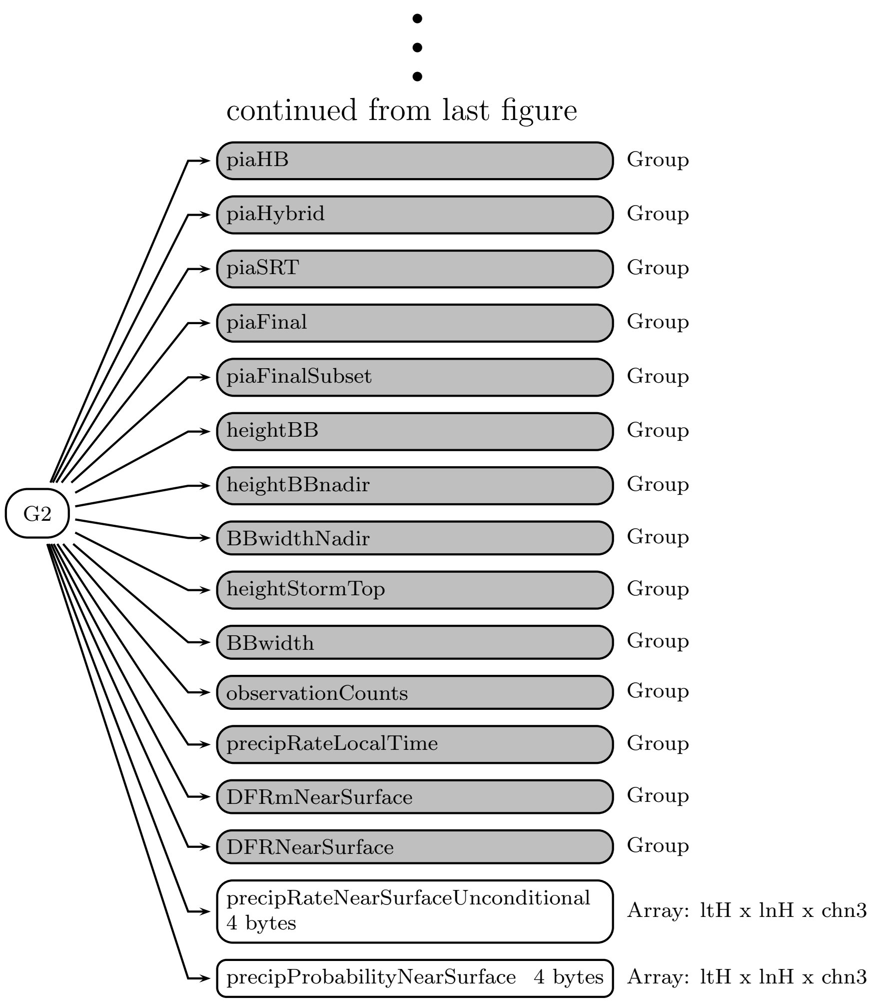


Figure 833: Data Format Structure for 3PR, MS, G2

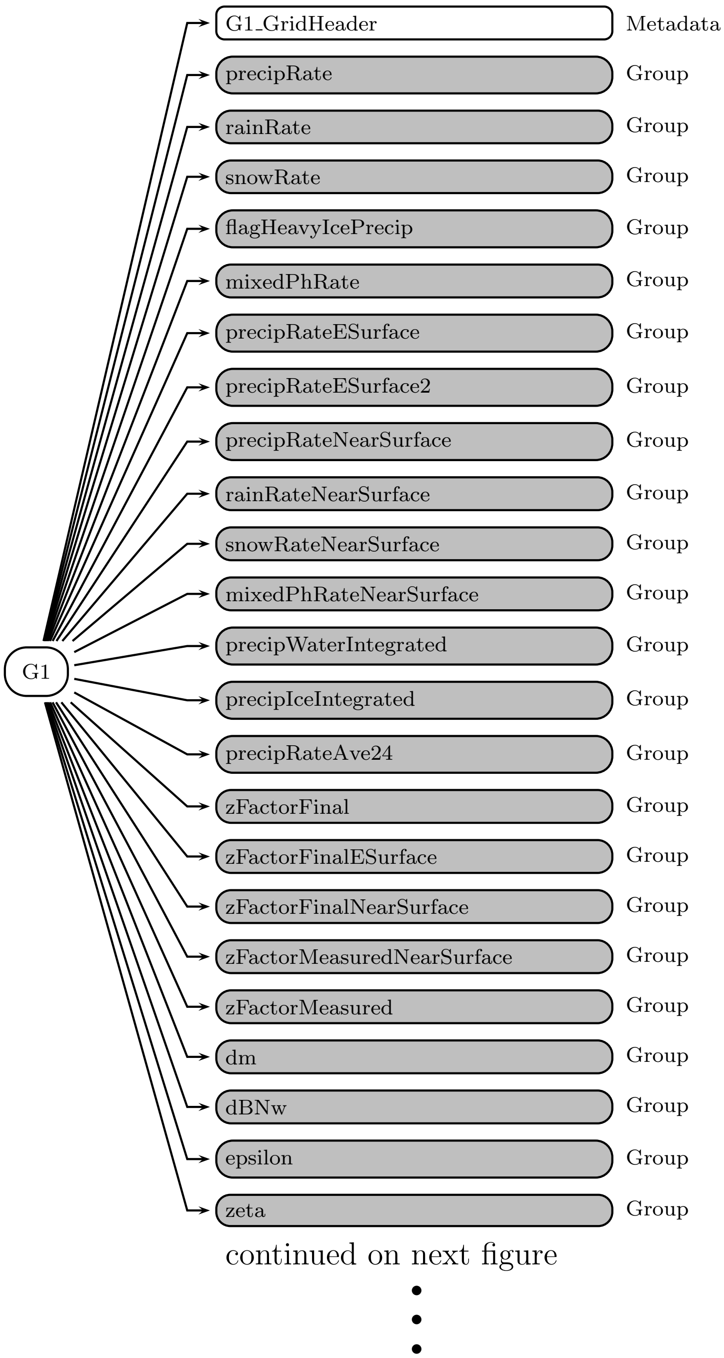


Figure 834: Data Format Structure for 3PR, HS, G1,

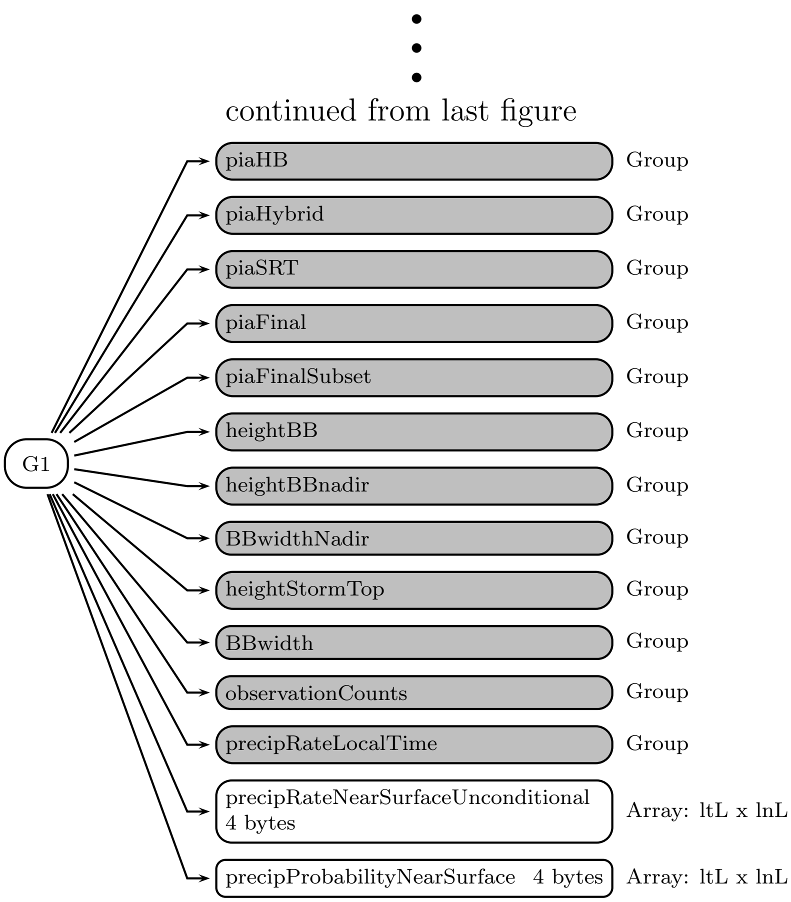
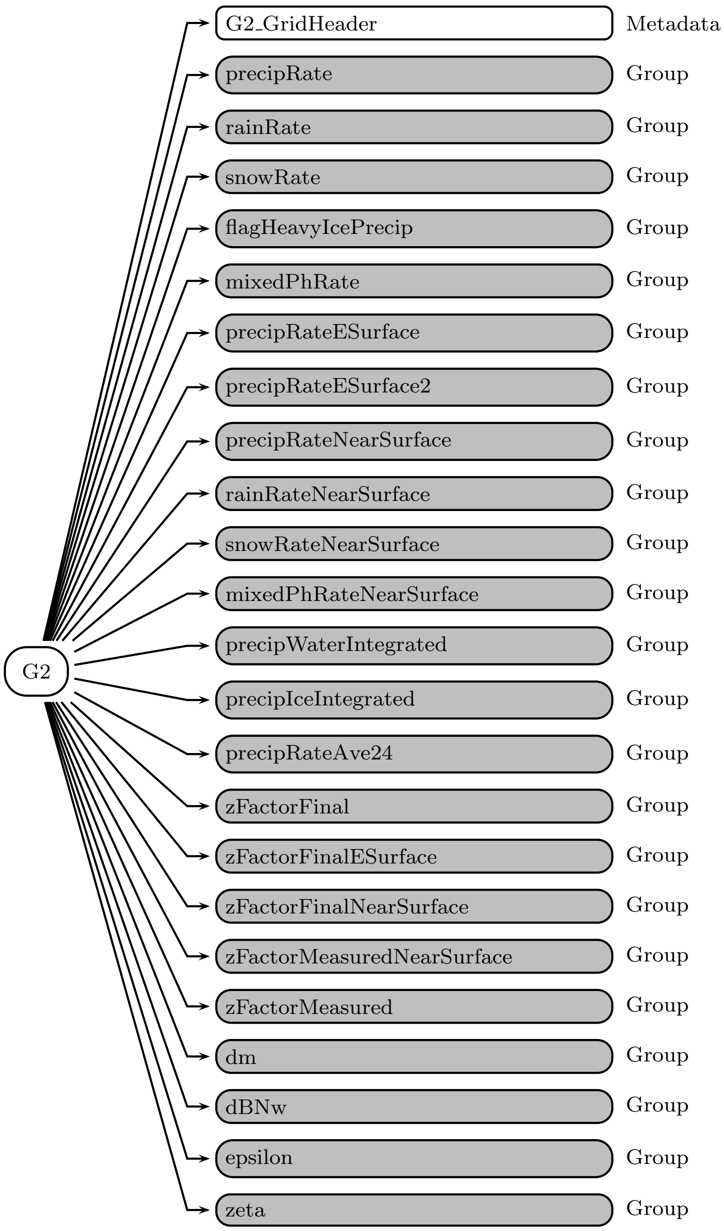


Figure 835: Data Format Structure for 3PR, HS, G1



continued on next figure

Figure 836: Data Format Structure for 3PR, HS, G2,

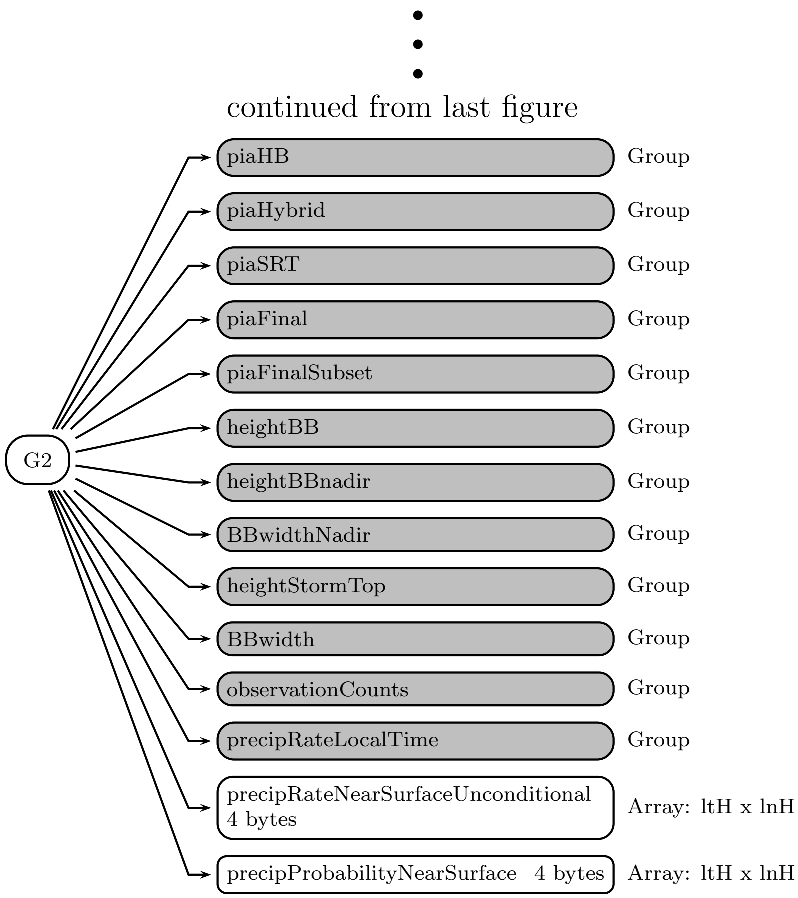


Figure 837: Data Format Structure for 3PR, HS, G2

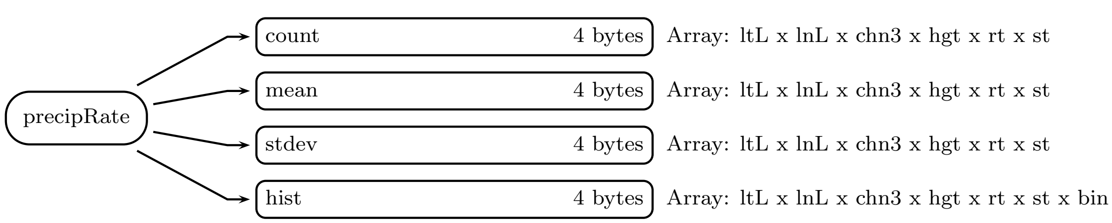


Figure 838: Data Format Structure for 3PR, FS, G1, precipRate

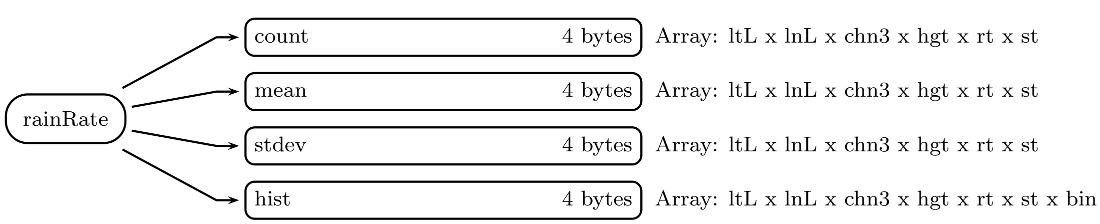


Figure 839: Data Format Structure for 3PR, FS, G1, rainRate

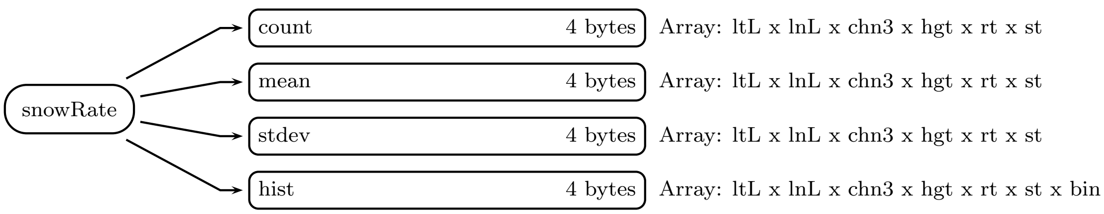


Figure 840: Data Format Structure for 3PR, FS, G1, snowRate

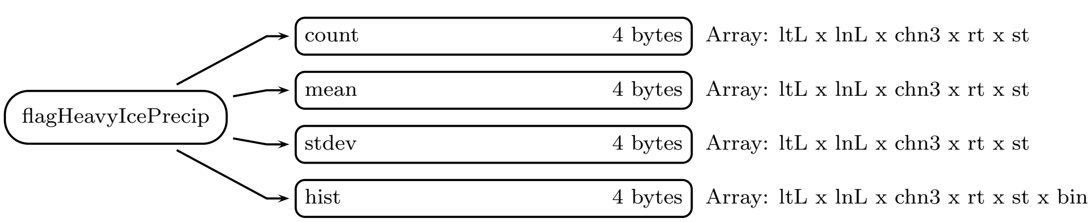


Figure 841: Data Format Structure for 3PR, FS, G1, flagHeavyIcePrecip

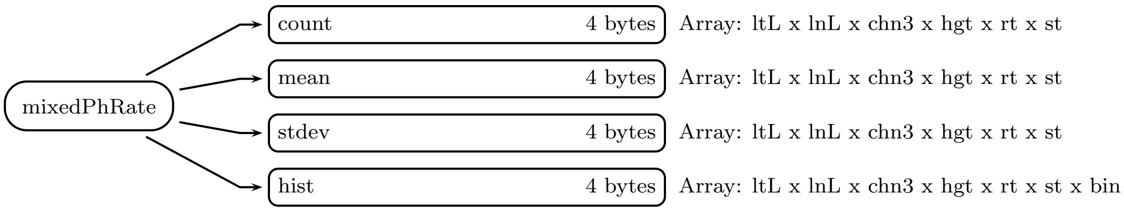


Figure 842: Data Format Structure for 3PR, FS, G1, mixedPhRate

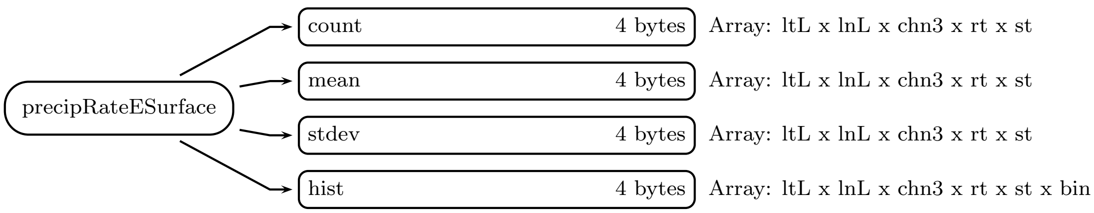


Figure 843: Data Format Structure for 3PR, FS, G1, precipRateESurface

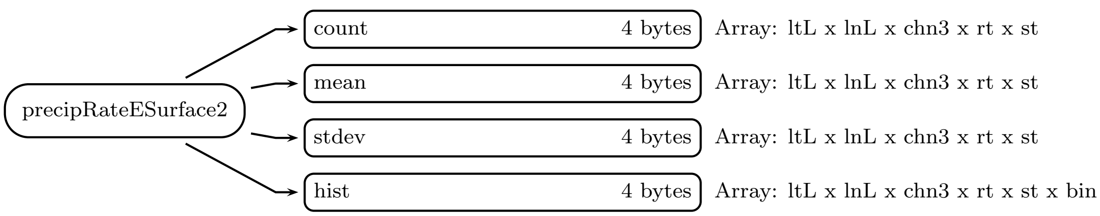


Figure 844: Data Format Structure for 3PR, FS, G1, precipRateESurface2

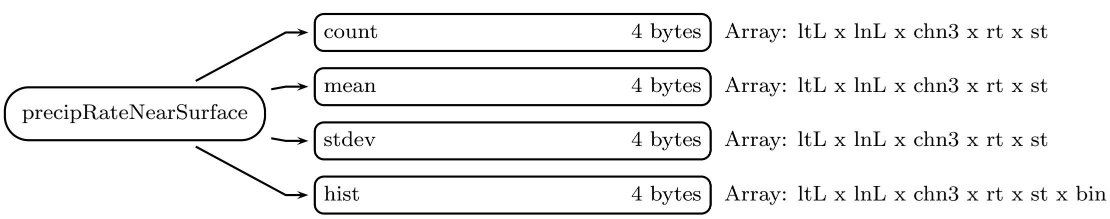


Figure 845: Data Format Structure for 3PR, FS, G1, precipRateNearSurface

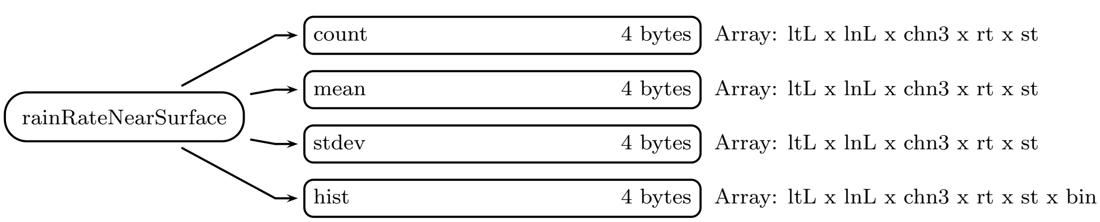


Figure 846: Data Format Structure for 3PR, FS, G1, rainRateNearSurface

snowRateNearSurface		
count	4 bytes	Array: ltL x lnL x chn3 x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 847: Data Format Structure for 3PR, FS, G1, snowRateNearSurface

mixedPhRateNearSurface		
count	4 bytes	Array: ltL x lnL x chn3 x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 848: Data Format Structure for 3PR, FS, G1, mixedPhRateNearSurface

precipWaterIntegrated		
count	4 bytes	Array: ltL x lnL x chn3 x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 849: Data Format Structure for 3PR, FS, G1, precipWaterIntegrated

precipIceIntegrated		
count	4 bytes	Array: ltL x lnL x chn3 x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 850: Data Format Structure for 3PR, FS, G1, precipIceIntegrated

precipRateAve24		
count	4 bytes	Array: ltL x lnL x chn3 x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 851: Data Format Structure for 3PR, FS, G1, precipRateAve24

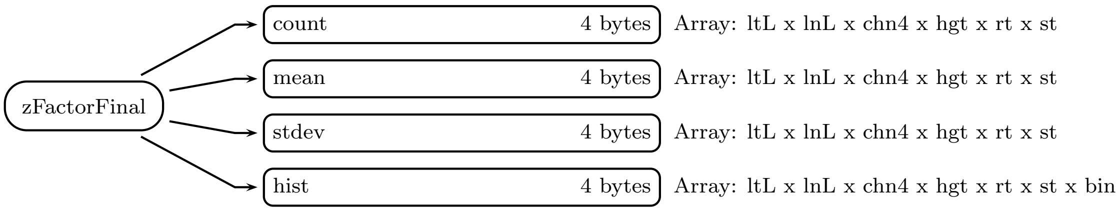


Figure 852: Data Format Structure for 3PR, FS, G1, zFactorFinal

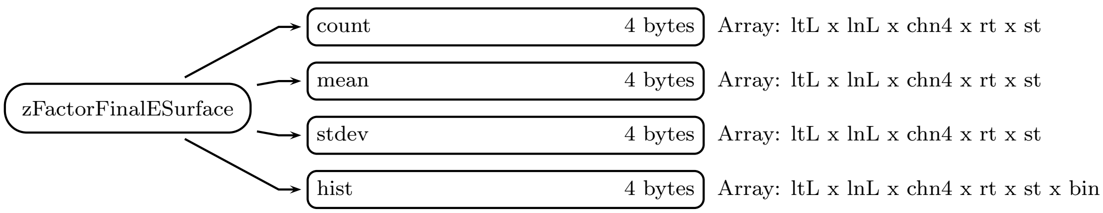


Figure 853: Data Format Structure for 3PR, FS, G1, zFactorFinalESurface

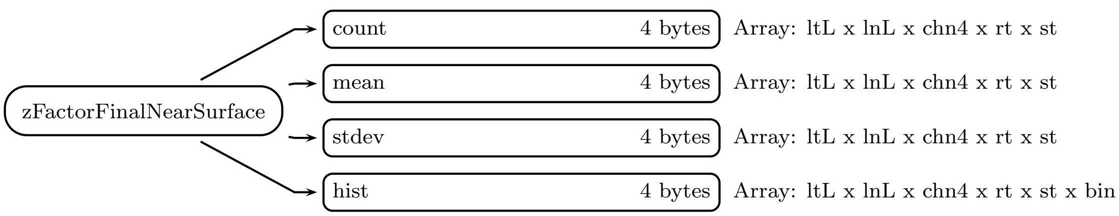


Figure 854: Data Format Structure for 3PR, FS, G1, zFactorFinalNearSurface

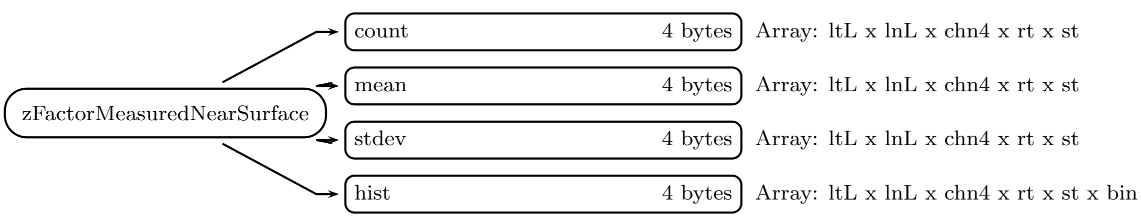


Figure 855: Data Format Structure for 3PR, FS, G1, zFactorMeasuredNearSurface

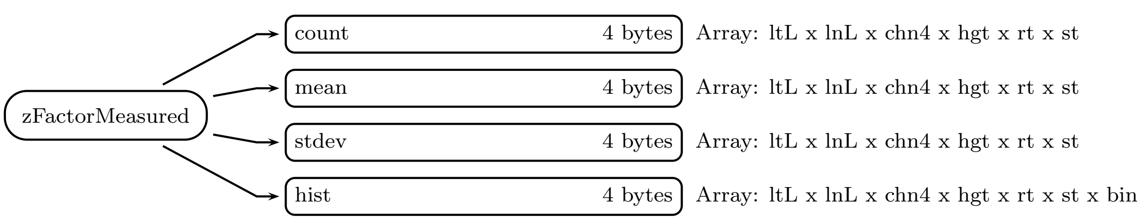


Figure 856: Data Format Structure for 3PR, FS, G1, zFactorMeasured

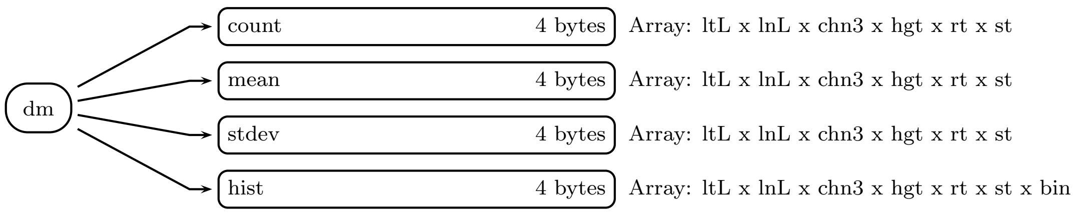


Figure 857: Data Format Structure for 3PR, FS, G1, dm

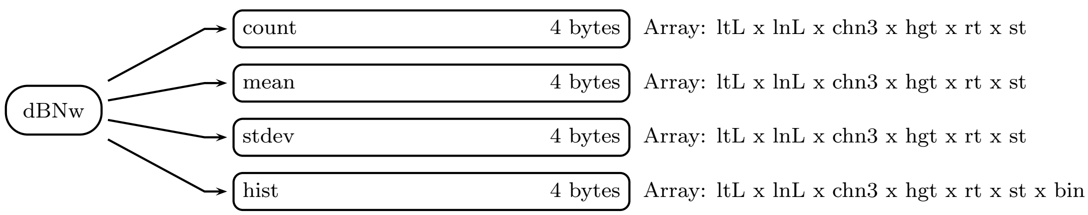


Figure 858: Data Format Structure for 3PR, FS, G1, dBNw

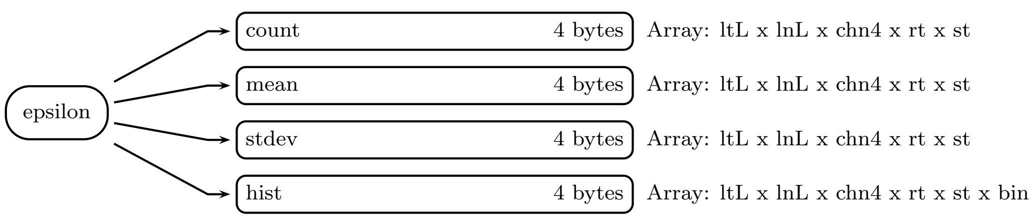


Figure 859: Data Format Structure for 3PR, FS, G1, epsilon

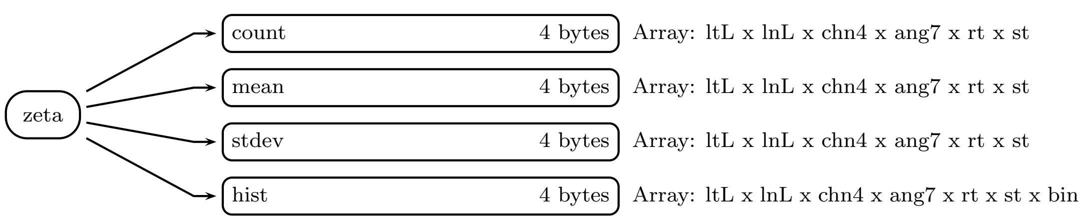


Figure 860: Data Format Structure for 3PR, FS, G1, zeta

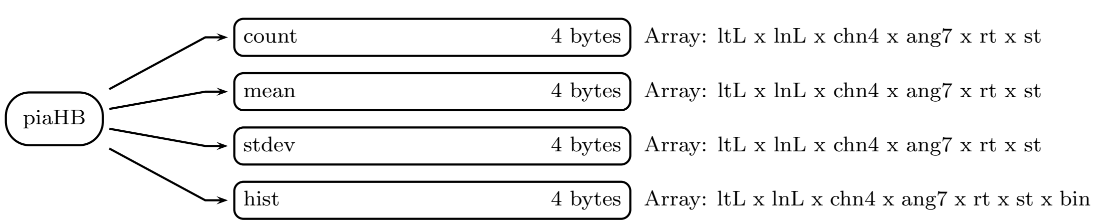


Figure 861: Data Format Structure for 3PR, FS, G1, piaHB

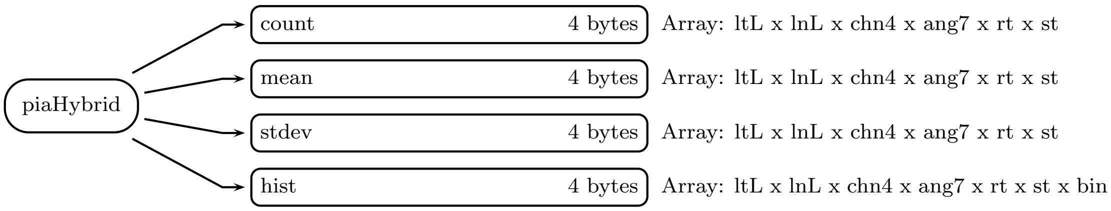


Figure 862: Data Format Structure for 3PR, FS, G1, piaHybrid

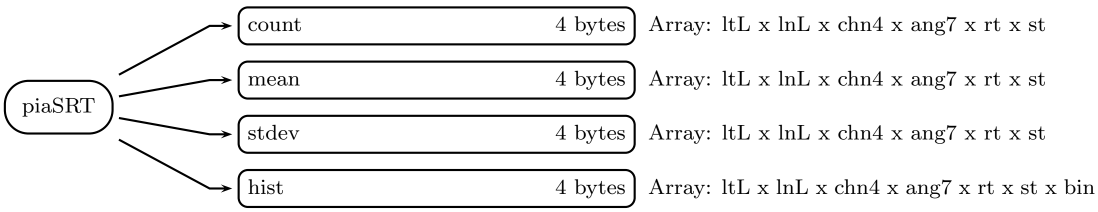


Figure 863: Data Format Structure for 3PR, FS, G1, piaSRT

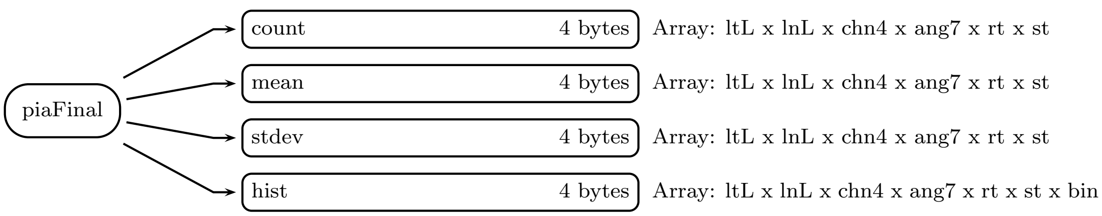


Figure 864: Data Format Structure for 3PR, FS, G1, piaFinal

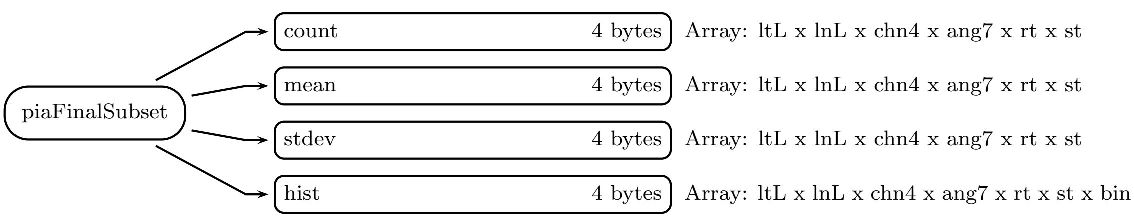


Figure 865: Data Format Structure for 3PR, FS, G1, piaFinalSubset

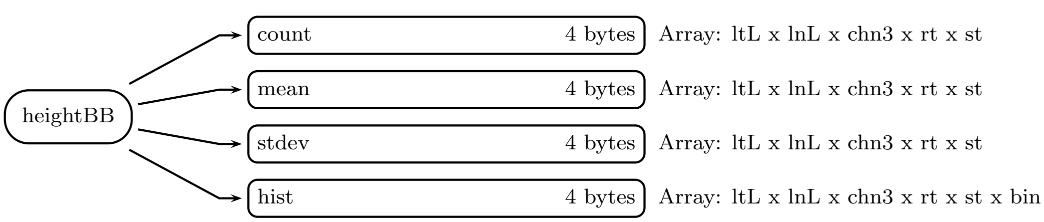


Figure 866: Data Format Structure for 3PR, FS, G1, heightBB

heightBBnadir

- count 4 bytes Array: ltL x lnL x chn3 x rt x st
- mean 4 bytes Array: ltL x lnL x chn3 x rt x st
- stdev 4 bytes Array: ltL x lnL x chn3 x rt x st
- hist 4 bytes Array: ltL x lnL x chn3 x rt x st x bin

Figure 867: Data Format Structure for 3PR, FS, G1, heightBBnadir

BBwidthNadir

- count 4 bytes Array: ltL x lnL x chn3 x rt x st
- mean 4 bytes Array: ltL x lnL x chn3 x rt x st
- stdev 4 bytes Array: ltL x lnL x chn3 x rt x st
- hist 4 bytes Array: ltL x lnL x chn3 x rt x st x bin

Figure 868: Data Format Structure for 3PR, FS, G1, BBwidthNadir

heightStormTop

- count 4 bytes Array: ltL x lnL x chn3 x rt x st
- mean 4 bytes Array: ltL x lnL x chn3 x rt x st
- stdev 4 bytes Array: ltL x lnL x chn3 x rt x st
- hist 4 bytes Array: ltL x lnL x chn3 x rt x st x bin

Figure 869: Data Format Structure for 3PR, FS, G1, heightStormTop

BBwidth

- count 4 bytes Array: ltL x lnL x chn3 x rt x st
- mean 4 bytes Array: ltL x lnL x chn3 x rt x st
- stdev 4 bytes Array: ltL x lnL x chn3 x rt x st
- hist 4 bytes Array: ltL x lnL x chn3 x rt x st x bin

Figure 870: Data Format Structure for 3PR, FS, G1, BBwidth

observationCounts

- total 4 bytes Array: ltL x lnL x chn3 x st
- localTime 4 bytes Array: ltL x lnL x chn3 x tim x st
- pia 4 bytes Array: ltL x lnL x chn3 x ang7 x st
- shallowRain 4 bytes Array: ltL x lnL x chn3 x st

Figure 871: Data Format Structure for 3PR, FS, G1, observationCounts

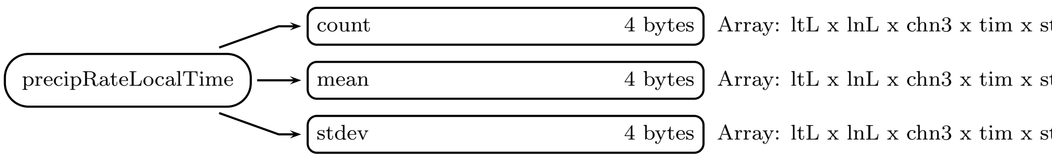


Figure 872: Data Format Structure for 3PR, FS, G1, precipRateLocalTime

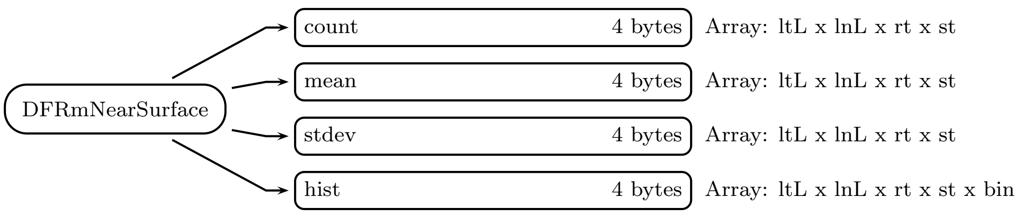


Figure 873: Data Format Structure for 3PR, FS, G1, DFRmNearSurface

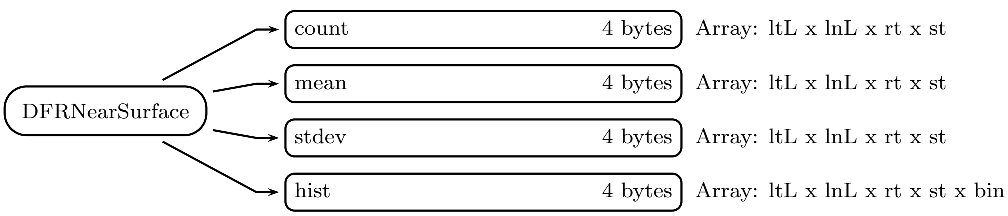


Figure 874: Data Format Structure for 3PR, FS, G1, DFRNearSurface

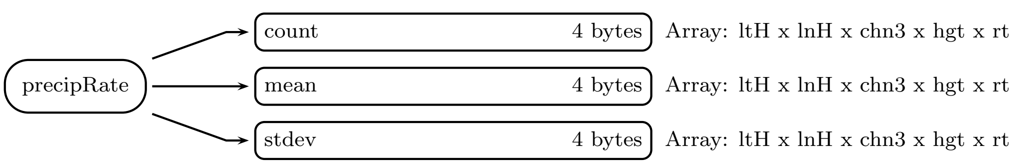


Figure 875: Data Format Structure for 3PR, FS, G2, precipRate

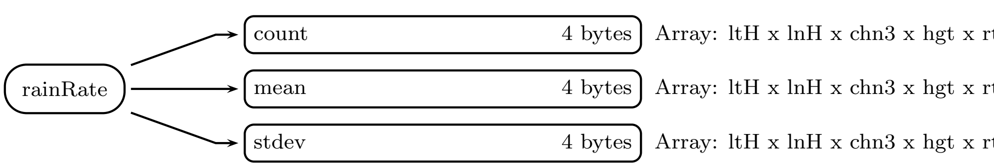


Figure 876: Data Format Structure for 3PR, FS, G2, rainRate

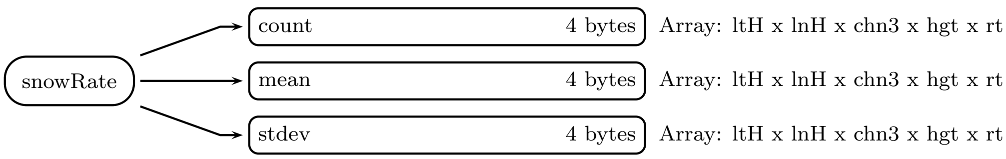


Figure 877: Data Format Structure for 3PR, FS, G2, snowRate

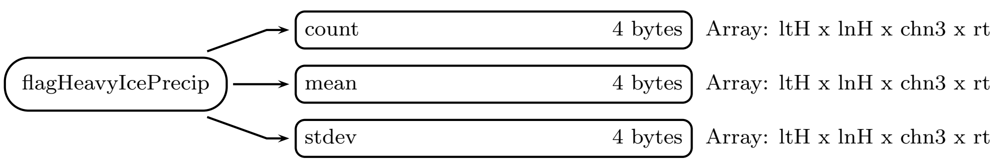


Figure 878: Data Format Structure for 3PR, FS, G2, flagHeavyIcePrecip

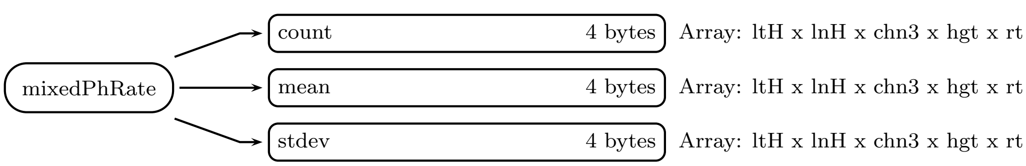


Figure 879: Data Format Structure for 3PR, FS, G2, mixedPhRate

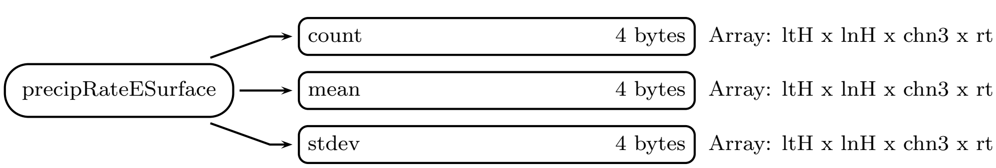


Figure 880: Data Format Structure for 3PR, FS, G2, precipRateESurface

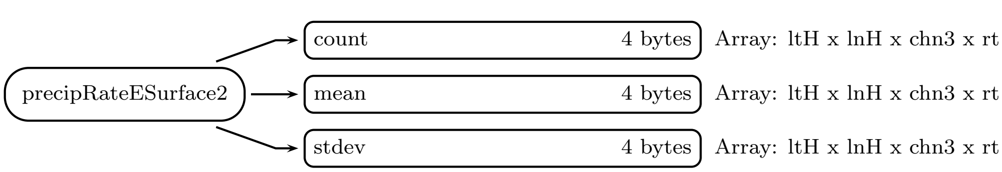


Figure 881: Data Format Structure for 3PR, FS, G2, precipRateESurface2

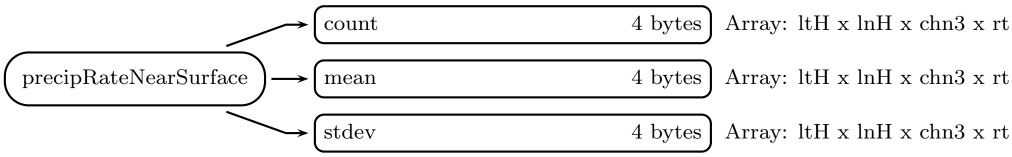


Figure 882: Data Format Structure for 3PR, FS, G2, precipRateNearSurface

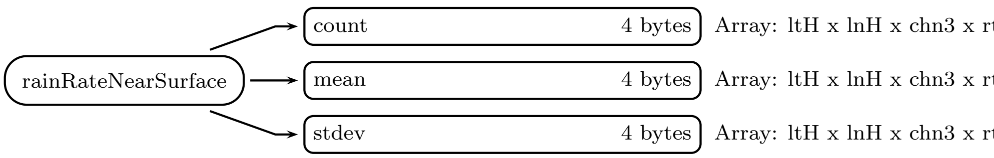


Figure 883: Data Format Structure for 3PR, FS, G2, rainRateNearSurface

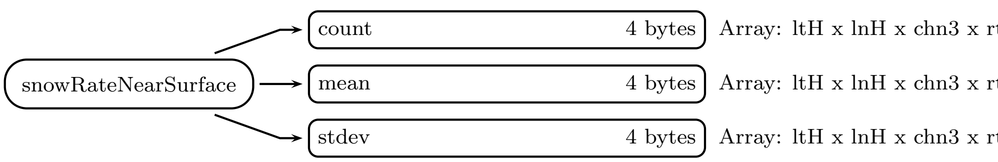


Figure 884: Data Format Structure for 3PR, FS, G2, snowRateNearSurface

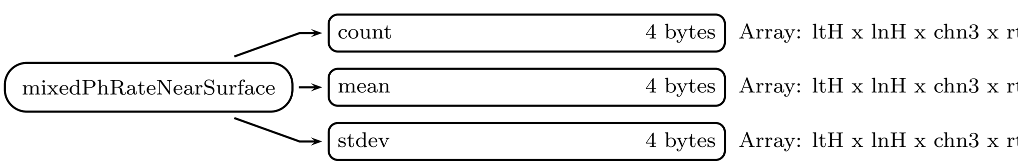


Figure 885: Data Format Structure for 3PR, FS, G2, mixedPhRateNearSurface

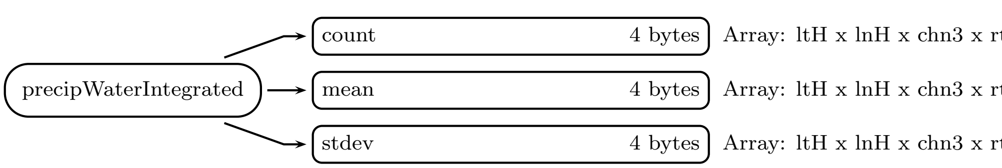


Figure 886: Data Format Structure for 3PR, FS, G2, precipWaterIntegrated

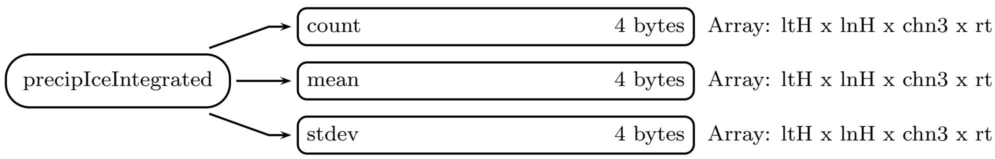


Figure 887: Data Format Structure for 3PR, FS, G2, precipIceIntegrated

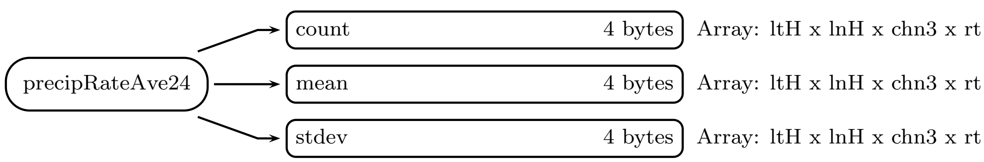


Figure 888: Data Format Structure for 3PR, FS, G2, precipRateAve24

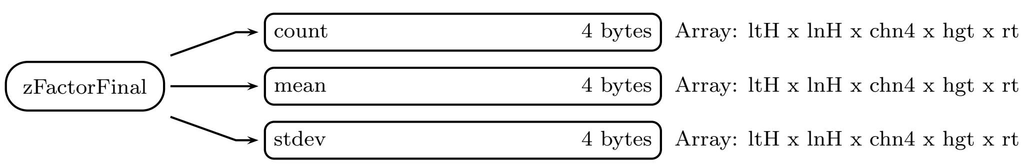


Figure 889: Data Format Structure for 3PR, FS, G2, zFactorFinal

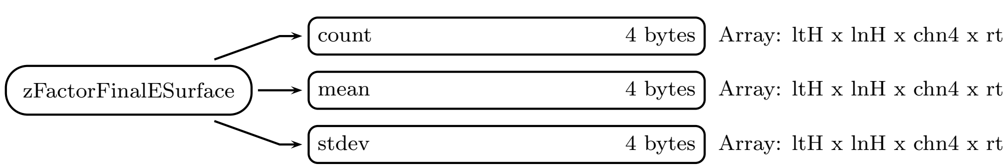


Figure 890: Data Format Structure for 3PR, FS, G2, zFactorFinalESurface

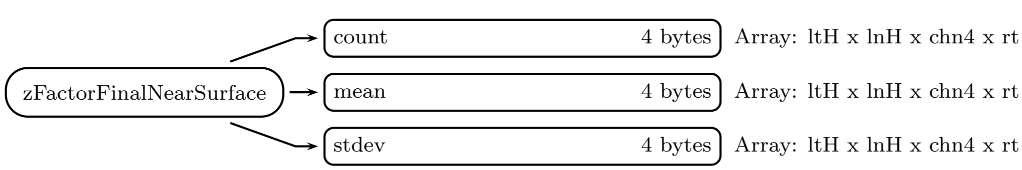


Figure 891: Data Format Structure for 3PR, FS, G2, zFactorFinalNearSurface

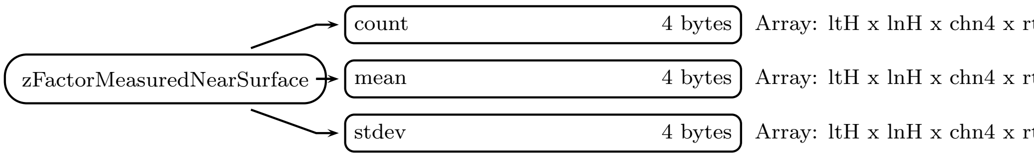


Figure 892: Data Format Structure for 3PR, FS, G2, zFactorMeasuredNearSurface

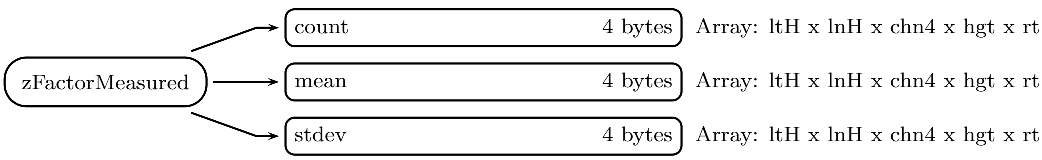


Figure 893: Data Format Structure for 3PR, FS, G2, zFactorMeasured

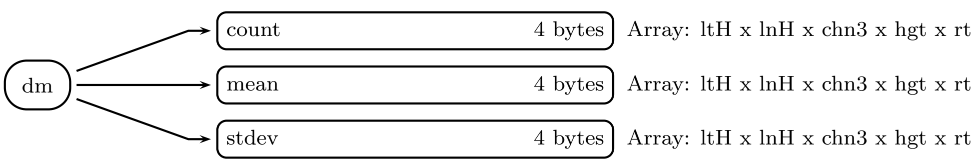


Figure 894: Data Format Structure for 3PR, FS, G2, dm

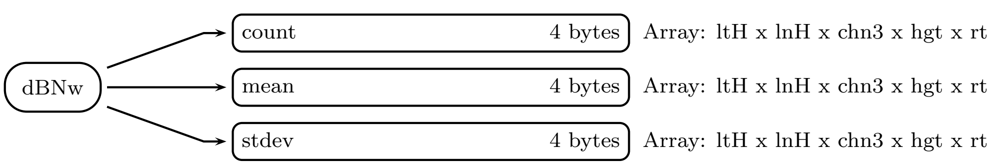


Figure 895: Data Format Structure for 3PR, FS, G2, dBNw

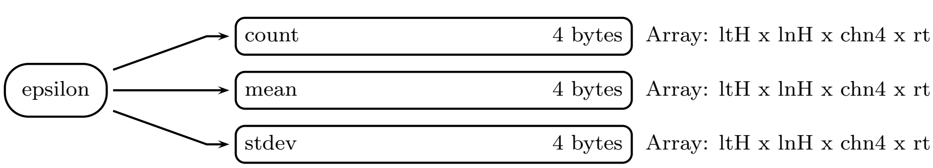


Figure 896: Data Format Structure for 3PR, FS, G2, epsilon

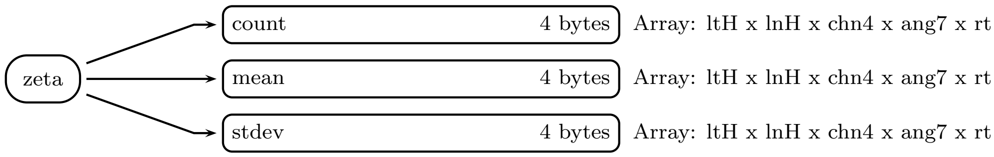


Figure 897: Data Format Structure for 3PR, FS, G2, zeta

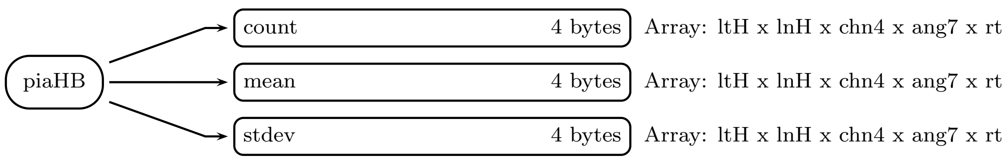


Figure 898: Data Format Structure for 3PR, FS, G2, piaHB

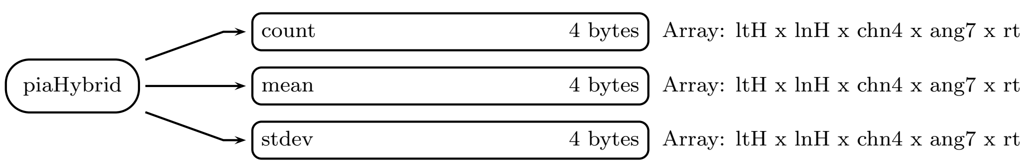


Figure 899: Data Format Structure for 3PR, FS, G2, piaHybrid

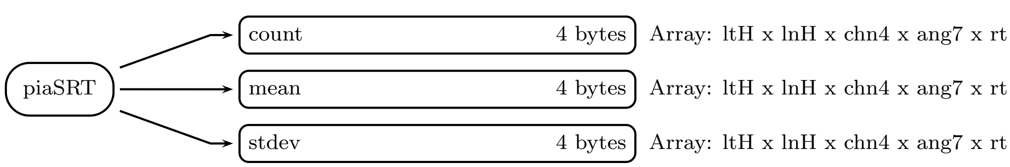


Figure 900: Data Format Structure for 3PR, FS, G2, piaSRT

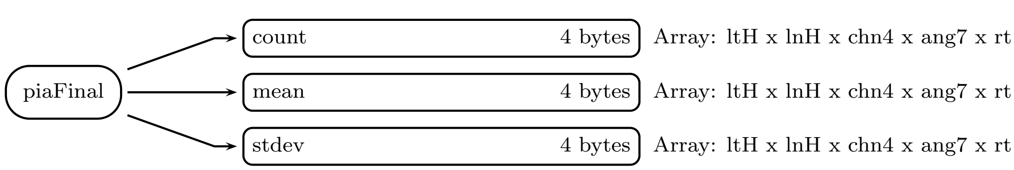


Figure 901: Data Format Structure for 3PR, FS, G2, piaFinal

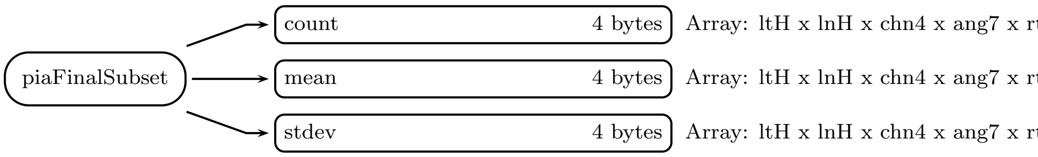


Figure 902: Data Format Structure for 3PR, FS, G2, piaFinalSubset

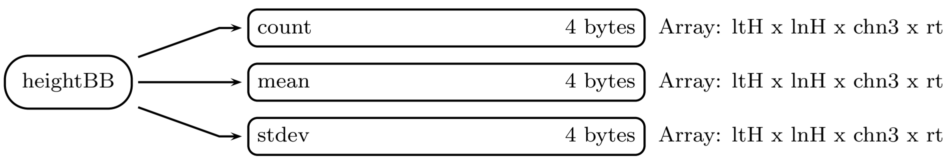


Figure 903: Data Format Structure for 3PR, FS, G2, heightBB

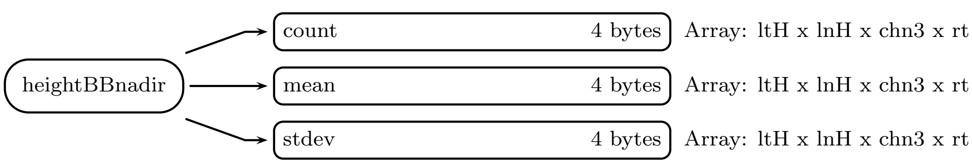


Figure 904: Data Format Structure for 3PR, FS, G2, heightBBnadir

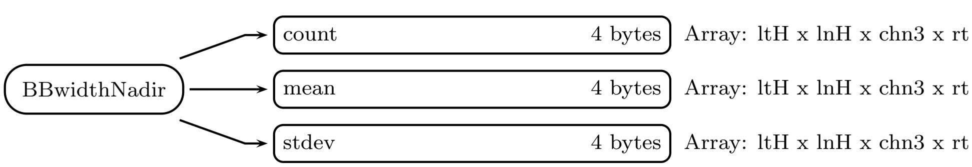


Figure 905: Data Format Structure for 3PR, FS, G2, BBwidthNadir

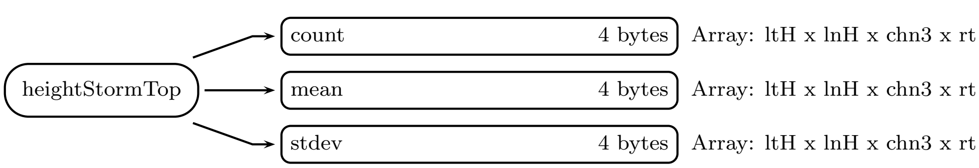


Figure 906: Data Format Structure for 3PR, FS, G2, heightStormTop

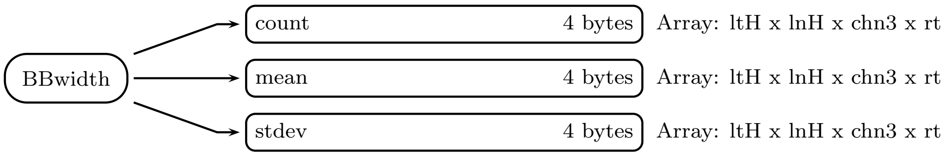


Figure 907: Data Format Structure for 3PR, FS, G2, BBwidth

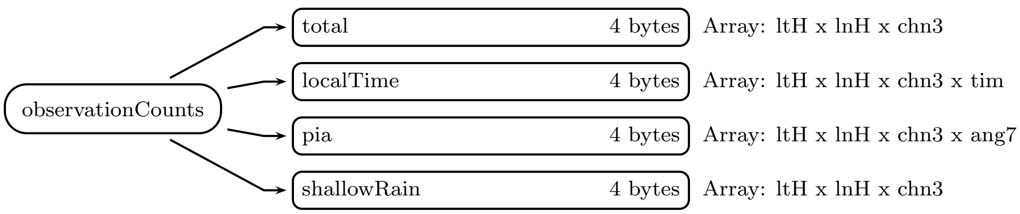


Figure 908: Data Format Structure for 3PR, FS, G2, observationCounts

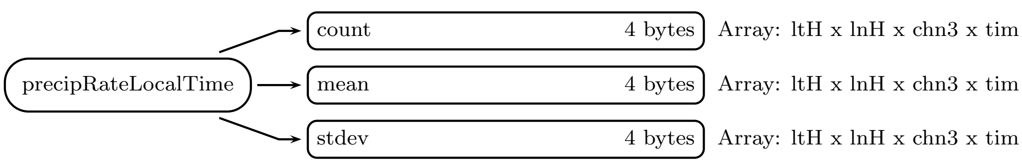


Figure 909: Data Format Structure for 3PR, FS, G2, precipRateLocalTime

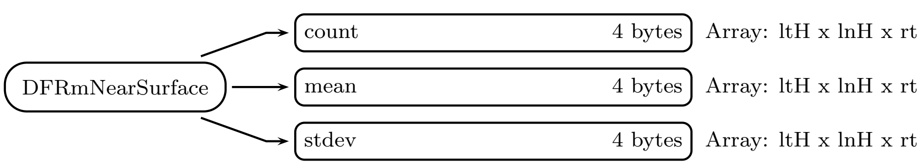


Figure 910: Data Format Structure for 3PR, FS, G2, DFRmNearSurface

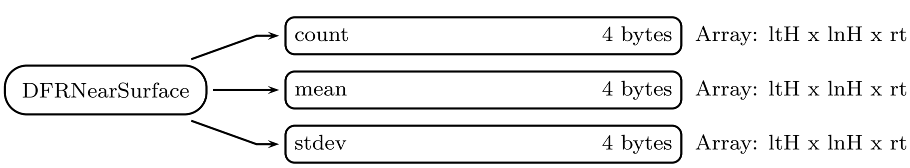


Figure 911: Data Format Structure for 3PR, FS, G2, DFRNearSurface

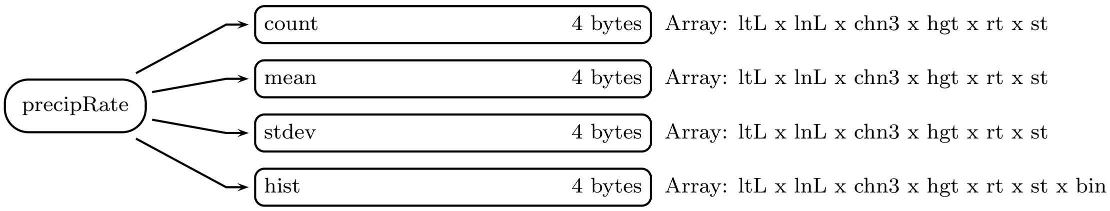


Figure 912: Data Format Structure for 3PR, MS, G1, precipRate

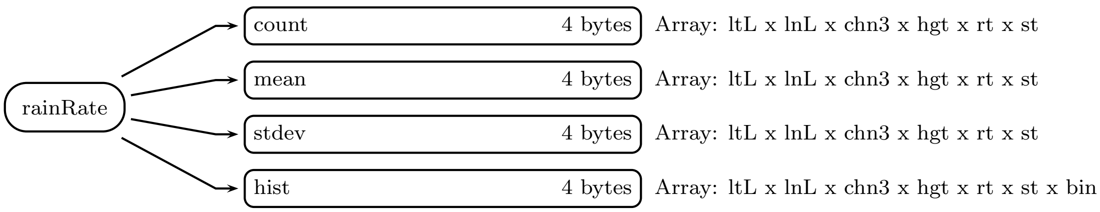


Figure 913: Data Format Structure for 3PR, MS, G1, rainRate

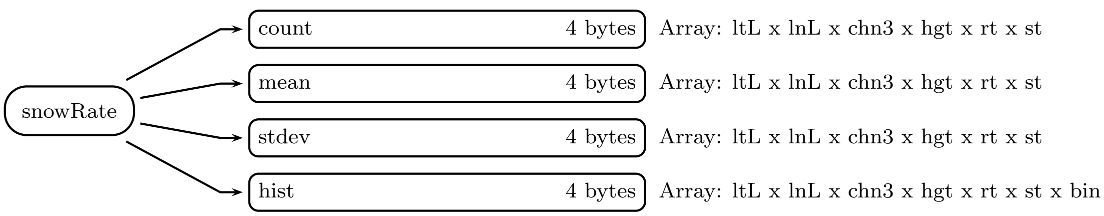


Figure 914: Data Format Structure for 3PR, MS, G1, snowRate

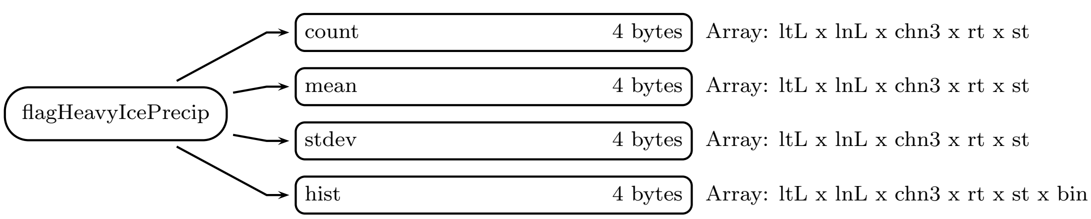


Figure 915: Data Format Structure for 3PR, MS, G1, flagHeavyIcePrecip

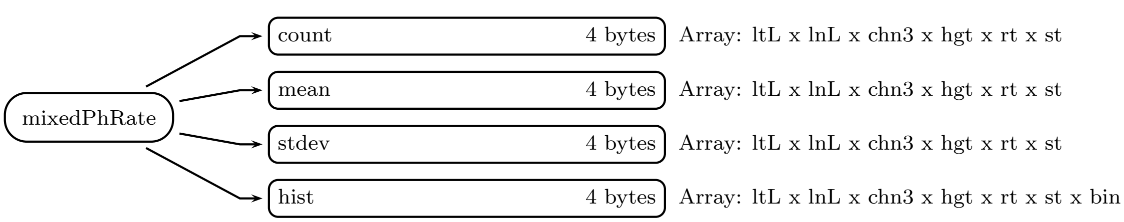


Figure 916: Data Format Structure for 3PR, MS, G1, mixedPhRate

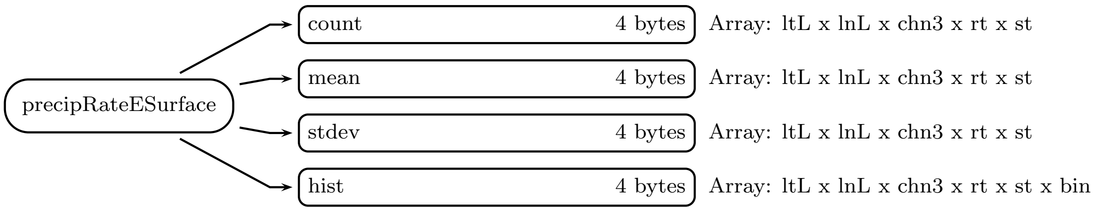


Figure 917: Data Format Structure for 3PR, MS, G1, precipRateESurface

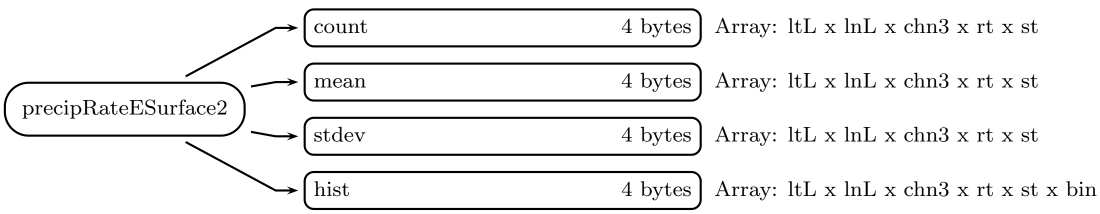


Figure 918: Data Format Structure for 3PR, MS, G1, precipRateESurface2

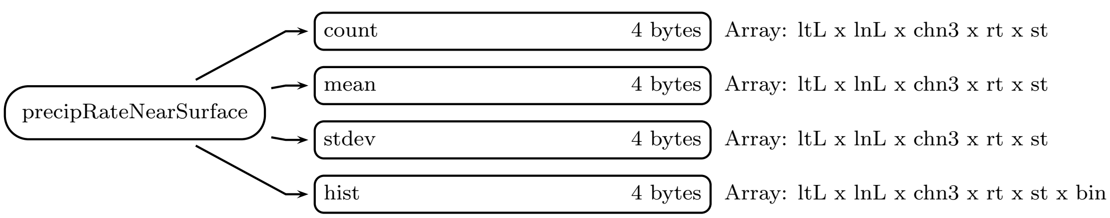


Figure 919: Data Format Structure for 3PR, MS, G1, precipRateNearSurface

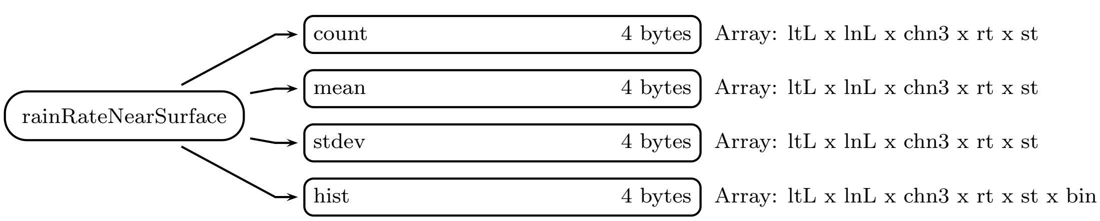


Figure 920: Data Format Structure for 3PR, MS, G1, rainRateNearSurface

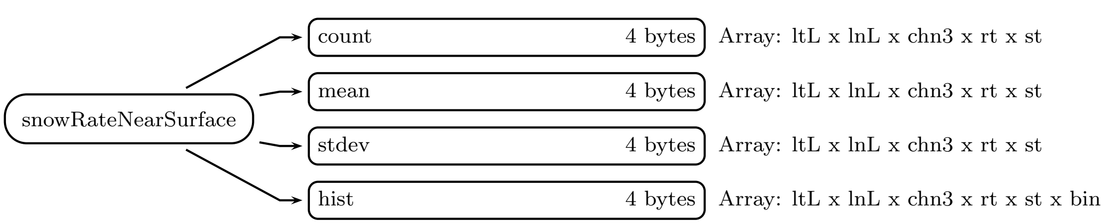


Figure 921: Data Format Structure for 3PR, MS, G1, snowRateNearSurface

mixedPhRateNearSurface

count	4 bytes	Array: ltL x lnL x chn3 x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 922: Data Format Structure for 3PR, MS, G1, mixedPhRateNearSurface

precipWaterIntegrated

count	4 bytes	Array: ltL x lnL x chn3 x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 923: Data Format Structure for 3PR, MS, G1, precipWaterIntegrated

precipIceIntegrated

count	4 bytes	Array: ltL x lnL x chn3 x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 924: Data Format Structure for 3PR, MS, G1, precipIceIntegrated

precipRateAve24

count	4 bytes	Array: ltL x lnL x chn3 x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x rt x st x bin

Figure 925: Data Format Structure for 3PR, MS, G1, precipRateAve24

zFactorFinal

count	4 bytes	Array: ltL x lnL x chn4 x hgt x rt x st
mean	4 bytes	Array: ltL x lnL x chn4 x hgt x rt x st
stdev	4 bytes	Array: ltL x lnL x chn4 x hgt x rt x st
hist	4 bytes	Array: ltL x lnL x chn4 x hgt x rt x st x bin

Figure 926: Data Format Structure for 3PR, MS, G1, zFactorFinal

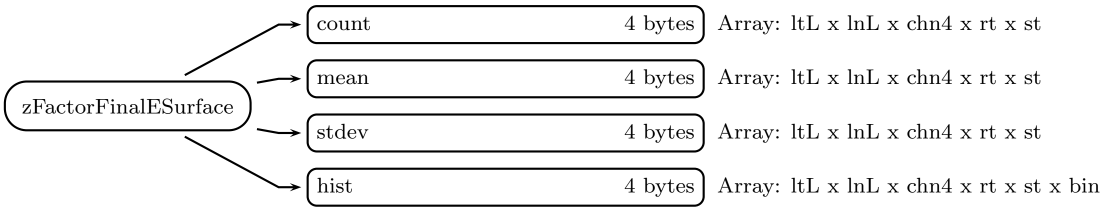


Figure 927: Data Format Structure for 3PR, MS, G1, zFactorFinalESurface

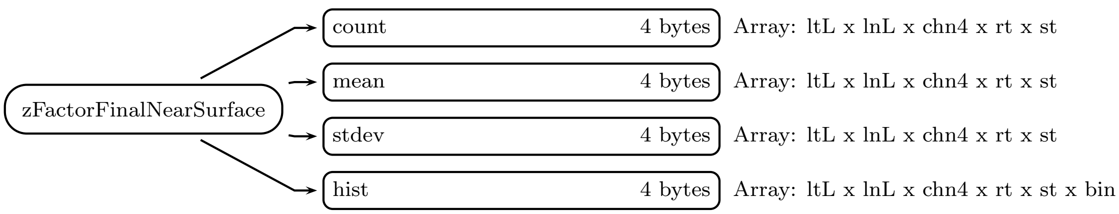


Figure 928: Data Format Structure for 3PR, MS, G1, zFactorFinalNearSurface

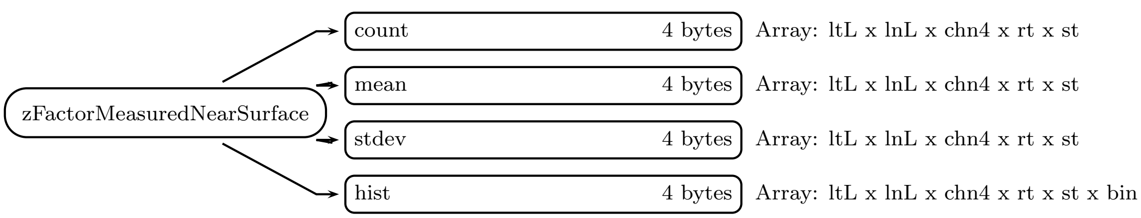


Figure 929: Data Format Structure for 3PR, MS, G1, zFactorMeasuredNearSurface

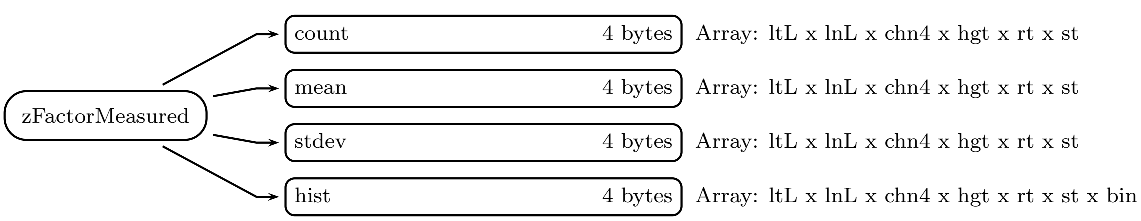


Figure 930: Data Format Structure for 3PR, MS, G1, zFactorMeasured

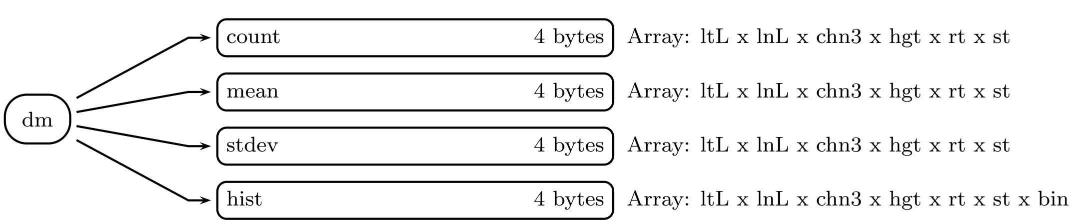


Figure 931: Data Format Structure for 3PR, MS, G1, dm

dBNw		
count	4 bytes	Array: ltL x lnL x chn3 x hgt x rt x st
mean	4 bytes	Array: ltL x lnL x chn3 x hgt x rt x st
stdev	4 bytes	Array: ltL x lnL x chn3 x hgt x rt x st
hist	4 bytes	Array: ltL x lnL x chn3 x hgt x rt x st x bin

Figure 932: Data Format Structure for 3PR, MS, G1, dBNw

epsilon		
count	4 bytes	Array: ltL x lnL x chn4 x rt x st
mean	4 bytes	Array: ltL x lnL x chn4 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn4 x rt x st
hist	4 bytes	Array: ltL x lnL x chn4 x rt x st x bin

Figure 933: Data Format Structure for 3PR, MS, G1, epsilon

zeta		
count	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st
mean	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st
hist	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st x bin

Figure 934: Data Format Structure for 3PR, MS, G1, zeta

piaHB		
count	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st
mean	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st
hist	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st x bin

Figure 935: Data Format Structure for 3PR, MS, G1, piaHB

piaHybrid		
count	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st
mean	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st
stdev	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st
hist	4 bytes	Array: ltL x lnL x chn4 x ang4 x rt x st x bin

Figure 936: Data Format Structure for 3PR, MS, G1, piaHybrid

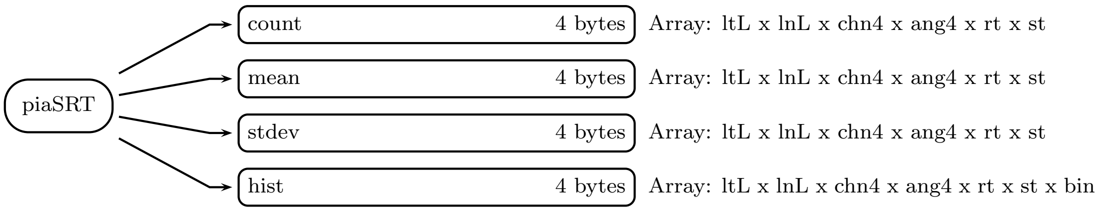


Figure 937: Data Format Structure for 3PR, MS, G1, piaSRT

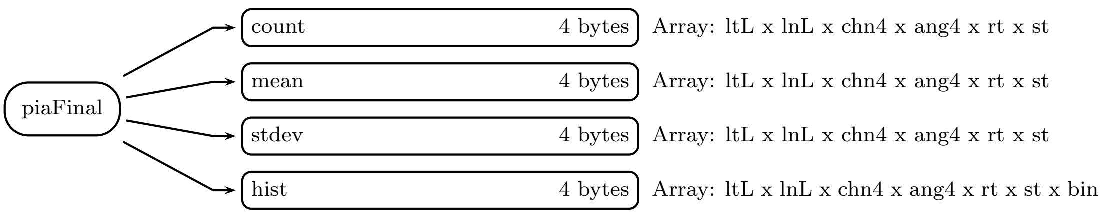


Figure 938: Data Format Structure for 3PR, MS, G1, piaFinal

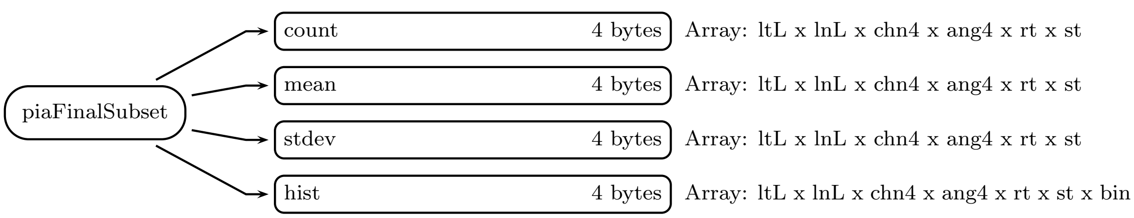


Figure 939: Data Format Structure for 3PR, MS, G1, piaFinalSubset

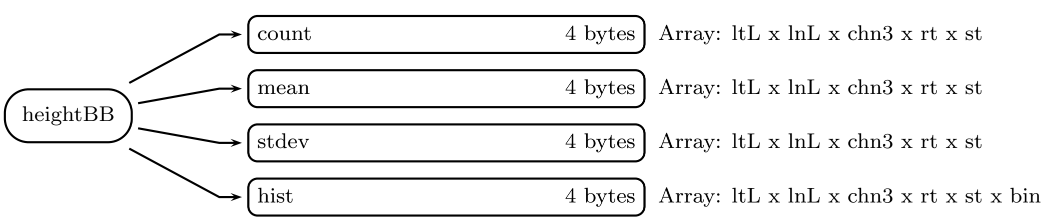


Figure 940: Data Format Structure for 3PR, MS, G1, heightBB

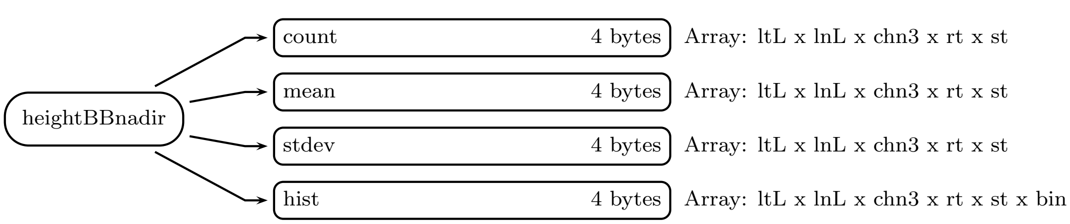


Figure 941: Data Format Structure for 3PR, MS, G1, heightBBnadir

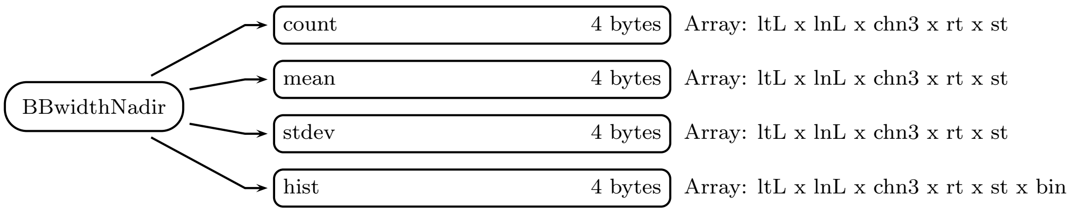


Figure 942: Data Format Structure for 3PR, MS, G1, BBwidthNadir

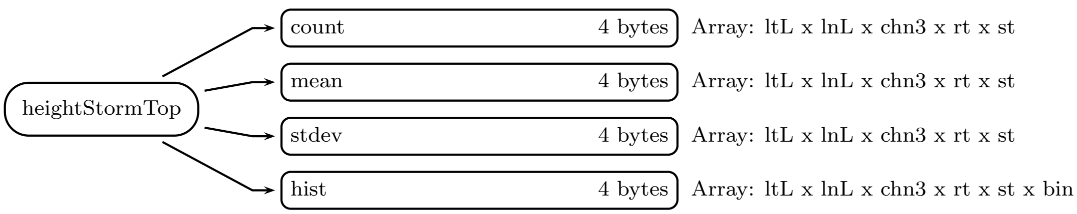


Figure 943: Data Format Structure for 3PR, MS, G1, heightStormTop

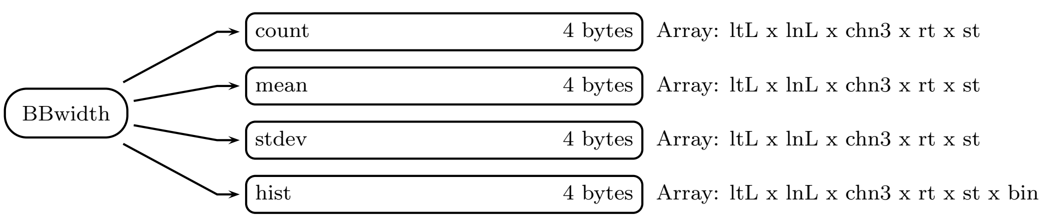


Figure 944: Data Format Structure for 3PR, MS, G1, BBwidth

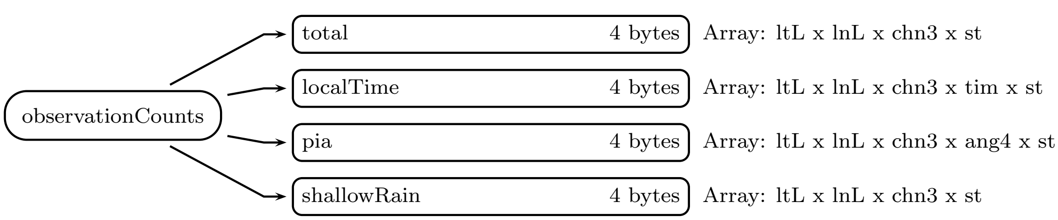


Figure 945: Data Format Structure for 3PR, MS, G1, observationCounts

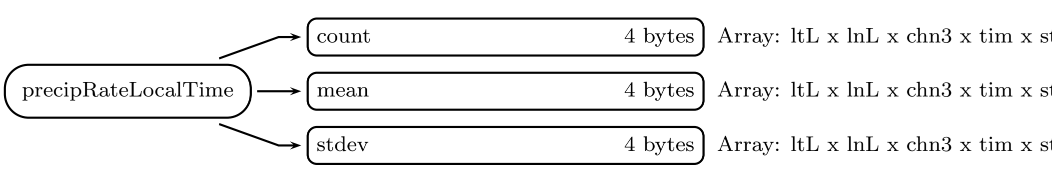


Figure 946: Data Format Structure for 3PR, MS, G1, precipRateLocalTime

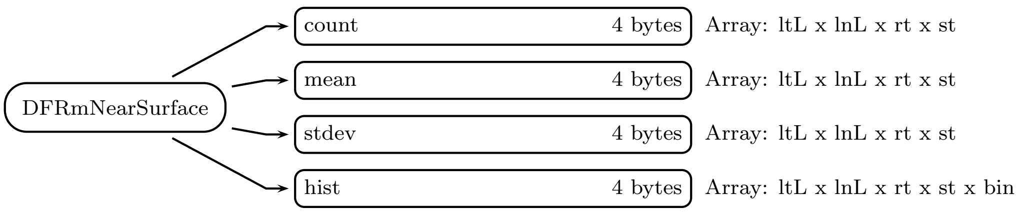


Figure 947: Data Format Structure for 3PR, MS, G1, DFRmNearSurface

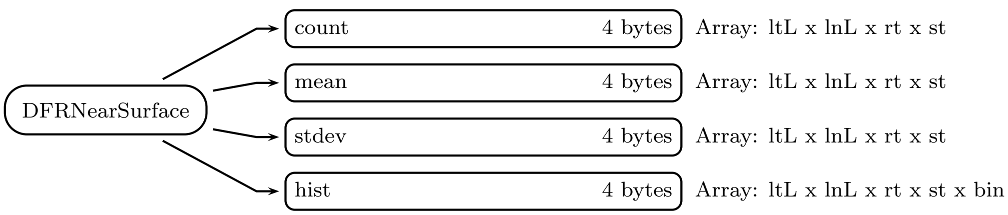


Figure 948: Data Format Structure for 3PR, MS, G1, DFRNearSurface

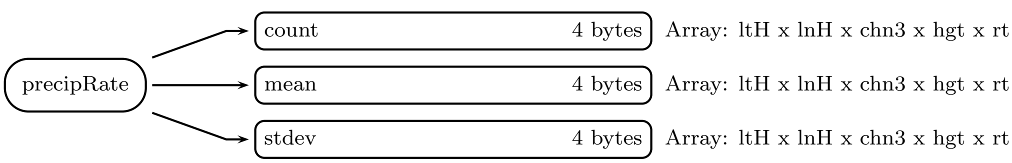


Figure 949: Data Format Structure for 3PR, MS, G2, precipRate

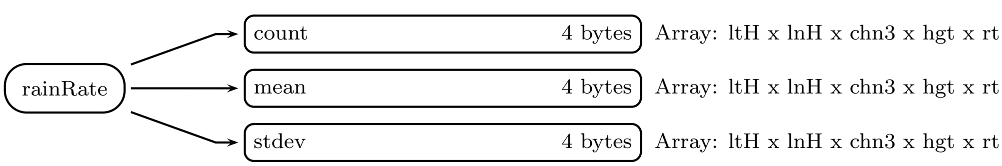


Figure 950: Data Format Structure for 3PR, MS, G2, rainRate

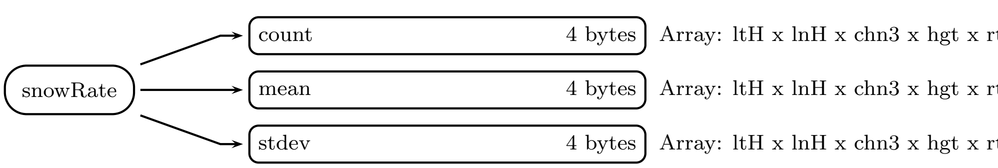


Figure 951: Data Format Structure for 3PR, MS, G2, snowRate

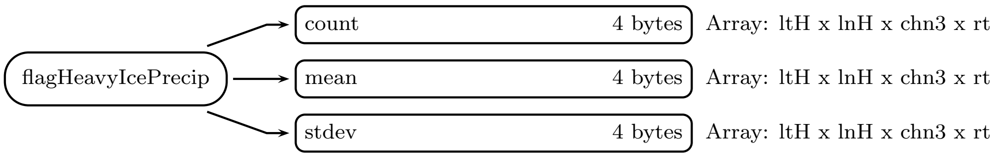


Figure 952: Data Format Structure for 3PR, MS, G2, flagHeavyIcePrecip

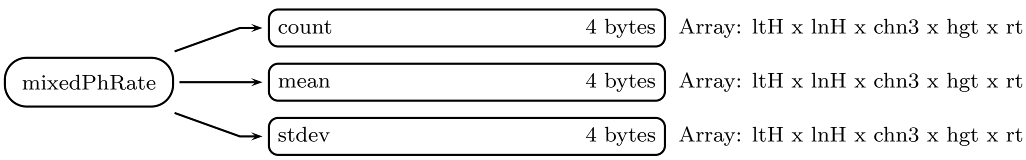


Figure 953: Data Format Structure for 3PR, MS, G2, mixedPhRate

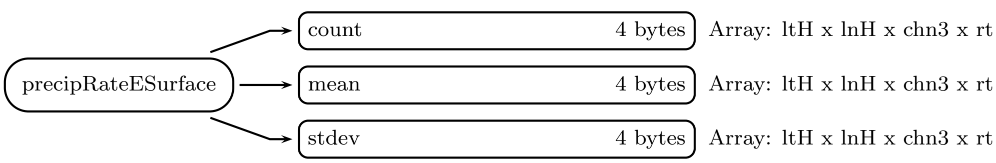


Figure 954: Data Format Structure for 3PR, MS, G2, precipRateESurface

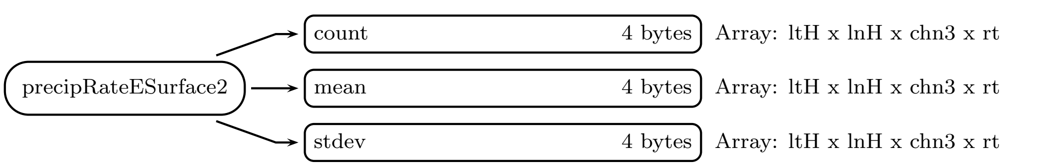


Figure 955: Data Format Structure for 3PR, MS, G2, precipRateESurface2

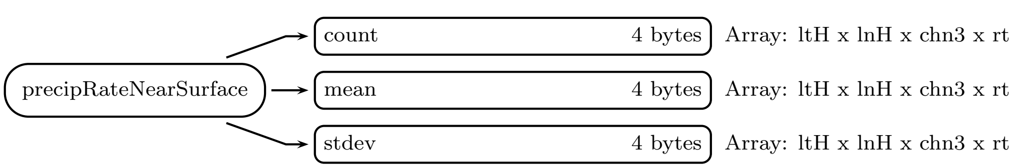


Figure 956: Data Format Structure for 3PR, MS, G2, precipRateNearSurface

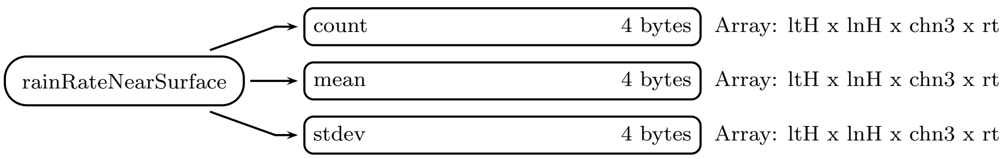


Figure 957: Data Format Structure for 3PR, MS, G2, rainRateNearSurface

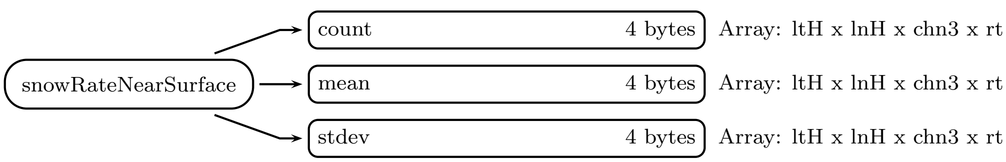


Figure 958: Data Format Structure for 3PR, MS, G2, snowRateNearSurface

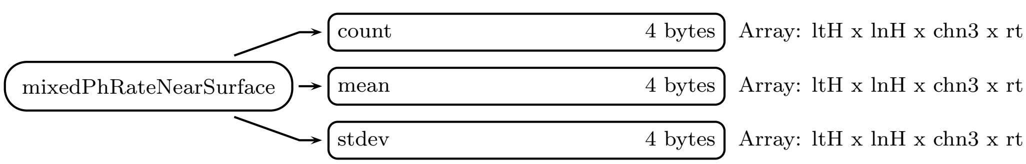


Figure 959: Data Format Structure for 3PR, MS, G2, mixedPhRateNearSurface

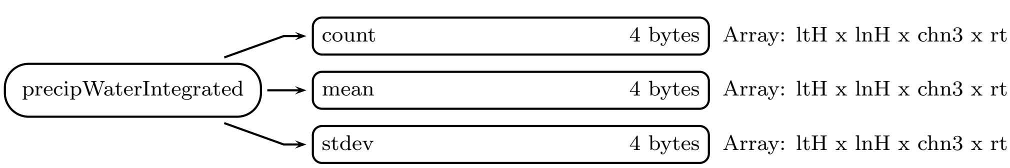


Figure 960: Data Format Structure for 3PR, MS, G2, precipWaterIntegrated

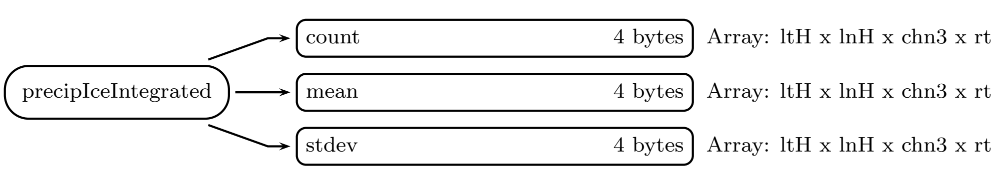


Figure 961: Data Format Structure for 3PR, MS, G2, precipIceIntegrated

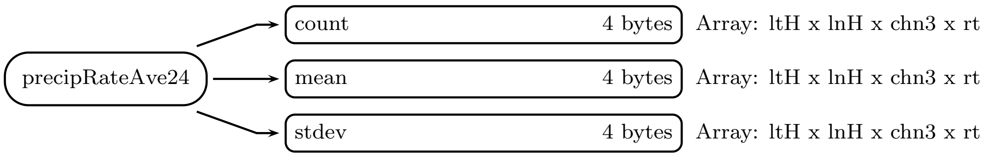


Figure 962: Data Format Structure for 3PR, MS, G2, precipRateAve24

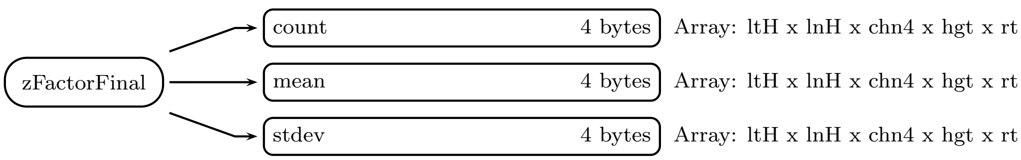


Figure 963: Data Format Structure for 3PR, MS, G2, zFactorFinal

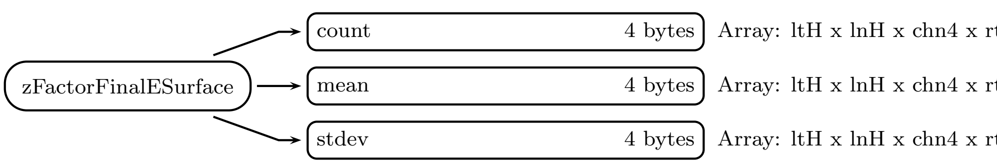


Figure 964: Data Format Structure for 3PR, MS, G2, zFactorFinalESurface

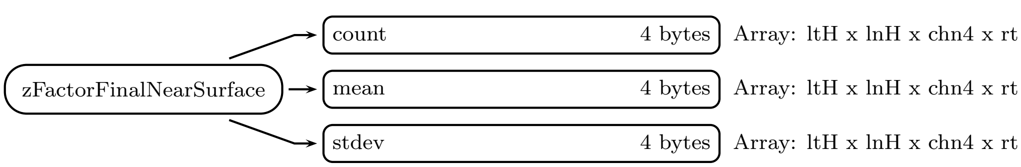


Figure 965: Data Format Structure for 3PR, MS, G2, zFactorFinalNearSurface

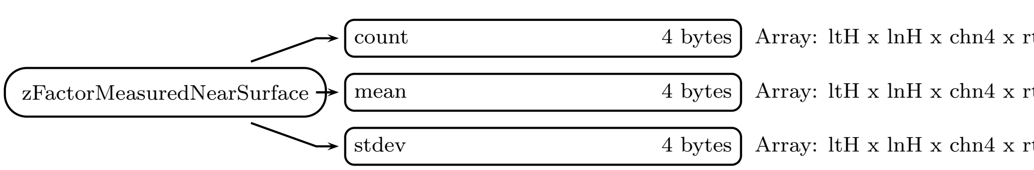


Figure 966: Data Format Structure for 3PR, MS, G2, zFactorMeasuredNearSurface

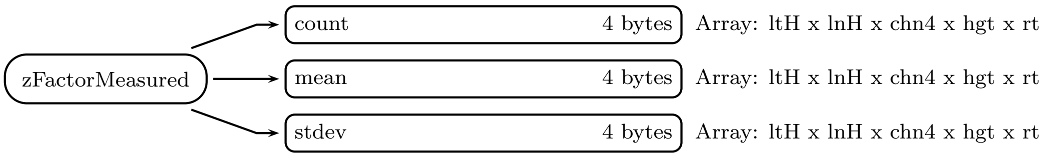


Figure 967: Data Format Structure for 3PR, MS, G2, zFactorMeasured

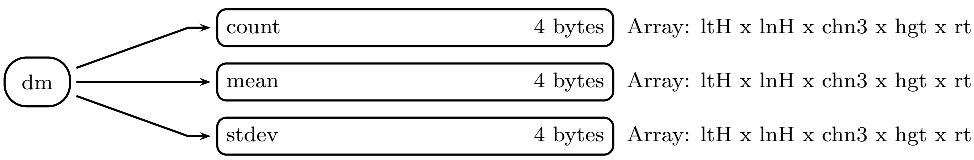


Figure 968: Data Format Structure for 3PR, MS, G2, dm

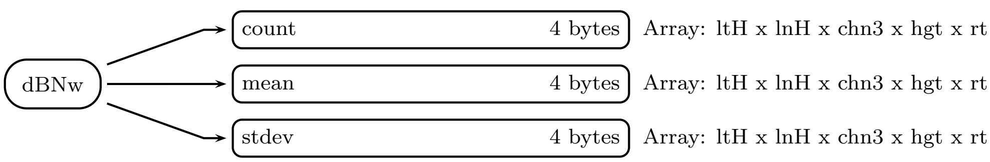


Figure 969: Data Format Structure for 3PR, MS, G2, dBNw

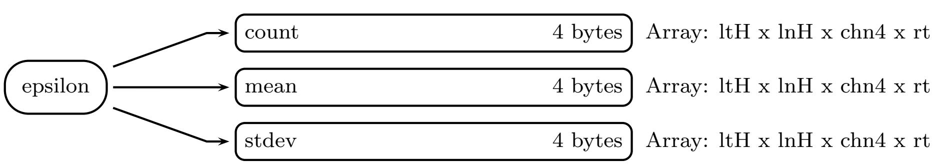


Figure 970: Data Format Structure for 3PR, MS, G2, epsilon

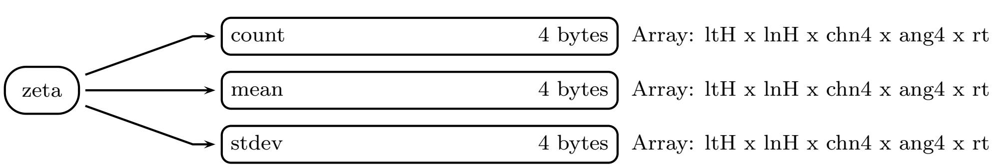


Figure 971: Data Format Structure for 3PR, MS, G2, zeta

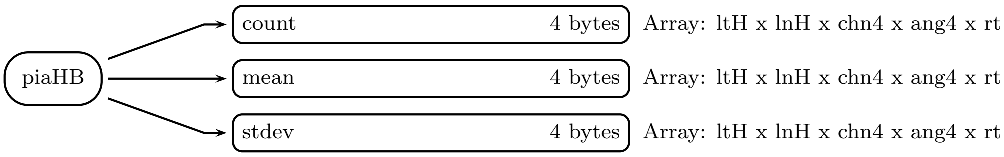


Figure 972: Data Format Structure for 3PR, MS, G2, piaHB

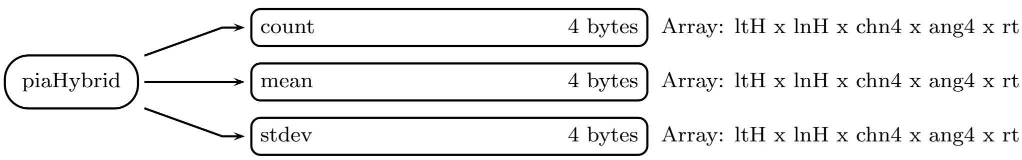


Figure 973: Data Format Structure for 3PR, MS, G2, piaHybrid

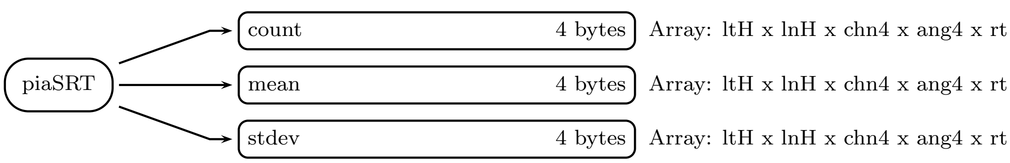


Figure 974: Data Format Structure for 3PR, MS, G2, piaSRT

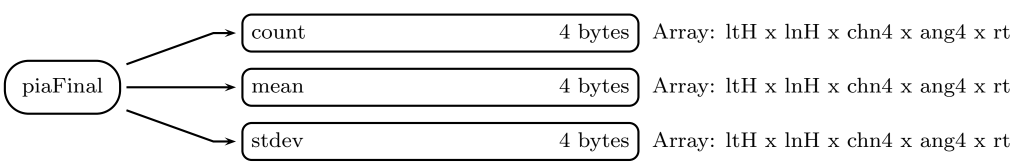


Figure 975: Data Format Structure for 3PR, MS, G2, piaFinal

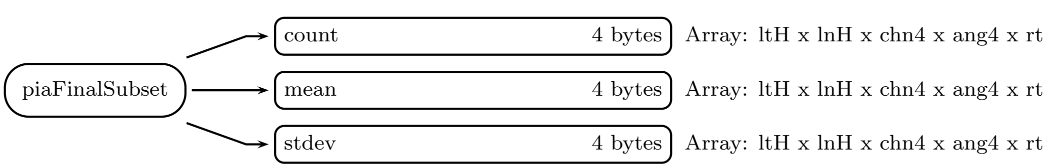


Figure 976: Data Format Structure for 3PR, MS, G2, piaFinalSubset

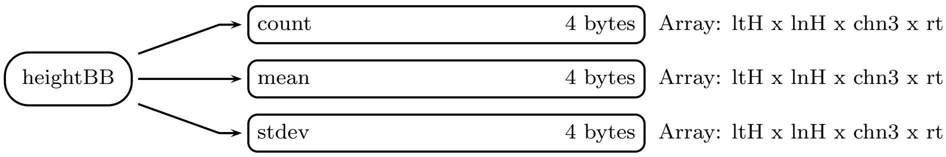


Figure 977: Data Format Structure for 3PR, MS, G2, heightBB

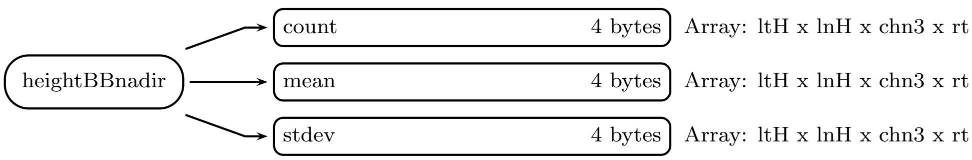


Figure 978: Data Format Structure for 3PR, MS, G2, heightBBnadir

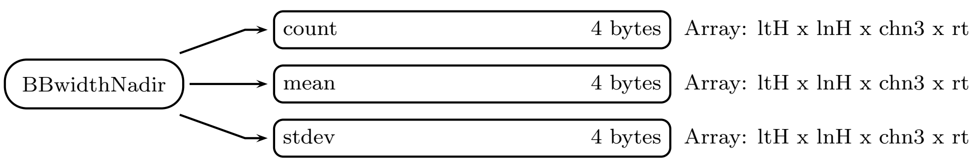


Figure 979: Data Format Structure for 3PR, MS, G2, BBwidthNadir

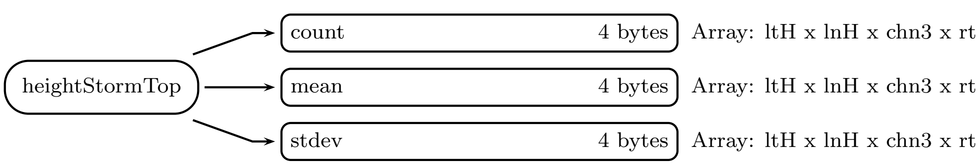


Figure 980: Data Format Structure for 3PR, MS, G2, heightStormTop

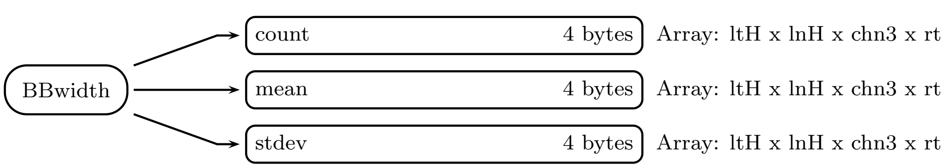


Figure 981: Data Format Structure for 3PR, MS, G2, BBwidth

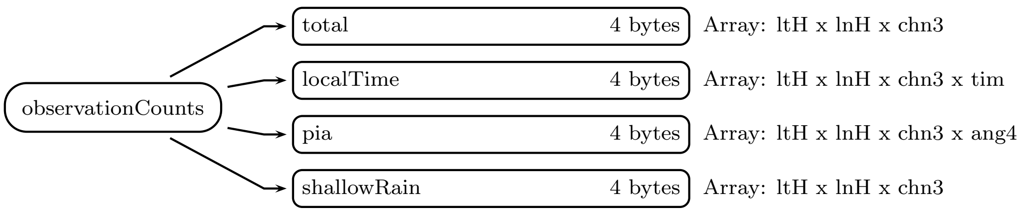


Figure 982: Data Format Structure for 3PR, MS, G2, observationCounts

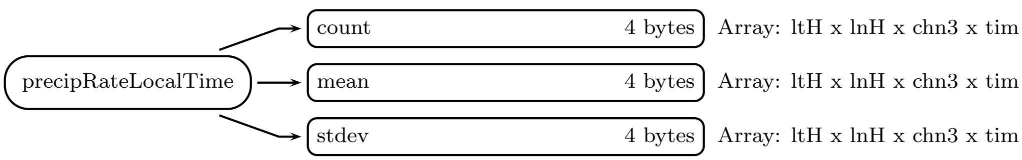


Figure 983: Data Format Structure for 3PR, MS, G2, precipRateLocalTime

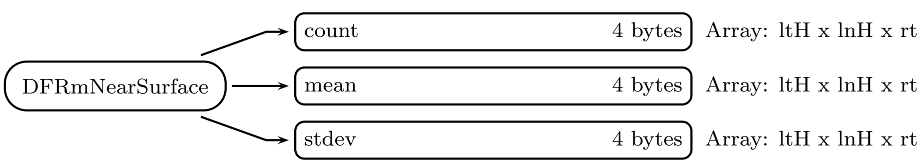


Figure 984: Data Format Structure for 3PR, MS, G2, DFRmNearSurface

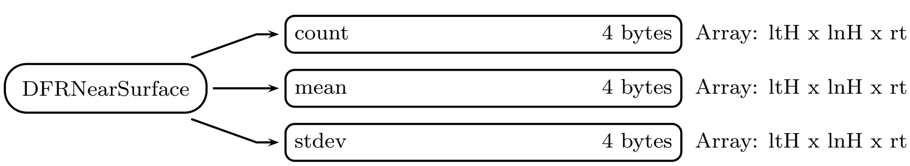


Figure 985: Data Format Structure for 3PR, MS, G2, DFRNearSurface

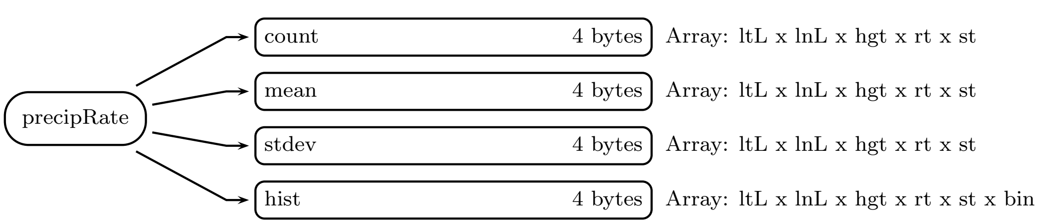


Figure 986: Data Format Structure for 3PR, HS, G1, precipRate

rainRate	count	4 bytes	Array: ltL x lnL x hgt x rt x st
	mean	4 bytes	Array: ltL x lnL x hgt x rt x st
	stdev	4 bytes	Array: ltL x lnL x hgt x rt x st
	hist	4 bytes	Array: ltL x lnL x hgt x rt x st x bin

Figure 987: Data Format Structure for 3PR, HS, G1, rainRate

snowRate	count	4 bytes	Array: ltL x lnL x hgt x rt x st
	mean	4 bytes	Array: ltL x lnL x hgt x rt x st
	stdev	4 bytes	Array: ltL x lnL x hgt x rt x st
	hist	4 bytes	Array: ltL x lnL x hgt x rt x st x bin

Figure 988: Data Format Structure for 3PR, HS, G1, snowRate

flagHeavyIcePrecip	count	4 bytes	Array: ltL x lnL x rt x st
	mean	4 bytes	Array: ltL x lnL x rt x st
	stdev	4 bytes	Array: ltL x lnL x rt x st
	hist	4 bytes	Array: ltL x lnL x rt x st x bin

Figure 989: Data Format Structure for 3PR, HS, G1, flagHeavyIcePrecip

mixedPhRate	count	4 bytes	Array: ltL x lnL x hgt x rt x st
	mean	4 bytes	Array: ltL x lnL x hgt x rt x st
	stdev	4 bytes	Array: ltL x lnL x hgt x rt x st
	hist	4 bytes	Array: ltL x lnL x hgt x rt x st x bin

Figure 990: Data Format Structure for 3PR, HS, G1, mixedPhRate

precipRateESurface	count	4 bytes	Array: ltL x lnL x rt x st
	mean	4 bytes	Array: ltL x lnL x rt x st
	stdev	4 bytes	Array: ltL x lnL x rt x st
	hist	4 bytes	Array: ltL x lnL x rt x st x bin

Figure 991: Data Format Structure for 3PR, HS, G1, precipRateESurface

precipRateESurface2

- count 4 bytes Array: ltL x lnL x rt x st
- mean 4 bytes Array: ltL x lnL x rt x st
- stdev 4 bytes Array: ltL x lnL x rt x st
- hist 4 bytes Array: ltL x lnL x rt x st x bin

Figure 992: Data Format Structure for 3PR, HS, G1, precipRateESurface2

precipRateNearSurface

- count 4 bytes Array: ltL x lnL x rt x st
- mean 4 bytes Array: ltL x lnL x rt x st
- stdev 4 bytes Array: ltL x lnL x rt x st
- hist 4 bytes Array: ltL x lnL x rt x st x bin

Figure 993: Data Format Structure for 3PR, HS, G1, precipRateNearSurface

rainRateNearSurface

- count 4 bytes Array: ltL x lnL x rt x st
- mean 4 bytes Array: ltL x lnL x rt x st
- stdev 4 bytes Array: ltL x lnL x rt x st
- hist 4 bytes Array: ltL x lnL x rt x st x bin

Figure 994: Data Format Structure for 3PR, HS, G1, rainRateNearSurface

snowRateNearSurface

- count 4 bytes Array: ltL x lnL x rt x st
- mean 4 bytes Array: ltL x lnL x rt x st
- stdev 4 bytes Array: ltL x lnL x rt x st
- hist 4 bytes Array: ltL x lnL x rt x st x bin

Figure 995: Data Format Structure for 3PR, HS, G1, snowRateNearSurface

mixedPhRateNearSurface

- count 4 bytes Array: ltL x lnL x rt x st
- mean 4 bytes Array: ltL x lnL x rt x st
- stdev 4 bytes Array: ltL x lnL x rt x st
- hist 4 bytes Array: ltL x lnL x rt x st x bin

Figure 996: Data Format Structure for 3PR, HS, G1, mixedPhRateNearSurface

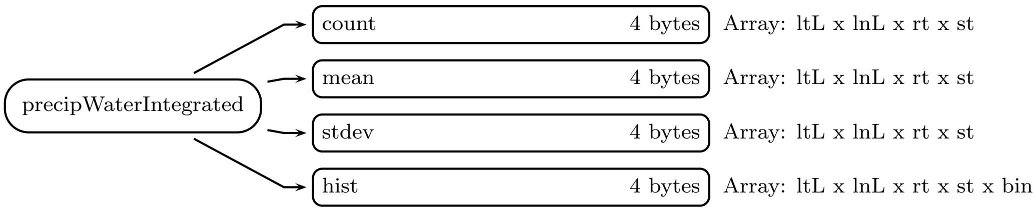


Figure 997: Data Format Structure for 3PR, HS, G1, precipWaterIntegrated

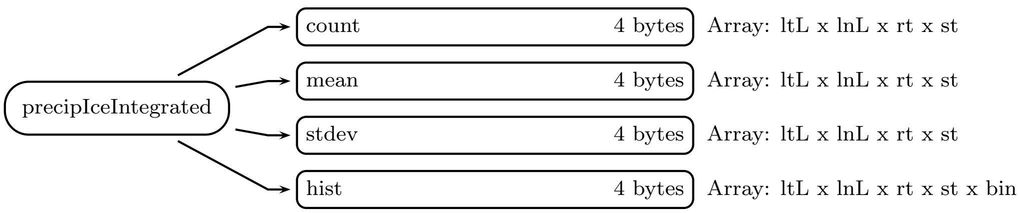


Figure 998: Data Format Structure for 3PR, HS, G1, precipIceIntegrated

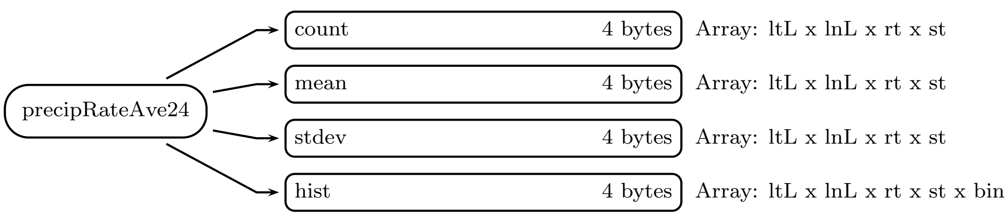


Figure 999: Data Format Structure for 3PR, HS, G1, precipRateAve24

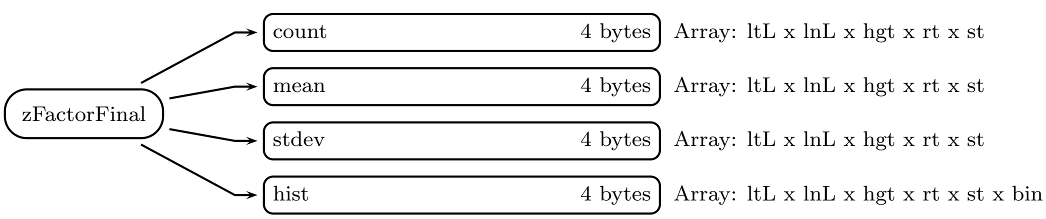


Figure 1000: Data Format Structure for 3PR, HS, G1, zFactorFinal

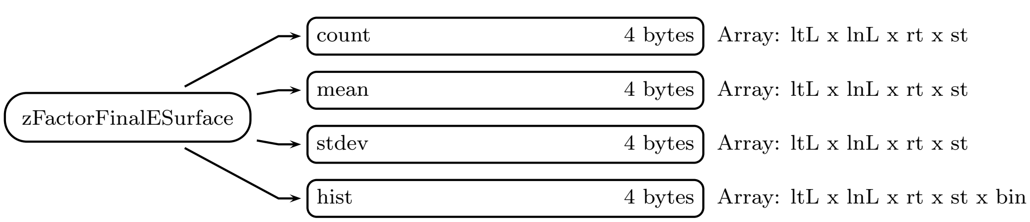


Figure 1001: Data Format Structure for 3PR, HS, G1, zFactorFinalESurface

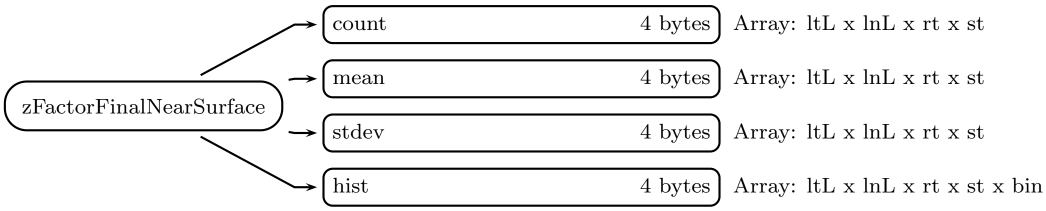


Figure 1002: Data Format Structure for 3PR, HS, G1, zFactorFinalNearSurface

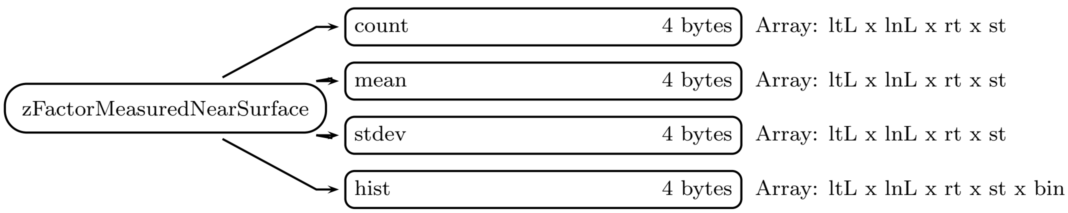


Figure 1003: Data Format Structure for 3PR, HS, G1, zFactorMeasuredNearSurface

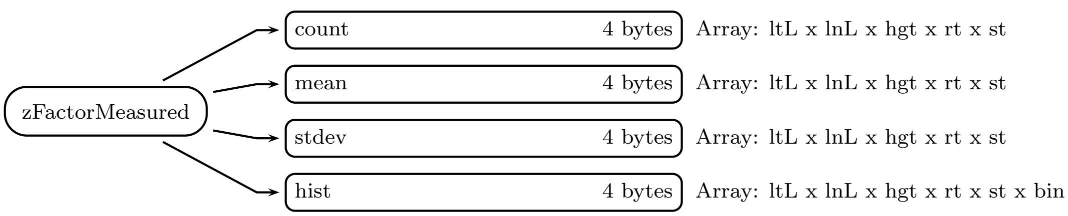


Figure 1004: Data Format Structure for 3PR, HS, G1, zFactorMeasured

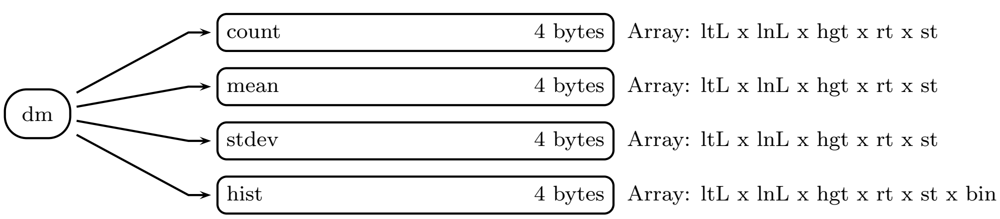


Figure 1005: Data Format Structure for 3PR, HS, G1, dm

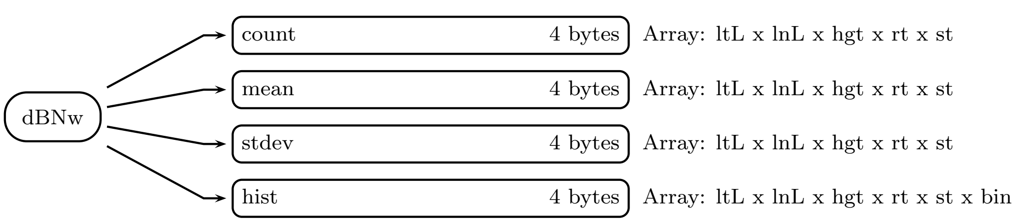


Figure 1006: Data Format Structure for 3PR, HS, G1, dBNw

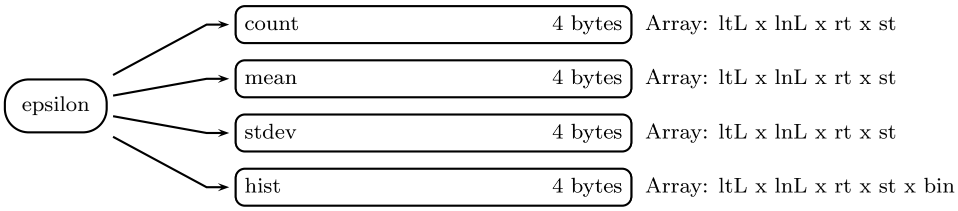


Figure 1007: Data Format Structure for 3PR, HS, G1, epsilon

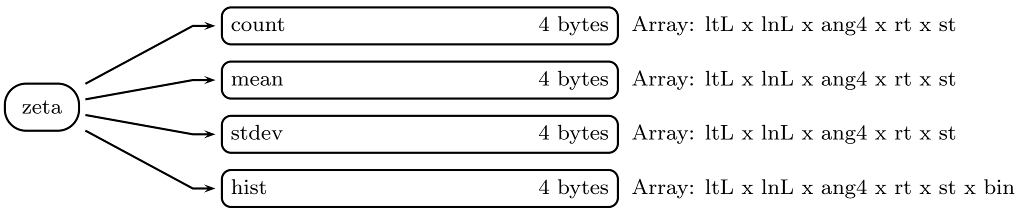


Figure 1008: Data Format Structure for 3PR, HS, G1, zeta

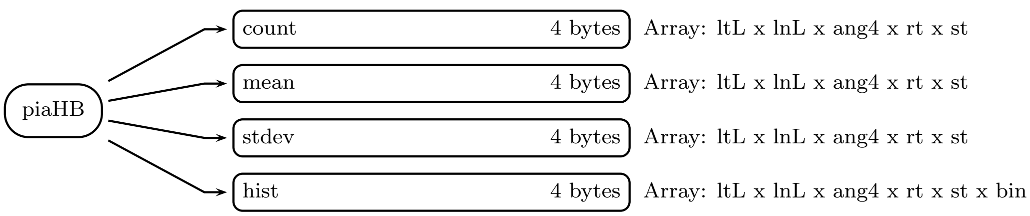


Figure 1009: Data Format Structure for 3PR, HS, G1, piaHB

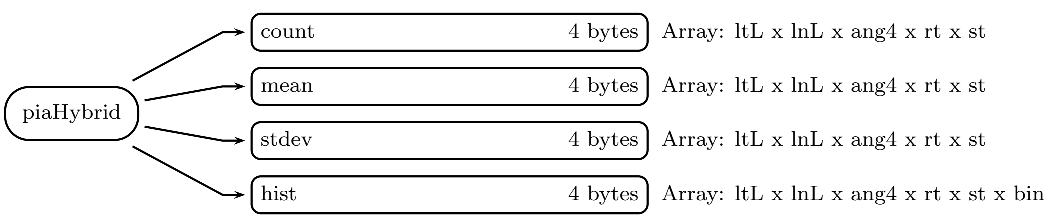


Figure 1010: Data Format Structure for 3PR, HS, G1, piaHybrid

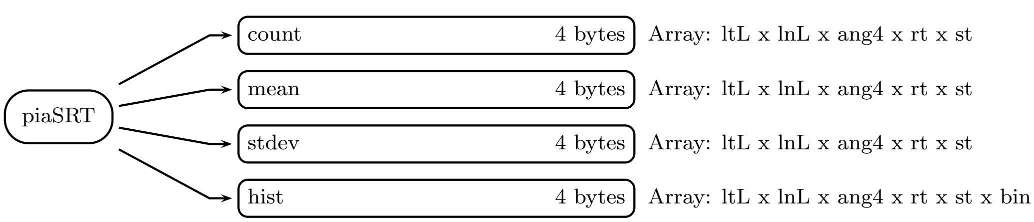


Figure 1011: Data Format Structure for 3PR, HS, G1, piaSRT

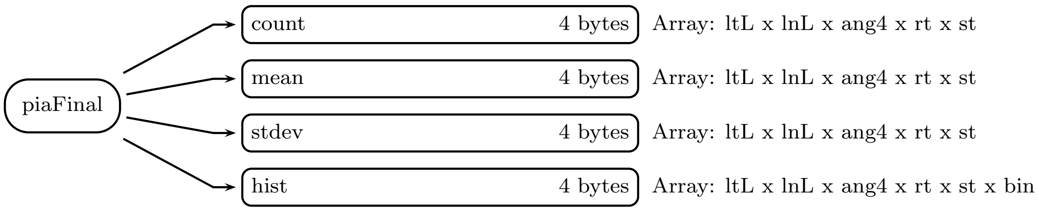


Figure 1012: Data Format Structure for 3PR, HS, G1, piaFinal

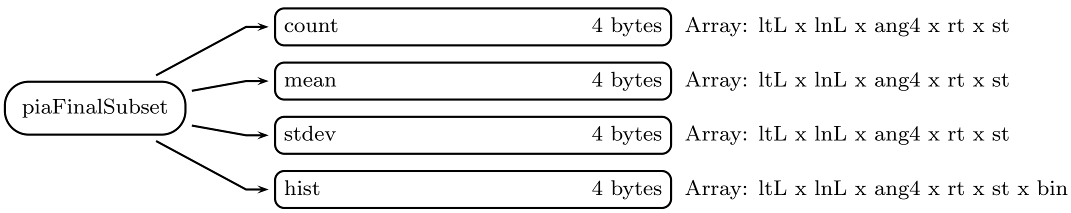


Figure 1013: Data Format Structure for 3PR, HS, G1, piaFinalSubset

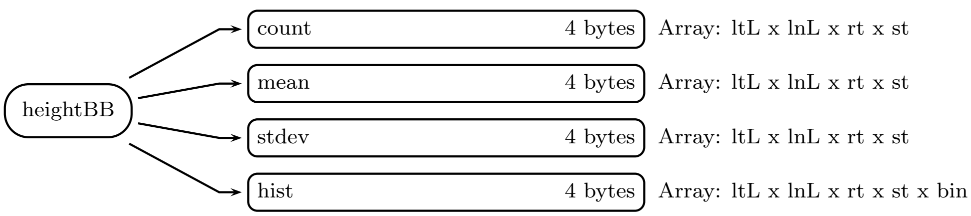


Figure 1014: Data Format Structure for 3PR, HS, G1, heightBB

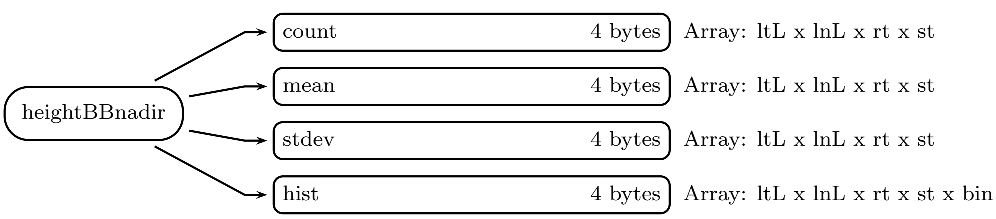


Figure 1015: Data Format Structure for 3PR, HS, G1, heightBBnadir

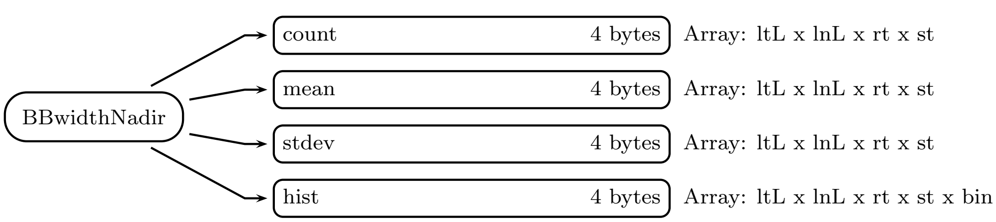


Figure 1016: Data Format Structure for 3PR, HS, G1, BBwidthNadir

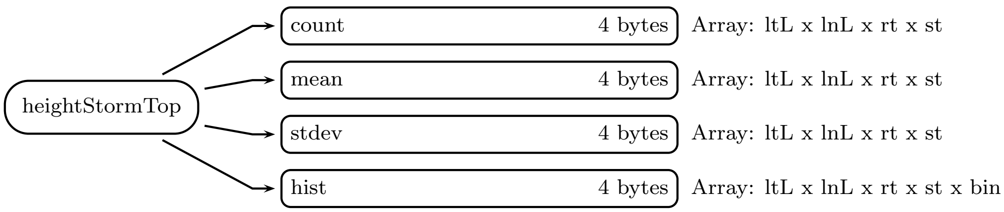


Figure 1017: Data Format Structure for 3PR, HS, G1, heightStormTop

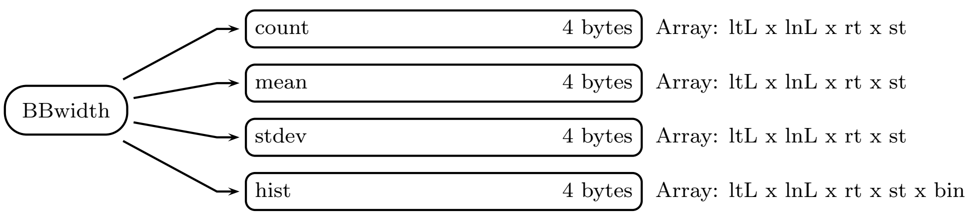


Figure 1018: Data Format Structure for 3PR, HS, G1, BBwidth

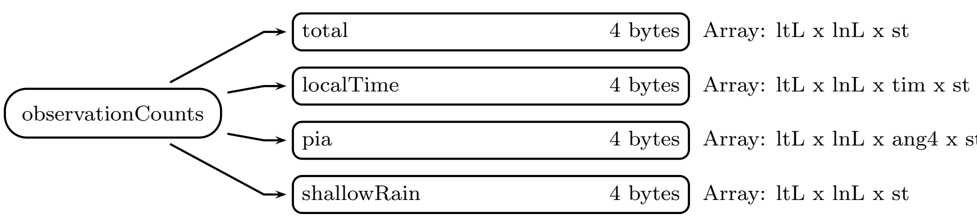


Figure 1019: Data Format Structure for 3PR, HS, G1, observationCounts

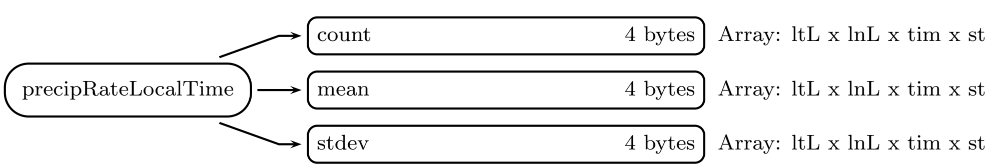


Figure 1020: Data Format Structure for 3PR, HS, G1, precipRateLocalTime

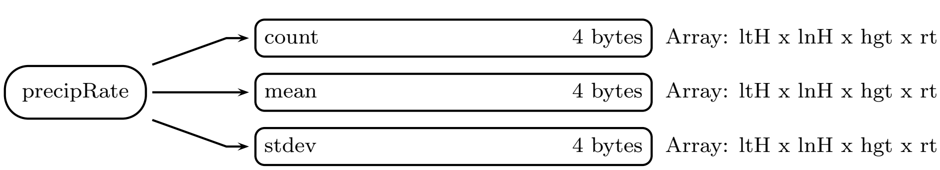


Figure 1021: Data Format Structure for 3PR, HS, G2, precipRate

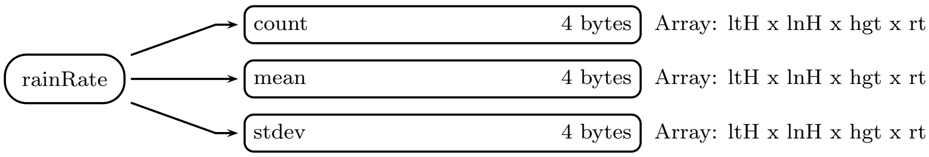


Figure 1022: Data Format Structure for 3PR, HS, G2, rainRate

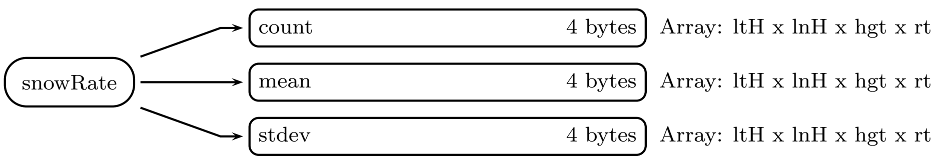


Figure 1023: Data Format Structure for 3PR, HS, G2, snowRate

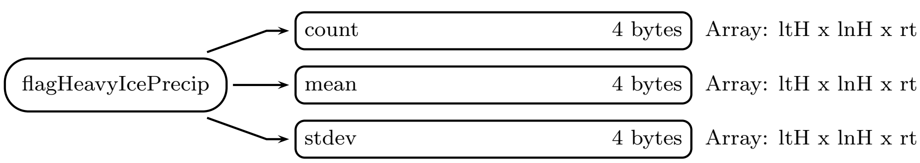


Figure 1024: Data Format Structure for 3PR, HS, G2, flagHeavyIcePrecip

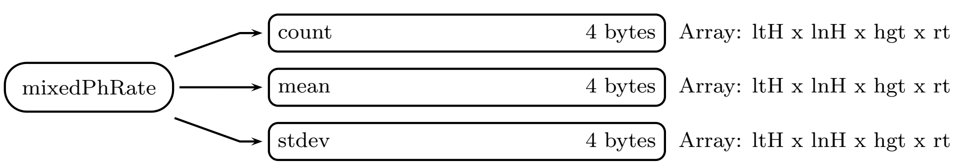


Figure 1025: Data Format Structure for 3PR, HS, G2, mixedPhRate

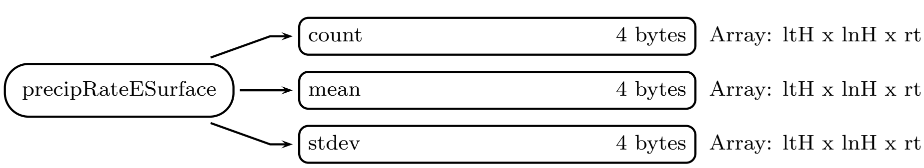


Figure 1026: Data Format Structure for 3PR, HS, G2, precipRateESurface

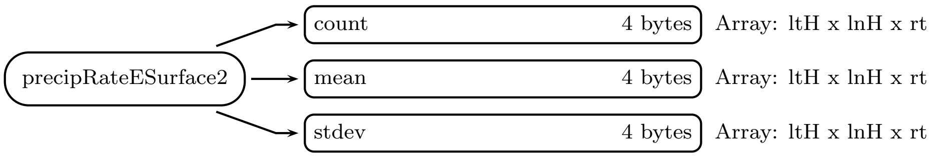


Figure 1027: Data Format Structure for 3PR, HS, G2, precipRateESurface2

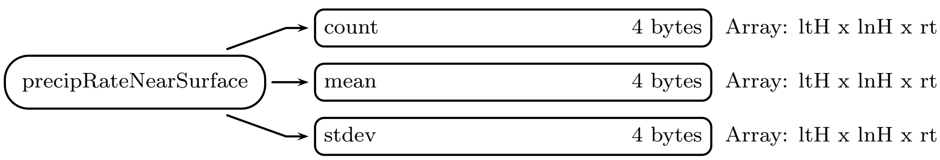


Figure 1028: Data Format Structure for 3PR, HS, G2, precipRateNearSurface

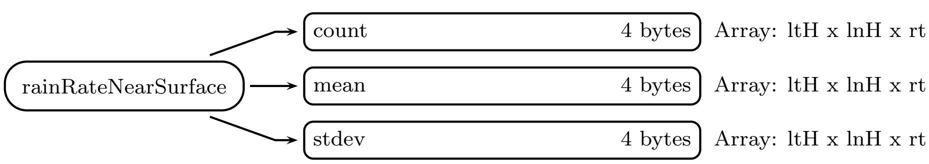


Figure 1029: Data Format Structure for 3PR, HS, G2, rainRateNearSurface

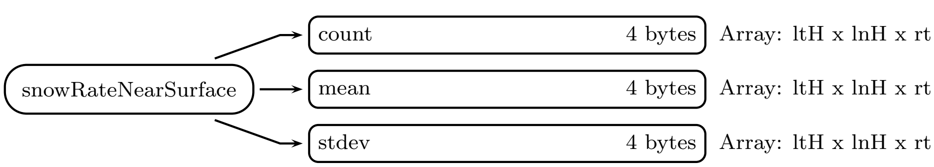


Figure 1030: Data Format Structure for 3PR, HS, G2, snowRateNearSurface

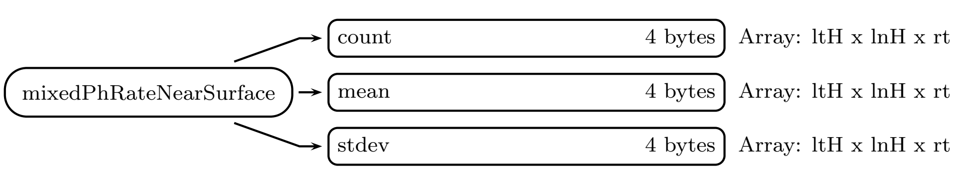


Figure 1031: Data Format Structure for 3PR, HS, G2, mixedPhRateNearSurface

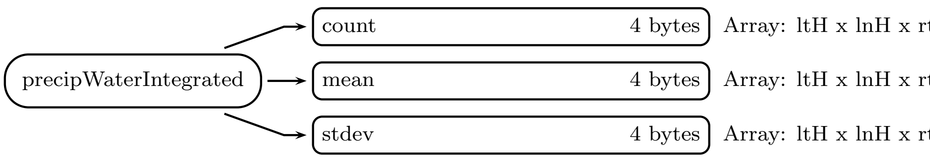


Figure 1032: Data Format Structure for 3PR, HS, G2, precipWaterIntegrated

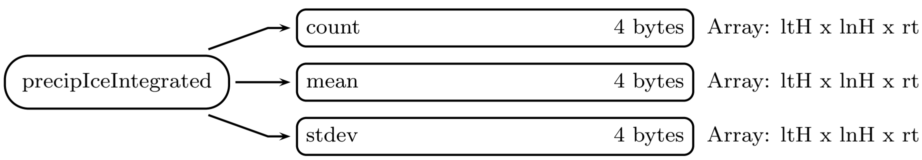


Figure 1033: Data Format Structure for 3PR, HS, G2, precipIceIntegrated

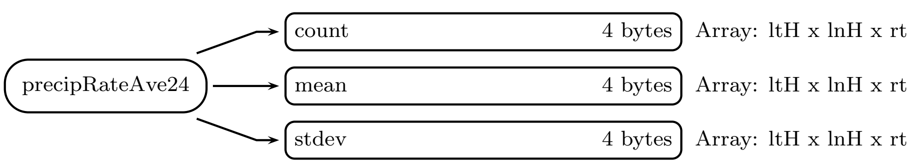


Figure 1034: Data Format Structure for 3PR, HS, G2, precipRateAve24

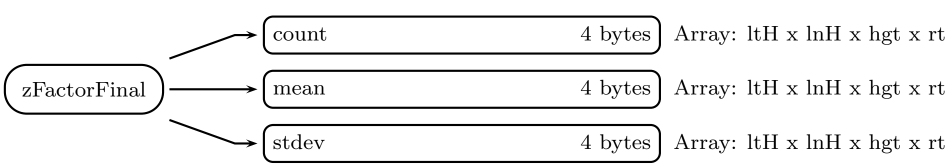


Figure 1035: Data Format Structure for 3PR, HS, G2, zFactorFinal

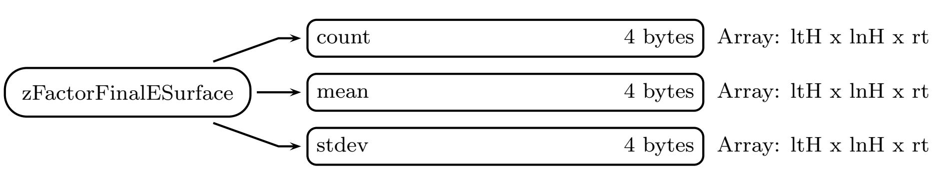


Figure 1036: Data Format Structure for 3PR, HS, G2, zFactorFinalESurface

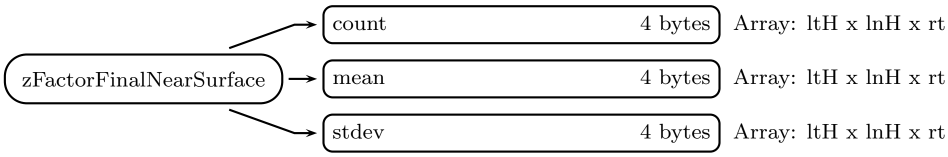


Figure 1037: Data Format Structure for 3PR, HS, G2, zFactorFinalNearSurface

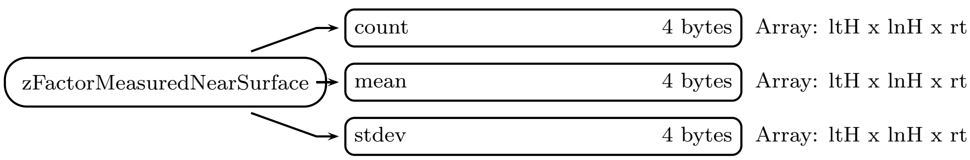


Figure 1038: Data Format Structure for 3PR, HS, G2, zFactorMeasuredNearSurface

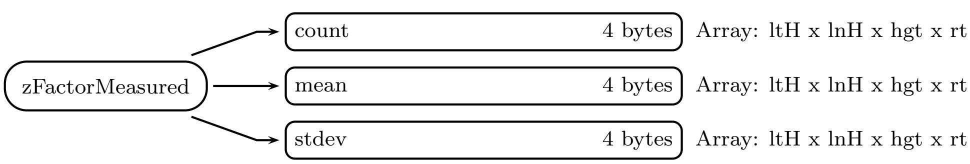


Figure 1039: Data Format Structure for 3PR, HS, G2, zFactorMeasured

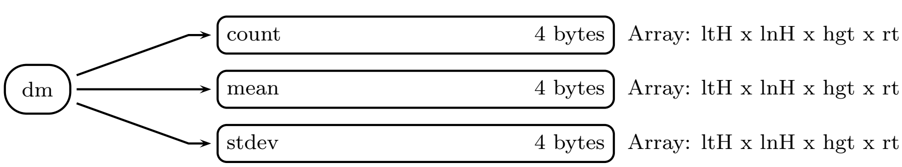


Figure 1040: Data Format Structure for 3PR, HS, G2, dm

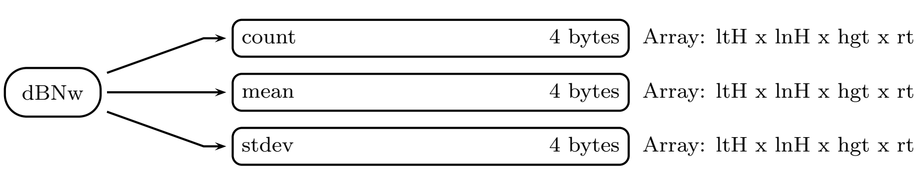


Figure 1041: Data Format Structure for 3PR, HS, G2, dBNw

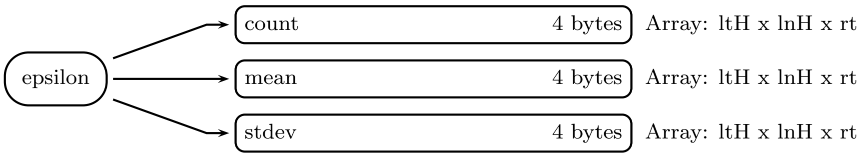


Figure 1042: Data Format Structure for 3PR, HS, G2, epsilon

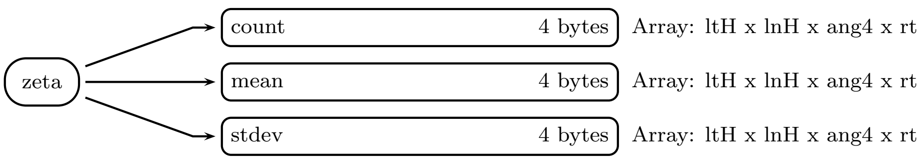


Figure 1043: Data Format Structure for 3PR, HS, G2, zeta

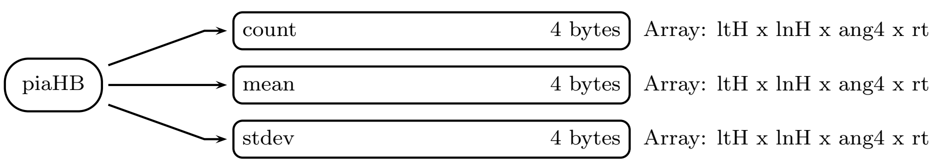


Figure 1044: Data Format Structure for 3PR, HS, G2, piaHB

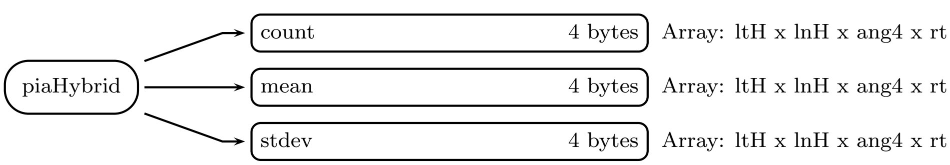


Figure 1045: Data Format Structure for 3PR, HS, G2, piaHybrid

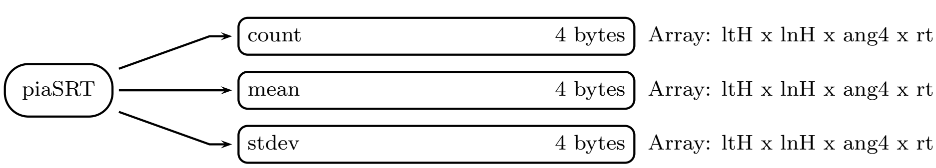


Figure 1046: Data Format Structure for 3PR, HS, G2, piaSRT

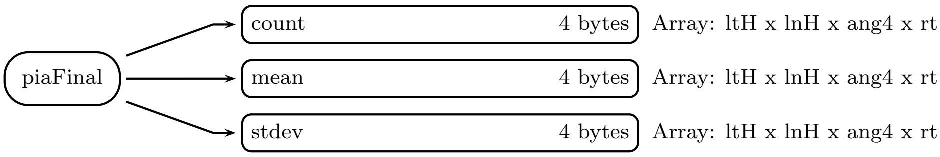


Figure 1047: Data Format Structure for 3PR, HS, G2, piaFinal

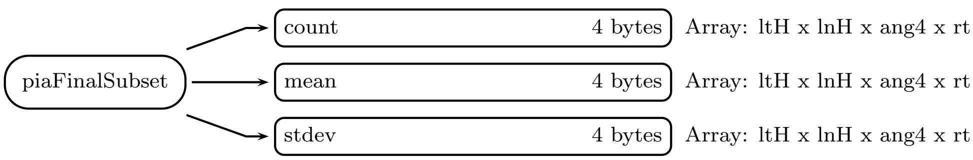


Figure 1048: Data Format Structure for 3PR, HS, G2, piaFinalSubset

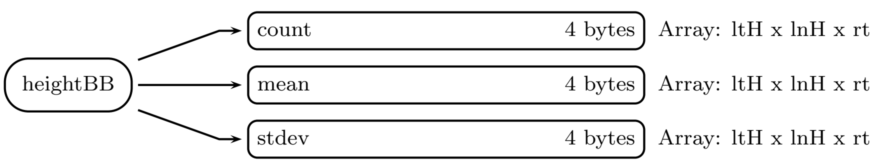


Figure 1049: Data Format Structure for 3PR, HS, G2, heightBB

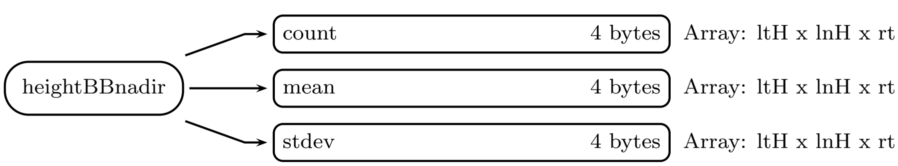


Figure 1050: Data Format Structure for 3PR, HS, G2, heightBBnadir

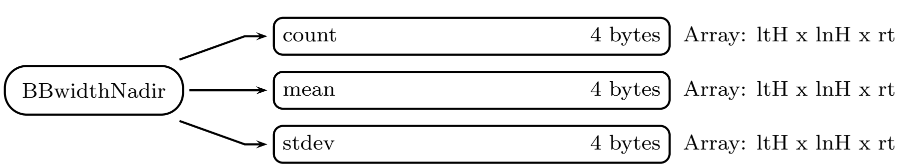


Figure 1051: Data Format Structure for 3PR, HS, G2, BBwidthNadir

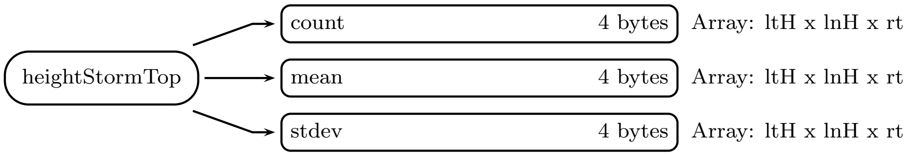


Figure 1052: Data Format Structure for 3PR, HS, G2, heightStormTop

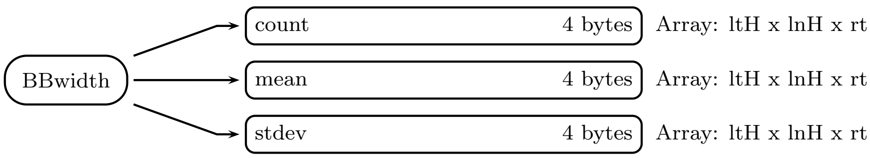


Figure 1053: Data Format Structure for 3PR, HS, G2, BBwidth

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

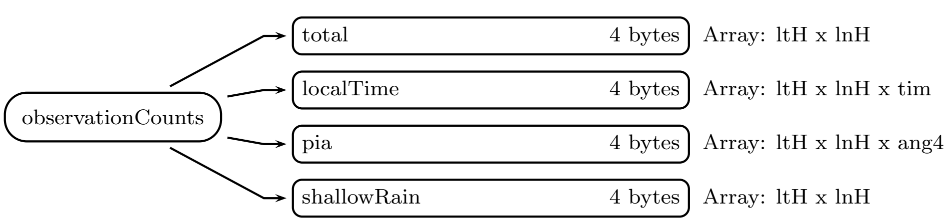


Figure 1054: Data Format Structure for 3PR, HS, G2, observationCounts

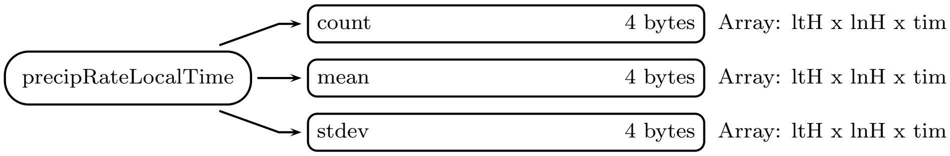


Figure 1055: Data Format Structure for 3PR, HS, G2, precipRateLocalTime

FS (Group)

G1 (Grid in FS)

G1_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in FS, G1)

Conditional Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRate (Group in FS, G1)

Conditional liquid water Rain Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRate (Group in FS, G1)

Conditional Snowfall Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

flagHeavyIcePrecip (Group in FS, G1)

Counts of the occurrence of flagHeavyIcePrecip. Mean and std. dev. are set to missing. The histogram contains counts of the integer flag values, with bins from 1 to 30.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRate (Group in FS, G1)

Conditional Mixed Phase Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface (Group in FS, G1)

Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface2 (Group in FS, G1)

Alternate Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateNearSurface (Group in FS, G1)

Conditional Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRateNearSurface (Group in FS, G1)

Unconditional liquid Rain Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRateNearSurface (Group in FS, G1)

Conditional Snow Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRateNearSurface (Group in FS, G1)

Conditional Mixed Phase Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipWaterIntegrated (Group in FS, G1)
Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipIceIntegrated (Group in FS, G1)
Integrated Precipitable Ice

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateAve24 (Group in FS, G1)
Average Precipitation Rate in 24hrs.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinal (Group in FS, G1)

Corrected Reflectivity

count (4-byte integer, array size: ltL x lnL x chn4 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinalESurface (Group in FS, G1)

Corrected Reflectivity at the Estimated Surface

count (4-byte integer, array size: ltL x lnL x chn4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinalNearSurface (Group in FS, G1)

Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorMeasuredNearSurface (Group in FS, G1)

Measured Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x chn4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorMeasured (Group in FS, G1)

Measured Reflectivity

count (4-byte integer, array size: ltL x lnL x chn4 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dm (Group in FS, G1)

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dBNw (Group in FS, G1)

count (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

epsilon (Group in FS, G1)

count (4-byte integer, array size: ltL x lnL x chn4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zeta (Group in FS, G1)

Integral of 0.2*ln(10)*alpha*Zm^{beta} over the slant range path where alpha and Zm are functions of range.

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaHB (Group in FS, G1)
Hitchfield-Bordan Path Integrated Attenuation for the slant range path.

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaHybrid (Group in FS, G1)
Weighted Hybrid PIA between the HB solution and the SRT PIA.

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaSRT (Group in FS, G1)
Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinal (Group in FS, G1)

Final Path Integrated Attenuation

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinalSubset (Group in FS, G1)

Final Path Integrated Attenuation Subset

count (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn4 x ang7 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn4 x ang7 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBB (Group in FS, G1)
Height of Bright Band.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBBnadir (Group in FS, G1)
Height of Bright Band from Nadir.

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidthNadir (Group in FS, G1)
Width of Bright Band at Nadir

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightStormTop (Group in FS, G1)

Storm Top Height

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidth (Group in FS, G1)

Bright Band Width

count (4-byte integer, array size: ltL x lnL x chn3 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x chn3 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

observationCounts (Group in FS, G1)

Observation Counts

total (4-byte integer, array size: ltL x lnL x chn3 x st):
Total obs. Special values are defined as:
-9999 Missing value

localTime (4-byte integer, array size: ltL x lnL x chn3 x tim x st):
obs time. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltL x lnL x chn3 x ang7 x st):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltL x lnL x chn3 x st):
obs time. Special values are defined as:
-9999 Missing value

precipRateLocalTime (Group in FS, G1)

Precipitation Rate by Local Time

count (4-byte integer, array size: ltL x lnL x chn3 x tim x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x chn3 x tim x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x chn3 x tim x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

DFRmNearSurface (Group in FS, G1)

DFRm at the Near Surface level

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

DFRNearSurface (Group in FS, G1)

DFR at the Near Surface level

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltL x lnL x chn3):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltL x lnL x chn3):
Probability of rain. Special values are defined as:
-9999.9 Missing value

G2 (Grid in FS)

G2_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in FS, G2)

Conditional Precipitation Rate

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRate (Group in FS, G2)

Conditional Liquid Rain Rate

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRate (Group in FS, G2)

Conditional Snow Rate

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

flagHeavyIcePrecip (Group in FS, G2)

Counts of the occurrence of flagHeavyIcePrecip. Mean and std. dev. are set to missing. The histogram contains counts of the integer flag values, with bins from 1 to 30.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRate (Group in FS, G2)

Conditional Preciptiation Rate of Mixed Phase

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface (Group in FS, G2)

Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface2 (Group in FS, G2)
Alternate Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurface (Group in FS, G2)
Conditional Precipitation Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRateNearSurface (Group in FS, G2)
Conditional Liquid Rain Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRateNearSurface (Group in FS, G2)
Conditional Snow Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRateNearSurface (Group in FS, G2)
Conditional Precipitation Rate of Mixed Phase at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (Group in FS, G2)
Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipIceIntegrated (Group in FS, G2)

Integrated Precipitable Ice

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (Group in FS, G2)

Conditional Precipitation Rate Averaged for 24hrs.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinal (Group in FS, G2)

Corrected Reflectivity.

count (4-byte integer, array size: ltH x lnH x chn4 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (Group in FS, G2)

Corrected Reflectivity Estimate at the Surface

count (4-byte integer, array size: ltH x lnH x chn4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (Group in FS, G2)

Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorMeasuredNearSurface (Group in FS, G2)

Measured Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x chn4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (Group in FS, G2)
Corrected Reflectivity

count (4-byte integer, array size: ltH x lnH x chn4 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dm (Group in FS, G2)
Mean Mass-Weighted Drop Diameter

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dBNw (Group in FS, G2)
Normalized Drop Concentration Parameter

count (4-byte integer, array size: ltH x lnH x chn3 x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

epsilon (Group in FS, G2)

count (4-byte integer, array size: ltH x lnH x chn4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zeta (Group in FS, G2)

Integral of 0.2*ln(10)*alpha*Zm^{beta} over the slant range path where alpha and Zm are functions of range.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaHB (Group in FS, G2)

Hitchfield-Bordan Path Integrated Attenuation for the slant range path.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaHybrid (Group in FS, G2)
Weighted Hybrid PIA between the HB solution and the SRT PIA.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaSRT (Group in FS, G2)
Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinal (Group in FS, G2)
Final Path Integrated Attenuation Estimate.

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinalSubset (Group in FS, G2)

Final Path Integrated Attenuation Subset

count (4-byte integer, array size: ltH x lnH x chn4 x ang7 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn4 x ang7 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightBB (Group in FS, G2)

Height Of the Bright Band.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightBBnadir (Group in FS, G2)

Height of Bright Band from Nadir.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

BBwidthNadir (Group in FS, G2)

Width of Bright Band at Nadir

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightStormTop (Group in FS, G2)

Height of the Storm Top.

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

BBwidth (Group in FS, G2)

Bright Band Width

count (4-byte integer, array size: ltH x lnH x chn3 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

observationCounts (Group in FS, G2)
Observation Counts.

total (4-byte integer, array size: ltH x lnH x chn3):
Total obs. Special values are defined as:
-9999 Missing value

localTime (4-byte integer, array size: ltH x lnH x chn3 x tim):
obs time. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltH x lnH x chn3 x ang7):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltH x lnH x chn3):
obs time. Special values are defined as:
-9999 Missing value

precipRateLocalTime (Group in FS, G2)
Precipitation Rate by Local Time

count (4-byte integer, array size: ltH x lnH x chn3 x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x chn3 x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x chn3 x tim):
Standard deviation. Special values are defined as:
-9999.9 Missing value

DFRmNearSurface (Group in FS, G2)
DFRm at the Near Surface level

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

DFRNearSurface (Group in FS, G2)

DFR at the Near Surface level

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltH x lnH x chn3):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltH x lnH x chn3):
Probability of rain. Special values are defined as:
-9999.9 Missing value

MS (Group)

G1 (Grid in MS)

Same as FS/G1 except all ang7 dimensions repaced by ang4

G2 (Grid in MS)

Same as FS/G2 except all ang7 dimensions repaced by ang4

HS (Group)

G1 (Grid in HS)

G1_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in HS, G1)

Conditional Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRate (Group in HS, G1)

Conditional liquid water Rain Rate.

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRate (Group in HS, G1)

Conditional Snowfall Rate.

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

flagHeavyIcePrecip (Group in HS, G1)

Counts of the occurrence of flagHeavyIcePrecip. Mean and std. dev. are set to missing. The histogram contains counts of the integer flag values, with bins from 1 to 30.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRate (Group in HS, G1)

Conditional Mixed Phase Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface (Group in HS, G1)

Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateESurface2 (Group in HS, G1)

Alternate Conditional Estimated Surface Precipitation Rate.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateNearSurface (Group in HS, G1)

Conditional Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

rainRateNearSurface (Group in HS, G1)

Unconditional liquid Rain Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

snowRateNearSurface (Group in HS, G1)

Conditional Snow Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

mixedPhRateNearSurface (Group in HS, G1)

Conditional Mixed Phase Precipitation Rate at Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipWaterIntegrated (Group in HS, G1)

Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipIceIntegrated (Group in HS, G1)

Integrated Precipitable Ice

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipRateAve24 (Group in HS, G1)

Average Precipitation Rate in 24hrs.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinal (Group in HS, G1)

Corrected Reflectivity

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinalESurface (Group in HS, G1)

Corrected Reflectivity at the Estimated Surface

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorFinalNearSurface (Group in HS, G1)

Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorMeasuredNearSurface (Group in HS, G1)

Measured Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zFactorMeasured (Group in HS, G1)

Measured Reflectivity

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dm (Group in HS, G1)

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

dBNw (Group in HS, G1)

count (4-byte integer, array size: ltL x lnL x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x hgt x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

epsilon (Group in HS, G1)

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

zeta (Group in HS, G1)

Integral of 0.2*ln(10)*alpha*Zm^{beta} over the slant range path where alpha and Zm are functions of range.

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaHB (Group in HS, G1)

Hitchfield-Bordan Path Integrated Attenuation for the slant range path.

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaHybrid (Group in HS, G1)

Weighted Hybrid PIA between the HB solution and the SRT PIA.

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaSRT (Group in HS, G1)

Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinal (Group in HS, G1)

Final Path Integrated Attenuation

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

piaFinalSubset (Group in HS, G1)

Final Path Integrated Attenuation Subset

count (4-byte integer, array size: ltL x lnL x ang4 x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ang4 x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ang4 x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ang4 x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBB (Group in HS, G1)
Height of Bright Band.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightBBnadir (Group in HS, G1)
Height of Bright Band from Nadir.

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidthNadir (Group in HS, G1)
Width of Bright Band at Nadir

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

heightStormTop (Group in HS, G1)

Storm Top Height

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

BBwidth (Group in HS, G1)

Bright Band Width

count (4-byte integer, array size: ltL x lnL x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x rt x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

observationCounts (Group in HS, G1)

Observation Counts

total (4-byte integer, array size: ltL x lnL x st):
Total obs. Special values are defined as:
-9999 Missing value

localTime (4-byte integer, array size: ltL x lnL x tim x st):
obs time. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltL x lnL x ang4 x st):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltL x lnL x st):
obs time. Special values are defined as:
-9999 Missing value

precipRateLocalTime (Group in HS, G1)

Precipitation Rate by Local Time

count (4-byte integer, array size: ltL x lnL x tim x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x tim x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x tim x st):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltL x lnL):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltL x lnL):
Probability of rain. Special values are defined as:
-9999.9 Missing value

G2 (Grid in HS)

G2_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

precipRate (Group in HS, G2)
Conditional Precipitation Rate

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRate (Group in HS, G2)
Conditional Liquid Rain Rate

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRate (Group in HS, G2)
Conditional Snow Rate

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

flagHeavyIcePrecip (Group in HS, G2)

Counts of the occurrence of flagHeavyIcePrecip. Mean and std. dev. are set to missing. The histogram contains counts of the integer flag values, with bins from 1 to 30.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRate (Group in HS, G2)

Conditional Preciptiation Rate of Mixed Phase

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface (Group in HS, G2)

Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateESurface2 (Group in HS, G2)
Alternate Conditional Estimated Precipitation Rate at the Surface

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurface (Group in HS, G2)
Conditional Precipitation Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

rainRateNearSurface (Group in HS, G2)
Conditional Liquid Rain Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

snowRateNearSurface (Group in HS, G2)

Conditional Snow Rate at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

mixedPhRateNearSurface (Group in HS, G2)

Conditional Precipitation Rate of Mixed Phase at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (Group in HS, G2)

Integrated Precipitable Water (g/m^2).

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipIceIntegrated (Group in HS, G2)
Integrated Precipitable Ice

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (Group in HS, G2)
Conditional Precipitation Rate Averaged for 24hrs.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinal (Group in HS, G2)
Corrected Reflectivity.

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinalESurface (Group in HS, G2)

Corrected Reflectivity Estimate at the Surface

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorFinalNearSurface (Group in HS, G2)

Corrected Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorMeasuredNearSurface (Group in HS, G2)

Measured Reflectivity at the Near Surface Level.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (Group in HS, G2)

Corrected Reflectivity

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dm (Group in HS, G2)

Mean Mass-Weighted Drop Diameter

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

dBNw (Group in HS, G2)

Normalized Drop Concentration Parameter

count (4-byte integer, array size: ltH x lnH x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x hgt x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

epsilon (Group in HS, G2)

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

zeta (Group in HS, G2)

Integral of 0.2*ln(10)*alpha*Zm^{beta} over the slant range path where alpha and Zm are functions of range.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaHB (Group in HS, G2)

Hitchfield-Bordan Path Integrated Attenuation for the slant range path.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaHybrid (Group in HS, G2)
Weighted Hybrid PIA between the HB solution and the SRT PIA.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaSRT (Group in HS, G2)
Path Integrated Attenuation from SRT.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinal (Group in HS, G2)
Final Path Integrated Attenuation Estimate.

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

piaFinalSubset (Group in HS, G2)

Final Path Integrated Attenuation Subset

count (4-byte integer, array size: ltH x lnH x ang4 x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ang4 x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ang4 x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightBB (Group in HS, G2)

Height Of the Bright Band.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightBBnadir (Group in HS, G2)

Height of Bright Band from Nadir.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

BBwidthNadir (Group in HS, G2)
Width of Bright Band at Nadir

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

heightStormTop (Group in HS, G2)
Height of the Storm Top.

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

BBwidth (Group in HS, G2)
Bright Band Width

count (4-byte integer, array size: ltH x lnH x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x rt):
Standard deviation. Special values are defined as:
-9999.9 Missing value

observationCounts (Group in HS, G2)
Observation Counts.

total (4-byte integer, array size: ltH x lnH):
Total obs. Special values are defined as:
-9999 Missing value

localTime (4-byte integer, array size: ltH x lnH x tim):
obs time. Special values are defined as:
-9999 Missing value

pia (4-byte integer, array size: ltH x lnH x ang4):
obs PIA. Special values are defined as:
-9999 Missing value

shallowRain (4-byte integer, array size: ltH x lnH):
obs time. Special values are defined as:
-9999 Missing value

precipRateLocalTime (Group in HS, G2)
Precipitation Rate by Local Time

count (4-byte integer, array size: ltH x lnH x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x tim):
Standard deviation. Special values are defined as:
-9999.9 Missing value

precipRateNearSurfaceUnconditional (4-byte float, array size: ltH x lnH):
Rain, not conditioned on rain. Special values are defined as:
-9999.9 Missing value

precipProbabilityNearSurface (4-byte float, array size: ltH x lnH):
Probability of rain. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3PR_H_
#define _TK_3PR_H_

#ifndef _L3PR_HS_G2_PRECIPRATELOCALTIME_
#define _L3PR_HS_G2_PRECIPRATELOCALTIME_

typedef struct {
    int count[24][1440][536];
    float mean[24][1440][536];
    float stdev[24][1440][536];
} L3PR_HS_G2_PRECIPRATELOCALTIME;

#endif

#ifndef _L3PR_HS_G2_OBSERVATIONCOUNTS_
#define _L3PR_HS_G2_OBSERVATIONCOUNTS_

typedef struct {
    int total[1440][536];
    int localTime[24][1440][536];
    int pia[4][1440][536];
    int shallowRain[1440][536];
} L3PR_HS_G2_OBSERVATIONCOUNTS;

#endif

#ifndef _L3PR_HS_G2_BBWIDTH_
#define _L3PR_HS_G2_BBWIDTH_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_BBWIDTH;

#endif

#ifndef _L3PR_HS_G2_HEIGHTSTORMTOP_
```

```
#define _L3PR_HS_G2_HEIGHTSTORMTOP_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_HEIGHTSTORMTOP;

#endif

#ifndef _L3PR_HS_G2_BBWIDTHNADIR_
#define _L3PR_HS_G2_BBWIDTHNADIR_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_BBWIDTHNADIR;

#endif

#ifndef _L3PR_HS_G2_HEIGHTBBNADIR_
#define _L3PR_HS_G2_HEIGHTBBNADIR_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_HEIGHTBBNADIR;

#endif

#ifndef _L3PR_HS_G2_HEIGHTBB_
#define _L3PR_HS_G2_HEIGHTBB_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_HEIGHTBB;

#endif
```

```
#ifndef _L3PR_HS_G2_PIAFINALSUBSET_
#define _L3PR_HS_G2_PIAFINALSUBSET_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_HS_G2_PIAFINALSUBSET;

#endif

#ifndef _L3PR_HS_G2_PIAFINAL_
#define _L3PR_HS_G2_PIAFINAL_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_HS_G2_PIAFINAL;

#endif

#ifndef _L3PR_HS_G2_PIASRT_
#define _L3PR_HS_G2_PIASRT_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_HS_G2_PIASRT;

#endif

#ifndef _L3PR_HS_G2_PIAHYBRID_
#define _L3PR_HS_G2_PIAHYBRID_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_HS_G2_PIAHYBRID;

#endif
```

```
#ifndef _L3PR_HS_G2_PIAHB_
#define _L3PR_HS_G2_PIAHB_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_HS_G2_PIAHB;

#endif

#ifndef _L3PR_HS_G2_ZETA_
#define _L3PR_HS_G2_ZETA_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_HS_G2_ZETA;

#endif

#ifndef _L3PR_HS_G2_EPSILON_
#define _L3PR_HS_G2_EPSILON_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_EPSILON;

#endif

#ifndef _L3PR_HS_G2_DBNW_
#define _L3PR_HS_G2_DBNW_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3PR_HS_G2_DBNW;
```

```
#endif

#ifndef _L3PR_HS_G2_DM_
#define _L3PR_HS_G2_DM_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3PR_HS_G2_DM;

#endif

#ifndef _L3PR_HS_G2_ZFACTORMEASURED_
#define _L3PR_HS_G2_ZFACTORMEASURED_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3PR_HS_G2_ZFACTORMEASURED;

#endif

#ifndef _L3PR_HS_G2_ZFACTORMEASUREDNEARSURFACE_
#define _L3PR_HS_G2_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3PR_HS_G2_ZFACTORFINALNEARSURFACE_
#define _L3PR_HS_G2_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_ZFACTORFINALNEARSURFACE;
```

```
#endif

#ifndef _L3PR_HS_G2_ZFACTORFINALESURFACE_
#define _L3PR_HS_G2_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_ZFACTORFINALESURFACE;

#endif

#ifndef _L3PR_HS_G2_ZFACTORFINAL_
#define _L3PR_HS_G2_ZFACTORFINAL_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3PR_HS_G2_ZFACTORFINAL;

#endif

#ifndef _L3PR_HS_G2_PRECIPRATEAVE24_
#define _L3PR_HS_G2_PRECIPRATEAVE24_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_PRECIPRATEAVE24;

#endif

#ifndef _L3PR_HS_G2_PRECIPICEINTEGRATED_
#define _L3PR_HS_G2_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
```

```
} L3PR_HS_G2_PRECIPICEINTEGRATED;

#endif

#ifndef _L3PR_HS_G2_PRECIPWATERINTEGRATED_
#define _L3PR_HS_G2_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3PR_HS_G2_MIXEDPHRATENEARSURFACE_
#define _L3PR_HS_G2_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3PR_HS_G2_SNOWRATENEARSURFACE_
#define _L3PR_HS_G2_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_SNOWRATENEARSURFACE;

#endif

#ifndef _L3PR_HS_G2_RAINRATENEARSURFACE_
#define _L3PR_HS_G2_RAINRATENEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
```

```
    float stdev[3][1440][536];
} L3PR_HS_G2_RAINRATENEARSURFACE;

#endif

#ifndef _L3PR_HS_G2_PRECIPRATENEARSURFACE_
#define _L3PR_HS_G2_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3PR_HS_G2_PRECIPRATEESURFACE2_
#define _L3PR_HS_G2_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_PRECIPRATEESURFACE2;

#endif

#ifndef _L3PR_HS_G2_PRECIPRATEESURFACE_
#define _L3PR_HS_G2_PRECIPRATEESURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_PRECIPRATEESURFACE;

#endif

#ifndef _L3PR_HS_G2_MIXEDPHRATE_
#define _L3PR_HS_G2_MIXEDPHRATE_

typedef struct {
    int count[3][5][1440][536];
```

```
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3PR_HS_G2_MIXEDPHRATE;

#endif

#ifndef _L3PR_HS_G2_FLAGHEAVYICEPRECIP_
#define _L3PR_HS_G2_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_HS_G2_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3PR_HS_G2_SNOWRATE_
#define _L3PR_HS_G2_SNOWRATE_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3PR_HS_G2_SNOWRATE;

#endif

#ifndef _L3PR_HS_G2_RAINRATE_
#define _L3PR_HS_G2_RAINRATE_

typedef struct {
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3PR_HS_G2_RAINRATE;

#endif

#ifndef _L3PR_HS_G2_PRECIPRATE_
#define _L3PR_HS_G2_PRECIPRATE_

typedef struct {
```

```
    int count[3][5][1440][536];
    float mean[3][5][1440][536];
    float stdev[3][5][1440][536];
} L3PR_HS_G2_PRECIPRATE;

#endif

#ifndef _L3PR_HS_G2_
#define _L3PR_HS_G2_

typedef struct {
    L3PR_HS_G2_PRECIPRATE precipRate;
    L3PR_HS_G2_RAINRATE rainRate;
    L3PR_HS_G2_SNOWRATE snowRate;
    L3PR_HS_G2_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3PR_HS_G2_MIXEDPHRATE mixedPhRate;
    L3PR_HS_G2_PRECIPRATEESURFACE precipRateESurface;
    L3PR_HS_G2_PRECIPRATEESURFACE2 precipRateESurface2;
    L3PR_HS_G2_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3PR_HS_G2_RAINRATENEARSURFACE rainRateNearSurface;
    L3PR_HS_G2_SNOWRATENEARSURFACE snowRateNearSurface;
    L3PR_HS_G2_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3PR_HS_G2_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3PR_HS_G2_PRECIPICEINTEGRATED precipIceIntegrated;
    L3PR_HS_G2_PRECIPRATEAVE24 precipRateAve24;
    L3PR_HS_G2_ZFACTORFINAL zFactorFinal;
    L3PR_HS_G2_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3PR_HS_G2_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3PR_HS_G2_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3PR_HS_G2_ZFACTORMEASURED zFactorMeasured;
    L3PR_HS_G2_DM dm;
    L3PR_HS_G2_DBNW dBNw;
    L3PR_HS_G2_EPSILON epsilon;
    L3PR_HS_G2_ZETA zeta;
    L3PR_HS_G2_PIAHB piaHB;
    L3PR_HS_G2_PIAHYBRID piaHybrid;
    L3PR_HS_G2_PIASRT piaSRT;
    L3PR_HS_G2_PIAFINAL piaFinal;
    L3PR_HS_G2_PIAFINALSUBSET piaFinalSubset;
    L3PR_HS_G2_HEIGHTBB heightBB;
    L3PR_HS_G2_HEIGHTBBNADIR heightBBnadir;
    L3PR_HS_G2_BBWIDTHNADIR BBwidthNadir;
    L3PR_HS_G2_HEIGHTSTORMTOP heightStormTop;
```

```
    L3PR_HS_G2_BBWIDTH BBwidth;
    L3PR_HS_G2_OBSERVATIONCOUNTS observationCounts;
    L3PR_HS_G2_PRECIPRATELOCALTIME precipRateLocalTime;
    float precipRateNearSurfaceUnconditional[1440][536];
    float precipProbabilityNearSurface[1440][536];
} L3PR_HS_G2;

#endif

#ifndef _L3PR_HS_G1_PRECIPRATELOCALTIME_
#define _L3PR_HS_G1_PRECIPRATELOCALTIME_

typedef struct {
    int count[3][24][72][28];
    float mean[3][24][72][28];
    float stdev[3][24][72][28];
} L3PR_HS_G1_PRECIPRATELOCALTIME;

#endif

#ifndef _L3PR_HS_G1_OBSERVATIONCOUNTS_
#define _L3PR_HS_G1_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][72][28];
    int localTime[3][24][72][28];
    int pia[3][4][72][28];
    int shallowRain[3][72][28];
} L3PR_HS_G1_OBSERVATIONCOUNTS;

#endif

#ifndef _L3PR_HS_G1_BBWIDTH_
#define _L3PR_HS_G1_BBWIDTH_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_BBWIDTH;

#endif
```

```
#ifndef _L3PR_HS_G1_HEIGHTSTORMTOP_
#define _L3PR_HS_G1_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_HEIGHTSTORMTOP;

#endif

#ifndef _L3PR_HS_G1_BBWIDTHNADIR_
#define _L3PR_HS_G1_BBWIDTHNADIR_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_BBWIDTHNADIR;

#endif

#ifndef _L3PR_HS_G1_HEIGHTBBNADIR_
#define _L3PR_HS_G1_HEIGHTBBNADIR_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_HEIGHTBBNADIR;

#endif

#ifndef _L3PR_HS_G1_HEIGHTBB_
#define _L3PR_HS_G1_HEIGHTBB_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
```

```
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_HEIGHTBB;

#endif

#ifndef _L3PR_HS_G1_PIAFINALSUBSET_
#define _L3PR_HS_G1_PIAFINALSUBSET_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_HS_G1_PIAFINALSUBSET;

#endif

#ifndef _L3PR_HS_G1_PIAFINAL_
#define _L3PR_HS_G1_PIAFINAL_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_HS_G1_PIAFINAL;

#endif

#ifndef _L3PR_HS_G1_PIASRT_
#define _L3PR_HS_G1_PIASRT_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_HS_G1_PIASRT;

#endif

#ifndef _L3PR_HS_G1_PIAHYBRID_
```

```
#define _L3PR_HS_G1_PIAHYBRID_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_HS_G1_PIAHYBRID;

#endif

#ifndef _L3PR_HS_G1_PIAHB_
#define _L3PR_HS_G1_PIAHB_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_HS_G1_PIAHB;

#endif

#ifndef _L3PR_HS_G1_ZETA_
#define _L3PR_HS_G1_ZETA_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_HS_G1_ZETA;

#endif

#ifndef _L3PR_HS_G1_EPSILON_
#define _L3PR_HS_G1_EPSILON_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
```

```
} L3PR_HS_G1_EPSILON;

#endif

#ifndef _L3PR_HS_G1_DBNW_
#define _L3PR_HS_G1_DBNW_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3PR_HS_G1_DBNW;

#endif

#ifndef _L3PR_HS_G1_DM_
#define _L3PR_HS_G1_DM_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3PR_HS_G1_DM;

#endif

#ifndef _L3PR_HS_G1_ZFACTORMEASURED_
#define _L3PR_HS_G1_ZFACTORMEASURED_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3PR_HS_G1_ZFACTORMEASURED;

#endif

#ifndef _L3PR_HS_G1_ZFACTORMEASUREDNEARSURFACE_
#define _L3PR_HS_G1_ZFACTORMEASUREDNEARSURFACE_
```

```
typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3PR_HS_G1_ZFACTORFINALNEARSURFACE_
#define _L3PR_HS_G1_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3PR_HS_G1_ZFACTORFINALESURFACE_
#define _L3PR_HS_G1_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_ZFACTORFINALESURFACE;

#endif

#ifndef _L3PR_HS_G1_ZFACTORFINAL_
#define _L3PR_HS_G1_ZFACTORFINAL_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3PR_HS_G1_ZFACTORFINAL;
```

```
#endif

#ifndef _L3PR_HS_G1_PRECIPRATEAVE24_
#define _L3PR_HS_G1_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_PRECIPRATEAVE24;

#endif

#ifndef _L3PR_HS_G1_PRECIPICEINTEGRATED_
#define _L3PR_HS_G1_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_PRECIPICEINTEGRATED;

#endif

#ifndef _L3PR_HS_G1_PRECIPWATERINTEGRATED_
#define _L3PR_HS_G1_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3PR_HS_G1_MIXEDPHRATENEARSURFACE_
#define _L3PR_HS_G1_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][3][72][28];
```

```
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3PR_HS_G1_SNOWRATENEARSURFACE_
#define _L3PR_HS_G1_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_SNOWRATENEARSURFACE;

#endif

#ifndef _L3PR_HS_G1_RAINRATENEARSURFACE_
#define _L3PR_HS_G1_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_RAINRATENEARSURFACE;

#endif

#ifndef _L3PR_HS_G1_PRECIPRATENEARSURFACE_
#define _L3PR_HS_G1_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_PRECIPRATENEARSURFACE;

#endif
```

```
#ifndef _L3PR_HS_G1_PRECIPRATEESURFACE2_
#define _L3PR_HS_G1_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_PRECIPRATEESURFACE2;

#endif

#ifndef _L3PR_HS_G1_PRECIPRATEESURFACE_
#define _L3PR_HS_G1_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_HS_G1_PRECIPRATEESURFACE;

#endif

#ifndef _L3PR_HS_G1_MIXEDPHRATE_
#define _L3PR_HS_G1_MIXEDPHRATE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3PR_HS_G1_MIXEDPHRATE;

#endif

#ifndef _L3PR_HS_G1_FLAGHEAVYICEPRECIP_
#define _L3PR_HS_G1_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
```

```
    int hist[30][3][3][72][28];
} L3PR_HS_G1_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3PR_HS_G1_SNOWRATE_
#define _L3PR_HS_G1_SNOWRATE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3PR_HS_G1_SNOWRATE;

#endif

#ifndef _L3PR_HS_G1_RAINRATE_
#define _L3PR_HS_G1_RAINRATE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3PR_HS_G1_RAINRATE;

#endif

#ifndef _L3PR_HS_G1_PRECIPRATE_
#define _L3PR_HS_G1_PRECIPRATE_

typedef struct {
    int count[3][3][5][72][28];
    float mean[3][3][5][72][28];
    float stdev[3][3][5][72][28];
    int hist[30][3][3][5][72][28];
} L3PR_HS_G1_PRECIPRATE;

#endif

#ifndef _L3PR_HS_G1_
#define _L3PR_HS_G1_
```

```
typedef struct {
    L3PR_HS_G1_PRECIPRATE precipRate;
    L3PR_HS_G1_RAINRATE rainRate;
    L3PR_HS_G1_SNOWRATE snowRate;
    L3PR_HS_G1_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3PR_HS_G1_MIXEDPHRATE mixedPhRate;
    L3PR_HS_G1_PRECIPRATEESURFACE precipRateESurface;
    L3PR_HS_G1_PRECIPRATEESURFACE2 precipRateESurface2;
    L3PR_HS_G1_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3PR_HS_G1_RAINRATENEARSURFACE rainRateNearSurface;
    L3PR_HS_G1_SNOWRATENEARSURFACE snowRateNearSurface;
    L3PR_HS_G1_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3PR_HS_G1_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3PR_HS_G1_PRECIPICEINTEGRATED precipIceIntegrated;
    L3PR_HS_G1_PRECIPRATEAVE24 precipRateAve24;
    L3PR_HS_G1_ZFACTORFINAL zFactorFinal;
    L3PR_HS_G1_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3PR_HS_G1_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3PR_HS_G1_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3PR_HS_G1_ZFACTORMEASURED zFactorMeasured;
    L3PR_HS_G1_DM dm;
    L3PR_HS_G1_DBNW dBNw;
    L3PR_HS_G1_EPSILON epsilon;
    L3PR_HS_G1_ZETA zeta;
    L3PR_HS_G1_PIAHB piaHB;
    L3PR_HS_G1_PIAHYBRID piaHybrid;
    L3PR_HS_G1_PIASRT piaSRT;
    L3PR_HS_G1_PIAFINAL piaFinal;
    L3PR_HS_G1_PIAFINALSUBSET piaFinalSubset;
    L3PR_HS_G1_HEIGHTBB heightBB;
    L3PR_HS_G1_HEIGHTBBNADIR heightBBnadir;
    L3PR_HS_G1_BBWIDTHNADIR BBwidthNadir;
    L3PR_HS_G1_HEIGHTSTORMTOP heightStormTop;
    L3PR_HS_G1_BBWIDTH BBwidth;
    L3PR_HS_G1_OBSERVATIONCOUNTS observationCounts;
    L3PR_HS_G1_PRECIPRATELOCALTIME precipRateLocalTime;
    float precipRateNearSurfaceUnconditional[72][28];
    float precipProbabilityNearSurface[72][28];
} L3PR_HS_G1;

#endif
```

```
#ifndef _L3PR_HS_
#define _L3PR_HS_

typedef struct {
    L3PR_HS_G1 G1;
    L3PR_HS_G2 G2;
} L3PR_HS;

#endif

#ifndef _L3PR_MS_G2_DFRNEARSURFACE_
#define _L3PR_MS_G2_DFRNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_MS_G2_DFRNEARSURFACE;

#endif

#ifndef _L3PR_MS_G2_DFRMNEARSURFACE_
#define _L3PR_MS_G2_DFRMNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_MS_G2_DFRMNEARSURFACE;

#endif

#ifndef _L3PR_MS_G2_PRECIPRATELOCALTIME_
#define _L3PR_MS_G2_PRECIPRATELOCALTIME_

typedef struct {
    int count[24][3][1440][536];
    float mean[24][3][1440][536];
    float stdev[24][3][1440][536];
} L3PR_MS_G2_PRECIPRATELOCALTIME;

#endif
```

```
#ifndef _L3PR_MS_G2_OBSERVATIONCOUNTS_
#define _L3PR_MS_G2_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][1440][536];
    int localTime[24][3][1440][536];
    int pia[4][3][1440][536];
    int shallowRain[3][1440][536];
} L3PR_MS_G2_OBSERVATIONCOUNTS;

#endif

#ifndef _L3PR_MS_G2_BBWIDTH_
#define _L3PR_MS_G2_BBWIDTH_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_BBWIDTH;

#endif

#ifndef _L3PR_MS_G2_HEIGHTSTORMTOP_
#define _L3PR_MS_G2_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_HEIGHTSTORMTOP;

#endif

#ifndef _L3PR_MS_G2_BBWIDTHNADIR_
#define _L3PR_MS_G2_BBWIDTHNADIR_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_BBWIDTHNADIR;
```

```
#endif

#ifndef _L3PR_MS_G2_HEIGHTBBNADIR_
#define _L3PR_MS_G2_HEIGHTBBNADIR_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_HEIGHTBBNADIR;

#endif

#ifndef _L3PR_MS_G2_HEIGHTBB_
#define _L3PR_MS_G2_HEIGHTBB_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_HEIGHTBB;

#endif

#ifndef _L3PR_MS_G2_PIAFINALSUBSET_
#define _L3PR_MS_G2_PIAFINALSUBSET_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3PR_MS_G2_PIAFINALSUBSET;

#endif

#ifndef _L3PR_MS_G2_PIAFINAL_
#define _L3PR_MS_G2_PIAFINAL_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3PR_MS_G2_PIAFINAL;
```

```
#endif

#ifndef _L3PR_MS_G2_PIASRT_
#define _L3PR_MS_G2_PIASRT_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3PR_MS_G2_PIASRT;

#endif

#ifndef _L3PR_MS_G2_PIAHYBRID_
#define _L3PR_MS_G2_PIAHYBRID_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3PR_MS_G2_PIAHYBRID;

#endif

#ifndef _L3PR_MS_G2_PIAHB_
#define _L3PR_MS_G2_PIAHB_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
} L3PR_MS_G2_PIAHB;

#endif

#ifndef _L3PR_MS_G2_ZETA_
#define _L3PR_MS_G2_ZETA_

typedef struct {
    int count[3][4][4][1440][536];
    float mean[3][4][4][1440][536];
    float stdev[3][4][4][1440][536];
```

```
} L3PR_MS_G2_ZETA;

#endif

#ifndef _L3PR_MS_G2_EPSILON_
#define _L3PR_MS_G2_EPSILON_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_MS_G2_EPSILON;

#endif

#ifndef _L3PR_MS_G2_DBNW_
#define _L3PR_MS_G2_DBNW_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_MS_G2_DBNW;

#endif

#ifndef _L3PR_MS_G2_DM_
#define _L3PR_MS_G2_DM_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_MS_G2_DM;

#endif

#ifndef _L3PR_MS_G2_ZFACTORMEASURED_
#define _L3PR_MS_G2_ZFACTORMEASURED_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
```

```
    float stdev[3][5][4][1440][536];
} L3PR_MS_G2_ZFACTORMEASURED;

#endif

#ifndef _L3PR_MS_G2_ZFACTORMEASUREDNEARSURFACE_
#define _L3PR_MS_G2_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_MS_G2_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3PR_MS_G2_ZFACTORFINALNEARSURFACE_
#define _L3PR_MS_G2_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_MS_G2_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3PR_MS_G2_ZFACTORFINALESURFACE_
#define _L3PR_MS_G2_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_MS_G2_ZFACTORFINALESURFACE;

#endif

#ifndef _L3PR_MS_G2_ZFACTORFINAL_
#define _L3PR_MS_G2_ZFACTORFINAL_

typedef struct {
    int count[3][5][4][1440][536];
```

```
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
} L3PR_MS_G2_ZFACTORFINAL;

#endif

#ifndef _L3PR_MS_G2_PRECIPRATEAVE24_
#define _L3PR_MS_G2_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_PRECIPRATEAVE24;

#endif

#ifndef _L3PR_MS_G2_PRECIPICEINTEGRATED_
#define _L3PR_MS_G2_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_PRECIPICEINTEGRATED;

#endif

#ifndef _L3PR_MS_G2_PRECIPWATERINTEGRATED_
#define _L3PR_MS_G2_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3PR_MS_G2_MIXEDPHRATENEARSURFACE_
#define _L3PR_MS_G2_MIXEDPHRATENEARSURFACE_

typedef struct {
```

```
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3PR_MS_G2_SNOWRATENEARSURFACE_
#define _L3PR_MS_G2_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_SNOWRATENEARSURFACE;

#endif

#ifndef _L3PR_MS_G2_RAINRATENEARSURFACE_
#define _L3PR_MS_G2_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_RAINRATENEARSURFACE;

#endif

#ifndef _L3PR_MS_G2_PRECIPRATENEARSURFACE_
#define _L3PR_MS_G2_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3PR_MS_G2_PRECIPRATEESURFACE2_
#define _L3PR_MS_G2_PRECIPRATEESURFACE2_
```

```
typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_PRECIPRATEESURFACE2;

#endif

#ifndef _L3PR_MS_G2_PRECIPRATEESURFACE_
#define _L3PR_MS_G2_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_PRECIPRATEESURFACE;

#endif

#ifndef _L3PR_MS_G2_MIXEDPHRATE_
#define _L3PR_MS_G2_MIXEDPHRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_MS_G2_MIXEDPHRATE;

#endif

#ifndef _L3PR_MS_G2_FLAGHEAVYICEPRECIP_
#define _L3PR_MS_G2_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_MS_G2_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3PR_MS_G2_SNOWRATE_
#define _L3PR_MS_G2_SNOWRATE_
```

```
typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_MS_G2_SNOWRATE;

#endif

#ifndef _L3PR_MS_G2_RAINRATE_
#define _L3PR_MS_G2_RAINRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_MS_G2_RAINRATE;

#endif

#ifndef _L3PR_MS_G2_PRECIPRATE_
#define _L3PR_MS_G2_PRECIPRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_MS_G2_PRECIPRATE;

#endif

#ifndef _L3PR_MS_G2_
#define _L3PR_MS_G2_

typedef struct {
    L3PR_MS_G2_PRECIPRATE precipRate;
    L3PR_MS_G2_RAINRATE rainRate;
    L3PR_MS_G2_SNOWRATE snowRate;
    L3PR_MS_G2_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3PR_MS_G2_MIXEDPHRATE mixedPhRate;
    L3PR_MS_G2_PRECIPRATEESURFACE precipRateESurface;
    L3PR_MS_G2_PRECIPRATEESURFACE2 precipRateESurface2;
    L3PR_MS_G2_PRECIPRATENEARSURFACE precipRateNearSurface;
```

```
    L3PR_MS_G2_RAINRATENEARSURFACE rainRateNearSurface;
    L3PR_MS_G2_SNOWRATENEARSURFACE snowRateNearSurface;
    L3PR_MS_G2_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3PR_MS_G2_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3PR_MS_G2_PRECIPICEINTEGRATED precipIceIntegrated;
    L3PR_MS_G2_PRECIPRATEAVE24 precipRateAve24;
    L3PR_MS_G2_ZFACTORFINAL zFactorFinal;
    L3PR_MS_G2_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3PR_MS_G2_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3PR_MS_G2_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3PR_MS_G2_ZFACTORMEASURED zFactorMeasured;
    L3PR_MS_G2_DM dm;
    L3PR_MS_G2_DBNW dBNw;
    L3PR_MS_G2_EPSILON epsilon;
    L3PR_MS_G2_ZETA zeta;
    L3PR_MS_G2_PIAHB piaHB;
    L3PR_MS_G2_PIAHYBRID piaHybrid;
    L3PR_MS_G2_PIASRT piaSRT;
    L3PR_MS_G2_PIAFINAL piaFinal;
    L3PR_MS_G2_PIAFINALSUBSET piaFinalSubset;
    L3PR_MS_G2_HEIGHTBB heightBB;
    L3PR_MS_G2_HEIGHTBBNADIR heightBBnadir;
    L3PR_MS_G2_BBWIDTHNADIR BBwidthNadir;
    L3PR_MS_G2_HEIGHTSTORMTOP heightStormTop;
    L3PR_MS_G2_BBWIDTH BBwidth;
    L3PR_MS_G2_OBSERVATIONCOUNTS observationCounts;
    L3PR_MS_G2_PRECIPRATELOCALTIME precipRateLocalTime;
    L3PR_MS_G2_DFRMNEARSURFACE DFRmNearSurface;
    L3PR_MS_G2_DFRNEARSURFACE DFRNearSurface;
    float precipRateNearSurfaceUnconditional[3][1440][536];
    float precipProbabilityNearSurface[3][1440][536];
} L3PR_MS_G2;

#endif

#ifndef _L3PR_MS_G1_DFRNEARSURFACE_
#define _L3PR_MS_G1_DFRNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
```

```
} L3PR_MS_G1_DFRNEARSURFACE;

#endif

#ifndef _L3PR_MS_G1_DFRMNEARSURFACE_
#define _L3PR_MS_G1_DFRMNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_MS_G1_DFRMNEARSURFACE;

#endif

#ifndef _L3PR_MS_G1_PRECIPRATELOCALTIME_
#define _L3PR_MS_G1_PRECIPRATELOCALTIME_

typedef struct {
    int count[3][24][3][72][28];
    float mean[3][24][3][72][28];
    float stdev[3][24][3][72][28];
} L3PR_MS_G1_PRECIPRATELOCALTIME;

#endif

#ifndef _L3PR_MS_G1_OBSERVATIONCOUNTS_
#define _L3PR_MS_G1_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][3][72][28];
    int localTime[3][24][3][72][28];
    int pia[3][4][3][72][28];
    int shallowRain[3][3][72][28];
} L3PR_MS_G1_OBSERVATIONCOUNTS;

#endif

#ifndef _L3PR_MS_G1_BBWIDTH_
#define _L3PR_MS_G1_BBWIDTH_

typedef struct {
```

```
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_BBWIDTH;

#endif

#ifndef _L3PR_MS_G1_HEIGHTSTORMTOP_
#define _L3PR_MS_G1_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_HEIGHTSTORMTOP;

#endif

#ifndef _L3PR_MS_G1_BBWIDTHNADIR_
#define _L3PR_MS_G1_BBWIDTHNADIR_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_BBWIDTHNADIR;

#endif

#ifndef _L3PR_MS_G1_HEIGHTBBNADIR_
#define _L3PR_MS_G1_HEIGHTBBNADIR_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_HEIGHTBBNADIR;

#endif
```

```
#ifndef _L3PR_MS_G1_HEIGHTBB_
#define _L3PR_MS_G1_HEIGHTBB_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_HEIGHTBB;

#endif

#ifndef _L3PR_MS_G1_PIAFINALSUBSET_
#define _L3PR_MS_G1_PIAFINALSUBSET_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3PR_MS_G1_PIAFINALSUBSET;

#endif

#ifndef _L3PR_MS_G1_PIAFINAL_
#define _L3PR_MS_G1_PIAFINAL_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3PR_MS_G1_PIAFINAL;

#endif

#ifndef _L3PR_MS_G1_PIASRT_
#define _L3PR_MS_G1_PIASRT_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
```

```
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3PR_MS_G1_PIASRT;

#endif

#ifndef _L3PR_MS_G1_PIAHYBRID_
#define _L3PR_MS_G1_PIAHYBRID_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3PR_MS_G1_PIAHYBRID;

#endif

#ifndef _L3PR_MS_G1_PIAHB_
#define _L3PR_MS_G1_PIAHB_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3PR_MS_G1_PIAHB;

#endif

#ifndef _L3PR_MS_G1_ZETA_
#define _L3PR_MS_G1_ZETA_

typedef struct {
    int count[3][3][4][4][72][28];
    float mean[3][3][4][4][72][28];
    float stdev[3][3][4][4][72][28];
    int hist[30][3][3][4][4][72][28];
} L3PR_MS_G1_ZETA;

#endif

#ifndef _L3PR_MS_G1_EPSILON_
```

```
#define _L3PR_MS_G1_EPSILON_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_MS_G1_EPSILON;

#endif

#ifndef _L3PR_MS_G1_DBNW_
#define _L3PR_MS_G1_DBNW_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_MS_G1_DBNW;

#endif

#ifndef _L3PR_MS_G1_DM_
#define _L3PR_MS_G1_DM_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_MS_G1_DM;

#endif

#ifndef _L3PR_MS_G1_ZFACTORMEASURED_
#define _L3PR_MS_G1_ZFACTORMEASURED_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
```

```
} L3PR_MS_G1_ZFACTORMEASURED;

#endif

#ifndef _L3PR_MS_G1_ZFACTORMEASUREDNEARSURFACE_
#define _L3PR_MS_G1_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_MS_G1_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3PR_MS_G1_ZFACTORFINALNEARSURFACE_
#define _L3PR_MS_G1_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_MS_G1_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3PR_MS_G1_ZFACTORFINALESURFACE_
#define _L3PR_MS_G1_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_MS_G1_ZFACTORFINALESURFACE;

#endif

#ifndef _L3PR_MS_G1_ZFACTORFINAL_
#define _L3PR_MS_G1_ZFACTORFINAL_
```

```
typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
} L3PR_MS_G1_ZFACTORFINAL;

#endif

#ifndef _L3PR_MS_G1_PRECIPRATEAVE24_
#define _L3PR_MS_G1_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_PRECIPRATEAVE24;

#endif

#ifndef _L3PR_MS_G1_PRECIPICEINTEGRATED_
#define _L3PR_MS_G1_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_PRECIPICEINTEGRATED;

#endif

#ifndef _L3PR_MS_G1_PRECIPWATERINTEGRATED_
#define _L3PR_MS_G1_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_PRECIPWATERINTEGRATED;
```

```
#endif

#ifndef _L3PR_MS_G1_MIXEDPHRATENEARSURFACE_
#define _L3PR_MS_G1_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3PR_MS_G1_SNOWRATENEARSURFACE_
#define _L3PR_MS_G1_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_SNOWRATENEARSURFACE;

#endif

#ifndef _L3PR_MS_G1_RAINRATENEARSURFACE_
#define _L3PR_MS_G1_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_RAINRATENEARSURFACE;

#endif

#ifndef _L3PR_MS_G1_PRECIPRATENEARSURFACE_
#define _L3PR_MS_G1_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
```

```
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3PR_MS_G1_PRECIPRATEESURFACE2_
#define _L3PR_MS_G1_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_PRECIPRATEESURFACE2;

#endif

#ifndef _L3PR_MS_G1_PRECIPRATEESURFACE_
#define _L3PR_MS_G1_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_PRECIPRATEESURFACE;

#endif

#ifndef _L3PR_MS_G1_MIXEDPHRATE_
#define _L3PR_MS_G1_MIXEDPHRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_MS_G1_MIXEDPHRATE;

#endif
```

```
#ifndef _L3PR_MS_G1_FLAGHEAVYICEPRECIP_
#define _L3PR_MS_G1_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_MS_G1_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3PR_MS_G1_SNOWRATE_
#define _L3PR_MS_G1_SNOWRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_MS_G1_SNOWRATE;

#endif

#ifndef _L3PR_MS_G1_RAINRATE_
#define _L3PR_MS_G1_RAINRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_MS_G1_RAINRATE;

#endif

#ifndef _L3PR_MS_G1_PRECIPRATE_
#define _L3PR_MS_G1_PRECIPRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
```

```
    int hist[30][3][3][5][3][72][28];
} L3PR_MS_G1_PRECIPRATE;

#endif

#ifndef _L3PR_MS_G1_
#define _L3PR_MS_G1_

typedef struct {
    L3PR_MS_G1_PRECIPRATE precipRate;
    L3PR_MS_G1_RAINRATE rainRate;
    L3PR_MS_G1_SNOWRATE snowRate;
    L3PR_MS_G1_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3PR_MS_G1_MIXEDPHRATE mixedPhRate;
    L3PR_MS_G1_PRECIPRATEESURFACE precipRateESurface;
    L3PR_MS_G1_PRECIPRATEESURFACE2 precipRateESurface2;
    L3PR_MS_G1_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3PR_MS_G1_RAINRATENEARSURFACE rainRateNearSurface;
    L3PR_MS_G1_SNOWRATENEARSURFACE snowRateNearSurface;
    L3PR_MS_G1_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3PR_MS_G1_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3PR_MS_G1_PRECIPICEINTEGRATED precipIceIntegrated;
    L3PR_MS_G1_PRECIPRATEAVE24 precipRateAve24;
    L3PR_MS_G1_ZFACTORFINAL zFactorFinal;
    L3PR_MS_G1_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3PR_MS_G1_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3PR_MS_G1_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3PR_MS_G1_ZFACTORMEASURED zFactorMeasured;
    L3PR_MS_G1_DM dm;
    L3PR_MS_G1_DBNW dBNw;
    L3PR_MS_G1_EPSILON epsilon;
    L3PR_MS_G1_ZETA zeta;
    L3PR_MS_G1_PIAHB piaHB;
    L3PR_MS_G1_PIAHYBRID piaHybrid;
    L3PR_MS_G1_PIASRT piaSRT;
    L3PR_MS_G1_PIAFINAL piaFinal;
    L3PR_MS_G1_PIAFINALSUBSET piaFinalSubset;
    L3PR_MS_G1_HEIGHTBB heightBB;
    L3PR_MS_G1_HEIGHTBBNADIR heightBBnadir;
    L3PR_MS_G1_BBWIDTHNADIR BBwidthNadir;
    L3PR_MS_G1_HEIGHTSTORMTOP heightStormTop;
    L3PR_MS_G1_BBWIDTH BBwidth;
    L3PR_MS_G1_OBSERVATIONCOUNTS observationCounts;
```

```
    L3PR_MS_G1_PRECIPRATELOCALTIME precipRateLocalTime;
    L3PR_MS_G1_DFRMNEARSURFACE DFRmNearSurface;
    L3PR_MS_G1_DFRNEARSURFACE DFRNearSurface;
    float precipRateNearSurfaceUnconditional[3][72][28];
    float precipProbabilityNearSurface[3][72][28];
} L3PR_MS_G1;

#endif

#ifndef _L3PR_MS_
#define _L3PR_MS_

typedef struct {
    L3PR_MS_G1 G1;
    L3PR_MS_G2 G2;
} L3PR_MS;

#endif

#ifndef _L3PR_FS_G2_DFRNEARSURFACE_
#define _L3PR_FS_G2_DFRNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_FS_G2_DFRNEARSURFACE;

#endif

#ifndef _L3PR_FS_G2_DFRMNEARSURFACE_
#define _L3PR_FS_G2_DFRMNEARSURFACE_

typedef struct {
    int count[3][1440][536];
    float mean[3][1440][536];
    float stdev[3][1440][536];
} L3PR_FS_G2_DFRMNEARSURFACE;

#endif

#ifndef _L3PR_FS_G2_PRECIPRATELOCALTIME_
#define _L3PR_FS_G2_PRECIPRATELOCALTIME_
```

```
typedef struct {
    int count[24][3][1440][536];
    float mean[24][3][1440][536];
    float stdev[24][3][1440][536];
} L3PR_FS_G2_PRECIPRATELOCALTIME;

#endif

#ifndef _L3PR_FS_G2_OBSERVATIONCOUNTS_
#define _L3PR_FS_G2_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][1440][536];
    int localTime[24][3][1440][536];
    int pia[7][3][1440][536];
    int shallowRain[3][1440][536];
} L3PR_FS_G2_OBSERVATIONCOUNTS;

#endif

#ifndef _L3PR_FS_G2_BBWIDTH_
#define _L3PR_FS_G2_BBWIDTH_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_BBWIDTH;

#endif

#ifndef _L3PR_FS_G2_HEIGHTSTORMTOP_
#define _L3PR_FS_G2_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_HEIGHTSTORMTOP;

#endif
```

```
#ifndef _L3PR_FS_G2_BBWIDTHNADIR_
#define _L3PR_FS_G2_BBWIDTHNADIR_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_BBWIDTHNADIR;

#endif

#ifndef _L3PR_FS_G2_HEIGHTBBNADIR_
#define _L3PR_FS_G2_HEIGHTBBNADIR_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_HEIGHTBBNADIR;

#endif

#ifndef _L3PR_FS_G2_HEIGHTBB_
#define _L3PR_FS_G2_HEIGHTBB_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_HEIGHTBB;

#endif

#ifndef _L3PR_FS_G2_PIAFINALSUBSET_
#define _L3PR_FS_G2_PIAFINALSUBSET_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3PR_FS_G2_PIAFINALSUBSET;

#endif
```

```
#ifndef _L3PR_FS_G2_PIAFINAL_
#define _L3PR_FS_G2_PIAFINAL_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3PR_FS_G2_PIAFINAL;

#endif

#ifndef _L3PR_FS_G2_PIASRT_
#define _L3PR_FS_G2_PIASRT_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3PR_FS_G2_PIASRT;

#endif

#ifndef _L3PR_FS_G2_PIAHYBRID_
#define _L3PR_FS_G2_PIAHYBRID_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3PR_FS_G2_PIAHYBRID;

#endif

#ifndef _L3PR_FS_G2_PIAHB_
#define _L3PR_FS_G2_PIAHB_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3PR_FS_G2_PIAHB;
```

```
#endif

#ifndef _L3PR_FS_G2_ZETA_
#define _L3PR_FS_G2_ZETA_

typedef struct {
    int count[3][7][4][1440][536];
    float mean[3][7][4][1440][536];
    float stdev[3][7][4][1440][536];
} L3PR_FS_G2_ZETA;

#endif

#ifndef _L3PR_FS_G2_EPSILON_
#define _L3PR_FS_G2_EPSILON_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_FS_G2_EPSILON;

#endif

#ifndef _L3PR_FS_G2_DBNW_
#define _L3PR_FS_G2_DBNW_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_FS_G2_DBNW;

#endif

#ifndef _L3PR_FS_G2_DM_
#define _L3PR_FS_G2_DM_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_FS_G2_DM;
```

```
#endif

#ifndef _L3PR_FS_G2_ZFACTORMEASURED_
#define _L3PR_FS_G2_ZFACTORMEASURED_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
} L3PR_FS_G2_ZFACTORMEASURED;

#endif

#ifndef _L3PR_FS_G2_ZFACTORMEASUREDNEARSURFACE_
#define _L3PR_FS_G2_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_FS_G2_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3PR_FS_G2_ZFACTORFINALNEARSURFACE_
#define _L3PR_FS_G2_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
} L3PR_FS_G2_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3PR_FS_G2_ZFACTORFINALESURFACE_
#define _L3PR_FS_G2_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][4][1440][536];
    float mean[3][4][1440][536];
    float stdev[3][4][1440][536];
```

```
} L3PR_FS_G2_ZFACTORFINALESURFACE;

#endif

#ifndef _L3PR_FS_G2_ZFACTORFINAL_
#define _L3PR_FS_G2_ZFACTORFINAL_

typedef struct {
    int count[3][5][4][1440][536];
    float mean[3][5][4][1440][536];
    float stdev[3][5][4][1440][536];
} L3PR_FS_G2_ZFACTORFINAL;

#endif

#ifndef _L3PR_FS_G2_PRECIPRATEAVE24_
#define _L3PR_FS_G2_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_PRECIPRATEAVE24;

#endif

#ifndef _L3PR_FS_G2_PRECIPICEINTEGRATED_
#define _L3PR_FS_G2_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_PRECIPICEINTEGRATED;

#endif

#ifndef _L3PR_FS_G2_PRECIPWATERINTEGRATED_
#define _L3PR_FS_G2_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
```

```
    float stdev[3][3][1440][536];
} L3PR_FS_G2_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3PR_FS_G2_MIXEDPHRATENEARSURFACE_
#define _L3PR_FS_G2_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3PR_FS_G2_SNOWRATENEARSURFACE_
#define _L3PR_FS_G2_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_SNOWRATENEARSURFACE;

#endif

#ifndef _L3PR_FS_G2_RAINRATENEARSURFACE_
#define _L3PR_FS_G2_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_RAINRATENEARSURFACE;

#endif

#ifndef _L3PR_FS_G2_PRECIPRATENEARSURFACE_
#define _L3PR_FS_G2_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][1440][536];
```

```
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3PR_FS_G2_PRECIPRATEESURFACE2_
#define _L3PR_FS_G2_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_PRECIPRATEESURFACE2;

#endif

#ifndef _L3PR_FS_G2_PRECIPRATEESURFACE_
#define _L3PR_FS_G2_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_PRECIPRATEESURFACE;

#endif

#ifndef _L3PR_FS_G2_MIXEDPHRATE_
#define _L3PR_FS_G2_MIXEDPHRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_FS_G2_MIXEDPHRATE;

#endif

#ifndef _L3PR_FS_G2_FLAGHEAVYICEPRECIP_
#define _L3PR_FS_G2_FLAGHEAVYICEPRECIP_

typedef struct {
```

```
    int count[3][3][1440][536];
    float mean[3][3][1440][536];
    float stdev[3][3][1440][536];
} L3PR_FS_G2_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3PR_FS_G2_SNOWRATE_
#define _L3PR_FS_G2_SNOWRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_FS_G2_SNOWRATE;

#endif

#ifndef _L3PR_FS_G2_RAINRATE_
#define _L3PR_FS_G2_RAINRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_FS_G2_RAINRATE;

#endif

#ifndef _L3PR_FS_G2_PRECIPRATE_
#define _L3PR_FS_G2_PRECIPRATE_

typedef struct {
    int count[3][5][3][1440][536];
    float mean[3][5][3][1440][536];
    float stdev[3][5][3][1440][536];
} L3PR_FS_G2_PRECIPRATE;

#endif

#ifndef _L3PR_FS_G2_
#define _L3PR_FS_G2_
```

```
typedef struct {
    L3PR_FS_G2_PRECIPRATE precipRate;
    L3PR_FS_G2_RAINRATE rainRate;
    L3PR_FS_G2_SNOWRATE snowRate;
    L3PR_FS_G2_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3PR_FS_G2_MIXEDPHRATE mixedPhRate;
    L3PR_FS_G2_PRECIPRATEESURFACE precipRateESurface;
    L3PR_FS_G2_PRECIPRATEESURFACE2 precipRateESurface2;
    L3PR_FS_G2_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3PR_FS_G2_RAINRATENEARSURFACE rainRateNearSurface;
    L3PR_FS_G2_SNOWRATENEARSURFACE snowRateNearSurface;
    L3PR_FS_G2_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3PR_FS_G2_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3PR_FS_G2_PRECIPICEINTEGRATED precipIceIntegrated;
    L3PR_FS_G2_PRECIPRATEAVE24 precipRateAve24;
    L3PR_FS_G2_ZFACTORFINAL zFactorFinal;
    L3PR_FS_G2_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3PR_FS_G2_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3PR_FS_G2_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3PR_FS_G2_ZFACTORMEASURED zFactorMeasured;
    L3PR_FS_G2_DM dm;
    L3PR_FS_G2_DBNW dBNw;
    L3PR_FS_G2_EPSILON epsilon;
    L3PR_FS_G2_ZETA zeta;
    L3PR_FS_G2_PIAHB piaHB;
    L3PR_FS_G2_PIAHYBRID piaHybrid;
    L3PR_FS_G2_PIASRT piaSRT;
    L3PR_FS_G2_PIAFINAL piaFinal;
    L3PR_FS_G2_PIAFINALSUBSET piaFinalSubset;
    L3PR_FS_G2_HEIGHTBB heightBB;
    L3PR_FS_G2_HEIGHTBBNADIR heightBBnadir;
    L3PR_FS_G2_BBWIDTHNADIR BBwidthNadir;
    L3PR_FS_G2_HEIGHTSTORMTOP heightStormTop;
    L3PR_FS_G2_BBWIDTH BBwidth;
    L3PR_FS_G2_OBSERVATIONCOUNTS observationCounts;
    L3PR_FS_G2_PRECIPRATELOCALTIME precipRateLocalTime;
    L3PR_FS_G2_DFRMNEARSURFACE DFRmNearSurface;
    L3PR_FS_G2_DFRNEARSURFACE DFRNearSurface;
    float precipRateNearSurfaceUnconditional[3][1440][536];
    float precipProbabilityNearSurface[3][1440][536];
} L3PR_FS_G2;

#endif
```

```
#ifndef _L3PR_FS_G1_DFRNEARSURFACE_
#define _L3PR_FS_G1_DFRNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_FS_G1_DFRNEARSURFACE;

#endif

#ifndef _L3PR_FS_G1_DFRMNEARSURFACE_
#define _L3PR_FS_G1_DFRMNEARSURFACE_

typedef struct {
    int count[3][3][72][28];
    float mean[3][3][72][28];
    float stdev[3][3][72][28];
    int hist[30][3][3][72][28];
} L3PR_FS_G1_DFRMNEARSURFACE;

#endif

#ifndef _L3PR_FS_G1_PRECIPRATELOCALTIME_
#define _L3PR_FS_G1_PRECIPRATELOCALTIME_

typedef struct {
    int count[3][24][3][72][28];
    float mean[3][24][3][72][28];
    float stdev[3][24][3][72][28];
} L3PR_FS_G1_PRECIPRATELOCALTIME;

#endif

#ifndef _L3PR_FS_G1_OBSERVATIONCOUNTS_
#define _L3PR_FS_G1_OBSERVATIONCOUNTS_

typedef struct {
    int total[3][3][72][28];
    int localTime[3][24][3][72][28];
    int pia[3][7][3][72][28];
```

```
    int shallowRain[3][3][72][28];
} L3PR_FS_G1_OBSERVATIONCOUNTS;

#endif

#ifndef _L3PR_FS_G1_BBWIDTH_
#define _L3PR_FS_G1_BBWIDTH_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_BBWIDTH;

#endif

#ifndef _L3PR_FS_G1_HEIGHTSTORMTOP_
#define _L3PR_FS_G1_HEIGHTSTORMTOP_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_HEIGHTSTORMTOP;

#endif

#ifndef _L3PR_FS_G1_BBWIDTHNADIR_
#define _L3PR_FS_G1_BBWIDTHNADIR_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_BBWIDTHNADIR;

#endif

#ifndef _L3PR_FS_G1_HEIGHTBBNADIR_
#define _L3PR_FS_G1_HEIGHTBBNADIR_
```

```
typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_HEIGHTBBNADIR;

#endif

#ifndef _L3PR_FS_G1_HEIGHTBB_
#define _L3PR_FS_G1_HEIGHTBB_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_HEIGHTBB;

#endif

#ifndef _L3PR_FS_G1_PIAFINALSUBSET_
#define _L3PR_FS_G1_PIAFINALSUBSET_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3PR_FS_G1_PIAFINALSUBSET;

#endif

#ifndef _L3PR_FS_G1_PIAFINAL_
#define _L3PR_FS_G1_PIAFINAL_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3PR_FS_G1_PIAFINAL;
```

```
#endif

#ifndef _L3PR_FS_G1_PIASRT_
#define _L3PR_FS_G1_PIASRT_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3PR_FS_G1_PIASRT;

#endif

#ifndef _L3PR_FS_G1_PIAHYBRID_
#define _L3PR_FS_G1_PIAHYBRID_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3PR_FS_G1_PIAHYBRID;

#endif

#ifndef _L3PR_FS_G1_PIAHB_
#define _L3PR_FS_G1_PIAHB_

typedef struct {
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3PR_FS_G1_PIAHB;

#endif

#ifndef _L3PR_FS_G1_ZETA_
#define _L3PR_FS_G1_ZETA_

typedef struct {
```

```
    int count[3][3][7][4][72][28];
    float mean[3][3][7][4][72][28];
    float stdev[3][3][7][4][72][28];
    int hist[30][3][3][7][4][72][28];
} L3PR_FS_G1_ZETA;

#endif

#ifndef _L3PR_FS_G1_EPSILON_
#define _L3PR_FS_G1_EPSILON_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_FS_G1_EPSILON;

#endif

#ifndef _L3PR_FS_G1_DBNW_
#define _L3PR_FS_G1_DBNW_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_FS_G1_DBNW;

#endif

#ifndef _L3PR_FS_G1_DM_
#define _L3PR_FS_G1_DM_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_FS_G1_DM;

#endif
```

```
#ifndef _L3PR_FS_G1_ZFACTORMEASURED_
#define _L3PR_FS_G1_ZFACTORMEASURED_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
} L3PR_FS_G1_ZFACTORMEASURED;

#endif

#ifndef _L3PR_FS_G1_ZFACTORMEASUREDNEARSURFACE_
#define _L3PR_FS_G1_ZFACTORMEASUREDNEARSURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_FS_G1_ZFACTORMEASUREDNEARSURFACE;

#endif

#ifndef _L3PR_FS_G1_ZFACTORFINALNEARSURFACE_
#define _L3PR_FS_G1_ZFACTORFINALNEARSURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_FS_G1_ZFACTORFINALNEARSURFACE;

#endif

#ifndef _L3PR_FS_G1_ZFACTORFINALESURFACE_
#define _L3PR_FS_G1_ZFACTORFINALESURFACE_

typedef struct {
    int count[3][3][4][72][28];
    float mean[3][3][4][72][28];
```

```
    float stdev[3][3][4][72][28];
    int hist[30][3][3][4][72][28];
} L3PR_FS_G1_ZFACTORFINALESURFACE;

#endif

#ifndef _L3PR_FS_G1_ZFACTORFINAL_
#define _L3PR_FS_G1_ZFACTORFINAL_

typedef struct {
    int count[3][3][5][4][72][28];
    float mean[3][3][5][4][72][28];
    float stdev[3][3][5][4][72][28];
    int hist[30][3][3][5][4][72][28];
} L3PR_FS_G1_ZFACTORFINAL;

#endif

#ifndef _L3PR_FS_G1_PRECIPRATEAVE24_
#define _L3PR_FS_G1_PRECIPRATEAVE24_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_PRECIPRATEAVE24;

#endif

#ifndef _L3PR_FS_G1_PRECIPICEINTEGRATED_
#define _L3PR_FS_G1_PRECIPICEINTEGRATED_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_PRECIPICEINTEGRATED;

#endif

#ifndef _L3PR_FS_G1_PRECIPWATERINTEGRATED_
```

```
#define _L3PR_FS_G1_PRECIPWATERINTEGRATED_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_PRECIPWATERINTEGRATED;

#endif

#ifndef _L3PR_FS_G1_MIXEDPHRATENEARSURFACE_
#define _L3PR_FS_G1_MIXEDPHRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_MIXEDPHRATENEARSURFACE;

#endif

#ifndef _L3PR_FS_G1_SNOWRATENEARSURFACE_
#define _L3PR_FS_G1_SNOWRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_SNOWRATENEARSURFACE;

#endif

#ifndef _L3PR_FS_G1_RAINRATENEARSURFACE_
#define _L3PR_FS_G1_RAINRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
```

```
} L3PR_FS_G1_RAINRATENEARSURFACE;

#endif

#ifndef _L3PR_FS_G1_PRECIPRATENEARSURFACE_
#define _L3PR_FS_G1_PRECIPRATENEARSURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_PRECIPRATENEARSURFACE;

#endif

#ifndef _L3PR_FS_G1_PRECIPRATEESURFACE2_
#define _L3PR_FS_G1_PRECIPRATEESURFACE2_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_PRECIPRATEESURFACE2;

#endif

#ifndef _L3PR_FS_G1_PRECIPRATEESURFACE_
#define _L3PR_FS_G1_PRECIPRATEESURFACE_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_PRECIPRATEESURFACE;

#endif

#ifndef _L3PR_FS_G1_MIXEDPHRATE_
#define _L3PR_FS_G1_MIXEDPHRATE_
```

```
typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_FS_G1_MIXEDPHRATE;

#endif

#ifndef _L3PR_FS_G1_FLAGHEAVYICEPRECIP_
#define _L3PR_FS_G1_FLAGHEAVYICEPRECIP_

typedef struct {
    int count[3][3][3][72][28];
    float mean[3][3][3][72][28];
    float stdev[3][3][3][72][28];
    int hist[30][3][3][3][72][28];
} L3PR_FS_G1_FLAGHEAVYICEPRECIP;

#endif

#ifndef _L3PR_FS_G1_SNOWRATE_
#define _L3PR_FS_G1_SNOWRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_FS_G1_SNOWRATE;

#endif

#ifndef _L3PR_FS_G1_RAINRATE_
#define _L3PR_FS_G1_RAINRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_FS_G1_RAINRATE;
```

```
#endif

#ifndef _L3PR_FS_G1_PRECIPRATE_
#define _L3PR_FS_G1_PRECIPRATE_

typedef struct {
    int count[3][3][5][3][72][28];
    float mean[3][3][5][3][72][28];
    float stdev[3][3][5][3][72][28];
    int hist[30][3][3][5][3][72][28];
} L3PR_FS_G1_PRECIPRATE;

#endif

#ifndef _L3PR_FS_G1_
#define _L3PR_FS_G1_

typedef struct {
    L3PR_FS_G1_PRECIPRATE precipRate;
    L3PR_FS_G1_RAINRATE rainRate;
    L3PR_FS_G1_SNOWRATE snowRate;
    L3PR_FS_G1_FLAGHEAVYICEPRECIP flagHeavyIcePrecip;
    L3PR_FS_G1_MIXEDPHRATE mixedPhRate;
    L3PR_FS_G1_PRECIPRATEESURFACE precipRateESurface;
    L3PR_FS_G1_PRECIPRATEESURFACE2 precipRateESurface2;
    L3PR_FS_G1_PRECIPRATENEARSURFACE precipRateNearSurface;
    L3PR_FS_G1_RAINRATENEARSURFACE rainRateNearSurface;
    L3PR_FS_G1_SNOWRATENEARSURFACE snowRateNearSurface;
    L3PR_FS_G1_MIXEDPHRATENEARSURFACE mixedPhRateNearSurface;
    L3PR_FS_G1_PRECIPWATERINTEGRATED precipWaterIntegrated;
    L3PR_FS_G1_PRECIPICEINTEGRATED precipIceIntegrated;
    L3PR_FS_G1_PRECIPRATEAVE24 precipRateAve24;
    L3PR_FS_G1_ZFACTORFINAL zFactorFinal;
    L3PR_FS_G1_ZFACTORFINALESURFACE zFactorFinalESurface;
    L3PR_FS_G1_ZFACTORFINALNEARSURFACE zFactorFinalNearSurface;
    L3PR_FS_G1_ZFACTORMEASUREDNEARSURFACE zFactorMeasuredNearSurface;
    L3PR_FS_G1_ZFACTORMEASURED zFactorMeasured;
    L3PR_FS_G1_DM dm;
    L3PR_FS_G1_DBNW dBNw;
    L3PR_FS_G1_EPSILON epsilon;
    L3PR_FS_G1_ZETA zeta;
    L3PR_FS_G1_PIAHB piaHB;
    L3PR_FS_G1_PIAHYBRID piaHybrid;
```

```
    L3PR_FS_G1_PIASRT piaSRT;
    L3PR_FS_G1_PIAFINAL piaFinal;
    L3PR_FS_G1_PIAFINALSUBSET piaFinalSubset;
    L3PR_FS_G1_HEIGHTBB heightBB;
    L3PR_FS_G1_HEIGHTBBNADIR heightBBnadir;
    L3PR_FS_G1_BBWIDTHNADIR BBwidthNadir;
    L3PR_FS_G1_HEIGHTSTORMTOP heightStormTop;
    L3PR_FS_G1_BBWIDTH BBwidth;
    L3PR_FS_G1_OBSERVATIONCOUNTS observationCounts;
    L3PR_FS_G1_PRECIPRATELOCALTIME precipRateLocalTime;
    L3PR_FS_G1_DFRMNEARSURFACE DFRmNearSurface;
    L3PR_FS_G1_DFRNEARSURFACE DFRNearSurface;
    float precipRateNearSurfaceUnconditional[3][72][28];
    float precipProbabilityNearSurface[3][72][28];
} L3PR_FS_G1;

#endif

#ifndef _L3PR_FS_
#define _L3PR_FS_

typedef struct {
    L3PR_FS_G1 G1;
    L3PR_FS_G2 G2;
} L3PR_FS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3PR_HS_G2_PRECIPRATELOCALTIME/
    INTEGER*4 count(536,1440,24)
    REAL*4 mean(536,1440,24)
    REAL*4 stdev(536,1440,24)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_OBSERVATIONCOUNTS/
    INTEGER*4 total(536,1440)
    INTEGER*4 localTime(536,1440,24)
    INTEGER*4 pia(536,1440,4)
    INTEGER*4 shallowRain(536,1440)
```

```
END STRUCTURE

STRUCTURE /L3PR_HS_G2_BBWIDTH/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_HEIGHTSTORMTOP/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_BBWIDTHNADIR/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_HEIGHTBBNADIR/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_HEIGHTBB/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PIAFINALSUBSET/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PIAFINAL/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE
```

```
STRUCTURE /L3PR_HS_G2_PIASRT/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PIAHYBRID/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PIAHB/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_ZETA/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_EPSILON/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_DBNW/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_DM/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE
```

```
STRUCTURE /L3PR_HS_G2_ZFACTORMEASURED/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_ZFACTORFINALESURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_ZFACTORFINAL/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PRECIPRATEAVE24/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PRECIPICEINTEGRATED/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PRECIPWATERINTEGRATED/
```

```
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_SNOWRATENEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_RAINRATENEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PRECIPRATENEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PRECIPRATEESURFACE2/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PRECIPRATEESURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_MIXEDPHRATE/
    INTEGER*4 count(536,1440,5,3)
```

```
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_SNOWRATE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_RAINRATE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2_PRECIPRATE/
    INTEGER*4 count(536,1440,5,3)
    REAL*4 mean(536,1440,5,3)
    REAL*4 stdev(536,1440,5,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G2/
    RECORD /L3PR_HS_G2_PRECIPRATE/ precipRate
    RECORD /L3PR_HS_G2_RAINRATE/ rainRate
    RECORD /L3PR_HS_G2_SNOWRATE/ snowRate
    RECORD /L3PR_HS_G2_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3PR_HS_G2_MIXEDPHRATE/ mixedPhRate
    RECORD /L3PR_HS_G2_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3PR_HS_G2_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3PR_HS_G2_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3PR_HS_G2_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3PR_HS_G2_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3PR_HS_G2_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3PR_HS_G2_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3PR_HS_G2_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3PR_HS_G2_PRECIPRATEAVE24/ precipRateAve24
```

```
    RECORD /L3PR_HS_G2_ZFACTORFINAL/ zFactorFinal
    RECORD /L3PR_HS_G2_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3PR_HS_G2_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3PR_HS_G2_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3PR_HS_G2_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3PR_HS_G2_DM/ dm
    RECORD /L3PR_HS_G2_DBNW/ dBNw
    RECORD /L3PR_HS_G2_EPSILON/ epsilon
    RECORD /L3PR_HS_G2_ZETA/ zeta
    RECORD /L3PR_HS_G2_PIAHB/ piaHB
    RECORD /L3PR_HS_G2_PIAHYBRID/ piaHybrid
    RECORD /L3PR_HS_G2_PIASRT/ piaSRT
    RECORD /L3PR_HS_G2_PIAFINAL/ piaFinal
    RECORD /L3PR_HS_G2_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3PR_HS_G2_HEIGHTBB/ heightBB
    RECORD /L3PR_HS_G2_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3PR_HS_G2_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3PR_HS_G2_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3PR_HS_G2_BBWIDTH/ BBwidth
    RECORD /L3PR_HS_G2_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3PR_HS_G2_PRECIPRATELOCALTIME/ precipRateLocalTime
    REAL*4 precipRateNearSurfaceUnconditional(536,1440)
    REAL*4 precipProbabilityNearSurface(536,1440)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PRECIPRATELOCALTIME/
    INTEGER*4 count(28,72,24,3)
    REAL*4 mean(28,72,24,3)
    REAL*4 stdev(28,72,24,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_OBSERVATIONCOUNTS/
    INTEGER*4 total(28,72,3)
    INTEGER*4 localTime(28,72,24,3)
    INTEGER*4 pia(28,72,4,3)
    INTEGER*4 shallowRain(28,72,3)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_BBWIDTH/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
```

```
END STRUCTURE

STRUCTURE /L3PR_HS_G1_HEIGHTSTORMTOP/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_BBWIDTHNADIR/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_HEIGHTBBNADIR/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_HEIGHTBB/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PIAFINALSUBSET/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PIAFINAL/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3PR_HS_G1_PIASRT/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PIAHYBRID/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PIAHB/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_ZETA/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_EPSILON/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_DBNW/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3PR_HS_G1_DM/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_ZFACTORMEASURED/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_ZFACTORFINALESURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_ZFACTORFINAL/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PRECIPRATEAVE24/
```

```
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PRECIPICEINTEGRATED/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PRECIPWATERINTEGRATED/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_SNOWRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_RAINRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PRECIPRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3)
```

```
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PRECIPRATEESURFACE2/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PRECIPRATEESURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_MIXEDPHRATE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_SNOWRATE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_RAINRATE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
```

```
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1_PRECIPRATE/
    INTEGER*4 count(28,72,5,3,3)
    REAL*4 mean(28,72,5,3,3)
    REAL*4 stdev(28,72,5,3,3)
    INTEGER*4 hist(28,72,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_HS_G1/
    RECORD /L3PR_HS_G1_PRECIPRATE/ precipRate
    RECORD /L3PR_HS_G1_RAINRATE/ rainRate
    RECORD /L3PR_HS_G1_SNOWRATE/ snowRate
    RECORD /L3PR_HS_G1_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3PR_HS_G1_MIXEDPHRATE/ mixedPhRate
    RECORD /L3PR_HS_G1_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3PR_HS_G1_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3PR_HS_G1_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3PR_HS_G1_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3PR_HS_G1_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3PR_HS_G1_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3PR_HS_G1_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3PR_HS_G1_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3PR_HS_G1_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3PR_HS_G1_ZFACTORFINAL/ zFactorFinal
    RECORD /L3PR_HS_G1_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3PR_HS_G1_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3PR_HS_G1_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3PR_HS_G1_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3PR_HS_G1_DM/ dm
    RECORD /L3PR_HS_G1_DBNW/ dBNw
    RECORD /L3PR_HS_G1_EPSILON/ epsilon
    RECORD /L3PR_HS_G1_ZETA/ zeta
    RECORD /L3PR_HS_G1_PIAHB/ piaHB
    RECORD /L3PR_HS_G1_PIAHYBRID/ piaHybrid
    RECORD /L3PR_HS_G1_PIASRT/ piaSRT
    RECORD /L3PR_HS_G1_PIAFINAL/ piaFinal
    RECORD /L3PR_HS_G1_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3PR_HS_G1_HEIGHTBB/ heightBB
    RECORD /L3PR_HS_G1_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3PR_HS_G1_BBWIDTHNADIR/ BBwidthNadir
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    RECORD /L3PR_HS_G1_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3PR_HS_G1_BBWIDTH/ BBwidth
    RECORD /L3PR_HS_G1_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3PR_HS_G1_PRECIPRATELOCALTIME/ precipRateLocalTime
    REAL*4 precipRateNearSurfaceUnconditional(28,72)
    REAL*4 precipProbabilityNearSurface(28,72)
END STRUCTURE

STRUCTURE /L3PR_HS/
    RECORD /L3PR_HS_G1/ G1
    RECORD /L3PR_HS_G2/ G2
END STRUCTURE

STRUCTURE /L3PR_MS_G2_DFRNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_DFRMNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PRECIPRATELOCALTIME/
    INTEGER*4 count(536,1440,3,24)
    REAL*4 mean(536,1440,3,24)
    REAL*4 stdev(536,1440,3,24)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_OBSERVATIONCOUNTS/
    INTEGER*4 total(536,1440,3)
    INTEGER*4 localTime(536,1440,3,24)
    INTEGER*4 pia(536,1440,3,4)
    INTEGER*4 shallowRain(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_BBWIDTH/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE
```

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STRUCTURE /L3PR_MS_G2_HEIGHTSTORMTOP/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_BBWIDTHNADIR/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_HEIGHTBBNADIR/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_HEIGHTBB/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PIAFINALSUBSET/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PIAFINAL/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PIASRT/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE
```

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STRUCTURE /L3PR_MS_G2_PIAHYBRID/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PIAHB/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_ZETA/
    INTEGER*4 count(536,1440,4,4,3)
    REAL*4 mean(536,1440,4,4,3)
    REAL*4 stdev(536,1440,4,4,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_EPSILON/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_DBNW/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_DM/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_ZFACTORMEASURED/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_ZFACTORMEASUREDNEARSURFACE/
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```
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_ZFACTORFINALESURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_ZFACTORFINAL/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PRECIPRATEAVE24/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PRECIPICEINTEGRATED/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PRECIPWATERINTEGRATED/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
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```
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_SNOWRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_RAINRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PRECIPRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PRECIPRATEESURFACE2/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PRECIPRATEESURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_MIXEDPHRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
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```
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_SNOWRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_RAINRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2_PRECIPRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G2/
    RECORD /L3PR_MS_G2_PRECIPRATE/ precipRate
    RECORD /L3PR_MS_G2_RAINRATE/ rainRate
    RECORD /L3PR_MS_G2_SNOWRATE/ snowRate
    RECORD /L3PR_MS_G2_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3PR_MS_G2_MIXEDPHRATE/ mixedPhRate
    RECORD /L3PR_MS_G2_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3PR_MS_G2_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3PR_MS_G2_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3PR_MS_G2_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3PR_MS_G2_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3PR_MS_G2_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3PR_MS_G2_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3PR_MS_G2_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3PR_MS_G2_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3PR_MS_G2_ZFACTORFINAL/ zFactorFinal
    RECORD /L3PR_MS_G2_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3PR_MS_G2_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3PR_MS_G2_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3PR_MS_G2_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3PR_MS_G2_DM/ dm
    RECORD /L3PR_MS_G2_DBNW/ dBNw
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    RECORD /L3PR_MS_G2_EPSILON/ epsilon
    RECORD /L3PR_MS_G2_ZETA/ zeta
    RECORD /L3PR_MS_G2_PIAHB/ piaHB
    RECORD /L3PR_MS_G2_PIAHYBRID/ piaHybrid
    RECORD /L3PR_MS_G2_PIASRT/ piaSRT
    RECORD /L3PR_MS_G2_PIAFINAL/ piaFinal
    RECORD /L3PR_MS_G2_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3PR_MS_G2_HEIGHTBB/ heightBB
    RECORD /L3PR_MS_G2_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3PR_MS_G2_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3PR_MS_G2_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3PR_MS_G2_BBWIDTH/ BBwidth
    RECORD /L3PR_MS_G2_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3PR_MS_G2_PRECIPRATELOCALTIME/ precipRateLocalTime
    RECORD /L3PR_MS_G2_DFRMNEARSURFACE/ DFRmNearSurface
    RECORD /L3PR_MS_G2_DFRNEARSURFACE/ DFRNearSurface
    REAL*4 precipRateNearSurfaceUnconditional(536,1440,3)
    REAL*4 precipProbabilityNearSurface(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_DFRNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_DFRMNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PRECIPRATELOCALTIME/
    INTEGER*4 count(28,72,3,24,3)
    REAL*4 mean(28,72,3,24,3)
    REAL*4 stdev(28,72,3,24,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_OBSERVATIONCOUNTS/
    INTEGER*4 total(28,72,3,3)
    INTEGER*4 localTime(28,72,3,24,3)
```

```
    INTEGER*4 pia(28,72,3,4,3)
    INTEGER*4 shallowRain(28,72,3,3)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_BBWIDTH/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_HEIGHTSTORMTOP/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_BBWIDTHNADIR/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_HEIGHTBBNADIR/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_HEIGHTBB/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PIAFINALSUBSET/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
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    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PIAFINAL/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PIASRT/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PIAHYBRID/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PIAHB/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_ZETA/
    INTEGER*4 count(28,72,4,4,3,3)
    REAL*4 mean(28,72,4,4,3,3)
    REAL*4 stdev(28,72,4,4,3,3)
    INTEGER*4 hist(28,72,4,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_EPSILON/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
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END STRUCTURE

STRUCTURE /L3PR_MS_G1_DBNW/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_DM/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_ZFACTORMEASURED/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_ZFACTORFINALESURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE
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STRUCTURE /L3PR_MS_G1_ZFACTORFINAL/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PRECIPRATEAVE24/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PRECIPICEINTEGRATED/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PRECIPWATERINTEGRATED/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_SNOWRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE
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STRUCTURE /L3PR_MS_G1_RAINRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PRECIPRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PRECIPRATEESURFACE2/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PRECIPRATEESURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_MIXEDPHRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_SNOWRATE/
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```
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_RAINRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1_PRECIPRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_MS_G1/
    RECORD /L3PR_MS_G1_PRECIPRATE/ precipRate
    RECORD /L3PR_MS_G1_RAINRATE/ rainRate
    RECORD /L3PR_MS_G1_SNOWRATE/ snowRate
    RECORD /L3PR_MS_G1_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3PR_MS_G1_MIXEDPHRATE/ mixedPhRate
    RECORD /L3PR_MS_G1_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3PR_MS_G1_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3PR_MS_G1_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3PR_MS_G1_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3PR_MS_G1_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3PR_MS_G1_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3PR_MS_G1_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3PR_MS_G1_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3PR_MS_G1_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3PR_MS_G1_ZFACTORFINAL/ zFactorFinal
    RECORD /L3PR_MS_G1_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3PR_MS_G1_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3PR_MS_G1_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3PR_MS_G1_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3PR_MS_G1_DM/ dm
    RECORD /L3PR_MS_G1_DBNW/ dBNw
    RECORD /L3PR_MS_G1_EPSILON/ epsilon
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    RECORD /L3PR_MS_G1_ZETA/ zeta
    RECORD /L3PR_MS_G1_PIAHB/ piaHB
    RECORD /L3PR_MS_G1_PIAHYBRID/ piaHybrid
    RECORD /L3PR_MS_G1_PIASRT/ piaSRT
    RECORD /L3PR_MS_G1_PIAFINAL/ piaFinal
    RECORD /L3PR_MS_G1_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3PR_MS_G1_HEIGHTBB/ heightBB
    RECORD /L3PR_MS_G1_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3PR_MS_G1_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3PR_MS_G1_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3PR_MS_G1_BBWIDTH/ BBwidth
    RECORD /L3PR_MS_G1_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3PR_MS_G1_PRECIPRATELOCALTIME/ precipRateLocalTime
    RECORD /L3PR_MS_G1_DFRMNEARSURFACE/ DFRmNearSurface
    RECORD /L3PR_MS_G1_DFRNEARSURFACE/ DFRNearSurface
    REAL*4 precipRateNearSurfaceUnconditional(28,72,3)
    REAL*4 precipProbabilityNearSurface(28,72,3)
END STRUCTURE

STRUCTURE /L3PR_MS/
    RECORD /L3PR_MS_G1/ G1
    RECORD /L3PR_MS_G2/ G2
END STRUCTURE

STRUCTURE /L3PR_FS_G2_DFRNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_DFRMNEARSURFACE/
    INTEGER*4 count(536,1440,3)
    REAL*4 mean(536,1440,3)
    REAL*4 stdev(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PRECIPRATELOCALTIME/
    INTEGER*4 count(536,1440,3,24)
    REAL*4 mean(536,1440,3,24)
    REAL*4 stdev(536,1440,3,24)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_OBSERVATIONCOUNTS/
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```
    INTEGER*4 total(536,1440,3)
    INTEGER*4 localTime(536,1440,3,24)
    INTEGER*4 pia(536,1440,3,7)
    INTEGER*4 shallowRain(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_BBWIDTH/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_HEIGHTSTORMTOP/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_BBWIDTHNADIR/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_HEIGHTBBNADIR/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_HEIGHTBB/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PIAFINALSUBSET/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PIAFINAL/
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```
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PIASRT/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PIAHYBRID/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PIAHB/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_ZETA/
    INTEGER*4 count(536,1440,4,7,3)
    REAL*4 mean(536,1440,4,7,3)
    REAL*4 stdev(536,1440,4,7,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_EPSILON/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_DBNW/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_DM/
    INTEGER*4 count(536,1440,3,5,3)
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```
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_ZFACTORMEASURED/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_ZFACTORFINALESURFACE/
    INTEGER*4 count(536,1440,4,3)
    REAL*4 mean(536,1440,4,3)
    REAL*4 stdev(536,1440,4,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_ZFACTORFINAL/
    INTEGER*4 count(536,1440,4,5,3)
    REAL*4 mean(536,1440,4,5,3)
    REAL*4 stdev(536,1440,4,5,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PRECIPRATEAVE24/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PRECIPICEINTEGRATED/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
```

```
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PRECIPWATERINTEGRATED/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_SNOWRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_RAINRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PRECIPRATENEARSURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PRECIPRATEESURFACE2/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PRECIPRATEESURFACE/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
```

```
END STRUCTURE

STRUCTURE /L3PR_FS_G2_MIXEDPHRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(536,1440,3,3)
    REAL*4 mean(536,1440,3,3)
    REAL*4 stdev(536,1440,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_SNOWRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_RAINRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2_PRECIPRATE/
    INTEGER*4 count(536,1440,3,5,3)
    REAL*4 mean(536,1440,3,5,3)
    REAL*4 stdev(536,1440,3,5,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G2/
    RECORD /L3PR_FS_G2_PRECIPRATE/ precipRate
    RECORD /L3PR_FS_G2_RAINRATE/ rainRate
    RECORD /L3PR_FS_G2_SNOWRATE/ snowRate
    RECORD /L3PR_FS_G2_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3PR_FS_G2_MIXEDPHRATE/ mixedPhRate
    RECORD /L3PR_FS_G2_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3PR_FS_G2_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3PR_FS_G2_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3PR_FS_G2_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3PR_FS_G2_SNOWRATENEARSURFACE/ snowRateNearSurface
```

```
    RECORD /L3PR_FS_G2_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
    RECORD /L3PR_FS_G2_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3PR_FS_G2_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3PR_FS_G2_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3PR_FS_G2_ZFACTORFINAL/ zFactorFinal
    RECORD /L3PR_FS_G2_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3PR_FS_G2_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3PR_FS_G2_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3PR_FS_G2_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3PR_FS_G2_DM/ dm
    RECORD /L3PR_FS_G2_DBNW/ dBNw
    RECORD /L3PR_FS_G2_EPSILON/ epsilon
    RECORD /L3PR_FS_G2_ZETA/ zeta
    RECORD /L3PR_FS_G2_PIAHB/ piaHB
    RECORD /L3PR_FS_G2_PIAHYBRID/ piaHybrid
    RECORD /L3PR_FS_G2_PIASRT/ piaSRT
    RECORD /L3PR_FS_G2_PIAFINAL/ piaFinal
    RECORD /L3PR_FS_G2_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3PR_FS_G2_HEIGHTBB/ heightBB
    RECORD /L3PR_FS_G2_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3PR_FS_G2_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3PR_FS_G2_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3PR_FS_G2_BBWIDTH/ BBwidth
    RECORD /L3PR_FS_G2_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3PR_FS_G2_PRECIPRATELOCALTIME/ precipRateLocalTime
    RECORD /L3PR_FS_G2_DFRMNEARSURFACE/ DFRmNearSurface
    RECORD /L3PR_FS_G2_DFRNEARSURFACE/ DFRNearSurface
    REAL*4 precipRateNearSurfaceUnconditional(536,1440,3)
    REAL*4 precipProbabilityNearSurface(536,1440,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_DFRNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_DFRMNEARSURFACE/
    INTEGER*4 count(28,72,3,3)
    REAL*4 mean(28,72,3,3)
    REAL*4 stdev(28,72,3,3)
    INTEGER*4 hist(28,72,3,3,30)
```

```
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PRECIPRATELOCALTIME/
    INTEGER*4 count(28,72,3,24,3)
    REAL*4 mean(28,72,3,24,3)
    REAL*4 stdev(28,72,3,24,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_OBSERVATIONCOUNTS/
    INTEGER*4 total(28,72,3,3)
    INTEGER*4 localTime(28,72,3,24,3)
    INTEGER*4 pia(28,72,3,7,3)
    INTEGER*4 shallowRain(28,72,3,3)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_BBWIDTH/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_HEIGHTSTORMTOP/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_BBWIDTHNADIR/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_HEIGHTBBNADIR/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3PR_FS_G1_HEIGHTBB/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PIAFINALSUBSET/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PIAFINAL/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PIASRT/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PIAHYBRID/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PIAHB/
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_ZETA/
```

```
    INTEGER*4 count(28,72,4,7,3,3)
    REAL*4 mean(28,72,4,7,3,3)
    REAL*4 stdev(28,72,4,7,3,3)
    INTEGER*4 hist(28,72,4,7,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_EPSILON/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_DBNW/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_DM/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_ZFACTORMEASURED/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_ZFACTORMEASUREDNEARSURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_ZFACTORFINALNEARSURFACE/
    INTEGER*4 count(28,72,4,3,3)
```

```
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_ZFACTORFINALESURFACE/
    INTEGER*4 count(28,72,4,3,3)
    REAL*4 mean(28,72,4,3,3)
    REAL*4 stdev(28,72,4,3,3)
    INTEGER*4 hist(28,72,4,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_ZFACTORFINAL/
    INTEGER*4 count(28,72,4,5,3,3)
    REAL*4 mean(28,72,4,5,3,3)
    REAL*4 stdev(28,72,4,5,3,3)
    INTEGER*4 hist(28,72,4,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PRECIPRATEAVE24/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PRECIPICEINTEGRATED/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PRECIPWATERINTEGRATED/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_MIXEDPHRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
```

```
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_SNOWRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_RAINRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PRECIPRATENEARSURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PRECIPRATEESURFACE2/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PRECIPRATEESURFACE/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_MIXEDPHRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
```

```
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_FLAGHEAVYICEPRECIP/
    INTEGER*4 count(28,72,3,3,3)
    REAL*4 mean(28,72,3,3,3)
    REAL*4 stdev(28,72,3,3,3)
    INTEGER*4 hist(28,72,3,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_SNOWRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_RAINRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1_PRECIPRATE/
    INTEGER*4 count(28,72,3,5,3,3)
    REAL*4 mean(28,72,3,5,3,3)
    REAL*4 stdev(28,72,3,5,3,3)
    INTEGER*4 hist(28,72,3,5,3,3,30)
END STRUCTURE

STRUCTURE /L3PR_FS_G1/
    RECORD /L3PR_FS_G1_PRECIPRATE/ precipRate
    RECORD /L3PR_FS_G1_RAINRATE/ rainRate
    RECORD /L3PR_FS_G1_SNOWRATE/ snowRate
    RECORD /L3PR_FS_G1_FLAGHEAVYICEPRECIP/ flagHeavyIcePrecip
    RECORD /L3PR_FS_G1_MIXEDPHRATE/ mixedPhRate
    RECORD /L3PR_FS_G1_PRECIPRATEESURFACE/ precipRateESurface
    RECORD /L3PR_FS_G1_PRECIPRATEESURFACE2/ precipRateESurface2
    RECORD /L3PR_FS_G1_PRECIPRATENEARSURFACE/ precipRateNearSurface
    RECORD /L3PR_FS_G1_RAINRATENEARSURFACE/ rainRateNearSurface
    RECORD /L3PR_FS_G1_SNOWRATENEARSURFACE/ snowRateNearSurface
    RECORD /L3PR_FS_G1_MIXEDPHRATENEARSURFACE/ mixedPhRateNearSurface
```

```
    RECORD /L3PR_FS_G1_PRECIPWATERINTEGRATED/ precipWaterIntegrated
    RECORD /L3PR_FS_G1_PRECIPICEINTEGRATED/ precipIceIntegrated
    RECORD /L3PR_FS_G1_PRECIPRATEAVE24/ precipRateAve24
    RECORD /L3PR_FS_G1_ZFACTORFINAL/ zFactorFinal
    RECORD /L3PR_FS_G1_ZFACTORFINALESURFACE/ zFactorFinalESurface
    RECORD /L3PR_FS_G1_ZFACTORFINALNEARSURFACE/ zFactorFinalNearSurface
    RECORD /L3PR_FS_G1_ZFACTORMEASUREDNEARSURFACE/ zFactorMeasuredNearSurface
    RECORD /L3PR_FS_G1_ZFACTORMEASURED/ zFactorMeasured
    RECORD /L3PR_FS_G1_DM/ dm
    RECORD /L3PR_FS_G1_DBNW/ dBNw
    RECORD /L3PR_FS_G1_EPSILON/ epsilon
    RECORD /L3PR_FS_G1_ZETA/ zeta
    RECORD /L3PR_FS_G1_PIAHB/ piaHB
    RECORD /L3PR_FS_G1_PIAHYBRID/ piaHybrid
    RECORD /L3PR_FS_G1_PIASRT/ piaSRT
    RECORD /L3PR_FS_G1_PIAFINAL/ piaFinal
    RECORD /L3PR_FS_G1_PIAFINALSUBSET/ piaFinalSubset
    RECORD /L3PR_FS_G1_HEIGHTBB/ heightBB
    RECORD /L3PR_FS_G1_HEIGHTBBNADIR/ heightBBnadir
    RECORD /L3PR_FS_G1_BBWIDTHNADIR/ BBwidthNadir
    RECORD /L3PR_FS_G1_HEIGHTSTORMTOP/ heightStormTop
    RECORD /L3PR_FS_G1_BBWIDTH/ BBwidth
    RECORD /L3PR_FS_G1_OBSERVATIONCOUNTS/ observationCounts
    RECORD /L3PR_FS_G1_PRECIPRATELOCALTIME/ precipRateLocalTime
    RECORD /L3PR_FS_G1_DFRMNEARSURFACE/ DFRmNearSurface
    RECORD /L3PR_FS_G1_DFRNEARSURFACE/ DFRNearSurface
    REAL*4 precipRateNearSurfaceUnconditional(28,72,3)
    REAL*4 precipProbabilityNearSurface(28,72,3)
END STRUCTURE

STRUCTURE /L3PR_FS/
    RECORD /L3PR_FS_G1/ G1
    RECORD /L3PR_FS_G2/ G2
END STRUCTURE
```

5.52 3DPRD - DPR Daily Product

3DPRD, "DPR Daily Product", computes daily statistics of the DPR measurements at a high horizontal resolution (0.25^o x 0.25^o latitude/longitude).

Dimension definitions:

nlat	536	Number of high resolution 0.25^o grid intervals of latitude from 67^{o}S to 67^{o}N.
nlon	1440	Number of high resolution 0.25^o grid intervals of longitude from 180^{o}W to 180^{o}E.
nalt	5	Number of heights above the earth ellipsoid: 2km, 4km, 6km, 10km, and 15km.
nvar	3	Number of phase bins. Bins are counts of phase less than 100, counts of phase greater than or equal to 100 and less than 200, counts of phase greater than or equal to 200.
chd	3	Number of channels. Channels are KuFS, DPRMS, DPRFS.
AD	2	Ascending or descending half of the orbit.

Figure 1056 through Figure 1059 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

GRID (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

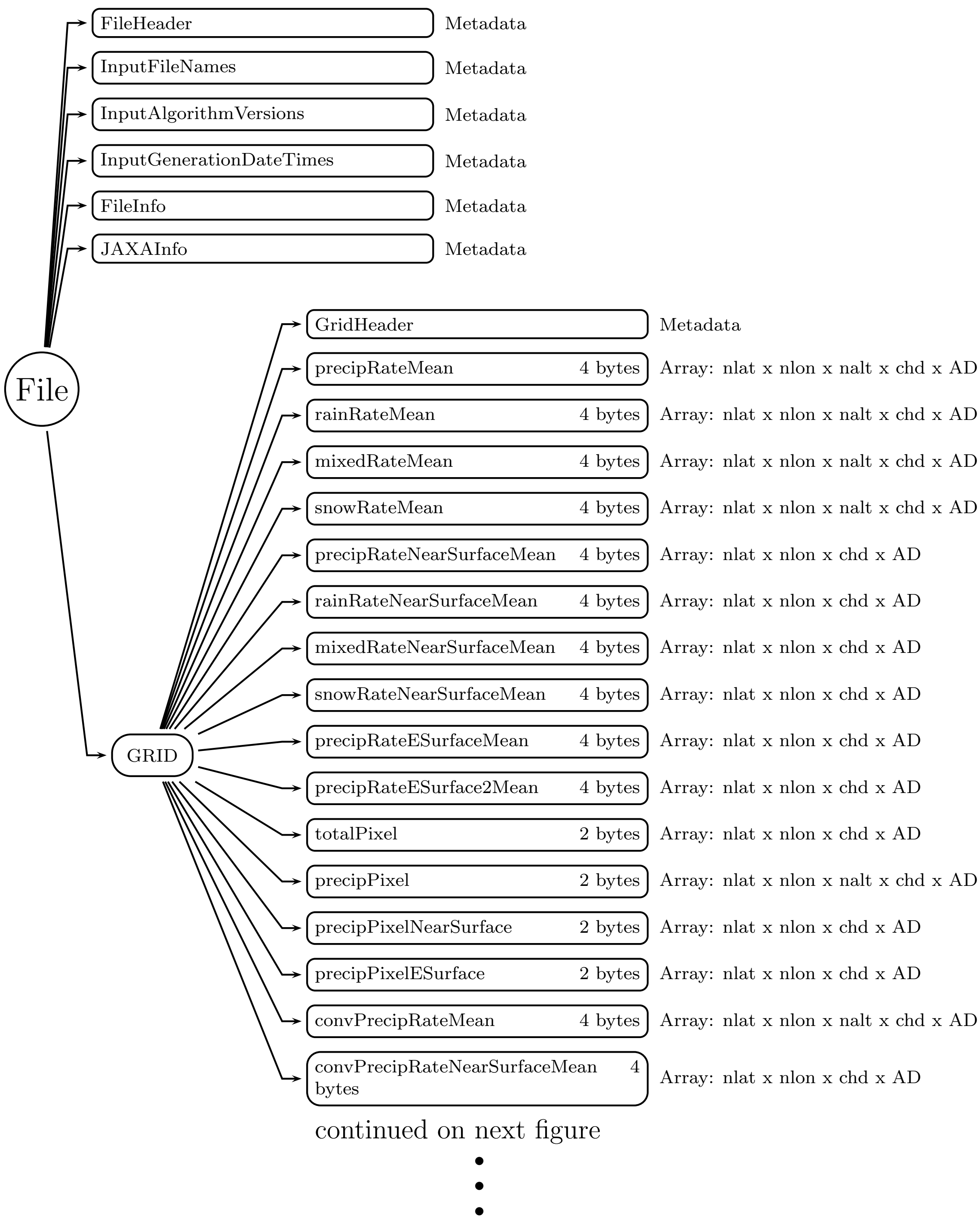


Figure 1056: Data Format Structure for 3DPRD, DPR Daily Product

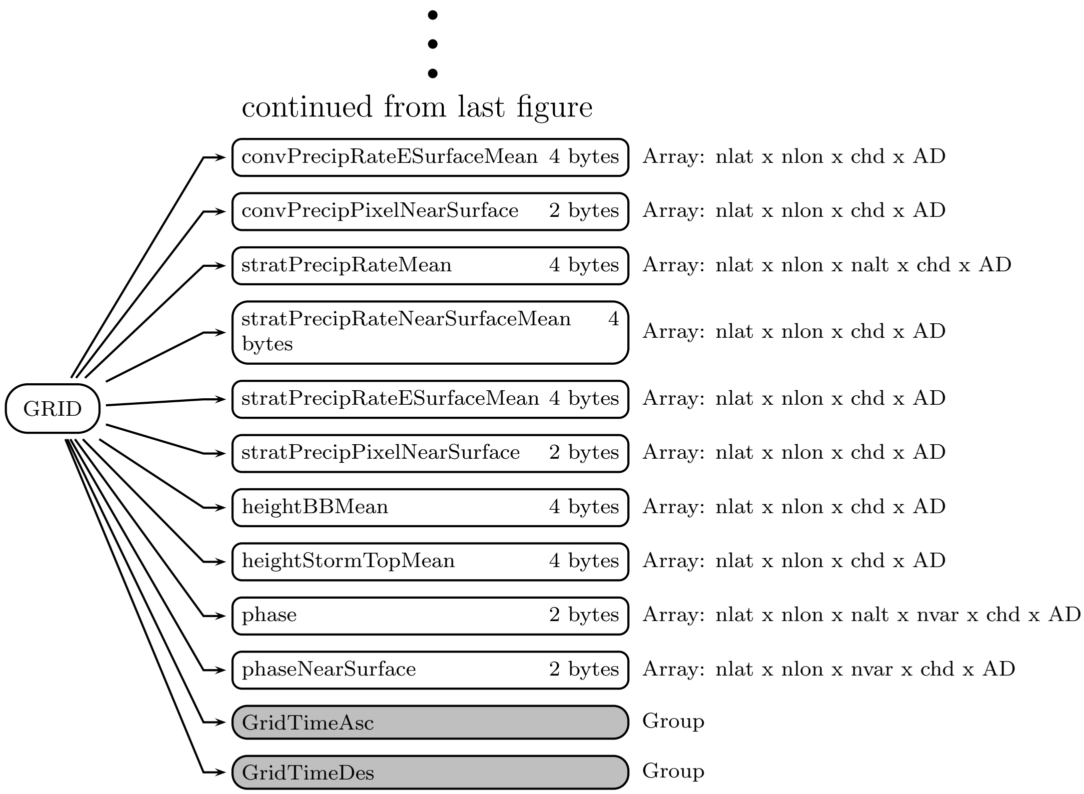


Figure 1057: Data Format Structure for 3DPRD, DPR Daily Product

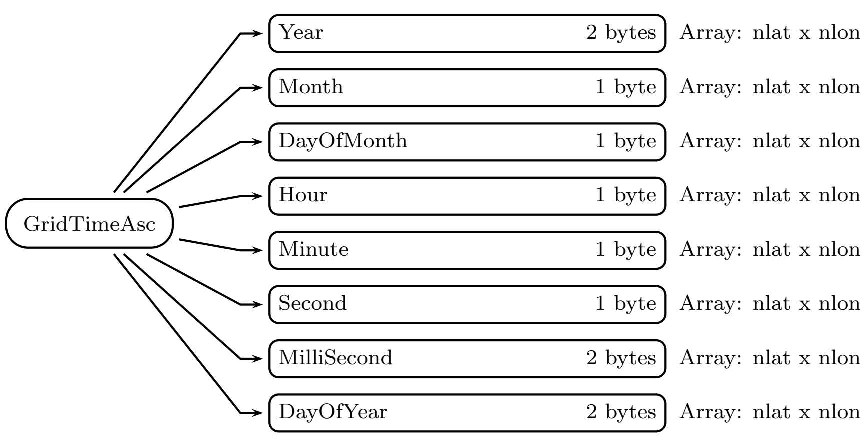


Figure 1058: Data Format Structure for 3DPRD, GridTimeAsc

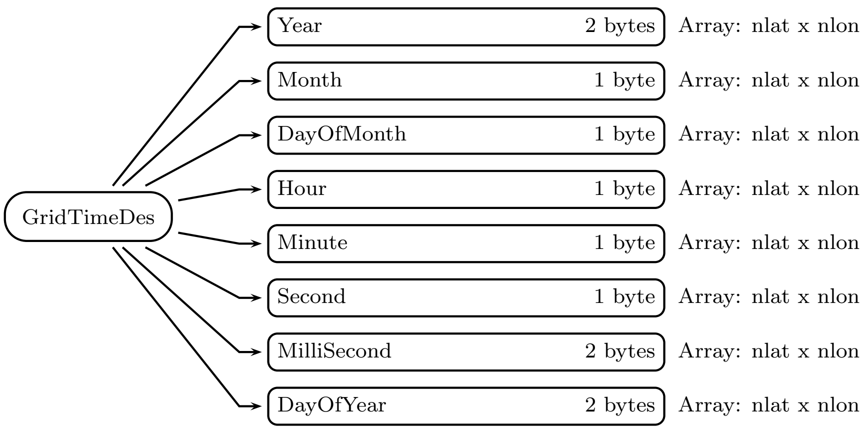


Figure 1059: Data Format Structure for 3DPRD, GridTimeDes

precipRateMean (4-byte float, array size: nlat x nlon x nalt x chd x AD):
Mean Precipitation rate, includes both liquid and solid phases at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainRateMean (4-byte float, array size: nlat x nlon x nalt x chd x AD):
Mean rainfall rate, excludes solid precipitation at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

mixedRateMean (4-byte float, array size: nlat x nlon x nalt x chd x AD):
Mean rainfall rate of the mixed phase precipitation at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

snowRateMean (4-byte float, array size: nlat x nlon x nalt x chd x AD):
Mean rainfall rate of solid precipitation at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateNearSurfaceMean (4-byte float, array size: nlat x nlon x chd x AD):
Mean precipitation rate in a grid box using only the Near Surface location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

rainRateNearSurfaceMean (4-byte float, array size: nlat x nlon x chd x AD):
Mean rainfall rate of liquid precipitation in a grid box using only the Near Surface location along the slant path for each radar ray. First index is Ascending node, second index is

Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

mixedRateNearSurfaceMean (4-byte float, array size: nlat x nlon x chd x AD):
Mean rainfall rate of mixed phase precipitation in a grid box using only the Near Surface location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

snowRateNearSurfaceMean (4-byte float, array size: nlat x nlon x chd x AD):
Mean rainfall rate of solid precipitation in a grid box using only the Near Surface location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurfaceMean (4-byte float, array size: nlat x nlon x chd x AD):
Mean precipitation rate in a grid box using only the Estimated Surface location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Mean (4-byte float, array size: nlat x nlon x chd x AD):
Mean precipitation rate in a grid box using only the Estimated Surface 2 location along the slant path for each radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

totalPixel (2-byte integer, array size: nlat x nlon x chd x AD):
The total number of measurements in each grid box. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

precipPixel (2-byte integer, array size: nlat x nlon x nalt x chd x AD):
The number of measurements in each grid box that included detectable precipitation at various height levels. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

precipPixelNearSurface (2-byte integer, array size: nlat x nlon x chd x AD):
The number of measurements in a grid box that included detectable precipitation at the Near Surface level. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

precipPixelESurface (2-byte integer, array size: nlat x nlon x chd x AD):
The number of measurements in a grid box that included detectable precipitation at the Estimated Surface level. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

convPrecipRateMean (4-byte float, array size: nlat x nlon x nalt x chd x AD):
The mean precipitation rate of convective type at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

convPrecipRateNearSurfaceMean (4-byte float, array size: nlat x nlon x chd x AD):
The mean precipitation rate of convective type at the Near Surface level along the radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

convPrecipRateESurfaceMean (4-byte float, array size: nlat x nlon x chd x AD):
The mean precipitation rate of convective type at the Estimated Surface level along the radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

convPrecipPixelNearSurface (2-byte integer, array size: nlat x nlon x chd x AD):
The number of convective precipitation measurements in a grid box at the Near Surface level. First index is Ascending node, second index is Descending. Special values are defined as:

-9999 Missing value

stratPrecipRateMean (4-byte float, array size: nlat x nlon x nalt x chd x AD):
The mean precipitation rate of stratiform type at various height levels. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

stratPrecipRateNearSurfaceMean (4-byte float, array size: nlat x nlon x chd x AD):
The mean precipitation rate of stratiform type at the Near Surface level along the radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

stratPrecipRateESurfaceMean (4-byte float, array size: nlat x nlon x chd x AD):
The mean precipitation rate of stratiform type at the Estimated Surface level along the radar ray. First index is Ascending node, second index is Descending. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

stratPrecipPixelNearSurface (2-byte integer, array size: nlat x nlon x chd x AD):
The number of stratiform precipitation measurements in a grid box at the Near Surface level. First index is Ascending node, second index is Descending. Special values are defined as:

-9999 Missing value

heightBBMean (4-byte float, array size: nlat x nlon x chd x AD):
The mean bright band height in a grid box. First index is Ascending node, second index is Descending. Values are in m. Special values are defined as:
-9999.9 Missing value

heightStormTopMean (4-byte float, array size: nlat x nlon x chd x AD):
The mean storm top height in a grid box. First index is Ascending node, second index is Descending. Values are in m. Special values are defined as:
-9999.9 Missing value

phase (2-byte integer, array size: nlat x nlon x nalt x nvar x chd x AD):
The precipitation phase type in a grid box a various heights. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

phaseNearSurface (2-byte integer, array size: nlat x nlon x nvar x chd x AD):
The precipitation phase type in a grid box. First index is Ascending node, second index is Descending. Special values are defined as:
-9999 Missing value

GridTimeAsc (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

GridTimeDes (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3DPRD_H_
#define _TK_3DPRD_H_
```

```
#ifndef _L3DPRD_GRIDTIMEDES_
#define _L3DPRD_GRIDTIMEDES_

typedef struct {
    short Year[1440][536];
    signed char Month[1440][536];
    signed char DayOfMonth[1440][536];
    signed char Hour[1440][536];
    signed char Minute[1440][536];
    signed char Second[1440][536];
    short MilliSecond[1440][536];
    short DayOfYear[1440][536];
} L3DPRD_GRIDTIMEDES;

#endif

#ifndef _L3DPRD_GRIDTIMEASC_
#define _L3DPRD_GRIDTIMEASC_

typedef struct {
    short Year[1440][536];
    signed char Month[1440][536];
    signed char DayOfMonth[1440][536];
    signed char Hour[1440][536];
    signed char Minute[1440][536];
    signed char Second[1440][536];
    short MilliSecond[1440][536];
    short DayOfYear[1440][536];
} L3DPRD_GRIDTIMEASC;

#endif

#ifndef _L3DPRD_GRID_
#define _L3DPRD_GRID_

typedef struct {
    float precipRateMean[2][3][5][1440][536];
    float rainRateMean[2][3][5][1440][536];
    float mixedRateMean[2][3][5][1440][536];
    float snowRateMean[2][3][5][1440][536];
    float precipRateNearSurfaceMean[2][3][1440][536];
    float rainRateNearSurfaceMean[2][3][1440][536];
```

```
    float mixedRateNearSurfaceMean[2][3][1440][536];
    float snowRateNearSurfaceMean[2][3][1440][536];
    float precipRateESurfaceMean[2][3][1440][536];
    float precipRateESurface2Mean[2][3][1440][536];
    short totalPixel[2][3][1440][536];
    short precipPixel[2][3][5][1440][536];
    short precipPixelNearSurface[2][3][1440][536];
    short precipPixelESurface[2][3][1440][536];
    float convPrecipRateMean[2][3][5][1440][536];
    float convPrecipRateNearSurfaceMean[2][3][1440][536];
    float convPrecipRateESurfaceMean[2][3][1440][536];
    short convPrecipPixelNearSurface[2][3][1440][536];
    float stratPrecipRateMean[2][3][5][1440][536];
    float stratPrecipRateNearSurfaceMean[2][3][1440][536];
    float stratPrecipRateESurfaceMean[2][3][1440][536];
    short stratPrecipPixelNearSurface[2][3][1440][536];
    float heightBBMean[2][3][1440][536];
    float heightStormTopMean[2][3][1440][536];
    short phase[2][3][3][5][1440][536];
    short phaseNearSurface[2][3][3][1440][536];
    L3DPRD_GRIDTIMEASC GridTimeAsc;
    L3DPRD_GRIDTIMEDES GridTimeDes;
} L3DPRD_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3DPRD_GRIDTIMEDES/
    INTEGER*2 Year(536,1440)
    BYTE Month(536,1440)
    BYTE DayOfMonth(536,1440)
    BYTE Hour(536,1440)
    BYTE Minute(536,1440)
    BYTE Second(536,1440)
    INTEGER*2 MilliSecond(536,1440)
    INTEGER*2 DayOfYear(536,1440)
END STRUCTURE

STRUCTURE /L3DPRD_GRIDTIMEASC/
    INTEGER*2 Year(536,1440)
```

```
    BYTE Month(536,1440)
    BYTE DayOfMonth(536,1440)
    BYTE Hour(536,1440)
    BYTE Minute(536,1440)
    BYTE Second(536,1440)
    INTEGER*2 MilliSecond(536,1440)
    INTEGER*2 DayOfYear(536,1440)
END STRUCTURE

STRUCTURE /L3DPRD_GRID/
    REAL*4 precipRateMean(536,1440,5,3,2)
    REAL*4 rainRateMean(536,1440,5,3,2)
    REAL*4 mixedRateMean(536,1440,5,3,2)
    REAL*4 snowRateMean(536,1440,5,3,2)
    REAL*4 precipRateNearSurfaceMean(536,1440,3,2)
    REAL*4 rainRateNearSurfaceMean(536,1440,3,2)
    REAL*4 mixedRateNearSurfaceMean(536,1440,3,2)
    REAL*4 snowRateNearSurfaceMean(536,1440,3,2)
    REAL*4 precipRateESurfaceMean(536,1440,3,2)
    REAL*4 precipRateESurface2Mean(536,1440,3,2)
    INTEGER*2 totalPixel(536,1440,3,2)
    INTEGER*2 precipPixel(536,1440,5,3,2)
    INTEGER*2 precipPixelNearSurface(536,1440,3,2)
    INTEGER*2 precipPixelESurface(536,1440,3,2)
    REAL*4 convPrecipRateMean(536,1440,5,3,2)
    REAL*4 convPrecipRateNearSurfaceMean(536,1440,3,2)
    REAL*4 convPrecipRateESurfaceMean(536,1440,3,2)
    INTEGER*2 convPrecipPixelNearSurface(536,1440,3,2)
    REAL*4 stratPrecipRateMean(536,1440,5,3,2)
    REAL*4 stratPrecipRateNearSurfaceMean(536,1440,3,2)
    REAL*4 stratPrecipRateESurfaceMean(536,1440,3,2)
    INTEGER*2 stratPrecipPixelNearSurface(536,1440,3,2)
    REAL*4 heightBBMean(536,1440,3,2)
    REAL*4 heightStormTopMean(536,1440,3,2)
    INTEGER*2 phase(536,1440,5,3,3,2)
    INTEGER*2 phaseNearSurface(536,1440,3,3,2)
    RECORD /L3DPRD_GRIDTIMEASC/ GridTimeAsc
    RECORD /L3DPRD_GRIDTIMEDES/ GridTimeDes
END STRUCTURE
```

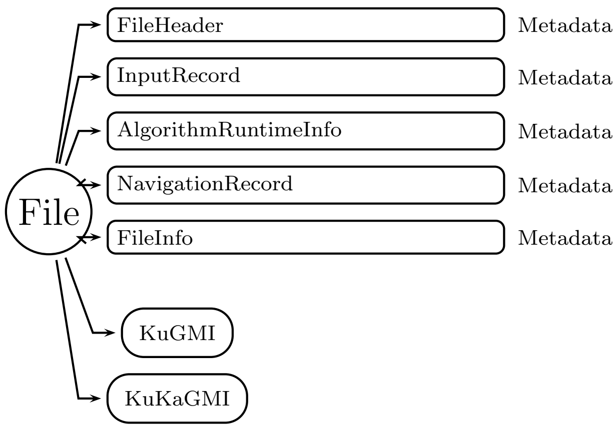


Figure 1060: Data Format Structure for 2BCMB, Level-2 DPR and GMI Combined

5.53 2BCMB - Level-2 DPR and GMI Combined

The GPM Combined Level-2 product, 2BCMB, "Level-2 DPR and GMI Combined," is written as a two-swath structure. The first swath, NS, contains 49 rays that match Ku DPR. The second swath, FS, contains 49 rays that match Ka Matched DPR. Surface variables refer to the level of the 2ADPR "near surface", not the "estimated surface". The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of rays (angle bins) in each NS and FS scan.
nPhsBnN	5	Number of phase bin nodes.
nBnEnv	10	Number of environmental bins.
nBnPSD	88	Number of vertical range bins at 250m interval.
nemiss	13	Number of microwave surface emissivities for GMI channels, including separate emissivities for the double side-band channels.
nKuKa	2	Number of Ku and Ka

Figure 1060 through Figure 1080 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

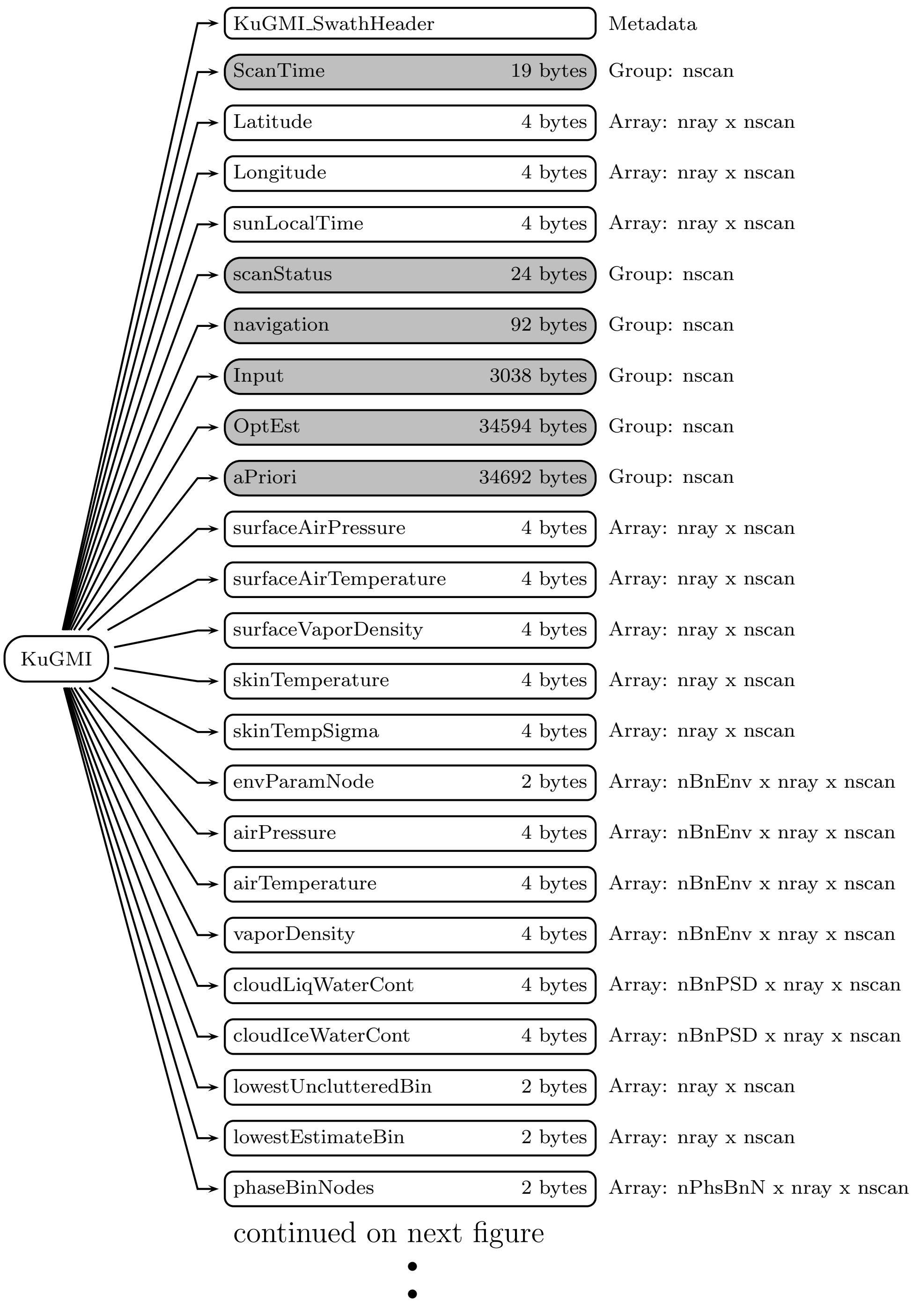


Figure 1061: Data Format Structure for 2BCMB, KuGMI,

continued from last figure

KuGMI

precipTotDm	4 bytes	Array: nBnPSD x nray x nscan
precipTotLogNw	4 bytes	Array: nBnPSD x nray x nscan
precipTotMu	4 bytes	Array: nBnPSD x nray x nscan
precipTotWaterCont	4 bytes	Array: nBnPSD x nray x nscan
precipTotWaterContSigma	4 bytes	Array: nBnPSD x nray x nscan
precipLiqWaterCont	4 bytes	Array: nBnPSD x nray x nscan
precipTotRate	4 bytes	Array: nBnPSD x nray x nscan
precipTotRateSigma	4 bytes	Array: nBnPSD x nray x nscan
precipLiqRate	4 bytes	Array: nBnPSD x nray x nscan
multiScatMaxContrib	4 bytes	Array: nray x nscan
nubfPIAfactor	4 bytes	Array: nray x nscan
nearSurfPrecipTotRate	4 bytes	Array: nray x nscan
nearSurfPrecipTotRateSigma	4 bytes	Array: nray x nscan
nearSurfPrecipLiqRate	4 bytes	Array: nray x nscan
estimSurfPrecipTotRate	4 bytes	Array: nray x nscan
estimSurfPrecipTotRateSigma	4 bytes	Array: nray x nscan
estimSurfPrecipLiqRate	4 bytes	Array: nray x nscan
tenMeterWindSpeed	4 bytes	Array: nray x nscan
tenMeterWindSigma	4 bytes	Array: nray x nscan
surfEmissivity	4 bytes	Array: nemiss x nray x nscan
surfEmissSigma	4 bytes	Array: nemiss x nray x nscan
simulatedBrightTemp	4 bytes	Array: nemiss x nray x nscan
pia	4 bytes	Array: nray x nscan
correctedReflectFactor	4 bytes	Array: nBnPSD x nray x nscan

continued on next figure

Figure 1062: Data Format Structure for 2BCMB, KuGMI,

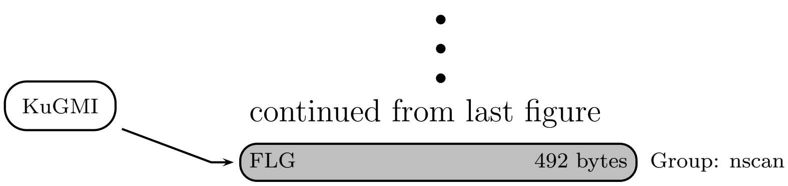
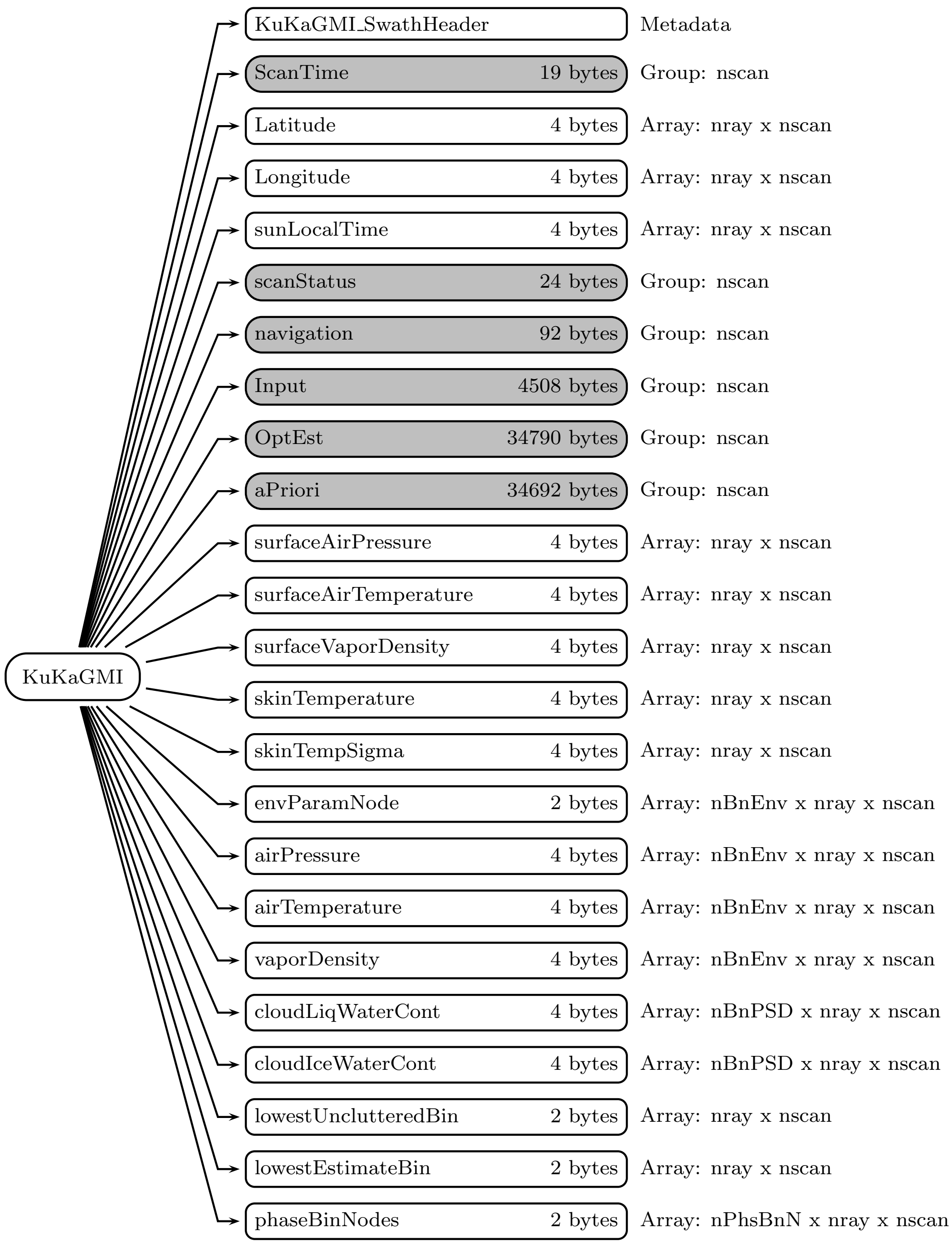


Figure 1063: Data Format Structure for 2BCMB, KuGMI



continued on next figure

Figure 1064: Data Format Structure for 2BCMB, KuKaGMI,

continued from last figure

KuKaGMI

precipTotDm	4 bytes	Array: nBnPSD x nray x nscan
precipTotLogNw	4 bytes	Array: nBnPSD x nray x nscan
precipTotMu	4 bytes	Array: nBnPSD x nray x nscan
precipTotWaterCont	4 bytes	Array: nBnPSD x nray x nscan
precipTotWaterContSigma	4 bytes	Array: nBnPSD x nray x nscan
precipLiqWaterCont	4 bytes	Array: nBnPSD x nray x nscan
precipTotRate	4 bytes	Array: nBnPSD x nray x nscan
precipTotRateSigma	4 bytes	Array: nBnPSD x nray x nscan
precipLiqRate	4 bytes	Array: nBnPSD x nray x nscan
multiScatMaxContrib	4 bytes	Array: nray x nscan
nubfPIAfactor	4 bytes	Array: nray x nscan
nearSurfPrecipTotRate	4 bytes	Array: nray x nscan
nearSurfPrecipTotRateSigma	4 bytes	Array: nray x nscan
nearSurfPrecipLiqRate	4 bytes	Array: nray x nscan
estimSurfPrecipTotRate	4 bytes	Array: nray x nscan
estimSurfPrecipTotRateSigma	4 bytes	Array: nray x nscan
estimSurfPrecipLiqRate	4 bytes	Array: nray x nscan
tenMeterWindSpeed	4 bytes	Array: nray x nscan
tenMeterWindSigma	4 bytes	Array: nray x nscan
surfEmissivity	4 bytes	Array: nemiss x nray x nscan
surfEmissSigma	4 bytes	Array: nemiss x nray x nscan
simulatedBrightTemp	4 bytes	Array: nemiss x nray x nscan
pia	4 bytes	Array: nKuKa x nray x nscan
correctedReflectFactor	4 bytes	Array: nKuKa x nBnPSD x nray x nscan

continued on next figure

Figure 1065: Data Format Structure for 2BCMB, KuKaGMI,

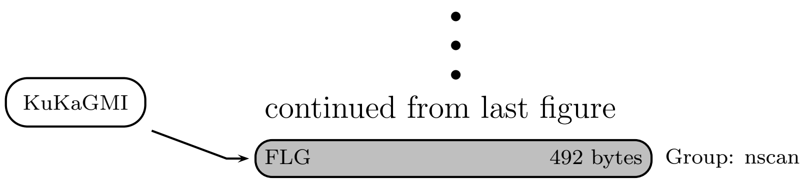


Figure 1066: Data Format Structure for 2BCMB, KuKaGMI

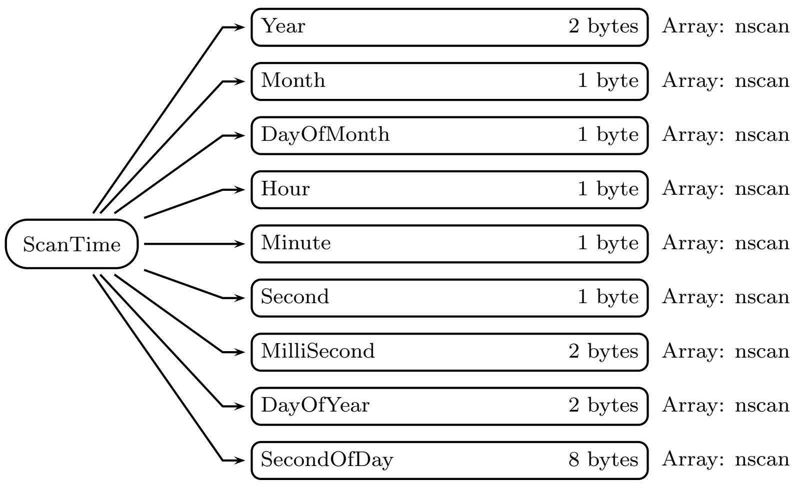


Figure 1067: Data Format Structure for 2BCMB, KuGMI, ScanTime

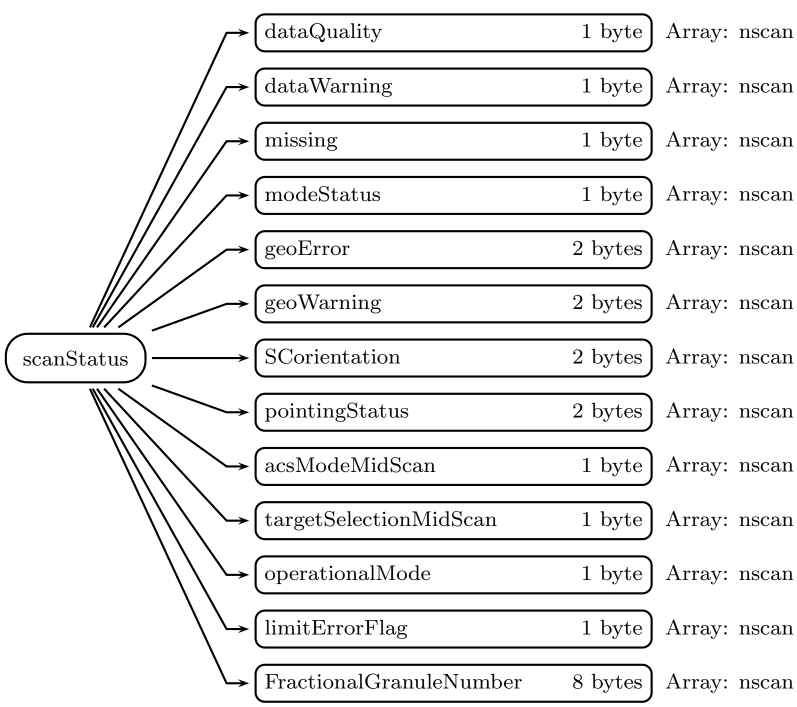


Figure 1068: Data Format Structure for 2BCMB, KuGMI, scanStatus

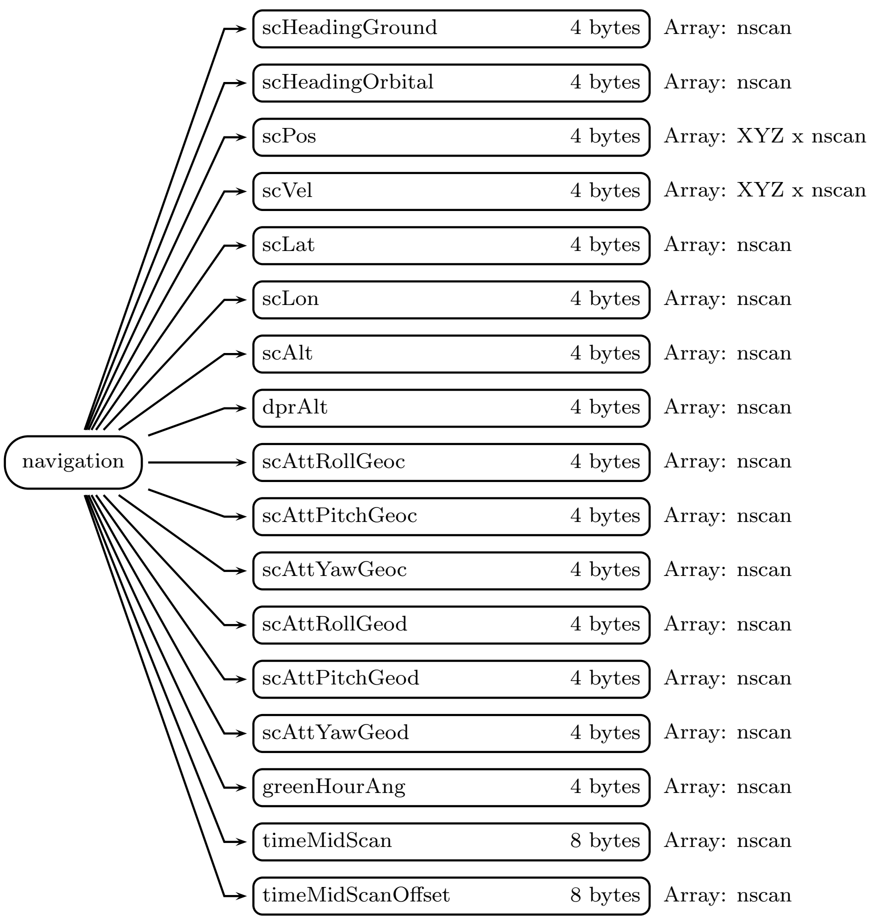


Figure 1069: Data Format Structure for 2BCMB, KuGMI, navigation

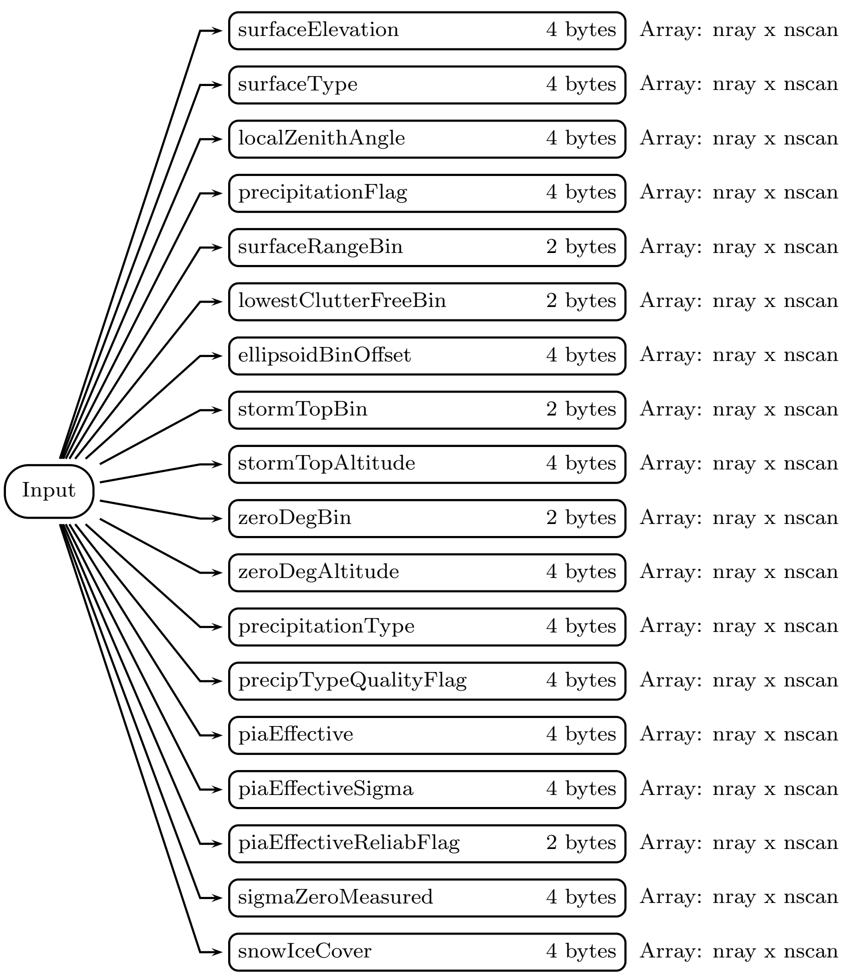


Figure 1070: Data Format Structure for 2BCMB, KuGMI, Input

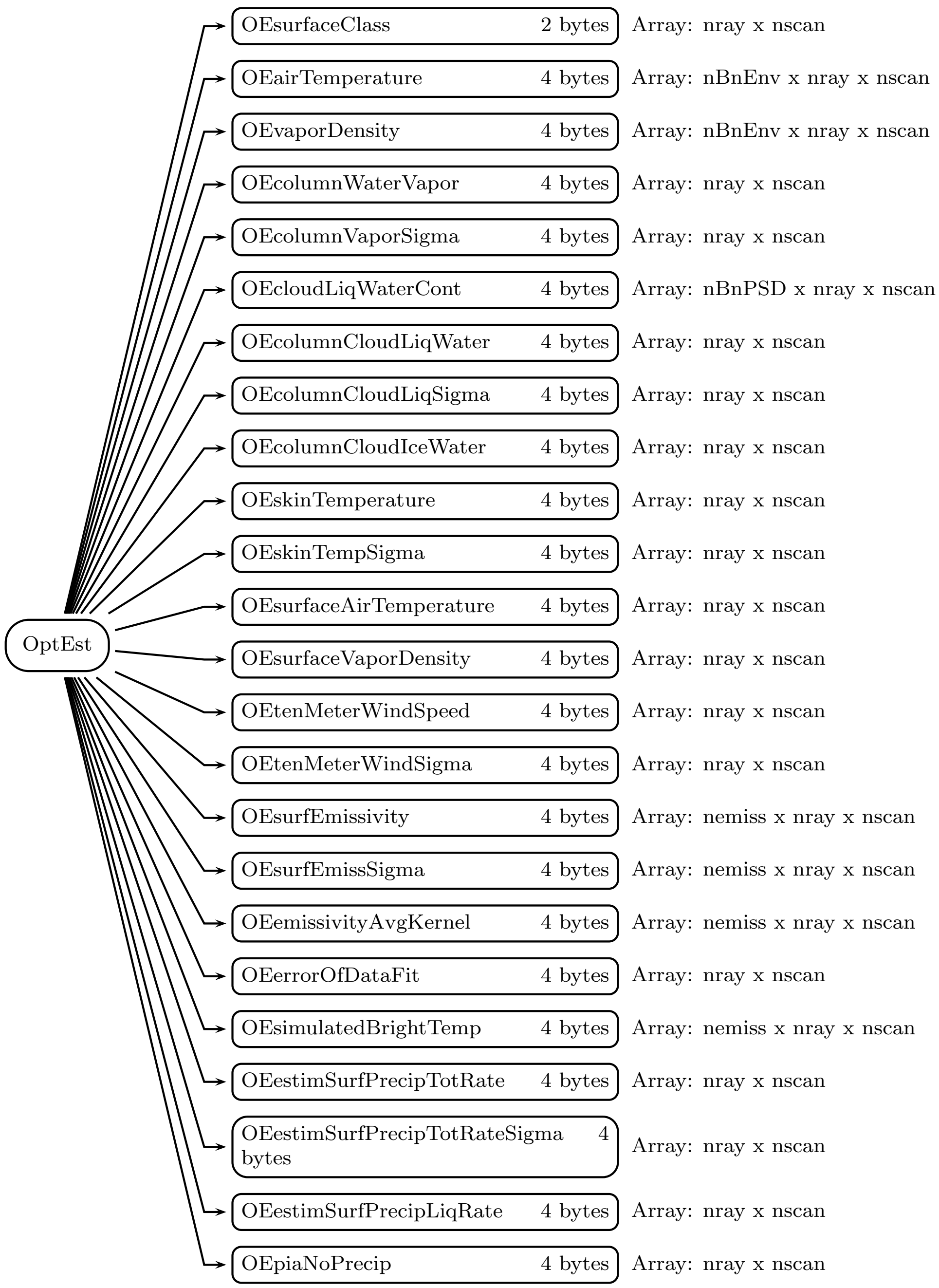


Figure 1071: Data Format Structure for 2BCMB, KuGMI, OptEst

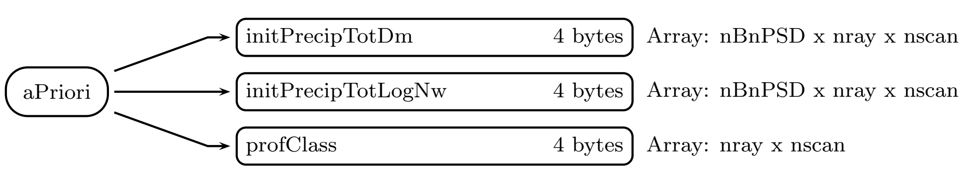


Figure 1072: Data Format Structure for 2BCMB, KuGMI, aPriori

FLG	scanPatternFlag	2 bytes	Array: nscan
	ioQuality	4 bytes	Array: nray x nscan
	multiScatCalc	4 bytes	Array: nray x nscan
	estimPrecipInClutter	2 bytes	Array: nray x nscan

Figure 1073: Data Format Structure for 2BCMB, KuGMI, FLG

ScanTime	Year	2 bytes	Array: nscan
	Month	1 byte	Array: nscan
	DayOfMonth	1 byte	Array: nscan
	Hour	1 byte	Array: nscan
	Minute	1 byte	Array: nscan
	Second	1 byte	Array: nscan
	MilliSecond	2 bytes	Array: nscan
	DayOfYear	2 bytes	Array: nscan
	SecondOfDay	8 bytes	Array: nscan

Figure 1074: Data Format Structure for 2BCMB, KuKaGMI, ScanTime

scanStatus	dataQuality	1 byte	Array: nscan
	dataWarning	1 byte	Array: nscan
	missing	1 byte	Array: nscan
	modeStatus	1 byte	Array: nscan
	geoError	2 bytes	Array: nscan
	geoWarning	2 bytes	Array: nscan
	SCorientation	2 bytes	Array: nscan
	pointingStatus	2 bytes	Array: nscan
	acsModeMidScan	1 byte	Array: nscan
	targetSelectionMidScan	1 byte	Array: nscan
	operationalMode	1 byte	Array: nscan
	limitErrorFlag	1 byte	Array: nscan
	FractionalGranuleNumber	8 bytes	Array: nscan

Figure 1075: Data Format Structure for 2BCMB, KuKaGMI, scanStatus

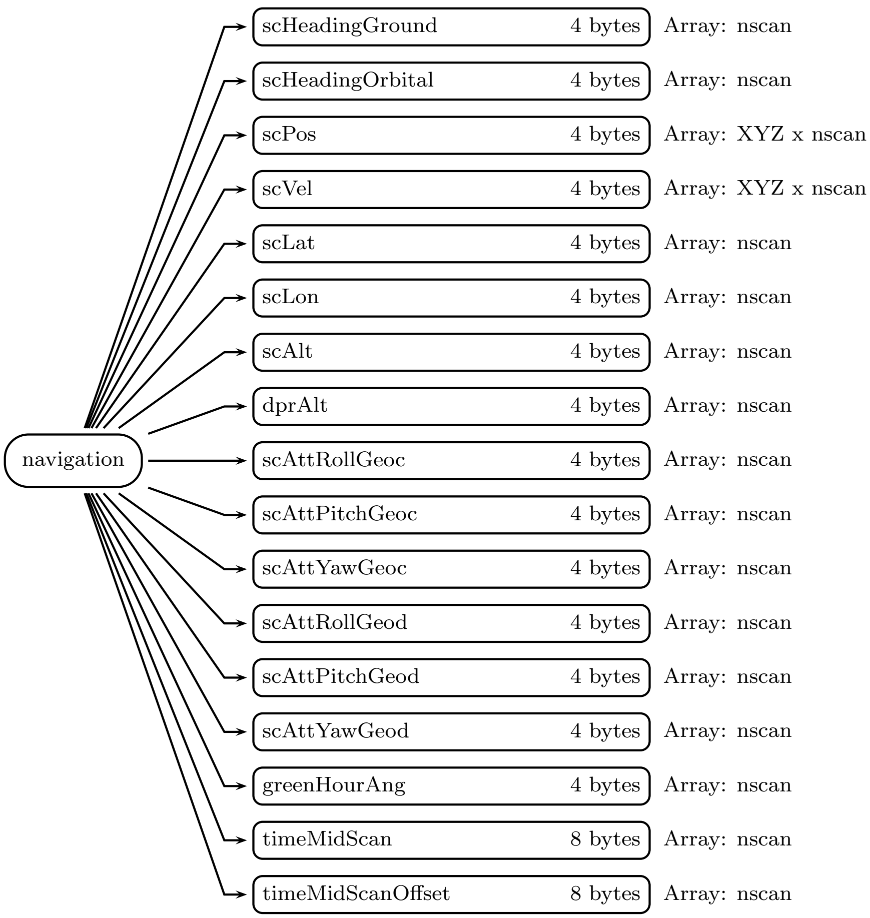


Figure 1076: Data Format Structure for 2BCMB, KuKaGMI, navigation

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):

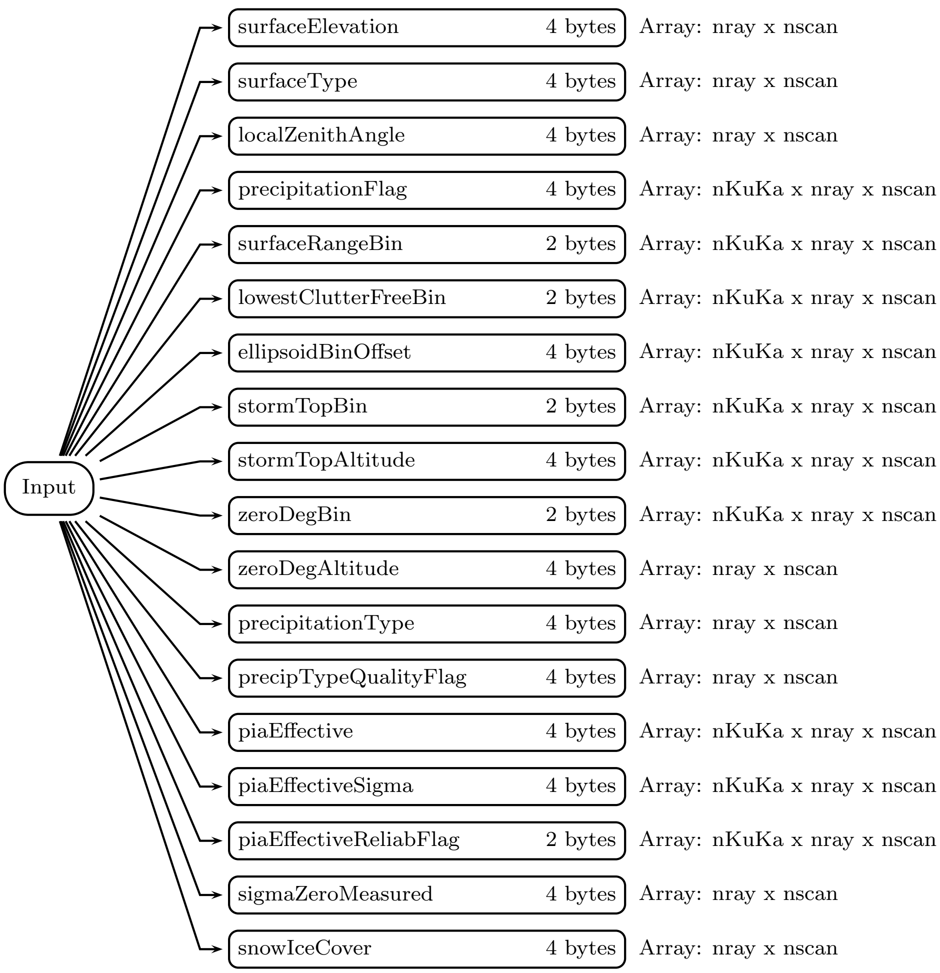


Figure 1077: Data Format Structure for 2BCMB, KuKaGMI, Input

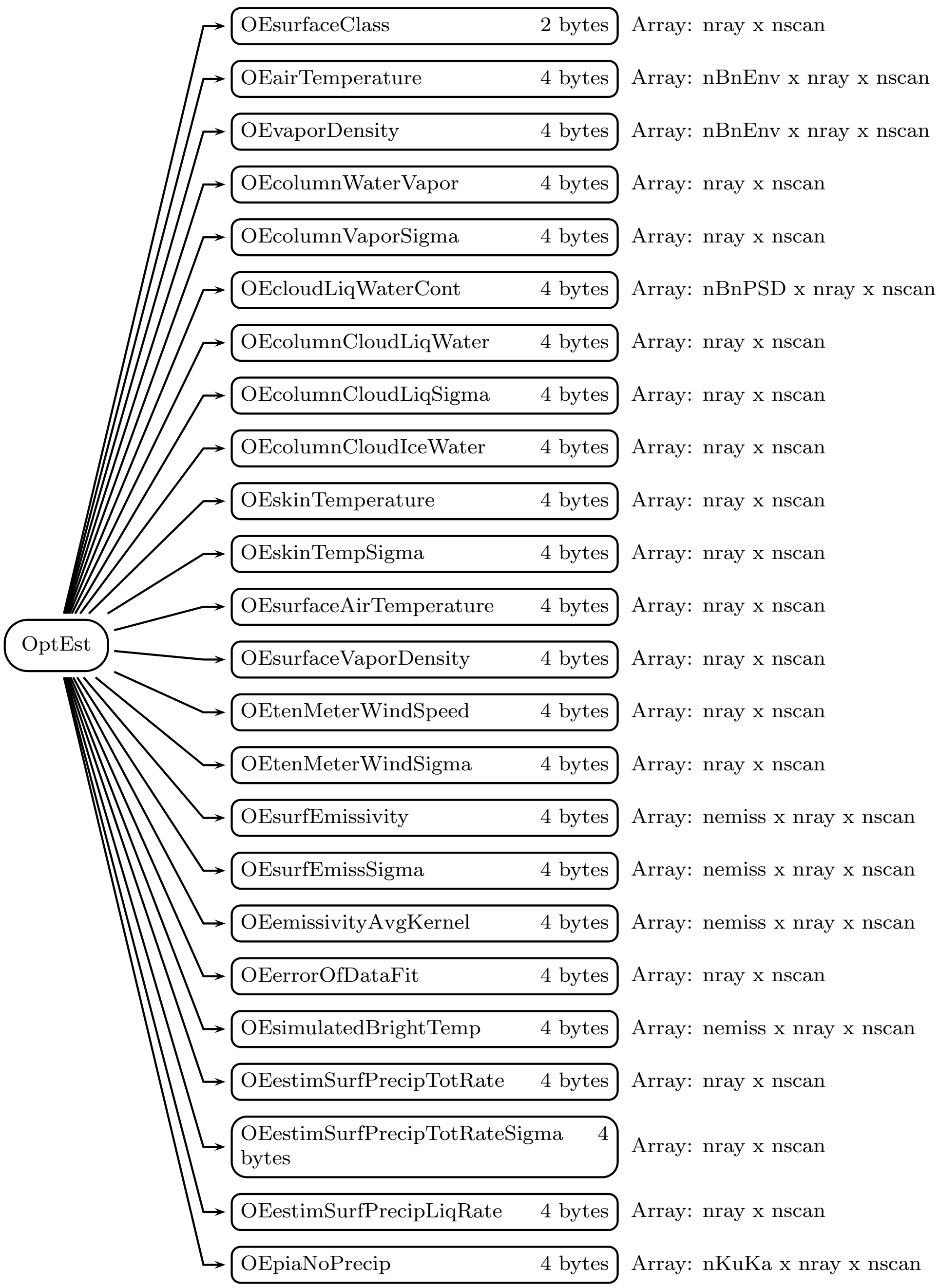


Figure 1078: Data Format Structure for 2BCMB, KuKaGMI, OptEst

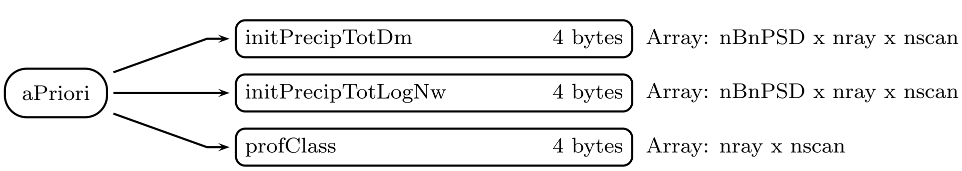


Figure 1079: Data Format Structure for 2BCMB, KuKaGMI, aPriori

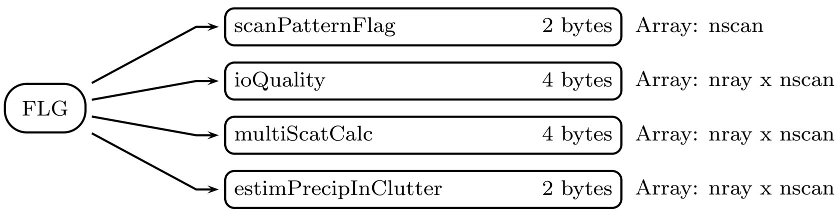


Figure 1080: Data Format Structure for 2BCMB, KuKaGMI, FLG

FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

KuGMI (Swath)

KuGMI_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in KuGMI)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in KuGMI)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
```

```
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
```

```
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
```

```
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in KuGMI)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time.

Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values

range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

Input (Group in KuGMI)

surfaceElevation (4-byte float, array size: nray x nscan):
Altitudes above the earth ellipsoid of the surface gates from 2AKu. Values are in m.

Special values are defined as:
-9999.9 Missing value

surfaceType (4-byte integer, array size: nray x nscan):
Surface type from 2AKu. Special values are defined as:
-9999 Missing value

localZenithAngle (4-byte float, array size: nray x nscan):
Zenith angle of the ray at the earth's surface from 2AKu. Values are in degree. Special values are defined as:
-9999.9 Missing value

precipitationFlag (4-byte integer, array size: nray x nscan):
Precipitation flag from 2AKu. Special values are defined as:
-9999 Missing value

surfaceRangeBin (2-byte integer, array size: nray x nscan):
Index of the surface range bin from 2AKu. Special values are defined as:
-9999 Missing value

lowestClutterFreeBin (2-byte integer, array size: nray x nscan):
Index of lowest clutter-free bin from 2AKu. Special values are defined as:
-9999 Missing value

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
Offset of surface bin from the earth ellipsoid from 2AKu. Values are in m. Special values are defined as:
-9999.9 Missing value

stormTopBin (2-byte integer, array size: nray x nscan):
Index of storm top bin from 2AKu. Special values are defined as:
-9999 Missing value

stormTopAltitude (4-byte float, array size: nray x nscan):
Altitude of storm top bin from 2AKu. Values are in m. Special values are defined as:
-9999.9 Missing value

zeroDegBin (2-byte integer, array size: nray x nscan):
Range bin of the freezing level. Special values are defined as:
-9999 Missing value

zeroDegAltitude (4-byte float, array size: nray x nscan):
Altitude of the freezing level. Values are in m. Special values are defined as:
-9999.9 Missing value

precipitationType (4-byte integer, array size: nray x nscan):
Precipitation type classification from 2AKu. Special values are defined as:
-9999 Missing value

precipTypeQualityFlag (4-byte integer, array size: nray x nscan):
Quality flag of precipitation type from 2AKu. Special values are defined as:
-9999 Missing value

piaEffective (4-byte float, array size: nray x nscan):
Effective 2-way PIA from 2AKu. Values range from 0 to 1000 dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveSigma (4-byte float, array size: nray x nscan):
Effective PIA uncertainty from 2AKu. Values are in dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveReliabFlag (2-byte integer, array size: nray x nscan):
Reliability flag of effective PIA from 2AKu. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nray x nscan):
The surface normalized radar cross section. Values are in dB. Special values are defined as:
-9999.9 Missing value

snowIceCover (4-byte integer, array size: nray x nscan):
Snow and ice cover. Values are defined as: 0 = ice-free ocean 1 = snow-free land 2 = snow-covered land 3 = sea ice. Special values are defined as:
-9999 Missing value

OptEst (Group in KuGMI)

OEsurfaceClass (2-byte integer, array size: nray x nscan):
OE surface classification. Special values are defined as:
-9999 Missing value

OEairTemperature (4-byte float, array size: nBnEnv x nray x nscan):
OE air temperatuere. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

OEvaporDensity (4-byte float, array size: nBnEnv x nray x nscan):
OE vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

OEcolumnWaterVapor (4-byte float, array size: nray x nscan):
OE vertically-integrated water vapor. Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcolumnVaporSigma (4-byte float, array size: nray x nscan):
OE column vapor uncertainty. Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcloudLiqWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
OE cloud liquid water content. Values range from 0 to 18 g/m^3. Special values are defined

as:
-9999.9 Missing value

OEcolumnCloudLiqWater (4-byte float, array size: nray x nscan):
OE vertically-integrated cloud liquid water Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudLiqSigma (4-byte float, array size: nray x nscan):
OE column cloud liquid uncertainty Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudIceWater (4-byte float, array size: nray x nscan):
OE vertically-integrated cloud ice water Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEskinTemperature (4-byte float, array size: nray x nscan):
OE surface skin temperatuere. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

OEskinTempSigma (4-byte float, array size: nray x nscan):
OE skin temperatuere uncertainty. Values are in K. Special values are defined as:
-9999.9 Missing value

OEsurfaceAirTemperature (4-byte float, array size: nray x nscan):
OE surface air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

OEsurfaceVaporDensity (4-byte float, array size: nray x nscan):
OE surface vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSpeed (4-byte float, array size: nray x nscan):
OE ten meter altitude wind speed. Values range from 0 to 100 m/s. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSigma (4-byte float, array size: nray x nscan):
OE ten meter wind uncertainty. Values are in m/s. Special values are defined as:
-9999.9 Missing value

OEsurfEmissivity (4-byte float, array size: nemiss x nray x nscan):
OE GMI emissivities. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

OEsurfEmissSigma (4-byte float, array size: nemiss x nray x nscan):
OE GMI emissivity uncertainties. Special values are defined as:
-9999.9 Missing value

OEemissivityAvgKernel (4-byte float, array size: nemiss x nray x nscan):
OE GMI emissivity averaging kernel. Special values are defined as:
-9999.9 Missing value

OEerrorOfDataFit (4-byte float, array size: nray x nscan):
OE error of brightness temp fit. Special values are defined as:
-9999.9 Missing value

OEsimulatedBrightTemp (4-byte float, array size: nemiss x nray x nscan):
OE simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:
-9999.9 Missing value

OEestimSurfPrecipTotRate (4-byte float, array size: nray x nscan):
OE estimated surface total precip rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

OEestimSurfPrecipTotRateSigma (4-byte float, array size: nray x nscan):
OE estimated surface total precip rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

OEestimSurfPrecipLiqRate (4-byte float, array size: nray x nscan):
OE estimated surface liquid precip rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

OEpiaNoPrecip (4-byte float, array size: nray x nscan):
OE 2-way path-integrated attenuation w/o precip. Values are in dB. Special values are defined as:
-9999.9 Missing value

aPriori (Group in KuGMI)

initPrecipTotDm (4-byte float, array size: nBnPSD x nray x nscan):
Initial guess PSD volume-weighted mean diameter. Values range from 0 to 20 mm. Special values are defined as:
-9999.9 Missing value

initPrecipTotLogNw (4-byte float, array size: nBnPSD x nray x nscan):
Initial guess PSD log 10 of intercept. Values are in log10(m-4). Special values are defined as:
-9999.9 Missing value

profClass (4-byte integer, array size: nray x nscan):
The class number of the observed reflectivity profile using a classification based upon

measured reflectivity structure features. Unclassified profiles are assigned a value of -9999.

surfaceAirPressure (4-byte float, array size: nray x nscan):
Surface air pressure. Values range from 300 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

surfaceAirTemperature (4-byte float, array size: nray x nscan):
Surface air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

surfaceVaporDensity (4-byte float, array size: nray x nscan):
Surface vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

skinTemperature (4-byte float, array size: nray x nscan):
Surface skin temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

skinTempSigma (4-byte float, array size: nray x nscan):
Values are in K. Special values are defined as:
-9999.9 Missing value

envParamNode (2-byte integer, array size: nBnEnv x nray x nscan):
Bin indices for environmental parameters. Special values are defined as:
-9999 Missing value

airPressure (4-byte float, array size: nBnEnv x nray x nscan):
Air pressure. Values range from 50 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

airTemperature (4-byte float, array size: nBnEnv x nray x nscan):
Air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

vaporDensity (4-byte float, array size: nBnEnv x nray x nscan):
Vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudLiqWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Cloud liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudIceWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Cloud ice water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

lowestUnclutteredBin (2-byte integer, array size: nray x nscan):
Lowest clutter free bin. Special values are defined as:

-9999	Missing value

lowestEstimateBin (2-byte integer, array size: nray x nscan):
Lowest bin for estimated precipitation. Special values are defined as:

-9999	Missing value

phaseBinNodes (2-byte integer, array size: nPhsBnN x nray x nscan):
Bin numbers indicating (0) storm top, (1) top of mixed-phase later, (2) maximum reflectivity in mixed-phase layer if bright band detected; otherwise, the freezing level from analysis, (3) bottom of mixed-phase layer, and (4) bottom of rain layer Special values are defined as:

-9999	Missing value

precipTotDm (4-byte float, array size: nBnPSD x nray x nscan):
Total precip PSD volume-weighted mean diameter. Values range from 0 to 20 mm. Special values are defined as:

-9999.9	Missing value

precipTotLogNw (4-byte float, array size: nBnPSD x nray x nscan):
Total precip PSD log 10 of intercept. Values are in $log(m-4)$. Special values are defined as:

-9999.9	Missing value

precipTotMu (4-byte float, array size: nBnPSD x nray x nscan):
Total precip PSD shape parameter. Special values are defined as:

-9999.9	Missing value

precipTotWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:

-9999.9	Missing value

precipTotWaterContSigma (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation liquid water content uncertainty. Values range from 0 to 18 g/m^3. Special values are defined as:

-9999.9	Missing value

precipLiqWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Liquid precip water content. Values range from 0 to 18 g/m^3. Special values are defined as:

-9999.9	Missing value

precipTotRate (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation rate. Values range from 0 to 300 mm/hr. Special values are defined as:

-99	No precipitation detected
-9999.9	Missing value

precipTotRateSigma (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:

-99	No precipitation detected
-9999.9	Missing value

precipLiqRate (4-byte float, array size: nBnPSD x nray x nscan):
Liquid precip rate. Values range from 0 to 300 mm/hr. Special values are defined as:

-99	No precipitation detected
-9999.9	Missing value

multiScatMaxContrib (4-byte float, array size: nray x nscan):
multiScatMaxContrib is the maximum contribution, in a given radar profile, by multiple scattering to the simulated reflectivity. Values are in dB. Special values are defined as:
-9999.9 Missing value

nubfPIAfactor (4-byte float, array size: nray x nscan):
nubfPIAfactor is the factor applied to the Hitschfeld-Bordan path integrated attenuation to obtain the simulated path integrated attenuation, accounting for the nonuniform beamfilling by precipitation which is estimated from a 3x3 neighborhood of footprints. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRate (4-byte float, array size: nray x nscan):
Near-surface total precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateSigma (4-byte float, array size: nray x nscan):
Near-surface total precip rate uncertainty (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRate (4-byte float, array size: nray x nscan):
Near-surface liquid precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRate (4-byte float, array size: nray x nscan):
Estimated surface total precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateSigma (4-byte float, array size: nray x nscan):
Estimated surface total precip rate uncertainty (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRate (4-byte float, array size: nray x nscan):
Estimated surface liquid precip rate (from lowest clutter-free bin) Values range from 0 to

300 mm/hr. Special values are defined as:
-9999.9 Missing value

tenMeterWindSpeed (4-byte float, array size: nray x nscan):
Ten meter altitude wind speed magnitude. Values range from 0 to 100 m/s. Special values are defined as:
-9999.9 Missing value

tenMeterWindSigma (4-byte float, array size: nray x nscan):
Values are in m/s. Special values are defined as:
-9999.9 Missing value

surfEmissivity (4-byte float, array size: nemiss x nray x nscan):
GMI emissivities. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

surfEmissSigma (4-byte float, array size: nemiss x nray x nscan):
Special values are defined as:
-9999.9 Missing value

simulatedBrightTemp (4-byte float, array size: nemiss x nray x nscan):
GMI simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:
-9999.9 Missing value

pia (4-byte float, array size: nray x nscan):
Two-way path-integrated attenuation at Ku. Values range from 0 to 1000 dB. Special values are defined as:
-9999.9 Missing value

correctedReflectFactor (4-byte float, array size: nBnPSD x nray x nscan):
Corrected radar reflectivities at Ku band. Values range from -20 to 100 dBZ. Special values are defined as:
-9999.9 Missing value

FLG (Group in KuGMI)

scanPatternFlag (2-byte integer, array size: nscan):

Flag indicating scan pattern status. Values range from 0 to 1. Special values are defined as:
-9999 Missing value

ioQuality (4-byte integer, array size: nray x nscan):
Quality flag for input and output. The flag is a six digit number as follows.

```
1's place        0 : rain estimate is valid
                 9 : no estimate (bad scan)

10's place       0 : Ku data OK and rain detected using Ku
                 1 : Ku data OK and no rain detected using Ku
                 9 : bad Ku input data

100's place      0 : Ku-SRT gives a valid PIA estimate
                 1 : sigma-zero at Ku is within the noise of the background
                 2 : sigma-zero at Ku is completely attenuated
                 9 : bad Ku input data

1000's place     0 : freezing level is derived from Ku bright band
                 1 : freezing level is derived from GANAL analysis
                 9 : bad Ku input data

10000's place    0 : Ku classified as stratiform or convective
                 1 : Ku classified as indeterminate
                 2 : precipitation not detected at Ku (no feature)
                 9 : bad Ku input data

100000's place   0 : some measured Tb's (interpolated to DPR grid)
                     are valid
                 9 : no measured Tb's are valid
```

Special values are defined as:
-9999 Missing value

multiScatCalc (4-byte integer, array size: nray x nscan):

Special values are defined as:
-9999 Missing value

estimPrecipInClutter (2-byte integer, array size: nray x nscan):

Flag if precip is estimated in clutter region. Special values are defined as:
-9999 Missing value

KuKaGMI (Swath)

KuKaGMI_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in KuKaGMI)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude

is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in KuKaGMI)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
```

```
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):

The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
```

```
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group in KuKaGMI)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values

range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

Input (Group in KuKaGMI)

surfaceElevation (4-byte float, array size: nray x nscan):
Altitudes above the earth ellipsoid of the surface gates from 2ADPR. Values are in m. Special values are defined as:
-9999.9 Missing value

surfaceType (4-byte integer, array size: nray x nscan):
Surface type from 2ADPR. Special values are defined as:
-9999 Missing value

localZenithAngle (4-byte float, array size: nray x nscan):
Zenith angle of the ray at the earth's surface from 2ADPR. Values are in degree. Special values are defined as:
-9999.9 Missing value

precipitationFlag (4-byte integer, array size: nKuKa x nray x nscan):
Precipitation flag from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

surfaceRangeBin (2-byte integer, array size: nKuKa x nray x nscan):
Index of the surface range bin from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

lowestClutterFreeBin (2-byte integer, array size: nKuKa x nray x nscan):
Index of lowest clutter-free bin from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

ellipsoidBinOffset (4-byte float, array size: nKuKa x nray x nscan):
Offset of surface bin from the earth ellipsoid from 2ADPR (Ku/Ka). Values are in m. Special values are defined as:
-9999.9 Missing value

stormTopBin (2-byte integer, array size: nKuKa x nray x nscan):
Index of storm top bin from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

stormTopAltitude (4-byte float, array size: nKuKa x nray x nscan):
Altitude of storm top bin from 2ADPR (Ku/Ka). Values are in m. Special values are defined as:
-9999.9 Missing value

zeroDegBin (2-byte integer, array size: nKuKa x nray x nscan):
Range bin of the freezing level. Special values are defined as:
-9999 Missing value

zeroDegAltitude (4-byte float, array size: nray x nscan):
Altitude of the freezing level. Values are in m. Special values are defined as:
-9999.9 Missing value

precipitationType (4-byte integer, array size: nray x nscan):
Precipitation type classification from 2ADPR. Special values are defined as:
-9999 Missing value

precipTypeQualityFlag (4-byte integer, array size: nray x nscan):
Quality flag of precipitation type from 2ADPR. Special values are defined as:
-9999 Missing value

piaEffective (4-byte float, array size: nKuKa x nray x nscan):
Effective 2-way PIA at Ku band from 2ADPR (Ku/Ka). Values range from 0 to 1000 dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveSigma (4-byte float, array size: nKuKa x nray x nscan):
Effective PIA uncertainty at Ku band from 2ADPR (Ku/Ka). Values are in dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveReliabFlag (2-byte integer, array size: nKuKa x nray x nscan):
Reliability flag of effective PIA from 2ADPR (Ku/Ka). Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nray x nscan):
The surface normalized radar cross section. Values are in dB. Special values are defined as:
-9999.9 Missing value

snowIceCover (4-byte integer, array size: nray x nscan):
Snow and ice cover. Values are defined as: 0 = ice-free ocean 1 = snow-free land 2 = snow-covered land 3 = sea ice. Special values are defined as:
-9999 Missing value

OptEst (Group in KuKaGMI)

OEsurfaceClass (2-byte integer, array size: nray x nscan):
OE surface classification. Special values are defined as:
-9999 Missing value

OEairTemperature (4-byte float, array size: nBnEnv x nray x nscan):
OE air temperatuere. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

OEvaporDensity (4-byte float, array size: nBnEnv x nray x nscan):
OE vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

OEcolumnWaterVapor (4-byte float, array size: nray x nscan):
OE vertically-integrated water vapor. Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcolumnVaporSigma (4-byte float, array size: nray x nscan):
OE column vapor uncertainty. Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcloudLiqWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
OE cloud liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudLiqWater (4-byte float, array size: nray x nscan):
OE vertically-integrated cloud liquid water Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudLiqSigma (4-byte float, array size: nray x nscan):
OE column cloud liquid uncertainty Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudIceWater (4-byte float, array size: nray x nscan):
OE vertically-integrated cloud ice water Values are in kg/m^2. Special values are defined

as:
-9999.9 Missing value

OEskinTemperature (4-byte float, array size: nray x nscan):
OE surface skin temperatuere. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

OEskinTempSigma (4-byte float, array size: nray x nscan):
OE skin temperatuere uncertainty. Values are in K. Special values are defined as:
-9999.9 Missing value

OEsurfaceAirTemperature (4-byte float, array size: nray x nscan):
OE surface air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

OEsurfaceVaporDensity (4-byte float, array size: nray x nscan):
OE surface vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSpeed (4-byte float, array size: nray x nscan):
OE ten meter altitude wind speed. Values range from 0 to 100 m/s. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSigma (4-byte float, array size: nray x nscan):
OE ten meter wind uncertainty. Values are in m/s. Special values are defined as:
-9999.9 Missing value

OEsurfEmissivity (4-byte float, array size: nemiss x nray x nscan):
OE GMI emissivities. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

OEsurfEmissSigma (4-byte float, array size: nemiss x nray x nscan):
OE GMI emissivity uncertainties. Special values are defined as:
-9999.9 Missing value

OEemissivityAvgKernel (4-byte float, array size: nemiss x nray x nscan):
OE GMI emissivity averaging kernel. Special values are defined as:
-9999.9 Missing value

OEerrorOfDataFit (4-byte float, array size: nray x nscan):
OE error of brightness temp fit. Special values are defined as:
-9999.9 Missing value

OEsimulatedBrightTemp (4-byte float, array size: nemiss x nray x nscan):
OE simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:
-9999.9 Missing value

OEestimSurfPrecipTotRate (4-byte float, array size: nray x nscan):
OE estimated surface total precip rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

OEestimSurfPrecipTotRateSigma (4-byte float, array size: nray x nscan):
OE estimated surface total precip rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

OEestimSurfPrecipLiqRate (4-byte float, array size: nray x nscan):
OE estimated surface liquid precip rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

OEpiaNoPrecip (4-byte float, array size: nKuKa x nray x nscan):
OE 2-way path-integrated attenuation w/o precip. Values are in dB. Special values are defined as:
-9999.9 Missing value

aPriori (Group in KuKaGMI)

initPrecipTotDm (4-byte float, array size: nBnPSD x nray x nscan):
Initial guess PSD volume-weighted mean diameter. Values range from 0 to 20 mm. Special values are defined as:
-9999.9 Missing value

initPrecipTotLogNw (4-byte float, array size: nBnPSD x nray x nscan):
Initial guess PSD log 10 of intercept. Values are in log10(m-4). Special values are defined as:
-9999.9 Missing value

profClass (4-byte integer, array size: nray x nscan):
The class number of the observed reflectivity profile using a classification based upon measured reflectivity structure features. Unclassified profiles are assigned a value of -9999.

surfaceAirPressure (4-byte float, array size: nray x nscan):
Surface air pressure. Values range from 300 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

surfaceAirTemperature (4-byte float, array size: nray x nscan):
Surface air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

surfaceVaporDensity (4-byte float, array size: nray x nscan):
Surface vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

skinTemperature (4-byte float, array size: nray x nscan):
Surface skin temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

skinTempSigma (4-byte float, array size: nray x nscan):
Values are in K. Special values are defined as:
-9999.9 Missing value

envParamNode (2-byte integer, array size: nBnEnv x nray x nscan):
Bin indices for environmental parameters. Special values are defined as:
-9999 Missing value

airPressure (4-byte float, array size: nBnEnv x nray x nscan):
Air pressure. Values range from 50 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

airTemperature (4-byte float, array size: nBnEnv x nray x nscan):
Air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

vaporDensity (4-byte float, array size: nBnEnv x nray x nscan):
Vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudLiqWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Cloud liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudIceWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Cloud ice water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

lowestUnclutteredBin (2-byte integer, array size: nray x nscan):
Lowest clutter free bin. Special values are defined as:
-9999 Missing value

lowestEstimateBin (2-byte integer, array size: nray x nscan):
Lowest bin for estimated precipitation. Special values are defined as:
-9999 Missing value

phaseBinNodes (2-byte integer, array size: nPhsBnN x nray x nscan):
Bin numbers indicating (0) storm top, (1) top of mixed-phase later, (2) maximum reflectivity in mixed-phase layer if bright band detected; otherwise, the freezing level from

analysis, (3) bottom of mixed-phase layer, and (4) bottom of rain layer Special values are defined as:
-9999 Missing value

precipTotDm (4-byte float, array size: nBnPSD x nray x nscan):
Total precip PSD volume-weighted mean diameter. Values range from 0 to 20 mm. Special values are defined as:
-9999.9 Missing value

precipTotLogNw (4-byte float, array size: nBnPSD x nray x nscan):
Total precip PSD log 10 of intercept. Values are in $log(m-4)$. Special values are defined as:
-9999.9 Missing value

precipTotMu (4-byte float, array size: nBnPSD x nray x nscan):
Total precip PSD shape parameter. Special values are defined as:
-9999.9 Missing value

precipTotWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

precipTotWaterContSigma (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation liquid water content uncertainty. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

precipLiqWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Liquid precip water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

precipTotRate (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-99 No precipitation detected
-9999.9 Missing value

precipTotRateSigma (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:
-99 No precipitation detected
-9999.9 Missing value

precipLiqRate (4-byte float, array size: nBnPSD x nray x nscan):
Liquid precip rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-99 No precipitation detected
-9999.9 Missing value

multiScatMaxContrib (4-byte float, array size: nray x nscan):
multiScatMaxContrib is the maximum contribution, in a given radar profile, by multiple scattering to the simulated reflectivity. Values are in dB. Special values are defined as:
-9999.9 Missing value

nubfPIAfactor (4-byte float, array size: nray x nscan):
nubfPIAfactor is the factor applied to the Hitschfeld-Bordan path integrated attenuation to obtain the simulated path integrated attenuation, accounting for the nonuniform beamfilling by precipitation which is estimated from a 3x3 neighborhood of footprints. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRate (4-byte float, array size: nray x nscan):
Near-surface total precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateSigma (4-byte float, array size: nray x nscan):
Near-surface total precip rate uncertainty (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRate (4-byte float, array size: nray x nscan):
Near-surface liquid precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRate (4-byte float, array size: nray x nscan):
Estimated surface total precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateSigma (4-byte float, array size: nray x nscan):
Estimated surface total precip rate uncertainty (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRate (4-byte float, array size: nray x nscan):
Estimated surface liquid precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

tenMeterWindSpeed (4-byte float, array size: nray x nscan):
Ten meter altitude wind speed magnitude. Values range from 0 to 100 m/s. Special values are defined as:
-9999.9 Missing value

tenMeterWindSigma (4-byte float, array size: nray x nscan):
Values are in m/s. Special values are defined as:
-9999.9 Missing value

surfEmissivity (4-byte float, array size: nemiss x nray x nscan):
GMI emissivities. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

surfEmissSigma (4-byte float, array size: nemiss x nray x nscan):
Special values are defined as:
-9999.9 Missing value

simulatedBrightTemp (4-byte float, array size: nemiss x nray x nscan):
GMI simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:
-9999.9 Missing value

pia (4-byte float, array size: nKuKa x nray x nscan):
Two-way path-integrated attenuation (Ku/Ka). Values range from 0 to 1000 dB. Special values are defined as:
-9999.9 Missing value

correctedReflectFactor (4-byte float, array size: nKuKa x nBnPSD x nray x nscan):
Corrected radar reflectivities (Ku/Ka). Values range from -20 to 100 dBZ. Special values are defined as:
-9999.9 Missing value

FLG (Group in KuKaGMI)

scanPatternFlag (2-byte integer, array size: nscan):

Flag indicating scan pattern status. Values range from 0 to 1. Special values are defined as:
-9999 Missing value

ioQuality (4-byte integer, array size: nray x nscan):
Quality flag for input and output. The flag is a six digit number as follows.

```
1's place       0 : rain estimate is valid
                9 : no estimate (bad scan)

10's place      0 : Ku data OK and rain detected using Ku
                1 : Ku data OK and no rain detected using Ku
                9 : bad Ku input data

100's place     0 : Ku-SRT gives a valid PIA estimate
```

```
                 1 : sigma-zero at Ku is within the noise of the background
                 2 : sigma-zero at Ku is completely attenuated
                 9 : bad Ku input data

1000's place     0 : freezing level is derived from Ku bright band
                 1 : freezing level is derived from GANAL analysis
                 9 : bad Ku input data

10000's place    0 : Ku classified as stratiform or convective
                 1 : Ku classified as indeterminate
                 2 : precipitation not detected at Ku (no feature)
                 9 : bad Ku input data

100000's place   0 : some measured Tb's (interpolated to DPR grid)
                     are valid
                 9 : no measured Tb's are valid
```

Special values are defined as:
-9999 Missing value

multiScatCalc (4-byte integer, array size: nray x nscan):

Special values are defined as:
-9999 Missing value

estimPrecipInClutter (2-byte integer, array size: nray x nscan):

Flag if precip is estimated in clutter region. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_2BCMB_H_
#define _TK_2BCMB_H_

#ifndef _L2BCMB_KUKAGMI_FLG_
#define _L2BCMB_KUKAGMI_FLG_

typedef struct {
```

```
    short scanPatternFlag;
    int ioQuality[49];
    int multiScatCalc[49];
    short estimPrecipInClutter[49];
} L2BCMB_KUKAGMI_FLG;

#endif

#ifndef _L2BCMB_KUKAGMI_APRIORI_
#define _L2BCMB_KUKAGMI_APRIORI_

typedef struct {
    float initPrecipTotDm[49][88];
    float initPrecipTotLogNw[49][88];
    int profClass[49];
} L2BCMB_KUKAGMI_APRIORI;

#endif

#ifndef _L2BCMB_KUKAGMI_OPTEST_
#define _L2BCMB_KUKAGMI_OPTEST_

typedef struct {
    short OEsurfaceClass[49];
    float OEairTemperature[49][10];
    float OEvaporDensity[49][10];
    float OEcolumnWaterVapor[49];
    float OEcolumnVaporSigma[49];
    float OEcloudLiqWaterCont[49][88];
    float OEcolumnCloudLiqWater[49];
    float OEcolumnCloudLiqSigma[49];
    float OEcolumnCloudIceWater[49];
    float OEskinTemperature[49];
    float OEskinTempSigma[49];
    float OEsurfaceAirTemperature[49];
    float OEsurfaceVaporDensity[49];
    float OEtenMeterWindSpeed[49];
    float OEtenMeterWindSigma[49];
    float OEsurfEmissivity[49][13];
    float OEsurfEmissSigma[49][13];
    float OEemissivityAvgKernel[49][13];
    float OEerrorOfDataFit[49];
    float OEsimulatedBrightTemp[49][13];
```

```
    float OEestimSurfPrecipTotRate[49];
    float OEestimSurfPrecipTotRateSigma[49];
    float OEestimSurfPrecipLiqRate[49];
    float OEpiaNoPrecip[49][2];
} L2BCMB_KUKAGMI_OPTEST;

#endif

#ifndef _L2BCMB_KUKAGMI_INPUT_
#define _L2BCMB_KUKAGMI_INPUT_

typedef struct {
    float surfaceElevation[49];
    int surfaceType[49];
    float localZenithAngle[49];
    int precipitationFlag[49][2];
    short surfaceRangeBin[49][2];
    short lowestClutterFreeBin[49][2];
    float ellipsoidBinOffset[49][2];
    short stormTopBin[49][2];
    float stormTopAltitude[49][2];
    short zeroDegBin[49][2];
    float zeroDegAltitude[49];
    int precipitationType[49];
    int precipTypeQualityFlag[49];
    float piaEffective[49][2];
    float piaEffectiveSigma[49][2];
    short piaEffectiveReliabFlag[49][2];
    float sigmaZeroMeasured[49];
    int snowIceCover[49];
} L2BCMB_KUKAGMI_INPUT;

#endif

#ifndef _L2BCMB_KUKAGMI_SCANSTATUS_
#define _L2BCMB_KUKAGMI_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
```

```
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2BCMB_KUKAGMI_SCANSTATUS;

#endif

#ifndef _L2BCMB_KUKAGMI_
#define _L2BCMB_KUKAGMI_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float sunLocalTime[49];
    L2BCMB_KUKAGMI_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2BCMB_KUKAGMI_INPUT Input;
    L2BCMB_KUKAGMI_OPTEST OptEst;
    L2BCMB_KUKAGMI_APRIORI aPriori;
    float surfaceAirPressure[49];
    float surfaceAirTemperature[49];
    float surfaceVaporDensity[49];
    float skinTemperature[49];
    float skinTempSigma[49];
    short envParamNode[49][10];
    float airPressure[49][10];
    float airTemperature[49][10];
    float vaporDensity[49][10];
    float cloudLiqWaterCont[49][88];
    float cloudIceWaterCont[49][88];
    short lowestUnclutteredBin[49];
    short lowestEstimateBin[49];
    short phaseBinNodes[49][5];
    float precipTotDm[49][88];
    float precipTotLogNw[49][88];
    float precipTotMu[49][88];
    float precipTotWaterCont[49][88];
```

```
    float precipTotWaterContSigma[49][88];
    float precipLiqWaterCont[49][88];
    float precipTotRate[49][88];
    float precipTotRateSigma[49][88];
    float precipLiqRate[49][88];
    float multiScatMaxContrib[49];
    float nubfPIAfactor[49];
    float nearSurfPrecipTotRate[49];
    float nearSurfPrecipTotRateSigma[49];
    float nearSurfPrecipLiqRate[49];
    float estimSurfPrecipTotRate[49];
    float estimSurfPrecipTotRateSigma[49];
    float estimSurfPrecipLiqRate[49];
    float tenMeterWindSpeed[49];
    float tenMeterWindSigma[49];
    float surfEmissivity[49][13];
    float surfEmissSigma[49][13];
    float simulatedBrightTemp[49][13];
    float pia[49][2];
    float correctedReflectFactor[49][88][2];
    L2BCMB_KUKAGMI_FLG FLG;
} L2BCMB_KUKAGMI;

#endif

#ifndef _L2BCMB_KUGMI_FLG_
#define _L2BCMB_KUGMI_FLG_

typedef struct {
    short scanPatternFlag;
    int ioQuality[49];
    int multiScatCalc[49];
    short estimPrecipInClutter[49];
} L2BCMB_KUGMI_FLG;

#endif

#ifndef _L2BCMB_KUGMI_APRIORI_
#define _L2BCMB_KUGMI_APRIORI_

typedef struct {
    float initPrecipTotDm[49][88];
    float initPrecipTotLogNw[49][88];
```

```
    int profClass[49];
} L2BCMB_KUGMI_APRIORI;

#endif

#ifndef _L2BCMB_KUGMI_OPTEST_
#define _L2BCMB_KUGMI_OPTEST_

typedef struct {
    short OEsurfaceClass[49];
    float OEairTemperature[49][10];
    float OEvaporDensity[49][10];
    float OEcolumnWaterVapor[49];
    float OEcolumnVaporSigma[49];
    float OEcloudLiqWaterCont[49][88];
    float OEcolumnCloudLiqWater[49];
    float OEcolumnCloudLiqSigma[49];
    float OEcolumnCloudIceWater[49];
    float OEskinTemperature[49];
    float OEskinTempSigma[49];
    float OEsurfaceAirTemperature[49];
    float OEsurfaceVaporDensity[49];
    float OEtenMeterWindSpeed[49];
    float OEtenMeterWindSigma[49];
    float OEsurfEmissivity[49][13];
    float OEsurfEmissSigma[49][13];
    float OEemissivityAvgKernel[49][13];
    float OEerrorOfDataFit[49];
    float OEsimulatedBrightTemp[49][13];
    float OEestimSurfPrecipTotRate[49];
    float OEestimSurfPrecipTotRateSigma[49];
    float OEestimSurfPrecipLiqRate[49];
    float OEpiaNoPrecip[49];
} L2BCMB_KUGMI_OPTEST;

#endif

#ifndef _L2BCMB_KUGMI_INPUT_
#define _L2BCMB_KUGMI_INPUT_

typedef struct {
    float surfaceElevation[49];
    int surfaceType[49];
```

```
    float localZenithAngle[49];
    int precipitationFlag[49];
    short surfaceRangeBin[49];
    short lowestClutterFreeBin[49];
    float ellipsoidBinOffset[49];
    short stormTopBin[49];
    float stormTopAltitude[49];
    short zeroDegBin[49];
    float zeroDegAltitude[49];
    int precipitationType[49];
    int precipTypeQualityFlag[49];
    float piaEffective[49];
    float piaEffectiveSigma[49];
    short piaEffectiveReliabFlag[49];
    float sigmaZeroMeasured[49];
    int snowIceCover[49];
} L2BCMB_KUGMI_INPUT;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
    double timeMidScanOffset;
} NAVIGATION;
```

```
#endif

#ifndef _L2BCMB_KUGMI_SCANSTATUS_
#define _L2BCMB_KUGMI_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2BCMB_KUGMI_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2BCMB_KUGMI_
#define _L2BCMB_KUGMI_
```

```
typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float sunLocalTime[49];
    L2BCMB_KUGMI_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2BCMB_KUGMI_INPUT Input;
    L2BCMB_KUGMI_OPTEST OptEst;
    L2BCMB_KUGMI_APRIORI aPriori;
    float surfaceAirPressure[49];
    float surfaceAirTemperature[49];
    float surfaceVaporDensity[49];
    float skinTemperature[49];
    float skinTempSigma[49];
    short envParamNode[49][10];
    float airPressure[49][10];
    float airTemperature[49][10];
    float vaporDensity[49][10];
    float cloudLiqWaterCont[49][88];
    float cloudIceWaterCont[49][88];
    short lowestUnclutteredBin[49];
    short lowestEstimateBin[49];
    short phaseBinNodes[49][5];
    float precipTotDm[49][88];
    float precipTotLogNw[49][88];
    float precipTotMu[49][88];
    float precipTotWaterCont[49][88];
    float precipTotWaterContSigma[49][88];
    float precipLiqWaterCont[49][88];
    float precipTotRate[49][88];
    float precipTotRateSigma[49][88];
    float precipLiqRate[49][88];
    float multiScatMaxContrib[49];
    float nubfPIAfactor[49];
    float nearSurfPrecipTotRate[49];
    float nearSurfPrecipTotRateSigma[49];
    float nearSurfPrecipLiqRate[49];
    float estimSurfPrecipTotRate[49];
    float estimSurfPrecipTotRateSigma[49];
    float estimSurfPrecipLiqRate[49];
    float tenMeterWindSpeed[49];
    float tenMeterWindSigma[49];
```

```
    float surfEmissivity[49][13];
    float surfEmissSigma[49][13];
    float simulatedBrightTemp[49][13];
    float pia[49];
    float correctedReflectFactor[49][88];
    L2BCMB_KUGMI_FLG FLG;
} L2BCMB_KUGMI;

#endif

#ifndef _L2BCMB_SWATHS_
#define _L2BCMB_SWATHS_

typedef struct {
    L2BCMB_KUGMI KuGMI;
    L2BCMB_KUKAGMI KuKaGMI;
} L2BCMB_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2BCMB_KUKAGMI_FLG/
    INTEGER*2 scanPatternFlag
    INTEGER*4 ioQuality(49)
    INTEGER*4 multiScatCalc(49)
    INTEGER*2 estimPrecipInClutter(49)
END STRUCTURE

STRUCTURE /L2BCMB_KUKAGMI_APRIORI/
    REAL*4 initPrecipTotDm(88,49)
    REAL*4 initPrecipTotLogNw(88,49)
    INTEGER*4 profClass(49)
END STRUCTURE

STRUCTURE /L2BCMB_KUKAGMI_OPTEST/
    INTEGER*2 OEsurfaceClass(49)
    REAL*4 OEairTemperature(10,49)
    REAL*4 OEvaporDensity(10,49)
    REAL*4 OEcolumnWaterVapor(49)
    REAL*4 OEcolumnVaporSigma(49)
```

```
    REAL*4 OEcloudLiqWaterCont(88,49)
    REAL*4 OEcolumnCloudLiqWater(49)
    REAL*4 OEcolumnCloudLiqSigma(49)
    REAL*4 OEcolumnCloudIceWater(49)
    REAL*4 OEskinTemperature(49)
    REAL*4 OEskinTempSigma(49)
    REAL*4 OEsurfaceAirTemperature(49)
    REAL*4 OEsurfaceVaporDensity(49)
    REAL*4 OEtenMeterWindSpeed(49)
    REAL*4 OEtenMeterWindSigma(49)
    REAL*4 OEsurfEmissivity(13,49)
    REAL*4 OEsurfEmissSigma(13,49)
    REAL*4 OEemissivityAvgKernel(13,49)
    REAL*4 OEerrorOfDataFit(49)
    REAL*4 OEsimulatedBrightTemp(13,49)
    REAL*4 OEestimSurfPrecipTotRate(49)
    REAL*4 OEestimSurfPrecipTotRateSigma(49)
    REAL*4 OEestimSurfPrecipLiqRate(49)
    REAL*4 OEpiaNoPrecip(2,49)
END STRUCTURE

STRUCTURE /L2BCMB_KUKAGMI_INPUT/
    REAL*4 surfaceElevation(49)
    INTEGER*4 surfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 precipitationFlag(2,49)
    INTEGER*2 surfaceRangeBin(2,49)
    INTEGER*2 lowestClutterFreeBin(2,49)
    REAL*4 ellipsoidBinOffset(2,49)
    INTEGER*2 stormTopBin(2,49)
    REAL*4 stormTopAltitude(2,49)
    INTEGER*2 zeroDegBin(2,49)
    REAL*4 zeroDegAltitude(49)
    INTEGER*4 precipitationType(49)
    INTEGER*4 precipTypeQualityFlag(49)
    REAL*4 piaEffective(2,49)
    REAL*4 piaEffectiveSigma(2,49)
    INTEGER*2 piaEffectiveReliabFlag(2,49)
    REAL*4 sigmaZeroMeasured(49)
    INTEGER*4 snowIceCover(49)
END STRUCTURE

STRUCTURE /L2BCMB_KUKAGMI_SCANSTATUS/
```

```
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L2BCMB_KUKAGMI/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    RECORD /L2BCMB_KUKAGMI_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2BCMB_KUKAGMI_INPUT/ Input
    RECORD /L2BCMB_KUKAGMI_OPTEST/ OptEst
    RECORD /L2BCMB_KUKAGMI_APRIORI/ aPriori
    REAL*4 surfaceAirPressure(49)
    REAL*4 surfaceAirTemperature(49)
    REAL*4 surfaceVaporDensity(49)
    REAL*4 skinTemperature(49)
    REAL*4 skinTempSigma(49)
    INTEGER*2 envParamNode(10,49)
    REAL*4 airPressure(10,49)
    REAL*4 airTemperature(10,49)
    REAL*4 vaporDensity(10,49)
    REAL*4 cloudLiqWaterCont(88,49)
    REAL*4 cloudIceWaterCont(88,49)
    INTEGER*2 lowestUnclutteredBin(49)
    INTEGER*2 lowestEstimateBin(49)
    INTEGER*2 phaseBinNodes(5,49)
    REAL*4 precipTotDm(88,49)
    REAL*4 precipTotLogNw(88,49)
    REAL*4 precipTotMu(88,49)
    REAL*4 precipTotWaterCont(88,49)
```

```
    REAL*4 precipTotWaterContSigma(88,49)
    REAL*4 precipLiqWaterCont(88,49)
    REAL*4 precipTotRate(88,49)
    REAL*4 precipTotRateSigma(88,49)
    REAL*4 precipLiqRate(88,49)
    REAL*4 multiScatMaxContrib(49)
    REAL*4 nubfPIAfactor(49)
    REAL*4 nearSurfPrecipTotRate(49)
    REAL*4 nearSurfPrecipTotRateSigma(49)
    REAL*4 nearSurfPrecipLiqRate(49)
    REAL*4 estimSurfPrecipTotRate(49)
    REAL*4 estimSurfPrecipTotRateSigma(49)
    REAL*4 estimSurfPrecipLiqRate(49)
    REAL*4 tenMeterWindSpeed(49)
    REAL*4 tenMeterWindSigma(49)
    REAL*4 surfEmissivity(13,49)
    REAL*4 surfEmissSigma(13,49)
    REAL*4 simulatedBrightTemp(13,49)
    REAL*4 pia(2,49)
    REAL*4 correctedReflectFactor(2,88,49)
    RECORD /L2BCMB_KUKAGMI_FLG/ FLG
END STRUCTURE

STRUCTURE /L2BCMB_KUGMI_FLG/
    INTEGER*2 scanPatternFlag
    INTEGER*4 ioQuality(49)
    INTEGER*4 multiScatCalc(49)
    INTEGER*2 estimPrecipInClutter(49)
END STRUCTURE

STRUCTURE /L2BCMB_KUGMI_APRIORI/
    REAL*4 initPrecipTotDm(88,49)
    REAL*4 initPrecipTotLogNw(88,49)
    INTEGER*4 profClass(49)
END STRUCTURE

STRUCTURE /L2BCMB_KUGMI_OPTEST/
    INTEGER*2 OEsurfaceClass(49)
    REAL*4 OEairTemperature(10,49)
    REAL*4 OEvaporDensity(10,49)
    REAL*4 OEcolumnWaterVapor(49)
    REAL*4 OEcolumnVaporSigma(49)
    REAL*4 OEcloudLiqWaterCont(88,49)
```

```
    REAL*4 OEcolumnCloudLiqWater(49)
    REAL*4 OEcolumnCloudLiqSigma(49)
    REAL*4 OEcolumnCloudIceWater(49)
    REAL*4 OEskinTemperature(49)
    REAL*4 OEskinTempSigma(49)
    REAL*4 OEsurfaceAirTemperature(49)
    REAL*4 OEsurfaceVaporDensity(49)
    REAL*4 OEtenMeterWindSpeed(49)
    REAL*4 OEtenMeterWindSigma(49)
    REAL*4 OEsurfEmissivity(13,49)
    REAL*4 OEsurfEmissSigma(13,49)
    REAL*4 OEemissivityAvgKernel(13,49)
    REAL*4 OEerrorOfDataFit(49)
    REAL*4 OEsimulatedBrightTemp(13,49)
    REAL*4 OEestimSurfPrecipTotRate(49)
    REAL*4 OEestimSurfPrecipTotRateSigma(49)
    REAL*4 OEestimSurfPrecipLiqRate(49)
    REAL*4 OEpiaNoPrecip(49)
END STRUCTURE

STRUCTURE /L2BCMB_KUGMI_INPUT/
    REAL*4 surfaceElevation(49)
    INTEGER*4 surfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 precipitationFlag(49)
    INTEGER*2 surfaceRangeBin(49)
    INTEGER*2 lowestClutterFreeBin(49)
    REAL*4 ellipsoidBinOffset(49)
    INTEGER*2 stormTopBin(49)
    REAL*4 stormTopAltitude(49)
    INTEGER*2 zeroDegBin(49)
    REAL*4 zeroDegAltitude(49)
    INTEGER*4 precipitationType(49)
    INTEGER*4 precipTypeQualityFlag(49)
    REAL*4 piaEffective(49)
    REAL*4 piaEffectiveSigma(49)
    INTEGER*2 piaEffectiveReliabFlag(49)
    REAL*4 sigmaZeroMeasured(49)
    INTEGER*4 snowIceCover(49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
```

```
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2BCMB_KUGMI_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
```

```
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2BCMB_KUGMI/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    RECORD /L2BCMB_KUGMI_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2BCMB_KUGMI_INPUT/ Input
    RECORD /L2BCMB_KUGMI_OPTEST/ OptEst
    RECORD /L2BCMB_KUGMI_APRIORI/ aPriori
    REAL*4 surfaceAirPressure(49)
    REAL*4 surfaceAirTemperature(49)
    REAL*4 surfaceVaporDensity(49)
    REAL*4 skinTemperature(49)
    REAL*4 skinTempSigma(49)
    INTEGER*2 envParamNode(10,49)
    REAL*4 airPressure(10,49)
    REAL*4 airTemperature(10,49)
    REAL*4 vaporDensity(10,49)
    REAL*4 cloudLiqWaterCont(88,49)
    REAL*4 cloudIceWaterCont(88,49)
    INTEGER*2 lowestUnclutteredBin(49)
    INTEGER*2 lowestEstimateBin(49)
    INTEGER*2 phaseBinNodes(5,49)
    REAL*4 precipTotDm(88,49)
    REAL*4 precipTotLogNw(88,49)
    REAL*4 precipTotMu(88,49)
    REAL*4 precipTotWaterCont(88,49)
    REAL*4 precipTotWaterContSigma(88,49)
    REAL*4 precipLiqWaterCont(88,49)
    REAL*4 precipTotRate(88,49)
    REAL*4 precipTotRateSigma(88,49)
    REAL*4 precipLiqRate(88,49)
    REAL*4 multiScatMaxContrib(49)
    REAL*4 nubfPIAfactor(49)
    REAL*4 nearSurfPrecipTotRate(49)
    REAL*4 nearSurfPrecipTotRateSigma(49)
    REAL*4 nearSurfPrecipLiqRate(49)
    REAL*4 estimSurfPrecipTotRate(49)
    REAL*4 estimSurfPrecipTotRateSigma(49)
```

```
    REAL*4 estimSurfPrecipLiqRate(49)
    REAL*4 tenMeterWindSpeed(49)
    REAL*4 tenMeterWindSigma(49)
    REAL*4 surfEmissivity(13,49)
    REAL*4 surfEmissSigma(13,49)
    REAL*4 simulatedBrightTemp(13,49)
    REAL*4 pia(49)
    REAL*4 correctedReflectFactor(88,49)
    RECORD /L2BCMB_KUGMI_FLG/ FLG
END STRUCTURE

STRUCTURE /L2BCMB_SWATHS/
    RECORD /L2BCMB_KUGMI/ KuGMI;
    RECORD /L2BCMB_KUKAGMI/ KuKaGMI;
END STRUCTURE
```

5.54 2BCMBT - Level-2 PR and TMI Combined

The TRMM Combined Level-2 product, 2BCMBT, "Level-2 PR and TMI Combined," is written as a one-swath structure. The swath, KuTMI, contains 49 rays that match Ku PR. Surface variables refer to the level of the 2APR "near surface", not the "estimated surface". The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of rays (angle bins) in each NS scan.
nPhsBnN	5	Number of phase bin nodes.
nBnEnv	10	Number of environmental bins.
nBnPSD	88	Number of vertical range bins at 250m interval.
nemiss	9	Number of microwave surface emissivities for TMI channels.

Figure 1081 through Figure 1091 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

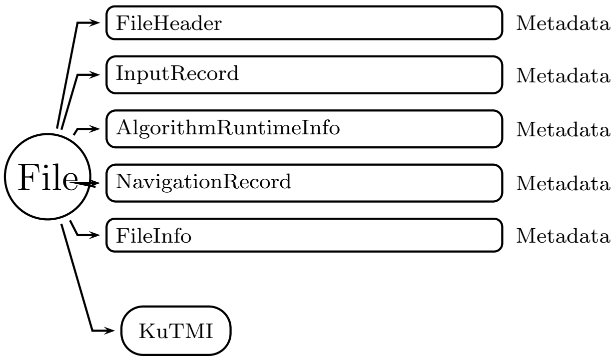


Figure 1081: Data Format Structure for 2BCMBT, Level-2 PR and TMI Combined

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

KuTMI (Swath)

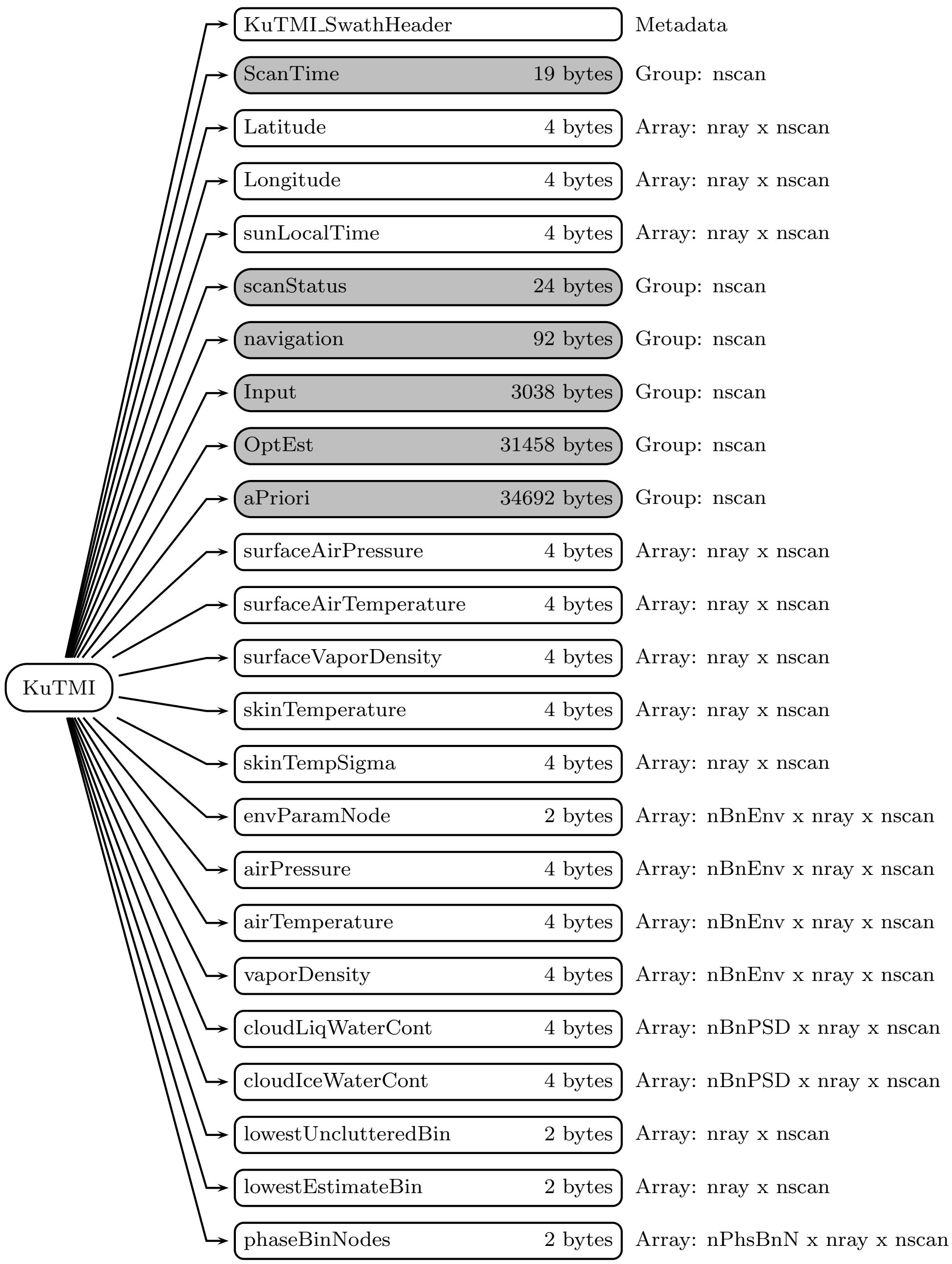
KuTMI_SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value



continued on next figure

Figure 1082: Data Format Structure for 2BCMBT,

continued from last figure

KuTMI

precipTotDm	4 bytes	Array: nBnPSD x nray x nscan
precipTotLogNw	4 bytes	Array: nBnPSD x nray x nscan
precipTotMu	4 bytes	Array: nBnPSD x nray x nscan
precipTotWaterCont	4 bytes	Array: nBnPSD x nray x nscan
precipTotWaterContSigma	4 bytes	Array: nBnPSD x nray x nscan
precipLiqWaterCont	4 bytes	Array: nBnPSD x nray x nscan
precipTotRate	4 bytes	Array: nBnPSD x nray x nscan
precipTotRateSigma	4 bytes	Array: nBnPSD x nray x nscan
precipLiqRate	4 bytes	Array: nBnPSD x nray x nscan
multiScatMaxContrib	4 bytes	Array: nray x nscan
nubfPIAfactor	4 bytes	Array: nray x nscan
nearSurfPrecipTotRate	4 bytes	Array: nray x nscan
nearSurfPrecipTotRateSigma	4 bytes	Array: nray x nscan
nearSurfPrecipLiqRate	4 bytes	Array: nray x nscan
estimSurfPrecipTotRate	4 bytes	Array: nray x nscan
estimSurfPrecipTotRateSigma	4 bytes	Array: nray x nscan
estimSurfPrecipLiqRate	4 bytes	Array: nray x nscan
tenMeterWindSpeed	4 bytes	Array: nray x nscan
tenMeterWindSigma	4 bytes	Array: nray x nscan
surfEmissivity	4 bytes	Array: nemiss x nray x nscan
surfEmissSigma	4 bytes	Array: nemiss x nray x nscan
simulatedBrightTemp	4 bytes	Array: nemiss x nray x nscan
pia	4 bytes	Array: nray x nscan
correctedReflectFactor	4 bytes	Array: nBnPSD x nray x nscan

continued on next figure

Figure 1083: Data Format Structure for 2BCMBT,

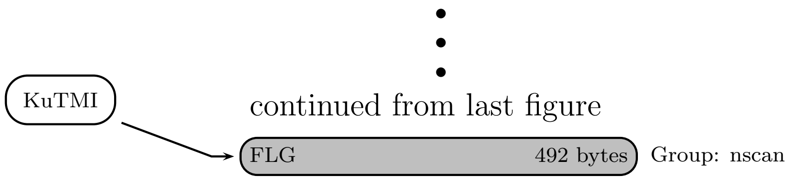


Figure 1084: Data Format Structure for 2BCMBT, KuTMI

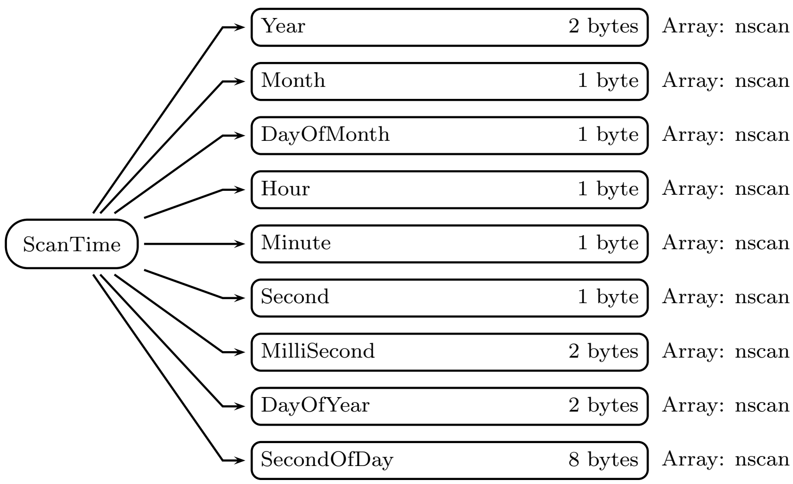


Figure 1085: Data Format Structure for 2BCMBT, ScanTime

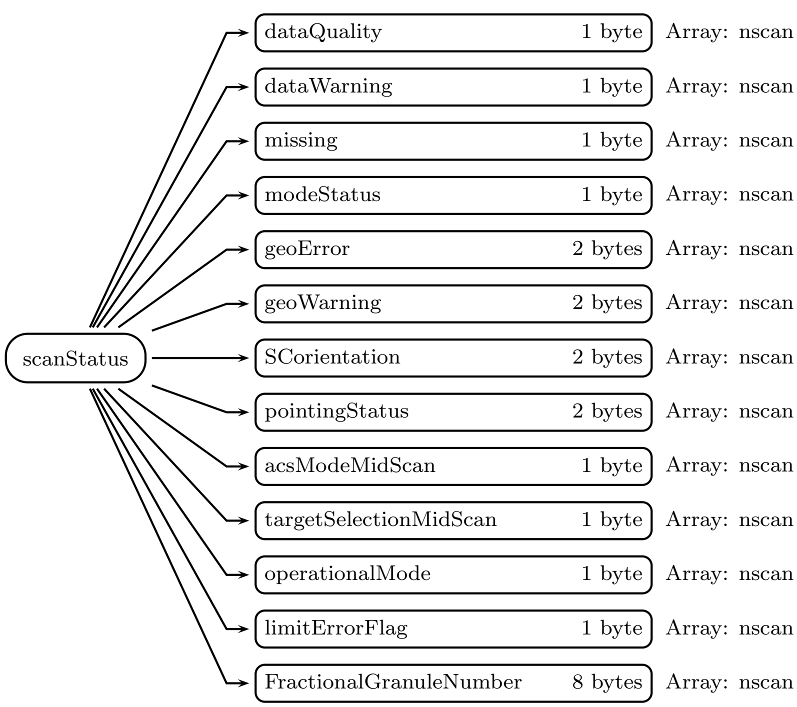


Figure 1086: Data Format Structure for 2BCMBT, scanStatus

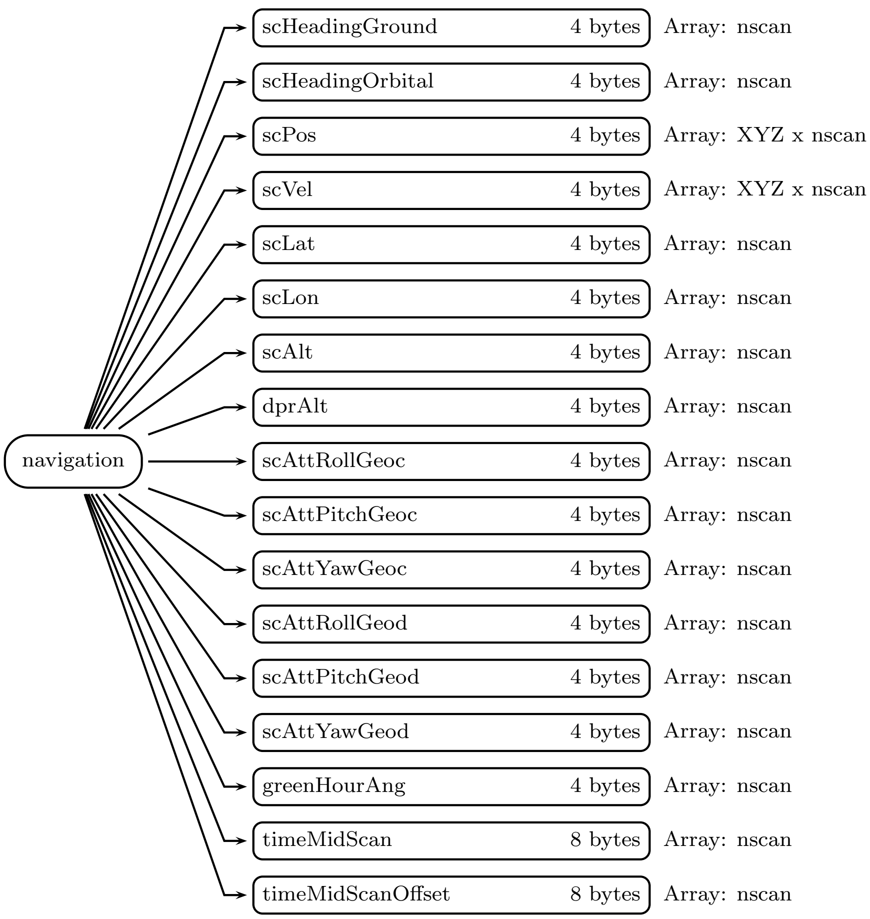


Figure 1087: Data Format Structure for 2BCMBT, navigation

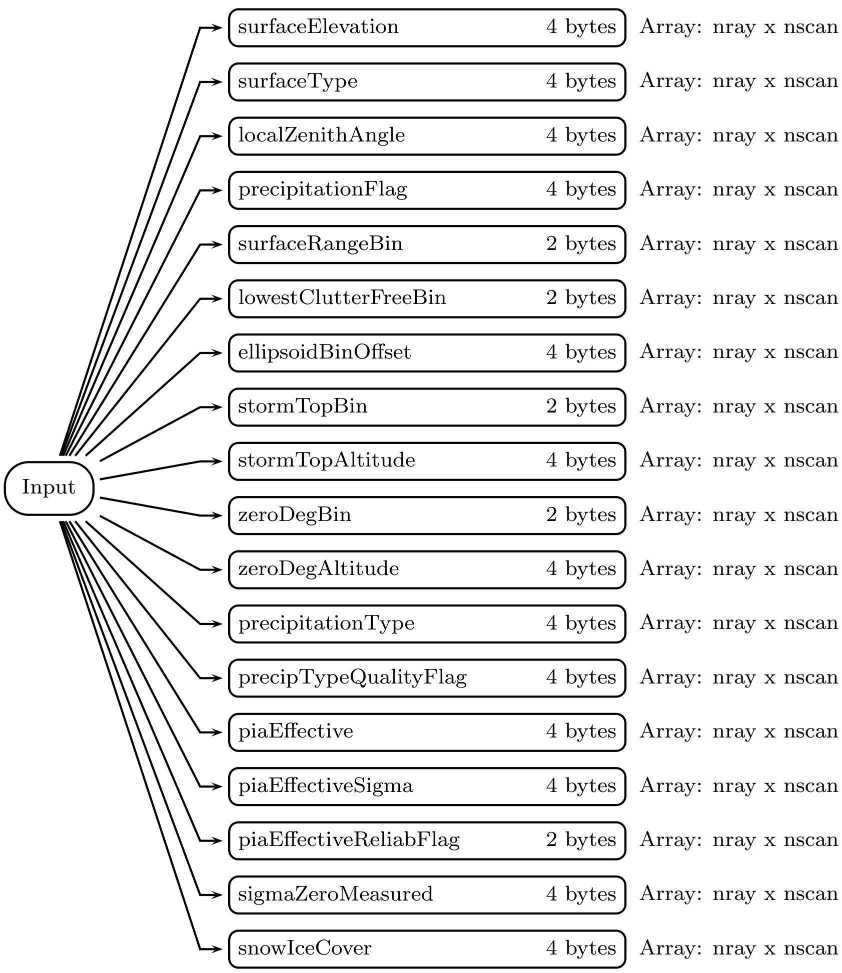


Figure 1088: Data Format Structure for 2BCMBT, Input

OptEst

OEsurfaceClass	2 bytes	Array: nray x nscan
OEairTemperature	4 bytes	Array: nBnEnv x nray x nscan
OEvaporDensity	4 bytes	Array: nBnEnv x nray x nscan
OEcolumnWaterVapor	4 bytes	Array: nray x nscan
OEcolumnVaporSigma	4 bytes	Array: nray x nscan
OEcloudLiqWaterCont	4 bytes	Array: nBnPSD x nray x nscan
OEcolumnCloudLiqWater	4 bytes	Array: nray x nscan
OEcolumnCloudLiqSigma	4 bytes	Array: nray x nscan
OEcolumnCloudIceWater	4 bytes	Array: nray x nscan
OEskinTemperature	4 bytes	Array: nray x nscan
OEskinTempSigma	4 bytes	Array: nray x nscan
OEsurfaceAirTemperature	4 bytes	Array: nray x nscan
OEsurfaceVaporDensity	4 bytes	Array: nray x nscan
OEtenMeterWindSpeed	4 bytes	Array: nray x nscan
OEtenMeterWindSigma	4 bytes	Array: nray x nscan
OEsurfEmissivity	4 bytes	Array: nemiss x nray x nscan
OEsurfEmissSigma	4 bytes	Array: nemiss x nray x nscan
OEemissivityAvgKernel	4 bytes	Array: nemiss x nray x nscan
OEerrorOfDataFit	4 bytes	Array: nray x nscan
OEsimulatedBrightTemp	4 bytes	Array: nemiss x nray x nscan
OEestimSurfPrecipTotRate	4 bytes	Array: nray x nscan
OEestimSurfPrecipTotRateSigma	4 bytes	Array: nray x nscan
OEestimSurfPrecipLiqRate	4 bytes	Array: nray x nscan
OEpiaNoPrecip	4 bytes	Array: nray x nscan

Figure 1089: Data Format Structure for 2BCMBT, OptEst

aPriori

initPrecipTotDm	4 bytes	Array: nBnPSD x nray x nscan
initPrecipTotLogNw	4 bytes	Array: nBnPSD x nray x nscan
profClass	4 bytes	Array: nray x nscan

Figure 1090: Data Format Structure for 2BCMBT, aPriori

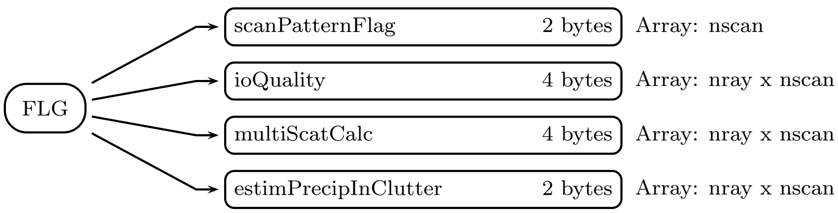


Figure 1091: Data Format Structure for 2BCMBT, FLG

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

scanStatus (Group)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
```

```
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
```

```
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
```

```
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

operationalMode (1-byte integer, array size: nscan):

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

limitErrorFlag (1-byte integer, array size: nscan):

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group)

scHeadingGround (4-byte float, array size: nscan):
The spacecraft ground track heading measured about the geodetic nadir with respect to North at the scan mid-Time. This is the apparent direction of spacecraft motion over the Earth's surface, accounting for Earth rotation effects. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scHeadingOrbital (4-byte float, array size: nscan):
The spacecraft orbital reference heading measured about the geodetic nadir with respect to North at the subsatellite point at the scan mid-Time. This is the apparent direction of the inertial velocity and the zero yaw angle reference direction for spacecraft control. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in True of Date (TOD) Earth-Centered Inertial (ECI) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (m/s) of the spacecraft in TOD ECI Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed

using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coor-

dinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

Input (Group)

surfaceElevation (4-byte float, array size: nray x nscan):
Altitudes above the earth ellipsoid of the surface gates from 2AKu. Values are in m. Special values are defined as:
-9999.9 Missing value

surfaceType (4-byte integer, array size: nray x nscan):
Surface type from 2AKu. Special values are defined as:
-9999 Missing value

localZenithAngle (4-byte float, array size: nray x nscan):
Zenith angle of the ray at the earth's surface from 2AKu. Values are in degree. Special values are defined as:
-9999.9 Missing value

precipitationFlag (4-byte integer, array size: nray x nscan):
Precipitation flag from 2AKu. Special values are defined as:
-9999 Missing value

surfaceRangeBin (2-byte integer, array size: nray x nscan):
Index of the surface range bin from 2AKu. Special values are defined as:
-9999 Missing value

lowestClutterFreeBin (2-byte integer, array size: nray x nscan):
Index of lowest clutter-free bin from 2AKu. Special values are defined as:
-9999 Missing value

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
Offset of surface bin from the earth ellipsoid from 2AKu. Values are in m. Special values are defined as:
-9999.9 Missing value

stormTopBin (2-byte integer, array size: nray x nscan):
Index of storm top bin from 2AKu. Special values are defined as:
-9999 Missing value

stormTopAltitude (4-byte float, array size: nray x nscan):
Altitude of storm top bin from 2AKu. Values are in m. Special values are defined as:
-9999.9 Missing value

zeroDegBin (2-byte integer, array size: nray x nscan):
Range bin of the freezing level. Special values are defined as:
-9999 Missing value

zeroDegAltitude (4-byte float, array size: nray x nscan):
Altitude of the freezing level. Values are in m. Special values are defined as:
-9999.9 Missing value

precipitationType (4-byte integer, array size: nray x nscan):
Precipitation type classification from 2AKu. Special values are defined as:
-9999 Missing value

precipTypeQualityFlag (4-byte integer, array size: nray x nscan):
Quality flag of precipitation type from 2AKu. Special values are defined as:
-9999 Missing value

piaEffective (4-byte float, array size: nray x nscan):
Effective 2-way PIA from 2AKu. Values range from 0 to 1000 dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveSigma (4-byte float, array size: nray x nscan):
Effective PIA uncertainty from 2AKu. Values are in dB. Special values are defined as:
-9999.9 Missing value

piaEffectiveReliabFlag (2-byte integer, array size: nray x nscan):
Reliability flag of effective PIA from 2AKu. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nray x nscan):
The surface normalized radar cross section. Values are in dB. Special values are defined as:
-9999.9 Missing value

snowIceCover (4-byte integer, array size: nray x nscan):
Snow and ice cover. Values are defined as: 0 = ice-free ocean 1 = snow-free land 2 = snow-covered land 3 = sea ice. Special values are defined as:
-9999 Missing value

OptEst (Group)

OEsurfaceClass (2-byte integer, array size: nray x nscan):
OE surface classification. Special values are defined as:
-9999 Missing value

OEairTemperature (4-byte float, array size: nBnEnv x nray x nscan):
OE air temperatuere. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

OEvaporDensity (4-byte float, array size: nBnEnv x nray x nscan):
OE vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

OEcolumnWaterVapor (4-byte float, array size: nray x nscan):
OE vertically-integrated water vapor. Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcolumnVaporSigma (4-byte float, array size: nray x nscan):
OE column vapor uncertainty. Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEcloudLiqWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
OE cloud liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudLiqWater (4-byte float, array size: nray x nscan):
OE vertically-integrated cloud liquid water Values are in g/m^3. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudLiqSigma (4-byte float, array size: nray x nscan):
OE column cloud liquid uncertainty Values are in g/m^3. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudIceWater (4-byte float, array size: nray x nscan):
OE vertically-integrated cloud ice water Values are in kg/m^2. Special values are defined as:
-9999.9 Missing value

OEskinTemperature (4-byte float, array size: nray x nscan):
OE surface skin temperatuere. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

OEskinTempSigma (4-byte float, array size: nray x nscan):
OE skin temperatuere uncertainty. Values are in K. Special values are defined as:
-9999.9 Missing value

OEsurfaceAirTemperature (4-byte float, array size: nray x nscan):
OE surface air temperature. Values range from 150 to 350 K. Special values are defined

as:
-9999.9 Missing value

OEsurfaceVaporDensity (4-byte float, array size: nray x nscan):
OE surface vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSpeed (4-byte float, array size: nray x nscan):
OE ten meter altitude wind speed. Values range from 0 to 100 m/s. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSigma (4-byte float, array size: nray x nscan):
OE ten meter wind uncertainty. Values are in m/s. Special values are defined as:
-9999.9 Missing value

OEsurfEmissivity (4-byte float, array size: nemiss x nray x nscan):
OE GMI emissivities. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

OEsurfEmissSigma (4-byte float, array size: nemiss x nray x nscan):
OE GMI emissivity uncertainties. Special values are defined as:
-9999.9 Missing value

OEemissivityAvgKernel (4-byte float, array size: nemiss x nray x nscan):
OE GMI emissivity averaging kernel. Special values are defined as:
-9999.9 Missing value

OEerrorOfDataFit (4-byte float, array size: nray x nscan):
OE error of brightness temp fit. Values are in K. Special values are defined as:
-9999.9 Missing value

OEsimulatedBrightTemp (4-byte float, array size: nemiss x nray x nscan):
OE simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:
-9999.9 Missing value

OEestimSurfPrecipTotRate (4-byte float, array size: nray x nscan):
OE estimated surface total precip rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

OEestimSurfPrecipTotRateSigma (4-byte float, array size: nray x nscan):
OE estimated surface total precip rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

OEestimSurfPrecipLiqRate (4-byte float, array size: nray x nscan):
OE estimated surface liquid precip rate. Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

OEpiaNoPrecip (4-byte float, array size: nray x nscan):
OE 2-way path-integrated attenuation w/o precip. Values are in dB. Special values are defined as:
-9999.9 Missing value

aPriori (Group)

initPrecipTotDm (4-byte float, array size: nBnPSD x nray x nscan):
Initial guess PSD volume-weighted mean diameter. Values range from 0 to 20 mm. Special values are defined as:
-9999.9 Missing value

initPrecipTotLogNw (4-byte float, array size: nBnPSD x nray x nscan):
Initial guess PSD log 10 of intercept. Values are in log10(m-4). Special values are defined as:
-9999.9 Missing value

profClass (4-byte integer, array size: nray x nscan):
The class number of the observed reflectivity profile using a classification based upon measured reflectivity structure features. Unclassified profiles are assigned a value of -9999.

surfaceAirPressure (4-byte float, array size: nray x nscan):
Surface air pressure. Values range from 300 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

surfaceAirTemperature (4-byte float, array size: nray x nscan):
Surface air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

surfaceVaporDensity (4-byte float, array size: nray x nscan):
Surface vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

skinTemperature (4-byte float, array size: nray x nscan):
Surface skin temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

skinTempSigma (4-byte float, array size: nray x nscan):
Values are in K. Special values are defined as:
-9999.9 Missing value

envParamNode (2-byte integer, array size: nBnEnv x nray x nscan):
Bin indices for environmental parameters. Special values are defined as:
-9999 Missing value

airPressure (4-byte float, array size: nBnEnv x nray x nscan):
Air pressure. Values range from 50 to 1100 hPa. Special values are defined as:
-9999.9 Missing value

airTemperature (4-byte float, array size: nBnEnv x nray x nscan):
Air temperature. Values range from 150 to 350 K. Special values are defined as:
-9999.9 Missing value

vaporDensity (4-byte float, array size: nBnEnv x nray x nscan):
Vapor density. Values range from 0 to 60 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudLiqWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Cloud liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

cloudIceWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Cloud ice water content. Values range from 0 to 18 g/m^3. Special values are defined as:
-9999.9 Missing value

lowestUnclutteredBin (2-byte integer, array size: nray x nscan):
Lowest clutter free bin. Special values are defined as:
-9999 Missing value

lowestEstimateBin (2-byte integer, array size: nray x nscan):
Lowest bin for estimated precipitation. Special values are defined as:
-9999 Missing value

phaseBinNodes (2-byte integer, array size: nPhsBnN x nray x nscan):
Bin numbers indicating (0) storm top, (1) top of mixed-phase later, (2) maximum reflectivity in mixed-phase layer if bright band detected; otherwise, the freezing level from analysis, (3) bottom of mixed-phase layer, and (4) bottom of rain layer Special values are defined as:
-9999 Missing value

precipTotDm (4-byte float, array size: nBnPSD x nray x nscan):
Total precip PSD volume-weighted mean diameter. Values range from 0 to 20 mm. Special values are defined as:
-9999.9 Missing value

precipTotLogNw (4-byte float, array size: nBnPSD x nray x nscan):
Total precip PSD log 10 of intercept. Values are in $log(m-4)$. Special values are defined as:
-9999.9 Missing value

precipTotMu (4-byte float, array size: nBnPSD x nray x nscan):
Total precip PSD shape parameter. Special values are defined as:

-9999.9	Missing value

precipTotWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation liquid water content. Values range from 0 to 18 g/m^3. Special values are defined as:

-9999.9	Missing value

precipTotWaterContSigma (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation liquid water content uncertainty. Values range from 0 to 18 g/m^3. Special values are defined as:

-9999.9	Missing value

precipLiqWaterCont (4-byte float, array size: nBnPSD x nray x nscan):
Liquid precip water content. Values range from 0 to 18 g/m^3. Special values are defined as:

-9999.9	Missing value

precipTotRate (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation rate. Values range from 0 to 300 mm/hr. Special values are defined as:

-99	No precipitation detected
-9999.9	Missing value

precipTotRateSigma (4-byte float, array size: nBnPSD x nray x nscan):
Total precipitation rate uncertainty. Values range from 0 to 300 mm/hr. Special values are defined as:

-99	No precipitation detected
-9999.9	Missing value

precipLiqRate (4-byte float, array size: nBnPSD x nray x nscan):
Liquid precip rate. Values range from 0 to 300 mm/hr. Special values are defined as:

-99	No precipitation detected
-9999.9	Missing value

multiScatMaxContrib (4-byte float, array size: nray x nscan):
multiScatMaxContrib is the maximum contribution, in a given radar profile, by multiple scattering to the simulated reflectivity. Values are in dB. Special values are defined as:

-9999.9	Missing value

nubfPIAfactor (4-byte float, array size: nray x nscan):
nubfPIAfactor is the factor applied to the Hitschfeld-Bordan path integrated attenuation to obtain the simulated path integrated attenuation, accounting for the nonuniform beamfilling by precipitation which is estimated from a 3x3 neighborhood of footprints. Special values are defined as:

-9999.9	Missing value

nearSurfPrecipTotRate (4-byte float, array size: nray x nscan):
Near-surface total precip rate (from lowest clutter-free bin) Values range from 0 to 300

mm/hr. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateSigma (4-byte float, array size: nray x nscan):
Near-surface total precip rate uncertainty (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRate (4-byte float, array size: nray x nscan):
Near-surface liquid precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRate (4-byte float, array size: nray x nscan):
Estimated surface total precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateSigma (4-byte float, array size: nray x nscan):
Estimated surface total precip rate uncertainty (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRate (4-byte float, array size: nray x nscan):
Estimated surface liquid precip rate (from lowest clutter-free bin) Values range from 0 to 300 mm/hr. Special values are defined as:
-9999.9 Missing value

tenMeterWindSpeed (4-byte float, array size: nray x nscan):
Ten meter altitude wind speed magnitude. Values range from 0 to 100 m/s. Special values are defined as:
-9999.9 Missing value

tenMeterWindSigma (4-byte float, array size: nray x nscan):
Values are in m/s. Special values are defined as:
-9999.9 Missing value

surfEmissivity (4-byte float, array size: nemiss x nray x nscan):
GMI emissivities. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

surfEmissSigma (4-byte float, array size: nemiss x nray x nscan):
Special values are defined as:
-9999.9 Missing value

simulatedBrightTemp (4-byte float, array size: nemiss x nray x nscan):
GMI simulated brightness temperatures. Values range from 20 to 350 K. Special values are defined as:
-9999.9 Missing value

pia (4-byte float, array size: nray x nscan):
Two-way path-integrated attenuation at Ku. Values range from 0 to 1000 dB. Special values are defined as:
-9999.9 Missing value

correctedReflectFactor (4-byte float, array size: nBnPSD x nray x nscan):
Corrected radar reflectivities at Ku band. Values range from -20 to 100 dBZ. Special values are defined as:
-9999.9 Missing value

FLG (Group)

scanPatternFlag (2-byte integer, array size: nscan):

Flag indicating scan pattern status. Values range from 0 to 1. Special values are defined as:
-9999 Missing value

ioQuality (4-byte integer, array size: nray x nscan):
Quality flag for input and output. The flag is a six digit number as follows.

```
1's place       0 : rain estimate is valid
                9 : no estimate (bad scan)

10's place      0 : Ku data OK and rain detected using Ku
                1 : Ku data OK and no rain detected using Ku
                9 : bad Ku input data

100's place     0 : Ku-SRT gives a valid PIA estimate
                1 : sigma-zero at Ku is within the noise of the background
                2 : sigma-zero at Ku is completely attenuated
                9 : bad Ku input data

1000's place    0 : freezing level is derived from Ku bright band
                1 : freezing level is derived from GANAL analysis
                9 : bad Ku input data

10000's place   0 : Ku classified as stratiform or convective
                1 : Ku classified as indeterminate
                2 : precipitation not detected at Ku (no feature)
```

```
                 9 : bad Ku input data

100000's place   0 : some measured Tb's (interpolated to DPR grid)
                     are valid
                 9 : no measured Tb's are valid
```

Special values are defined as:
-9999 Missing value

multiScatCalc (4-byte integer, array size: nray x nscan):

Special values are defined as:
-9999 Missing value

estimPrecipInClutter (2-byte integer, array size: nray x nscan):

Flag if precip is estimated in clutter region. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_2BCMBT_H_
#define _TK_2BCMBT_H_

#ifndef _L2BCMBT_FLG_
#define _L2BCMBT_FLG_

typedef struct {
    short scanPatternFlag;
    int ioQuality[49];
    int multiScatCalc[49];
    short estimPrecipInClutter[49];
} L2BCMBT_FLG;

#endif

#ifndef _L2BCMBT_APRIORI_
#define _L2BCMBT_APRIORI_
```

```
typedef struct {
    float initPrecipTotDm[49][88];
    float initPrecipTotLogNw[49][88];
    int profClass[49];
} L2BCMBT_APRIORI;

#endif

#ifndef _L2BCMBT_OPTEST_
#define _L2BCMBT_OPTEST_

typedef struct {
    short OEsurfaceClass[49];
    float OEairTemperature[49][10];
    float OEvaporDensity[49][10];
    float OEcolumnWaterVapor[49];
    float OEcolumnVaporSigma[49];
    float OEcloudLiqWaterCont[49][88];
    float OEcolumnCloudLiqWater[49];
    float OEcolumnCloudLiqSigma[49];
    float OEcolumnCloudIceWater[49];
    float OEskinTemperature[49];
    float OEskinTempSigma[49];
    float OEsurfaceAirTemperature[49];
    float OEsurfaceVaporDensity[49];
    float OEtenMeterWindSpeed[49];
    float OEtenMeterWindSigma[49];
    float OEsurfEmissivity[49][9];
    float OEsurfEmissSigma[49][9];
    float OEemissivityAvgKernel[49][9];
    float OEerrorOfDataFit[49];
    float OEsimulatedBrightTemp[49][9];
    float OEestimSurfPrecipTotRate[49];
    float OEestimSurfPrecipTotRateSigma[49];
    float OEestimSurfPrecipLiqRate[49];
    float OEpiaNoPrecip[49];
} L2BCMBT_OPTEST;

#endif

#ifndef _L2BCMBT_INPUT_
#define _L2BCMBT_INPUT_
```

```
typedef struct {
    float surfaceElevation[49];
    int surfaceType[49];
    float localZenithAngle[49];
    int precipitationFlag[49];
    short surfaceRangeBin[49];
    short lowestClutterFreeBin[49];
    float ellipsoidBinOffset[49];
    short stormTopBin[49];
    float stormTopAltitude[49];
    short zeroDegBin[49];
    float zeroDegAltitude[49];
    int precipitationType[49];
    int precipTypeQualityFlag[49];
    float piaEffective[49];
    float piaEffectiveSigma[49];
    short piaEffectiveReliabFlag[49];
    float sigmaZeroMeasured[49];
    int snowIceCover[49];
} L2BCMBT_INPUT;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scHeadingGround;
    float scHeadingOrbital;
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
```

```
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2BCMBT_SCANSTATUS_
#define _L2BCMBT_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2BCMBT_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif
```

```
#ifndef _L2BCMBT_KUTMI_
#define _L2BCMBT_KUTMI_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float sunLocalTime[49];
    L2BCMBT_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2BCMBT_INPUT Input;
    L2BCMBT_OPTEST OptEst;
    L2BCMBT_APRIORI aPriori;
    float surfaceAirPressure[49];
    float surfaceAirTemperature[49];
    float surfaceVaporDensity[49];
    float skinTemperature[49];
    float skinTempSigma[49];
    short envParamNode[49][10];
    float airPressure[49][10];
    float airTemperature[49][10];
    float vaporDensity[49][10];
    float cloudLiqWaterCont[49][88];
    float cloudIceWaterCont[49][88];
    short lowestUnclutteredBin[49];
    short lowestEstimateBin[49];
    short phaseBinNodes[49][5];
    float precipTotDm[49][88];
    float precipTotLogNw[49][88];
    float precipTotMu[49][88];
    float precipTotWaterCont[49][88];
    float precipTotWaterContSigma[49][88];
    float precipLiqWaterCont[49][88];
    float precipTotRate[49][88];
    float precipTotRateSigma[49][88];
    float precipLiqRate[49][88];
    float multiScatMaxContrib[49];
    float nubfPIAfactor[49];
    float nearSurfPrecipTotRate[49];
    float nearSurfPrecipTotRateSigma[49];
    float nearSurfPrecipLiqRate[49];
    float estimSurfPrecipTotRate[49];
    float estimSurfPrecipTotRateSigma[49];
```

```
    float estimSurfPrecipLiqRate[49];
    float tenMeterWindSpeed[49];
    float tenMeterWindSigma[49];
    float surfEmissivity[49][9];
    float surfEmissSigma[49][9];
    float simulatedBrightTemp[49][9];
    float pia[49];
    float correctedReflectFactor[49][88];
    L2BCMBT_FLG FLG;
} L2BCMBT_KUTMI;

#endif

#ifndef _L2BCMBT_SWATHS_
#define _L2BCMBT_SWATHS_

typedef struct {
    L2BCMBT_KUTMI KuTMI;
} L2BCMBT_SWATHS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2BCMBT_FLG/
    INTEGER*2 scanPatternFlag
    INTEGER*4 ioQuality(49)
    INTEGER*4 multiScatCalc(49)
    INTEGER*2 estimPrecipInClutter(49)
END STRUCTURE

STRUCTURE /L2BCMBT_APRIORI/
    REAL*4 initPrecipTotDm(88,49)
    REAL*4 initPrecipTotLogNw(88,49)
    INTEGER*4 profClass(49)
END STRUCTURE

STRUCTURE /L2BCMBT_OPTEST/
    INTEGER*2 OEsurfaceClass(49)
    REAL*4 OEairTemperature(10,49)
    REAL*4 OEvaporDensity(10,49)
```

```
    REAL*4 OEcolumnWaterVapor(49)
    REAL*4 OEcolumnVaporSigma(49)
    REAL*4 OEcloudLiqWaterCont(88,49)
    REAL*4 OEcolumnCloudLiqWater(49)
    REAL*4 OEcolumnCloudLiqSigma(49)
    REAL*4 OEcolumnCloudIceWater(49)
    REAL*4 OEskinTemperature(49)
    REAL*4 OEskinTempSigma(49)
    REAL*4 OEsurfaceAirTemperature(49)
    REAL*4 OEsurfaceVaporDensity(49)
    REAL*4 OEtenMeterWindSpeed(49)
    REAL*4 OEtenMeterWindSigma(49)
    REAL*4 OEsurfEmissivity(9,49)
    REAL*4 OEsurfEmissSigma(9,49)
    REAL*4 OEemissivityAvgKernel(9,49)
    REAL*4 OEerrorOfDataFit(49)
    REAL*4 OEsimulatedBrightTemp(9,49)
    REAL*4 OEestimSurfPrecipTotRate(49)
    REAL*4 OEestimSurfPrecipTotRateSigma(49)
    REAL*4 OEestimSurfPrecipLiqRate(49)
    REAL*4 OEpiaNoPrecip(49)
END STRUCTURE

STRUCTURE /L2BCMBT_INPUT/
    REAL*4 surfaceElevation(49)
    INTEGER*4 surfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 precipitationFlag(49)
    INTEGER*2 surfaceRangeBin(49)
    INTEGER*2 lowestClutterFreeBin(49)
    REAL*4 ellipsoidBinOffset(49)
    INTEGER*2 stormTopBin(49)
    REAL*4 stormTopAltitude(49)
    INTEGER*2 zeroDegBin(49)
    REAL*4 zeroDegAltitude(49)
    INTEGER*4 precipitationType(49)
    INTEGER*4 precipTypeQualityFlag(49)
    REAL*4 piaEffective(49)
    REAL*4 piaEffectiveSigma(49)
    INTEGER*2 piaEffectiveReliabFlag(49)
    REAL*4 sigmaZeroMeasured(49)
    INTEGER*4 snowIceCover(49)
END STRUCTURE
```

```
STRUCTURE /NAVIGATION/
    REAL*4 scHeadingGround
    REAL*4 scHeadingOrbital
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2BCMBT_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
```

```
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2BCMBT_KUTMI/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    RECORD /L2BCMBT_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2BCMBT_INPUT/ Input
    RECORD /L2BCMBT_OPTEST/ OptEst
    RECORD /L2BCMBT_APRIORI/ aPriori
    REAL*4 surfaceAirPressure(49)
    REAL*4 surfaceAirTemperature(49)
    REAL*4 surfaceVaporDensity(49)
    REAL*4 skinTemperature(49)
    REAL*4 skinTempSigma(49)
    INTEGER*2 envParamNode(10,49)
    REAL*4 airPressure(10,49)
    REAL*4 airTemperature(10,49)
    REAL*4 vaporDensity(10,49)
    REAL*4 cloudLiqWaterCont(88,49)
    REAL*4 cloudIceWaterCont(88,49)
    INTEGER*2 lowestUnclutteredBin(49)
    INTEGER*2 lowestEstimateBin(49)
    INTEGER*2 phaseBinNodes(5,49)
    REAL*4 precipTotDm(88,49)
    REAL*4 precipTotLogNw(88,49)
    REAL*4 precipTotMu(88,49)
    REAL*4 precipTotWaterCont(88,49)
    REAL*4 precipTotWaterContSigma(88,49)
    REAL*4 precipLiqWaterCont(88,49)
    REAL*4 precipTotRate(88,49)
    REAL*4 precipTotRateSigma(88,49)
    REAL*4 precipLiqRate(88,49)
    REAL*4 multiScatMaxContrib(49)
    REAL*4 nubfPIAfactor(49)
    REAL*4 nearSurfPrecipTotRate(49)
    REAL*4 nearSurfPrecipTotRateSigma(49)
```

```
    REAL*4 nearSurfPrecipLiqRate(49)
    REAL*4 estimSurfPrecipTotRate(49)
    REAL*4 estimSurfPrecipTotRateSigma(49)
    REAL*4 estimSurfPrecipLiqRate(49)
    REAL*4 tenMeterWindSpeed(49)
    REAL*4 tenMeterWindSigma(49)
    REAL*4 surfEmissivity(9,49)
    REAL*4 surfEmissSigma(9,49)
    REAL*4 simulatedBrightTemp(9,49)
    REAL*4 pia(49)
    REAL*4 correctedReflectFactor(88,49)
    RECORD /L2BCMBT_FLG/ FLG
END STRUCTURE

STRUCTURE /L2BCMBT_SWATHS/
    RECORD /L2BCMBT_KUTMI/ KuTMI;
END STRUCTURE
```

5.55 3CMB - Combined precipitation

3CMB, "Combined precipitation", computes statistics of the Combined measurements from GPM at both a low horizontal resolution (G1, 5^o x 5^o latitude/longitude) and a high horizontal resolution (G2, 0.25^o x 0.25^o latitude/longitude). There will be both a monthly product and a daily product.

Dimension definitions:

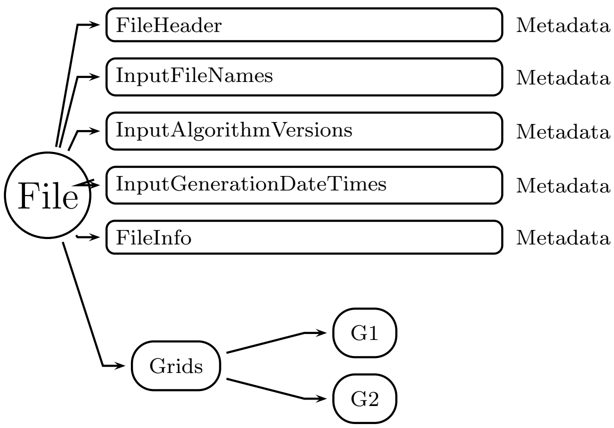


Figure 1092: Data Format Structure for 3CMB, Combined precipitation

ltL	28	Number of low resolution 5^o grid intervals of latitude from 70^oS to 70^oN.
lnL	72	Number of low resolution 5^o grid intervals of longitude from 180^oW to 180^oE.
ltH	536	Number of high resolution 0.25^o grid intervals of latitude from 67^oS to 67^oN.
lnH	1440	Number of high resolution 0.25^o grid intervals of longitude from 180^oW to 180^oE.
ns	4	Number of swaths:, 0 = Ku+Ka+GMI (full swath), 1 = Ku+GMI (full swath), 2 = Ku+Ka+GMI (narrow swath), 3 = Ku+GMI (narrow swath).
hgt	16	Number of level heights 0-15: 0: near surface, 1-10: height = 1.0km * index, 11-15: height = 10.0km + 2.0km * (index-10),
tim	24	Number of hourly local time bins.
rt	3	Number of rain types: stratiform, convective, all.
st	3	Number of surface types: ocean, land, all.
bin	30	Number of bins in histogram.
emiss	13	Number of radiometer channel emissivities.

Figure 1092 through Figure 1122 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

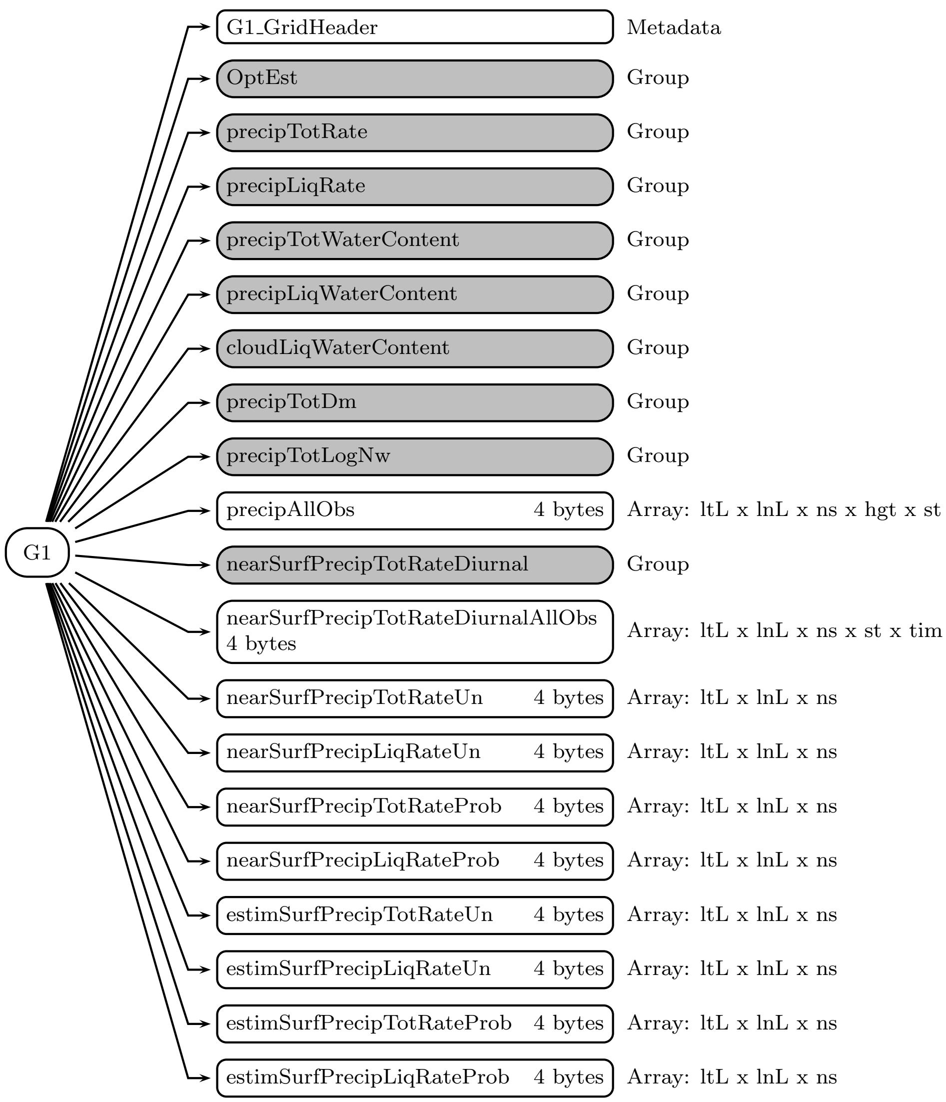


Figure 1093: Data Format Structure for 3CMB, G1

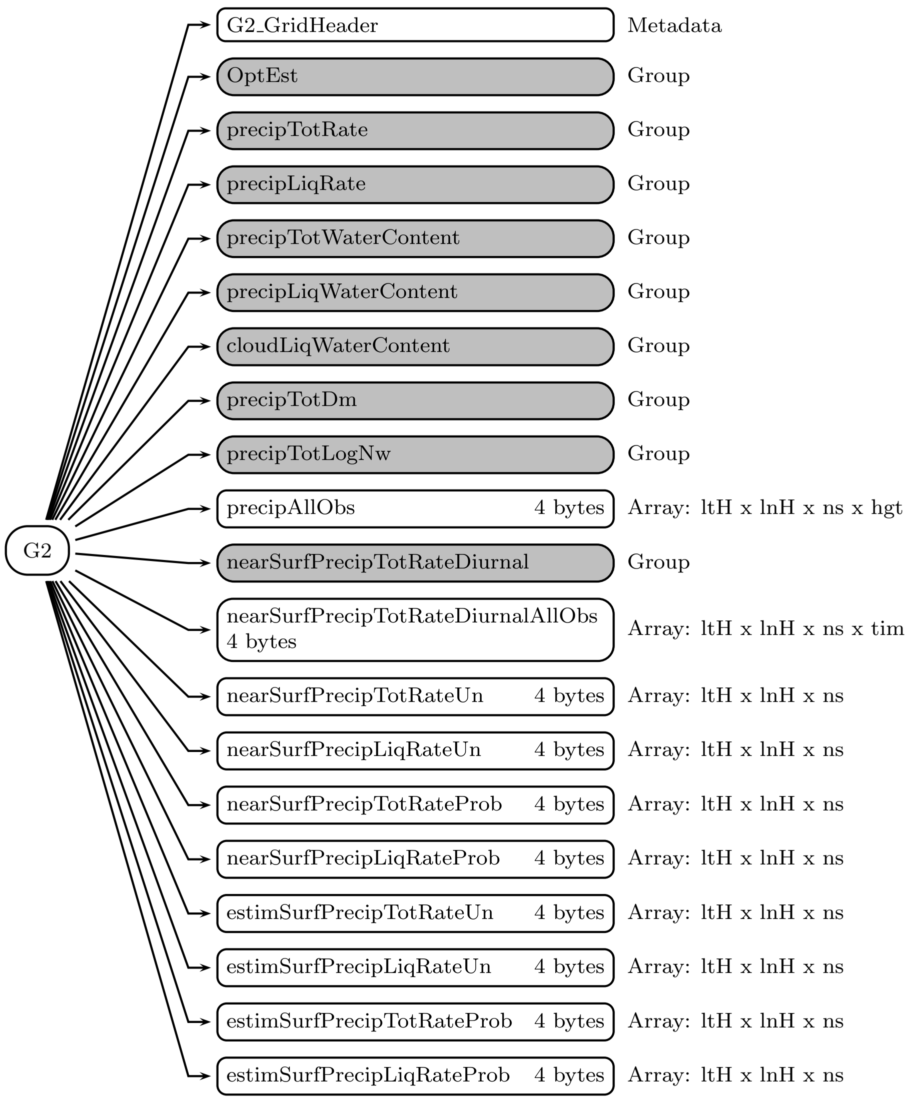


Figure 1094: Data Format Structure for 3CMB, G2

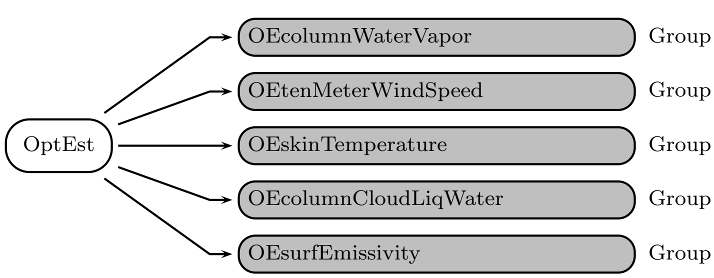


Figure 1095: Data Format Structure for 3CMB, G1, OptEst

OEcolumnWaterVapor			
	count	4 bytes	Array: ltL x lnL x ns
	mean	4 bytes	Array: ltL x lnL x ns

Figure 1096: Data Format Structure for 3CMB, G1, OptEst, OEcolumnWaterVapor

OEtenMeterWindSpeed			
	count	4 bytes	Array: ltL x lnL x ns
	mean	4 bytes	Array: ltL x lnL x ns

Figure 1097: Data Format Structure for 3CMB, G1, OptEst, OEtenMeterWindSpeed

OEskinTemperature			
	count	4 bytes	Array: ltL x lnL x ns
	mean	4 bytes	Array: ltL x lnL x ns

Figure 1098: Data Format Structure for 3CMB, G1, OptEst, OEskinTemperature

OEcolumnCloudLiqWater			
	count	4 bytes	Array: ltL x lnL x ns
	mean	4 bytes	Array: ltL x lnL x ns

Figure 1099: Data Format Structure for 3CMB, G1, OptEst, OEcolumnCloudLiqWater

OEsurfEmissivity			
	count	4 bytes	Array: ltL x lnL x ns x emiss
	mean	4 bytes	Array: ltL x lnL x ns x emiss

Figure 1100: Data Format Structure for 3CMB, G1, OptEst, OEsurfEmissivity

precipTotRate			
	count	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	mean	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	stdev	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	hist	4 bytes	Array: ltL x lnL x ns x hgt x rt x st x bin

Figure 1101: Data Format Structure for 3CMB, G1, precipTotRate

precipLiqRate			
	count	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	mean	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	stdev	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	hist	4 bytes	Array: ltL x lnL x ns x hgt x rt x st x bin

Figure 1102: Data Format Structure for 3CMB, G1, precipLiqRate

precipTotWaterContent

count	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
mean	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
stdev	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
hist	4 bytes	Array: ltL x lnL x ns x hgt x rt x st x bin

Figure 1103: Data Format Structure for 3CMB, G1, precipTotWaterContent

precipLiqWaterContent			
	count	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	mean	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	stdev	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	hist	4 bytes	Array: ltL x lnL x ns x hgt x rt x st x bin

Figure 1104: Data Format Structure for 3CMB, G1, precipLiqWaterContent

cloudLiqWaterContent			
	count	4 bytes	Array: ltL x lnL x ns x hgt x st
	mean	4 bytes	Array: ltL x lnL x ns x hgt x st
	stdev	4 bytes	Array: ltL x lnL x ns x hgt x st
	hist	4 bytes	Array: ltL x lnL x ns x hgt x st x bin

Figure 1105: Data Format Structure for 3CMB, G1, cloudLiqWaterContent

precipTotDm			
	count	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	mean	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	stdev	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	hist	4 bytes	Array: ltL x lnL x ns x hgt x rt x st x bin

Figure 1106: Data Format Structure for 3CMB, G1, precipTotDm

precipTotLogNw			
	count	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	mean	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	stdev	4 bytes	Array: ltL x lnL x ns x hgt x rt x st
	hist	4 bytes	Array: ltL x lnL x ns x hgt x rt x st x bin

Figure 1107: Data Format Structure for 3CMB, G1, precipTotLogNw

nearSurfPrecipTotRateDiurnal			
	count	4 bytes	Array: ltL x lnL x ns x st x tim
	mean	4 bytes	Array: ltL x lnL x ns x st x tim
	stdev	4 bytes	Array: ltL x lnL x ns x st x tim

Figure 1108: Data Format Structure for 3CMB, G1, nearSurfPrecipTotRateDiurnal

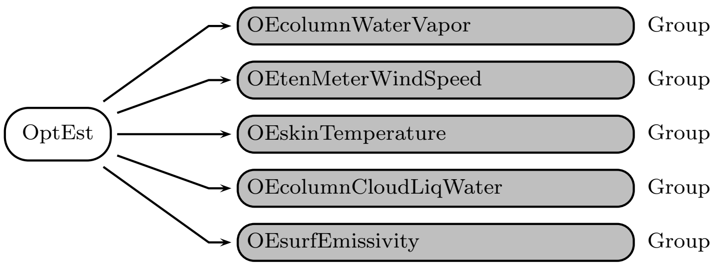


Figure 1109: Data Format Structure for 3CMB, G2, OptEst

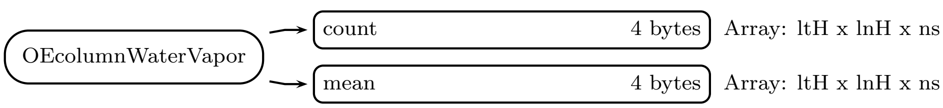


Figure 1110: Data Format Structure for 3CMB, G2, OptEst, OEcolumnWaterVapor

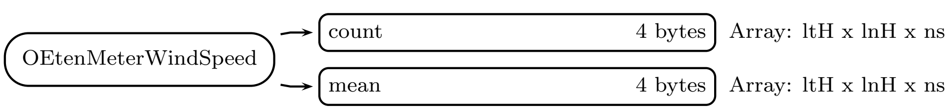


Figure 1111: Data Format Structure for 3CMB, G2, OptEst, OEtenMeterWindSpeed

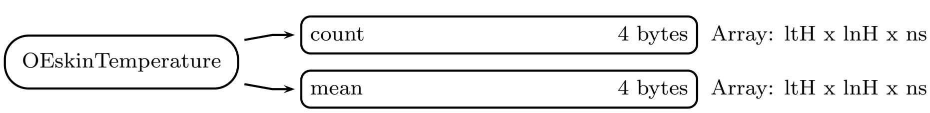


Figure 1112: Data Format Structure for 3CMB, G2, OptEst, OEskinTemperature

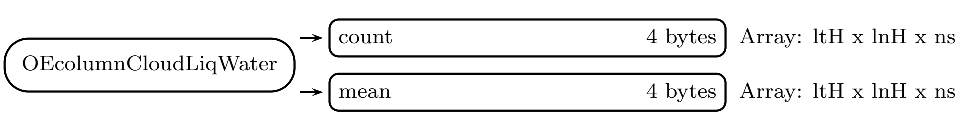


Figure 1113: Data Format Structure for 3CMB, G2, OptEst, OEcolumnCloudLiqWater

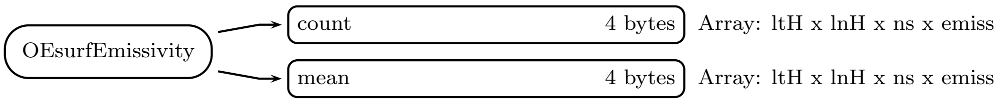


Figure 1114: Data Format Structure for 3CMB, G2, OptEst, OEsurfEmissivity

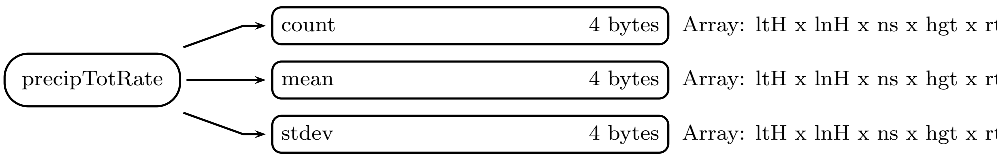


Figure 1115: Data Format Structure for 3CMB, G2, precipTotRate

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grids (Group)

G1 (Grid)

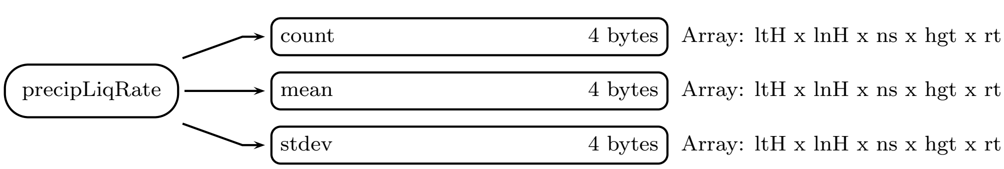


Figure 1116: Data Format Structure for 3CMB, G2, precipLiqRate

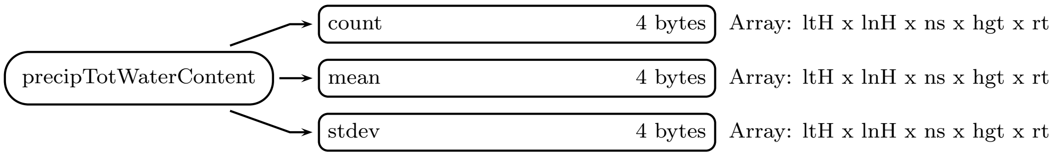


Figure 1117: Data Format Structure for 3CMB, G2, precipTotWaterContent

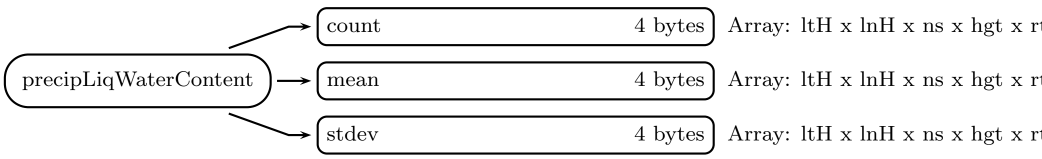


Figure 1118: Data Format Structure for 3CMB, G2, precipLiqWaterContent

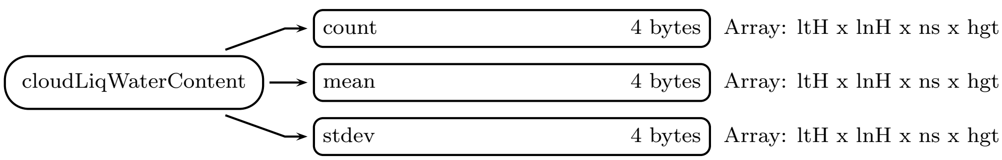


Figure 1119: Data Format Structure for 3CMB, G2, cloudLiqWaterContent

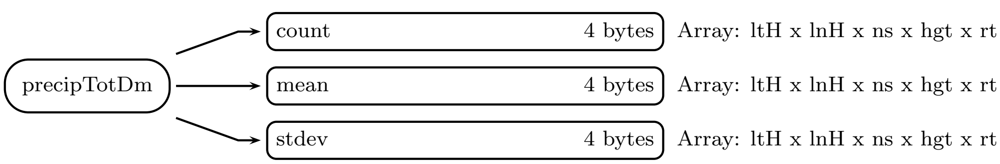


Figure 1120: Data Format Structure for 3CMB, G2, precipTotDm

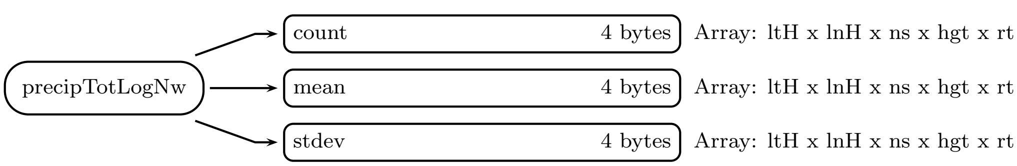


Figure 1121: Data Format Structure for 3CMB, G2, precipTotLogNw

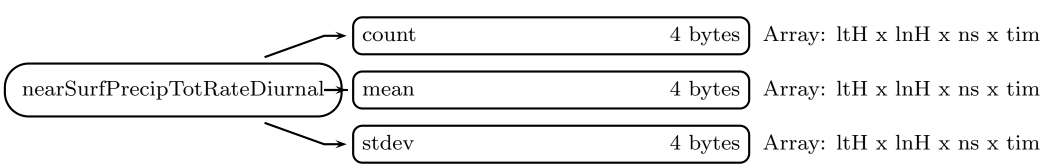


Figure 1122: Data Format Structure for 3CMB, G2, nearSurfPrecipTotRateDiurnal

G1_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

OptEst (Group in G1)

OEcolumnWaterVapor (Group in G1, OptEst)

OE vertically-integrated water vapor (kg/m^2).

count (4-byte integer, array size: ltL x lnL x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSpeed (Group in G1, OptEst)

OE ten meter wind speed (m/s).

count (4-byte integer, array size: ltL x lnL x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEskinTemperature (Group in G1, OptEst)

OE surface skin temperature (K).

count (4-byte integer, array size: ltL x lnL x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudLiqWater (Group in G1, OptEst)

OE vertically-integrated cloud water content (kg/m^2).

count (4-byte integer, array size: ltL x lnL x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEsurfEmissivity (Group in G1, OptEst)

OE surface emmisivity.

count (4-byte integer, array size: ltL x lnL x ns x emiss):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x emiss):
Conditional mean. Special values are defined as:
-9999.9 Missing value

precipTotRate (Group in G1)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitation water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipLiqRate (Group in G1)

Equivalent precipitation rate of liquid-phase precipitating water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipTotWaterContent (Group in G1)

Equivalent water content of both liquid-phase and ice-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or melt water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipLiqWaterContent (Group in G1)

Equivalent water content of liquid-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

cloudLiqWaterContent (Group in G1)

Equivalent water content of liquid-phase cloud water (g/m^3).

count (4-byte integer, array size: ltL x lnL x ns x hgt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipTotDm (Group in G1)

Volume-weighted mean of the liquid-equivalent precipitation particle diameter (mm).

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipTotLogNw (Group in G1)

Common logarithm of the intercept of the normalized gamma distribution representing the liquid-equivalent precipitation particle size distribution (log10(m^-4)).

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipAllObs (4-byte integer, array size: ltL x lnL x ns x hgt x st):
Number of total observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

nearSurfPrecipTotRateDiurnal (Group in G1)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitating water in the lowest uncontaminated range-bin (mm/hr), indexed by the local time. (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x st x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x st x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x st x tim):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateDiurnalAllObs (4-byte integer, array size: ltL x lnL x ns x st x tim):
Number of total diurnal observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

nearSurfPrecipTotRateUn (4-byte float, array size: ltL x lnL x ns):
Near surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRateUn (4-byte float, array size: ltL x lnL x ns):
Near surface liquid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of total near surface precipitation. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of liquid near surface precipitation. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateUn (4-byte float, array size: ltL x lnL x ns):
Estimated surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRateUn (4-byte float, array size: ltL x lnL x ns):
Estimated surface liquid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of total estimated surface precipitation. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of liquid estimated surface precipitation. Special values are defined as:
-9999.9 Missing value

G2 (Grid)

G2_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

OptEst (Group in G2)

OEcolumnWaterVapor (Group in G2, OptEst)

OE vertically-integrated water vapor (kg/m^2).

count (4-byte integer, array size: ltH x lnH x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSpeed (Group in G2, OptEst)

OE ten meter wind speed (m/s).

count (4-byte integer, array size: ltH x lnH x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEskinTemperature (Group in G2, OptEst)

OE surface skin temperature (K).

count (4-byte integer, array size: ltH x lnH x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudLiqWater (Group in G2, OptEst)

OE vertically-integrated cloud water content (kg/m^2).

count (4-byte integer, array size: ltH x lnH x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEsurfEmissivity (Group in G2, OptEst)

OE surface emmisivity.

count (4-byte integer, array size: ltH x lnH x ns x emiss):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x emiss):
Conditional mean. Special values are defined as:
-9999.9 Missing value

precipTotRate (Group in G2)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitation water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipLiqRate (Group in G2)

Equivalent precipitation rate of liquid-phase precipitating water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipTotWaterContent (Group in G2)

Equivalent water content of both liquid-phase and ice-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or melt water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipLiqWaterContent (Group in G2)

Equivalent water content of liquid-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

cloudLiqWaterContent (Group in G2)

Equivalent water content of liquid-phase cloud water (g/m^3).

count (4-byte integer, array size: ltH x lnH x ns x hgt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipTotDm (Group in G2)

Volume-weighted mean of the liquid-equivalent precipitation particle diameter (mm).

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipTotLogNw (Group in G2)

Common logarithm of the intercept of the normalized gamma distribution representing the liquid-equivalent precipitation particle size distribution (log10(m^-4)).

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipAllObs (4-byte integer, array size: ltH x lnH x ns x hgt):
Number of total observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

nearSurfPrecipTotRateDiurnal (Group in G2)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitating water in the lowest uncontaminated range-bin (mm/hr), indexed by the local time. (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x tim):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateDiurnalAllObs (4-byte integer, array size: ltH x lnH x ns x tim):
Number of total diurnal observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

nearSurfPrecipTotRateUn (4-byte float, array size: ltH x lnH x ns):
Surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRateUn (4-byte float, array size: ltH x lnH x ns):
Surface liguid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of total surface precipitation. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of liquid surface precipitation. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateUn (4-byte float, array size: ltH x lnH x ns):
Estimated surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRateUn (4-byte float, array size: ltH x lnH x ns):
Estimated surface liguid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of total estimated surface precipitation. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of liquid estimated surface precipitation. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3CMB_H_
#define _TK_3CMB_H_

#ifndef _L3CMB_G2_NEARSURFPRECIPTOTRATEDIURNAL_
#define _L3CMB_G2_NEARSURFPRECIPTOTRATEDIURNAL_

typedef struct {
    int count[24][4][1440][536];
    float mean[24][4][1440][536];
    float stdev[24][4][1440][536];
} L3CMB_G2_NEARSURFPRECIPTOTRATEDIURNAL;

#endif

#ifndef _L3CMB_G2_PRECIPTOTLOGNW_
```

```
#define _L3CMB_G2_PRECIPTOTLOGNW_

typedef struct {
    int count[3][16][4][1440][536];
    float mean[3][16][4][1440][536];
    float stdev[3][16][4][1440][536];
} L3CMB_G2_PRECIPTOTLOGNW;

#endif

#ifndef _L3CMB_G2_PRECIPTOTDM_
#define _L3CMB_G2_PRECIPTOTDM_

typedef struct {
    int count[3][16][4][1440][536];
    float mean[3][16][4][1440][536];
    float stdev[3][16][4][1440][536];
} L3CMB_G2_PRECIPTOTDM;

#endif

#ifndef _L3CMB_G2_CLOUDLIQWATERCONTENT_
#define _L3CMB_G2_CLOUDLIQWATERCONTENT_

typedef struct {
    int count[16][4][1440][536];
    float mean[16][4][1440][536];
    float stdev[16][4][1440][536];
} L3CMB_G2_CLOUDLIQWATERCONTENT;

#endif

#ifndef _L3CMB_G2_PRECIPLIQWATERCONTENT_
#define _L3CMB_G2_PRECIPLIQWATERCONTENT_

typedef struct {
    int count[3][16][4][1440][536];
    float mean[3][16][4][1440][536];
    float stdev[3][16][4][1440][536];
} L3CMB_G2_PRECIPLIQWATERCONTENT;

#endif
```

```
#ifndef _L3CMB_G2_PRECIPTOTWATERCONTENT_
#define _L3CMB_G2_PRECIPTOTWATERCONTENT_

typedef struct {
    int count[3][16][4][1440][536];
    float mean[3][16][4][1440][536];
    float stdev[3][16][4][1440][536];
} L3CMB_G2_PRECIPTOTWATERCONTENT;

#endif

#ifndef _L3CMB_G2_PRECIPLIQRATE_
#define _L3CMB_G2_PRECIPLIQRATE_

typedef struct {
    int count[3][16][4][1440][536];
    float mean[3][16][4][1440][536];
    float stdev[3][16][4][1440][536];
} L3CMB_G2_PRECIPLIQRATE;

#endif

#ifndef _L3CMB_G2_PRECIPTOTRATE_
#define _L3CMB_G2_PRECIPTOTRATE_

typedef struct {
    int count[3][16][4][1440][536];
    float mean[3][16][4][1440][536];
    float stdev[3][16][4][1440][536];
} L3CMB_G2_PRECIPTOTRATE;

#endif

#ifndef _L3CMB_G2_OPTEST_OESURFEMISSIVITY_
#define _L3CMB_G2_OPTEST_OESURFEMISSIVITY_

typedef struct {
    int count[13][4][1440][536];
    float mean[13][4][1440][536];
} L3CMB_G2_OPTEST_OESURFEMISSIVITY;

#endif
```

```
#ifndef _L3CMB_G2_OPTEST_OECOLUMNCLOUDLIQWATER_
#define _L3CMB_G2_OPTEST_OECOLUMNCLOUDLIQWATER_

typedef struct {
    int count[4][1440][536];
    float mean[4][1440][536];
} L3CMB_G2_OPTEST_OECOLUMNCLOUDLIQWATER;

#endif

#ifndef _L3CMB_G2_OPTEST_OESKINTEMPERATURE_
#define _L3CMB_G2_OPTEST_OESKINTEMPERATURE_

typedef struct {
    int count[4][1440][536];
    float mean[4][1440][536];
} L3CMB_G2_OPTEST_OESKINTEMPERATURE;

#endif

#ifndef _L3CMB_G2_OPTEST_OETENMETERWINDSPEED_
#define _L3CMB_G2_OPTEST_OETENMETERWINDSPEED_

typedef struct {
    int count[4][1440][536];
    float mean[4][1440][536];
} L3CMB_G2_OPTEST_OETENMETERWINDSPEED;

#endif

#ifndef _L3CMB_G2_OPTEST_OECOLUMNWATERVAPOR_
#define _L3CMB_G2_OPTEST_OECOLUMNWATERVAPOR_

typedef struct {
    int count[4][1440][536];
    float mean[4][1440][536];
} L3CMB_G2_OPTEST_OECOLUMNWATERVAPOR;

#endif

#ifndef _L3CMB_G2_OPTEST_
#define _L3CMB_G2_OPTEST_
```

```
typedef struct {
    L3CMB_G2_OPTEST_OECOLUMNWATERVAPOR OEcolumnWaterVapor;
    L3CMB_G2_OPTEST_OETENMETERWINDSPEED OEtenMeterWindSpeed;
    L3CMB_G2_OPTEST_OESKINTEMPERATURE OEskinTemperature;
    L3CMB_G2_OPTEST_OECOLUMNCLOUDLIQWATER OEcolumnCloudLiqWater;
    L3CMB_G2_OPTEST_OESURFEMISSIVITY OEsurfEmissivity;
} L3CMB_G2_OPTEST;

#endif

#ifndef _L3CMB_G2_
#define _L3CMB_G2_

typedef struct {
    L3CMB_G2_OPTEST OptEst;
    L3CMB_G2_PRECIPTOTRATE precipTotRate;
    L3CMB_G2_PRECIPLIQRATE precipLiqRate;
    L3CMB_G2_PRECIPTOTWATERCONTENT precipTotWaterContent;
    L3CMB_G2_PRECIPLIQWATERCONTENT precipLiqWaterContent;
    L3CMB_G2_CLOUDLIQWATERCONTENT cloudLiqWaterContent;
    L3CMB_G2_PRECIPTOTDM precipTotDm;
    L3CMB_G2_PRECIPTOTLOGNW precipTotLogNw;
    int precipAllObs[16][4][1440][536];
    L3CMB_G2_NEARSURFPRECIPTOTRATEDIURNAL nearSurfPrecipTotRateDiurnal;
    int nearSurfPrecipTotRateDiurnalAllObs[24][4][1440][536];
    float nearSurfPrecipTotRateUn[4][1440][536];
    float nearSurfPrecipLiqRateUn[4][1440][536];
    float nearSurfPrecipTotRateProb[4][1440][536];
    float nearSurfPrecipLiqRateProb[4][1440][536];
    float estimSurfPrecipTotRateUn[4][1440][536];
    float estimSurfPrecipLiqRateUn[4][1440][536];
    float estimSurfPrecipTotRateProb[4][1440][536];
    float estimSurfPrecipLiqRateProb[4][1440][536];
} L3CMB_G2;

#endif

#ifndef _L3CMB_G1_NEARSURFPRECIPTOTRATEDIURNAL_
#define _L3CMB_G1_NEARSURFPRECIPTOTRATEDIURNAL_

typedef struct {
    int count[24][3][4][72][28];
    float mean[24][3][4][72][28];
```

```
    float stdev[24][3][4][72][28];
} L3CMB_G1_NEARSURFPRECIPTOTRATEDIURNAL;

#endif

#ifndef _L3CMB_G1_PRECIPTOTLOGNW_
#define _L3CMB_G1_PRECIPTOTLOGNW_

typedef struct {
    int count[3][3][16][4][72][28];
    float mean[3][3][16][4][72][28];
    float stdev[3][3][16][4][72][28];
    int hist[30][3][3][16][4][72][28];
} L3CMB_G1_PRECIPTOTLOGNW;

#endif

#ifndef _L3CMB_G1_PRECIPTOTDM_
#define _L3CMB_G1_PRECIPTOTDM_

typedef struct {
    int count[3][3][16][4][72][28];
    float mean[3][3][16][4][72][28];
    float stdev[3][3][16][4][72][28];
    int hist[30][3][3][16][4][72][28];
} L3CMB_G1_PRECIPTOTDM;

#endif

#ifndef _L3CMB_G1_CLOUDLIQWATERCONTENT_
#define _L3CMB_G1_CLOUDLIQWATERCONTENT_

typedef struct {
    int count[3][16][4][72][28];
    float mean[3][16][4][72][28];
    float stdev[3][16][4][72][28];
    int hist[30][3][16][4][72][28];
} L3CMB_G1_CLOUDLIQWATERCONTENT;

#endif

#ifndef _L3CMB_G1_PRECIPLIQWATERCONTENT_
#define _L3CMB_G1_PRECIPLIQWATERCONTENT_
```

```
typedef struct {
    int count[3][3][16][4][72][28];
    float mean[3][3][16][4][72][28];
    float stdev[3][3][16][4][72][28];
    int hist[30][3][3][16][4][72][28];
} L3CMB_G1_PRECIPLIQWATERCONTENT;

#endif

#ifndef _L3CMB_G1_PRECIPTOTWATERCONTENT_
#define _L3CMB_G1_PRECIPTOTWATERCONTENT_

typedef struct {
    int count[3][3][16][4][72][28];
    float mean[3][3][16][4][72][28];
    float stdev[3][3][16][4][72][28];
    int hist[30][3][3][16][4][72][28];
} L3CMB_G1_PRECIPTOTWATERCONTENT;

#endif

#ifndef _L3CMB_G1_PRECIPLIQRATE_
#define _L3CMB_G1_PRECIPLIQRATE_

typedef struct {
    int count[3][3][16][4][72][28];
    float mean[3][3][16][4][72][28];
    float stdev[3][3][16][4][72][28];
    int hist[30][3][3][16][4][72][28];
} L3CMB_G1_PRECIPLIQRATE;

#endif

#ifndef _L3CMB_G1_PRECIPTOTRATE_
#define _L3CMB_G1_PRECIPTOTRATE_

typedef struct {
    int count[3][3][16][4][72][28];
    float mean[3][3][16][4][72][28];
    float stdev[3][3][16][4][72][28];
    int hist[30][3][3][16][4][72][28];
} L3CMB_G1_PRECIPTOTRATE;
```

```
#endif

#ifndef _L3CMB_G1_OPTEST_OESURFEMISSIVITY_
#define _L3CMB_G1_OPTEST_OESURFEMISSIVITY_

typedef struct {
    int count[13][4][72][28];
    float mean[13][4][72][28];
} L3CMB_G1_OPTEST_OESURFEMISSIVITY;

#endif

#ifndef _L3CMB_G1_OPTEST_OECOLUMNCLOUDLIQWATER_
#define _L3CMB_G1_OPTEST_OECOLUMNCLOUDLIQWATER_

typedef struct {
    int count[4][72][28];
    float mean[4][72][28];
} L3CMB_G1_OPTEST_OECOLUMNCLOUDLIQWATER;

#endif

#ifndef _L3CMB_G1_OPTEST_OESKINTEMPERATURE_
#define _L3CMB_G1_OPTEST_OESKINTEMPERATURE_

typedef struct {
    int count[4][72][28];
    float mean[4][72][28];
} L3CMB_G1_OPTEST_OESKINTEMPERATURE;

#endif

#ifndef _L3CMB_G1_OPTEST_OETENMETERWINDSPEED_
#define _L3CMB_G1_OPTEST_OETENMETERWINDSPEED_

typedef struct {
    int count[4][72][28];
    float mean[4][72][28];
} L3CMB_G1_OPTEST_OETENMETERWINDSPEED;

#endif
```

```
#ifndef _L3CMB_G1_OPTEST_OECOLUMNWATERVAPOR_
#define _L3CMB_G1_OPTEST_OECOLUMNWATERVAPOR_

typedef struct {
    int count[4][72][28];
    float mean[4][72][28];
} L3CMB_G1_OPTEST_OECOLUMNWATERVAPOR;

#endif

#ifndef _L3CMB_G1_OPTEST_
#define _L3CMB_G1_OPTEST_

typedef struct {
    L3CMB_G1_OPTEST_OECOLUMNWATERVAPOR OEcolumnWaterVapor;
    L3CMB_G1_OPTEST_OETENMETERWINDSPEED OEtenMeterWindSpeed;
    L3CMB_G1_OPTEST_OESKINTEMPERATURE OEskinTemperature;
    L3CMB_G1_OPTEST_OECOLUMNCLOUDLIQWATER OEcolumnCloudLiqWater;
    L3CMB_G1_OPTEST_OESURFEMISSIVITY OEsurfEmissivity;
} L3CMB_G1_OPTEST;

#endif

#ifndef _L3CMB_G1_
#define _L3CMB_G1_

typedef struct {
    L3CMB_G1_OPTEST OptEst;
    L3CMB_G1_PRECIPTOTRATE precipTotRate;
    L3CMB_G1_PRECIPLIQRATE precipLiqRate;
    L3CMB_G1_PRECIPTOTWATERCONTENT precipTotWaterContent;
    L3CMB_G1_PRECIPLIQWATERCONTENT precipLiqWaterContent;
    L3CMB_G1_CLOUDLIQWATERCONTENT cloudLiqWaterContent;
    L3CMB_G1_PRECIPTOTDM precipTotDm;
    L3CMB_G1_PRECIPTOTLOGNW precipTotLogNw;
    int precipAllObs[3][16][4][72][28];
    L3CMB_G1_NEARSURFPRECIPTOTRATEDIURNAL nearSurfPrecipTotRateDiurnal;
    int nearSurfPrecipTotRateDiurnalAllObs[24][3][4][72][28];
    float nearSurfPrecipTotRateUn[4][72][28];
    float nearSurfPrecipLiqRateUn[4][72][28];
    float nearSurfPrecipTotRateProb[4][72][28];
    float nearSurfPrecipLiqRateProb[4][72][28];
    float estimSurfPrecipTotRateUn[4][72][28];
```

```
    float estimSurfPrecipLiqRateUn[4][72][28];
    float estimSurfPrecipTotRateProb[4][72][28];
    float estimSurfPrecipLiqRateProb[4][72][28];
} L3CMB_G1;

#endif

#ifndef _L3CMB_GRIDS_
#define _L3CMB_GRIDS_

typedef struct {
    L3CMB_G1 G1;
    L3CMB_G2 G2;
} L3CMB_GRIDS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3CMB_G2_NEARSURFPRECIPTOTRATEDIURNAL/
    INTEGER*4 count(536,1440,4,24)
    REAL*4 mean(536,1440,4,24)
    REAL*4 stdev(536,1440,4,24)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPTOTLOGNW/
    INTEGER*4 count(536,1440,4,16,3)
    REAL*4 mean(536,1440,4,16,3)
    REAL*4 stdev(536,1440,4,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPTOTDM/
    INTEGER*4 count(536,1440,4,16,3)
    REAL*4 mean(536,1440,4,16,3)
    REAL*4 stdev(536,1440,4,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_CLOUDLIQWATERCONTENT/
    INTEGER*4 count(536,1440,4,16)
    REAL*4 mean(536,1440,4,16)
    REAL*4 stdev(536,1440,4,16)
```

```
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPLIQWATERCONTENT/
    INTEGER*4 count(536,1440,4,16,3)
    REAL*4 mean(536,1440,4,16,3)
    REAL*4 stdev(536,1440,4,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPTOTWATERCONTENT/
    INTEGER*4 count(536,1440,4,16,3)
    REAL*4 mean(536,1440,4,16,3)
    REAL*4 stdev(536,1440,4,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPLIQRATE/
    INTEGER*4 count(536,1440,4,16,3)
    REAL*4 mean(536,1440,4,16,3)
    REAL*4 stdev(536,1440,4,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_PRECIPTOTRATE/
    INTEGER*4 count(536,1440,4,16,3)
    REAL*4 mean(536,1440,4,16,3)
    REAL*4 stdev(536,1440,4,16,3)
END STRUCTURE

STRUCTURE /L3CMB_G2_OPTEST_OESURFEMISSIVITY/
    INTEGER*4 count(536,1440,4,13)
    REAL*4 mean(536,1440,4,13)
END STRUCTURE

STRUCTURE /L3CMB_G2_OPTEST_OECOLUMNCLOUDLIQWATER/
    INTEGER*4 count(536,1440,4)
    REAL*4 mean(536,1440,4)
END STRUCTURE

STRUCTURE /L3CMB_G2_OPTEST_OESKINTEMPERATURE/
    INTEGER*4 count(536,1440,4)
    REAL*4 mean(536,1440,4)
END STRUCTURE

STRUCTURE /L3CMB_G2_OPTEST_OETENMETERWINDSPEED/
    INTEGER*4 count(536,1440,4)
```

```
    REAL*4 mean(536,1440,4)
END STRUCTURE

STRUCTURE /L3CMB_G2_OPTEST_OECOLUMNWATERVAPOR/
    INTEGER*4 count(536,1440,4)
    REAL*4 mean(536,1440,4)
END STRUCTURE

STRUCTURE /L3CMB_G2_OPTEST/
    RECORD /L3CMB_G2_OPTEST_OECOLUMNWATERVAPOR/ OEcolumnWaterVapor
    RECORD /L3CMB_G2_OPTEST_OETENMETERWINDSPEED/ OEtenMeterWindSpeed
    RECORD /L3CMB_G2_OPTEST_OESKINTEMPERATURE/ OEskinTemperature
    RECORD /L3CMB_G2_OPTEST_OECOLUMNCLOUDLIQWATER/ OEcolumnCloudLiqWater
    RECORD /L3CMB_G2_OPTEST_OESURFEMISSIVITY/ OEsurfEmissivity
END STRUCTURE

STRUCTURE /L3CMB_G2/
    RECORD /L3CMB_G2_OPTEST/ OptEst
    RECORD /L3CMB_G2_PRECIPTOTRATE/ precipTotRate
    RECORD /L3CMB_G2_PRECIPLIQRATE/ precipLiqRate
    RECORD /L3CMB_G2_PRECIPTOTWATERCONTENT/ precipTotWaterContent
    RECORD /L3CMB_G2_PRECIPLIQWATERCONTENT/ precipLiqWaterContent
    RECORD /L3CMB_G2_CLOUDLIQWATERCONTENT/ cloudLiqWaterContent
    RECORD /L3CMB_G2_PRECIPTOTDM/ precipTotDm
    RECORD /L3CMB_G2_PRECIPTOTLOGNW/ precipTotLogNw
    INTEGER*4 precipAllObs(536,1440,4,16)
    RECORD /L3CMB_G2_NEARSURFPRECIPTOTRATEDIURNAL/ nearSurfPrecipTotRateDiurnal
    INTEGER*4 nearSurfPrecipTotRateDiurnalAllObs(536,1440,4,24)
    REAL*4 nearSurfPrecipTotRateUn(536,1440,4)
    REAL*4 nearSurfPrecipLiqRateUn(536,1440,4)
    REAL*4 nearSurfPrecipTotRateProb(536,1440,4)
    REAL*4 nearSurfPrecipLiqRateProb(536,1440,4)
    REAL*4 estimSurfPrecipTotRateUn(536,1440,4)
    REAL*4 estimSurfPrecipLiqRateUn(536,1440,4)
    REAL*4 estimSurfPrecipTotRateProb(536,1440,4)
    REAL*4 estimSurfPrecipLiqRateProb(536,1440,4)
END STRUCTURE

STRUCTURE /L3CMB_G1_NEARSURFPRECIPTOTRATEDIURNAL/
    INTEGER*4 count(28,72,4,3,24)
    REAL*4 mean(28,72,4,3,24)
    REAL*4 stdev(28,72,4,3,24)
END STRUCTURE
```

```
STRUCTURE /L3CMB_G1_PRECIPTOTLOGNW/
    INTEGER*4 count(28,72,4,16,3,3)
    REAL*4 mean(28,72,4,16,3,3)
    REAL*4 stdev(28,72,4,16,3,3)
    INTEGER*4 hist(28,72,4,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPTOTDM/
    INTEGER*4 count(28,72,4,16,3,3)
    REAL*4 mean(28,72,4,16,3,3)
    REAL*4 stdev(28,72,4,16,3,3)
    INTEGER*4 hist(28,72,4,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_CLOUDLIQWATERCONTENT/
    INTEGER*4 count(28,72,4,16,3)
    REAL*4 mean(28,72,4,16,3)
    REAL*4 stdev(28,72,4,16,3)
    INTEGER*4 hist(28,72,4,16,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPLIQWATERCONTENT/
    INTEGER*4 count(28,72,4,16,3,3)
    REAL*4 mean(28,72,4,16,3,3)
    REAL*4 stdev(28,72,4,16,3,3)
    INTEGER*4 hist(28,72,4,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPTOTWATERCONTENT/
    INTEGER*4 count(28,72,4,16,3,3)
    REAL*4 mean(28,72,4,16,3,3)
    REAL*4 stdev(28,72,4,16,3,3)
    INTEGER*4 hist(28,72,4,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_PRECIPLIQRATE/
    INTEGER*4 count(28,72,4,16,3,3)
    REAL*4 mean(28,72,4,16,3,3)
    REAL*4 stdev(28,72,4,16,3,3)
    INTEGER*4 hist(28,72,4,16,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3CMB_G1_PRECIPTOTRATE/
    INTEGER*4 count(28,72,4,16,3,3)
    REAL*4 mean(28,72,4,16,3,3)
    REAL*4 stdev(28,72,4,16,3,3)
    INTEGER*4 hist(28,72,4,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMB_G1_OPTEST_OESURFEMISSIVITY/
    INTEGER*4 count(28,72,4,13)
    REAL*4 mean(28,72,4,13)
END STRUCTURE

STRUCTURE /L3CMB_G1_OPTEST_OECOLUMNCLOUDLIQWATER/
    INTEGER*4 count(28,72,4)
    REAL*4 mean(28,72,4)
END STRUCTURE

STRUCTURE /L3CMB_G1_OPTEST_OESKINTEMPERATURE/
    INTEGER*4 count(28,72,4)
    REAL*4 mean(28,72,4)
END STRUCTURE

STRUCTURE /L3CMB_G1_OPTEST_OETENMETERWINDSPEED/
    INTEGER*4 count(28,72,4)
    REAL*4 mean(28,72,4)
END STRUCTURE

STRUCTURE /L3CMB_G1_OPTEST_OECOLUMNWATERVAPOR/
    INTEGER*4 count(28,72,4)
    REAL*4 mean(28,72,4)
END STRUCTURE

STRUCTURE /L3CMB_G1_OPTEST/
    RECORD /L3CMB_G1_OPTEST_OECOLUMNWATERVAPOR/ OEcolumnWaterVapor
    RECORD /L3CMB_G1_OPTEST_OETENMETERWINDSPEED/ OEtenMeterWindSpeed
    RECORD /L3CMB_G1_OPTEST_OESKINTEMPERATURE/ OEskinTemperature
    RECORD /L3CMB_G1_OPTEST_OECOLUMNCLOUDLIQWATER/ OEcolumnCloudLiqWater
    RECORD /L3CMB_G1_OPTEST_OESURFEMISSIVITY/ OEsurfEmissivity
END STRUCTURE

STRUCTURE /L3CMB_G1/
    RECORD /L3CMB_G1_OPTEST/ OptEst
    RECORD /L3CMB_G1_PRECIPTOTRATE/ precipTotRate
```

```
    RECORD /L3CMB_G1_PRECIPLIQRATE/ precipLiqRate
    RECORD /L3CMB_G1_PRECIPTOTWATERCONTENT/ precipTotWaterContent
    RECORD /L3CMB_G1_PRECIPLIQWATERCONTENT/ precipLiqWaterContent
    RECORD /L3CMB_G1_CLOUDLIQWATERCONTENT/ cloudLiqWaterContent
    RECORD /L3CMB_G1_PRECIPTOTDM/ precipTotDm
    RECORD /L3CMB_G1_PRECIPTOTLOGNW/ precipTotLogNw
    INTEGER*4 precipAllObs(28,72,4,16,3)
    RECORD /L3CMB_G1_NEARSURFPRECIPTOTRATEDIURNAL/ nearSurfPrecipTotRateDiurnal
    INTEGER*4 nearSurfPrecipTotRateDiurnalAllObs(28,72,4,3,24)
    REAL*4 nearSurfPrecipTotRateUn(28,72,4)
    REAL*4 nearSurfPrecipLiqRateUn(28,72,4)
    REAL*4 nearSurfPrecipTotRateProb(28,72,4)
    REAL*4 nearSurfPrecipLiqRateProb(28,72,4)
    REAL*4 estimSurfPrecipTotRateUn(28,72,4)
    REAL*4 estimSurfPrecipLiqRateUn(28,72,4)
    REAL*4 estimSurfPrecipTotRateProb(28,72,4)
    REAL*4 estimSurfPrecipLiqRateProb(28,72,4)
END STRUCTURE

STRUCTURE /L3CMB_GRIDS/
    RECORD /L3CMB_G1/ G1
    RECORD /L3CMB_G2/ G2
END STRUCTURE
```

5.56 3CMBT - Combined precipitation

3CMBT, "Combined precipitation", computes statistics of the Combined measurements from TRMM at both a low horizontal resolution (G1, 5^o x 5^o latitude/longitude) and a high horizontal resolution (G2, 0.25^o x 0.25^o latitude/longitude). There will be both a monthly product and a daily product.

Dimension definitions:

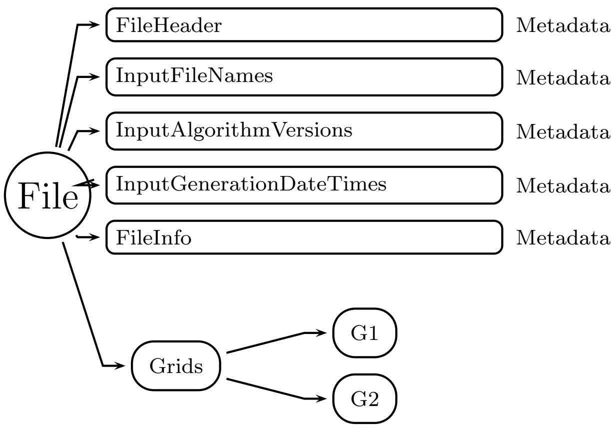


Figure 1123: Data Format Structure for 3CMBT, Combined precipitation

ltL	28	Number of low resolution 5^o grid intervals of latitude from 70^{o}S to 70^{o}N.
lnL	72	Number of low resolution 5^o grid intervals of longitude from 180^{o}W to 180^{o}E.
ltH	536	Number of high resolution 0.25^o grid intervals of latitude from 67^{o}S to 67^{o}N.
lnH	1440	Number of high resolution 0.25^o grid intervals of longitude from 180^{o}W to 180^{o}E.
ns	2	Number of swaths:, 0 = Ku+TMI (full swath), 1 = Ku+TMI (narrow swath).
hgt	16	Number of level heights 0-15: 0: near surface, 1-10: height = 1.0km * index, 11-15: height = 10.0km + 2.0km * (index-10),
tim	24	Number of hourly local time bins.
rt	3	Number of rain types: stratiform, convective, all.
st	3	Number of surface types: ocean, land, all.
bin	30	Number of bins in histogram.
emiss	9	Number of radiometer channel emissivities.

Figure 1123 through Figure 1153 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

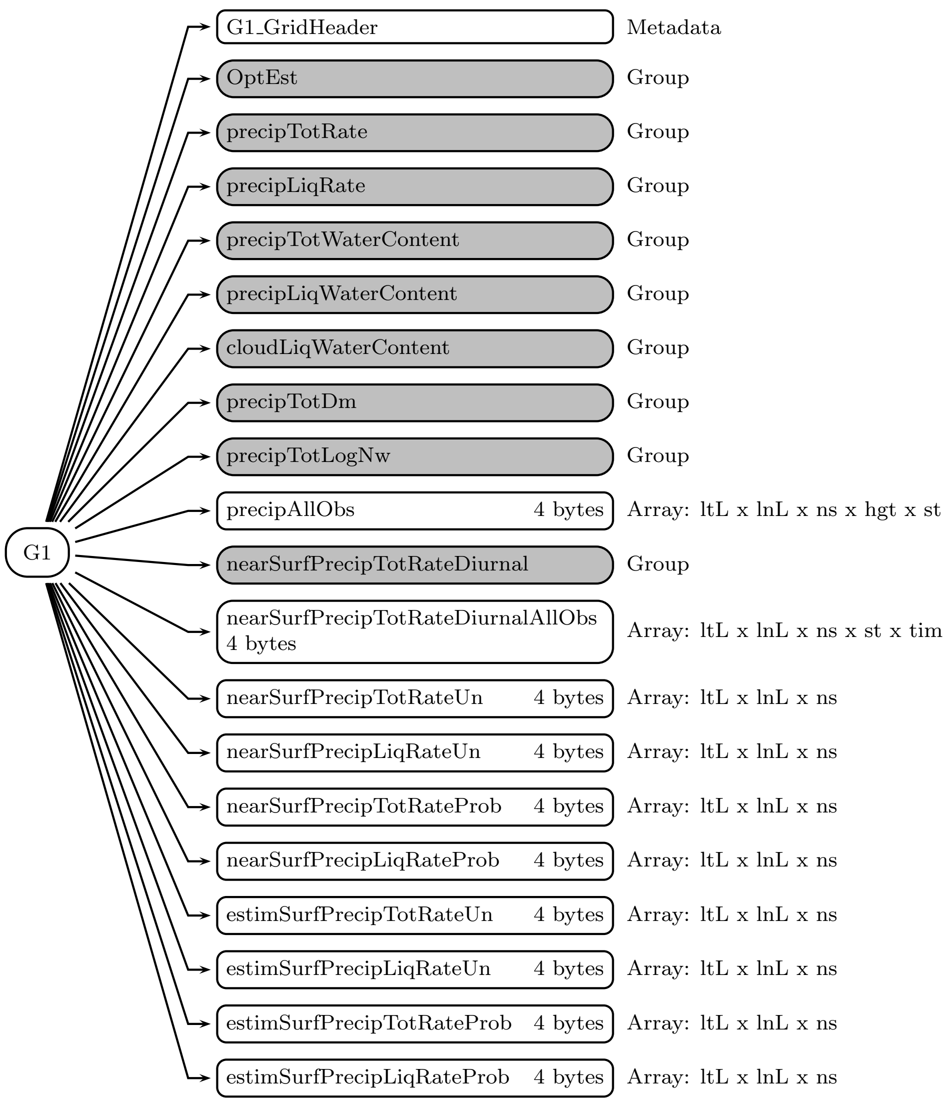


Figure 1124: Data Format Structure for 3CMBT, G1

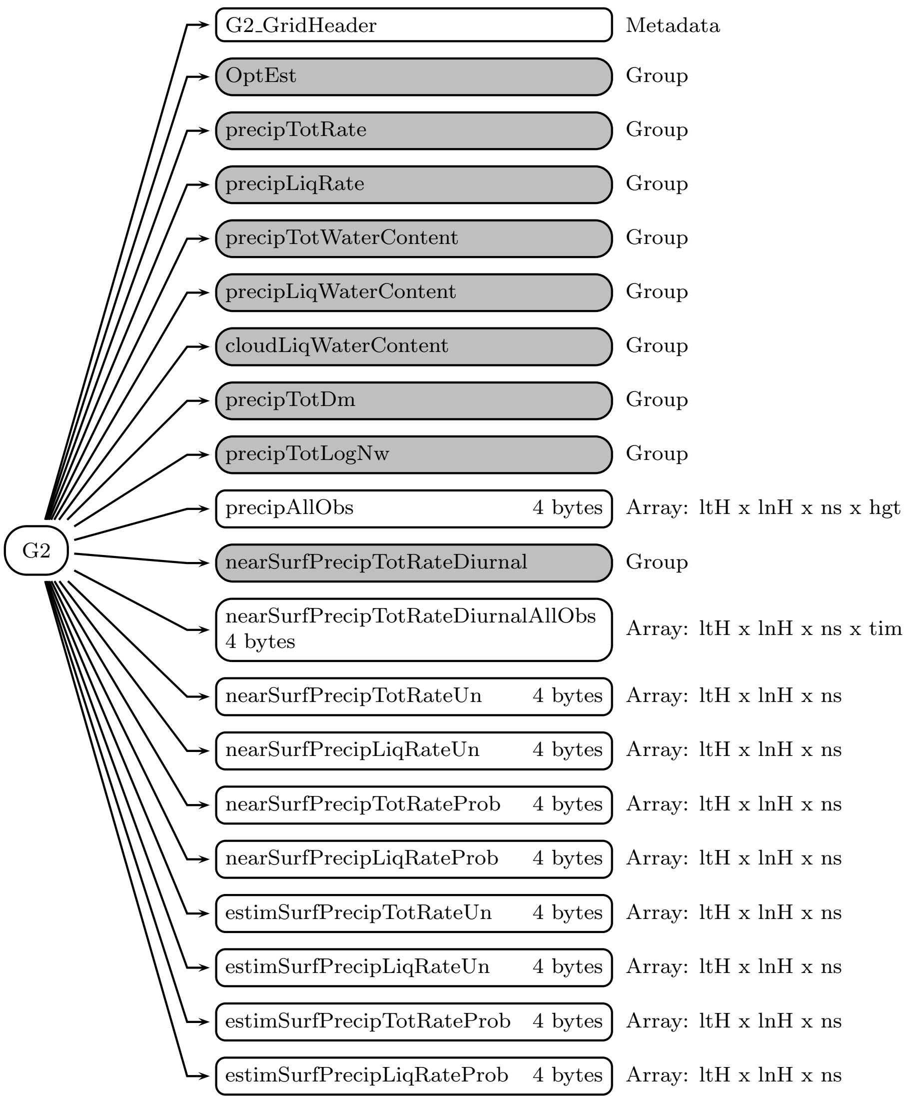


Figure 1125: Data Format Structure for 3CMBT, G2

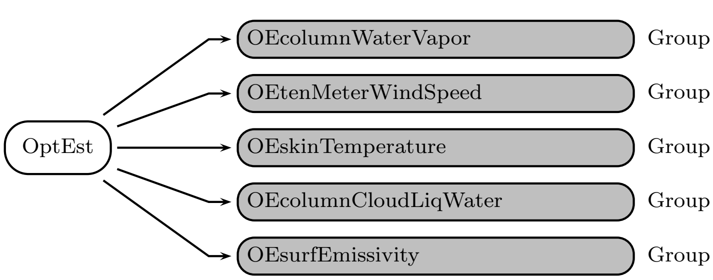


Figure 1126: Data Format Structure for 3CMBT, G1, OptEst

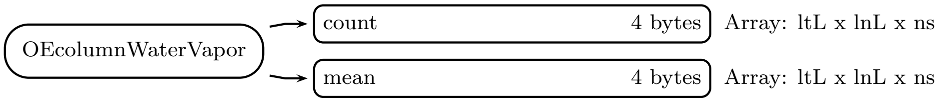


Figure 1127: Data Format Structure for 3CMBT, G1, OptEst, OEcolumnWaterVapor

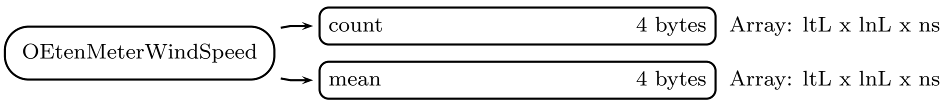


Figure 1128: Data Format Structure for 3CMBT, G1, OptEst, OEtenMeterWindSpeed

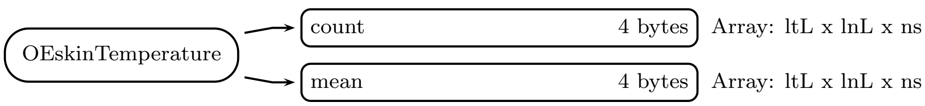


Figure 1129: Data Format Structure for 3CMBT, G1, OptEst, OEskinTemperature

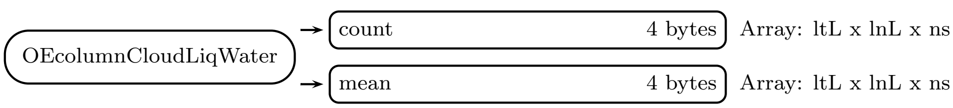


Figure 1130: Data Format Structure for 3CMBT, G1, OptEst, OEcolumnCloudLiqWater

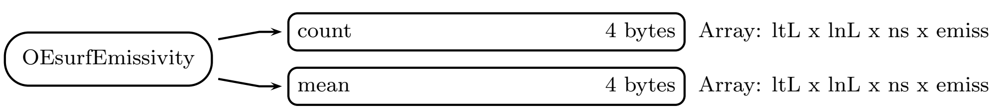


Figure 1131: Data Format Structure for 3CMBT, G1, OptEst, OEsurfEmissivity

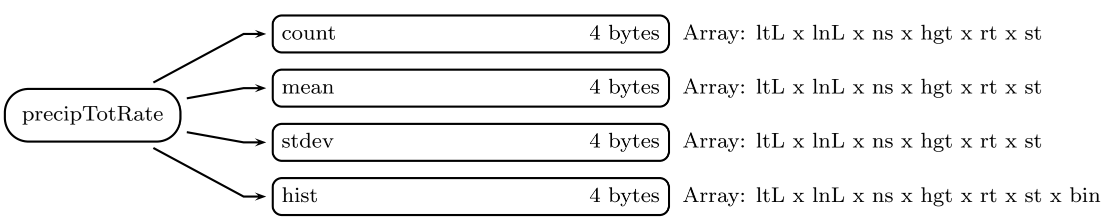


Figure 1132: Data Format Structure for 3CMBT, G1, precipTotRate

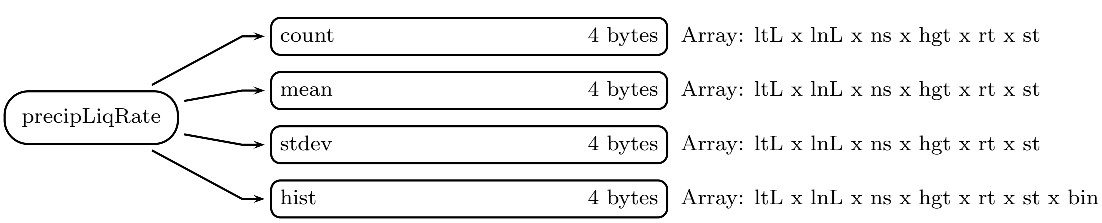


Figure 1133: Data Format Structure for 3CMBT, G1, precipLiqRate

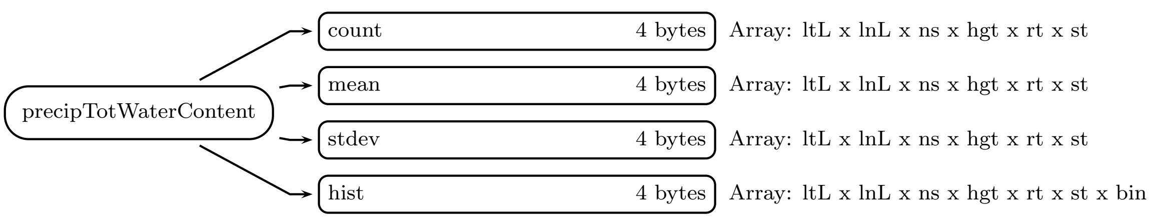


Figure 1134: Data Format Structure for 3CMBT, G1, precipTotWaterContent

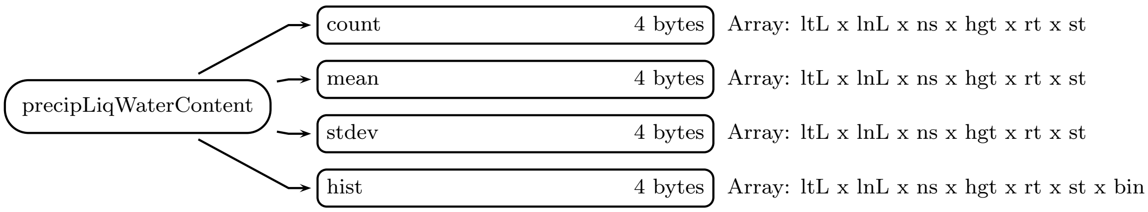


Figure 1135: Data Format Structure for 3CMBT, G1, precipLiqWaterContent

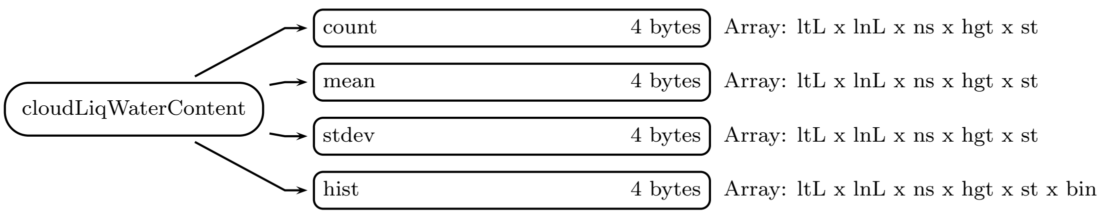


Figure 1136: Data Format Structure for 3CMBT, G1, cloudLiqWaterContent

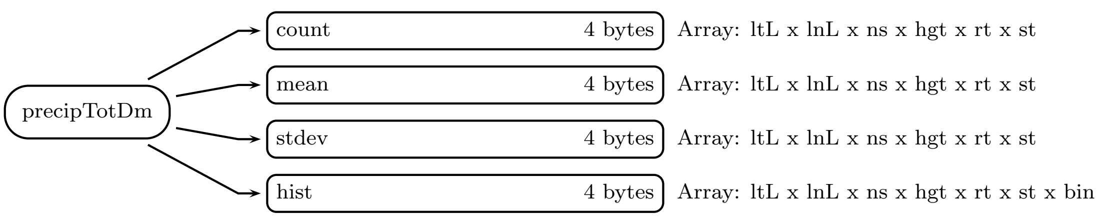


Figure 1137: Data Format Structure for 3CMBT, G1, precipTotDm

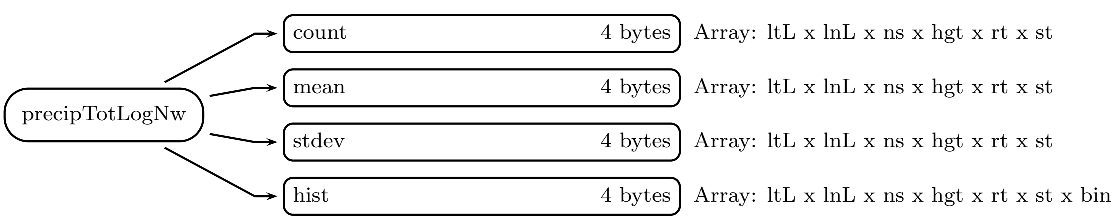


Figure 1138: Data Format Structure for 3CMBT, G1, precipTotLogNw

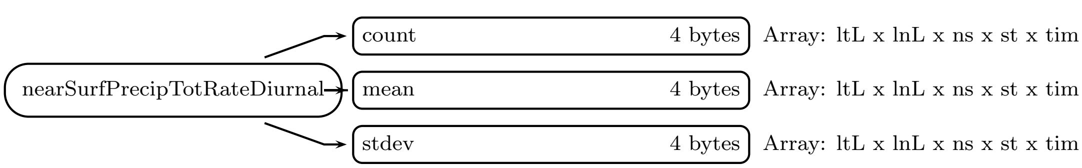


Figure 1139: Data Format Structure for 3CMBT, G1, nearSurfPrecipTotRateDiurnal

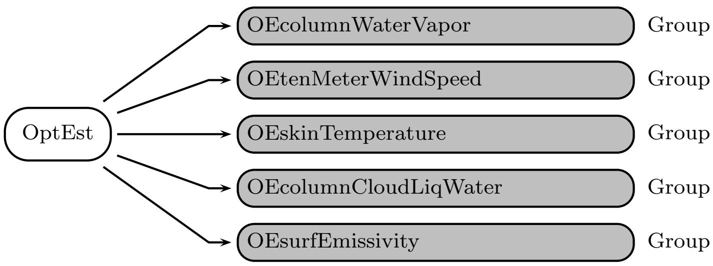


Figure 1140: Data Format Structure for 3CMBT, G2, OptEst

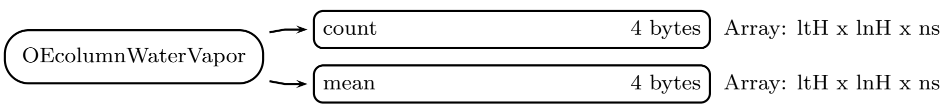


Figure 1141: Data Format Structure for 3CMBT, G2, OptEst, OEcolumnWaterVapor

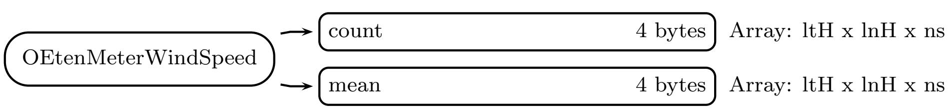


Figure 1142: Data Format Structure for 3CMBT, G2, OptEst, OEtenMeterWindSpeed

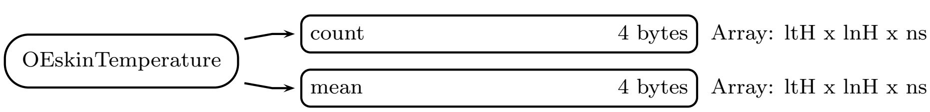


Figure 1143: Data Format Structure for 3CMBT, G2, OptEst, OEskinTemperature

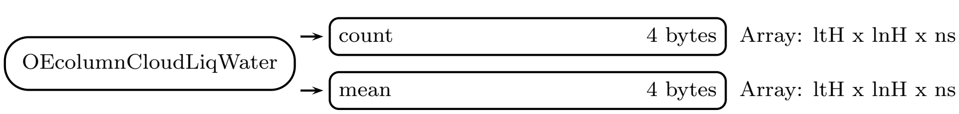


Figure 1144: Data Format Structure for 3CMBT, G2, OptEst, OEcolumnCloudLiqWater

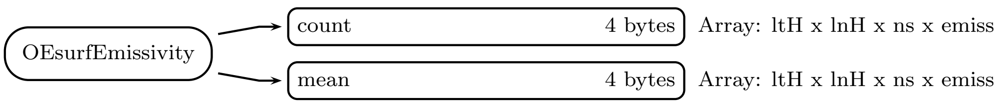


Figure 1145: Data Format Structure for 3CMBT, G2, OptEst, OEsurfEmissivity

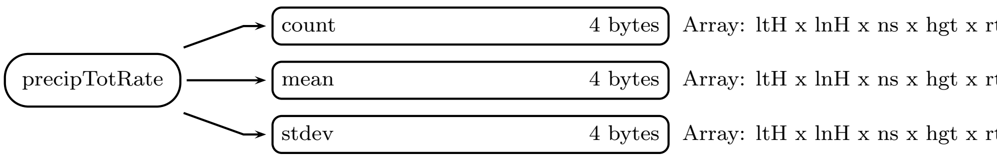


Figure 1146: Data Format Structure for 3CMBT, G2, precipTotRate

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grids (Group)

G1 (Grid)

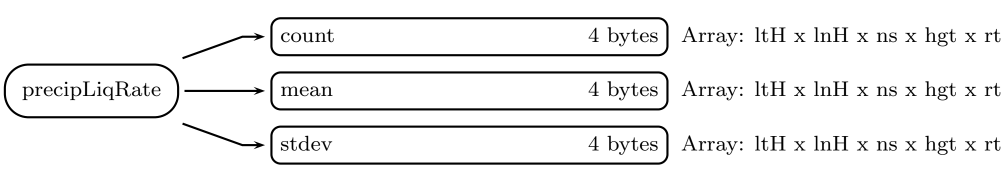


Figure 1147: Data Format Structure for 3CMBT, G2, precipLiqRate

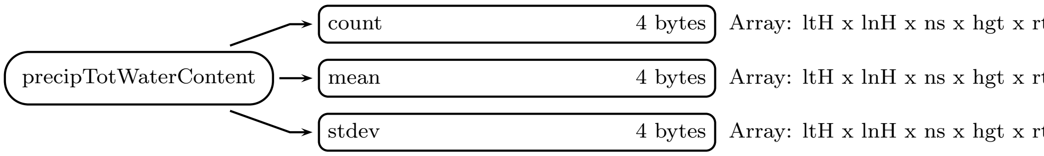


Figure 1148: Data Format Structure for 3CMBT, G2, precipTotWaterContent

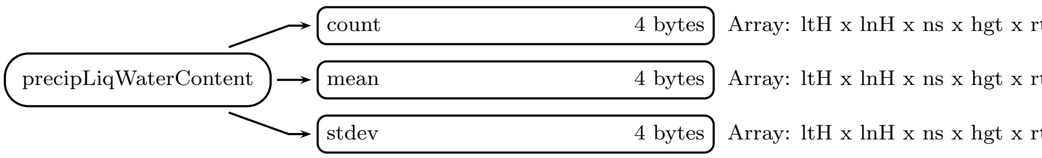


Figure 1149: Data Format Structure for 3CMBT, G2, precipLiqWaterContent

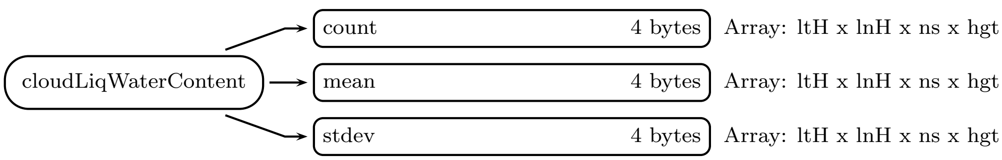


Figure 1150: Data Format Structure for 3CMBT, G2, cloudLiqWaterContent

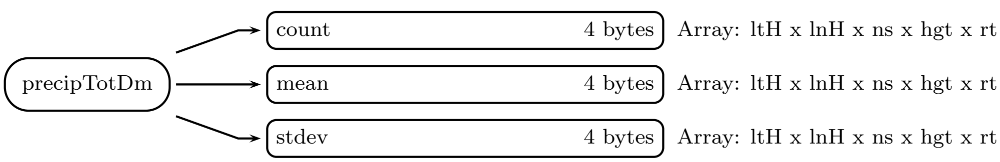


Figure 1151: Data Format Structure for 3CMBT, G2, precipTotDm

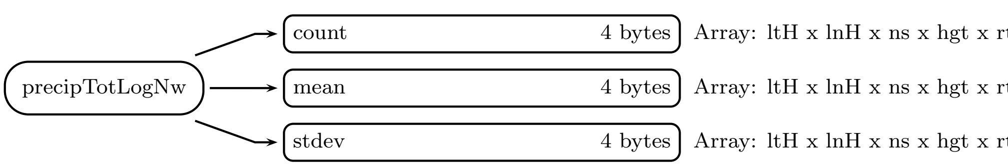


Figure 1152: Data Format Structure for 3CMBT, G2, precipTotLogNw

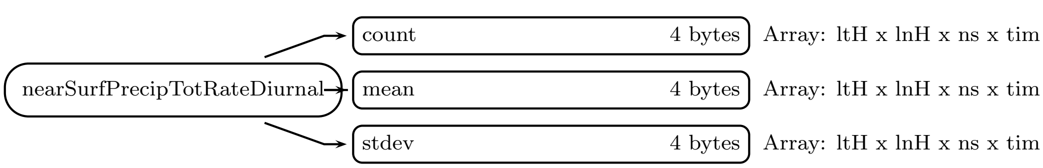


Figure 1153: Data Format Structure for 3CMBT, G2, nearSurfPrecipTotRateDiurnal

G1_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

OptEst (Group in G1)

OEcolumnWaterVapor (Group in G1, OptEst)
OE vertically-integrated water vapor (kg/m^2).

count (4-byte integer, array size: ltL x lnL x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSpeed (Group in G1, OptEst)
OE ten meter wind speed (m/s).

count (4-byte integer, array size: ltL x lnL x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEskinTemperature (Group in G1, OptEst)
OE surface skin temperature (K).

count (4-byte integer, array size: ltL x lnL x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudLiqWater (Group in G1, OptEst)

OE vertically-integrated cloud water content (kg/m^2).

count (4-byte integer, array size: ltL x lnL x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEsurfEmissivity (Group in G1, OptEst)

OE surface emmisivity.

count (4-byte integer, array size: ltL x lnL x ns x emiss):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x emiss):
Conditional mean. Special values are defined as:
-9999.9 Missing value

precipTotRate (Group in G1)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitation water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipLiqRate (Group in G1)

Equivalent precipitation rate of liquid-phase precipitating water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipTotWaterContent (Group in G1)

Equivalent water content of both liquid-phase and ice-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or melt water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipLiqWaterContent (Group in G1)

Equivalent water content of liquid-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

cloudLiqWaterContent (Group in G1)

Equivalent water content of liquid-phase cloud water (g/m^3).

count (4-byte integer, array size: ltL x lnL x ns x hgt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipTotDm (Group in G1)

Volume-weighted mean of the liquid-equivalent precipitation particle diameter (mm).

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipTotLogNw (Group in G1)

Common logarithm of the intercept of the normalized gamma distribution representing the liquid-equivalent precipitation particle size distribution (log10(m^-4)).

count (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x hgt x rt x st):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

hist (4-byte integer, array size: ltL x lnL x ns x hgt x rt x st x bin):
Histogram. Special values are defined as:
-9999 Missing value

precipAllObs (4-byte integer, array size: ltL x lnL x ns x hgt x st):
Number of total observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

nearSurfPrecipTotRateDiurnal (Group in G1)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitating water in the lowest uncontaminated range-bin (mm/hr), indexed by the local time. (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltL x lnL x ns x st x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltL x lnL x ns x st x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltL x lnL x ns x st x tim):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateDiurnalAllObs (4-byte integer, array size: ltL x lnL x ns x st x tim):
Number of total diurnal observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

nearSurfPrecipTotRateUn (4-byte float, array size: ltL x lnL x ns):
Near surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRateUn (4-byte float, array size: ltL x lnL x ns):
Near surface liquid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of total near surface precipitation. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of liquid near surface precipitation. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateUn (4-byte float, array size: ltL x lnL x ns):
Estimated surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRateUn (4-byte float, array size: ltL x lnL x ns):
Estimated surface liquid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of total estimated surface precipitation. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRateProb (4-byte float, array size: ltL x lnL x ns):
Probability of liquid estimated surface precipitation. Special values are defined as:
-9999.9 Missing value

G2 (Grid)

G2_GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

OptEst (Group in G2)

OEcolumnWaterVapor (Group in G2, OptEst)
OE vertically-integrated water vapor (kg/m^2).

count (4-byte integer, array size: ltH x lnH x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEtenMeterWindSpeed (Group in G2, OptEst)
OE ten meter wind speed (m/s).

count (4-byte integer, array size: ltH x lnH x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEskinTemperature (Group in G2, OptEst)
OE surface skin temperature (K).

count (4-byte integer, array size: ltH x lnH x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEcolumnCloudLiqWater (Group in G2, OptEst)

OE vertically-integrated cloud water content (kg/m^2).

count (4-byte integer, array size: ltH x lnH x ns):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns):
Conditional mean. Special values are defined as:
-9999.9 Missing value

OEsurfEmissivity (Group in G2, OptEst)

OE surface emmisivity.

count (4-byte integer, array size: ltH x lnH x ns x emiss):
Conditional count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x emiss):
Conditional mean. Special values are defined as:
-9999.9 Missing value

precipTotRate (Group in G2)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitation water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipLiqRate (Group in G2)
Equivalent precipitation rate of liquid-phase precipitating water (mm/hr). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipTotWaterContent (Group in G2)
Equivalent water content of both liquid-phase and ice-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or melt water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipLiqWaterContent (Group in G2)
Equivalent water content of liquid-phase precipitating water (g/m^3). (Note: liquid can be in the form of rain or liquid water in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

cloudLiqWaterContent (Group in G2)

Equivalent water content of liquid-phase cloud water (g/m^3).

count (4-byte integer, array size: ltH x lnH x ns x hgt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipTotDm (Group in G2)

Volume-weighted mean of the liquid-equivalent precipitation particle diameter (mm).

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipTotLogNw (Group in G2)

Common logarithm of the intercept of the normalized gamma distribution representing the liquid-equivalent precipitation particle size distribution (log10(m^-4)).

count (4-byte integer, array size: ltH x lnH x ns x hgt x rt):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x hgt x rt):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x hgt x rt):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

precipAllObs (4-byte integer, array size: ltH x lnH x ns x hgt):
Number of total observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

nearSurfPrecipTotRateDiurnal (Group in G2)

Equivalent precipitation rate of both liquid-phase and ice-phase precipitating water in the lowest uncontaminated range-bin (mm/hr), indexed by the local time. (Note: liquid can be in the form of rain or liquid water in mixed-phase particles; ice can be in the form of ice particles or ice in mixed-phase particles.)

count (4-byte integer, array size: ltH x lnH x ns x tim):
Count. Special values are defined as:
-9999 Missing value

mean (4-byte float, array size: ltH x lnH x ns x tim):
mean. Special values are defined as:
-9999.9 Missing value

stdev (4-byte float, array size: ltH x lnH x ns x tim):
Standard deviation for the monthly product. Mean of squares for the daily product. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateDiurnalAllObs (4-byte integer, array size: ltH x lnH x ns x tim):
Number of total diurnal observations, whether precipitating or not. Special values are defined as:
-9999 Missing value

nearSurfPrecipTotRateUn (4-byte float, array size: ltH x lnH x ns):
Surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRateUn (4-byte float, array size: ltH x lnH x ns):
Surface liguid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipTotRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of total surface precipitation. Special values are defined as:
-9999.9 Missing value

nearSurfPrecipLiqRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of liquid surface precipitation. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateUn (4-byte float, array size: ltH x lnH x ns):
Estimated surface total precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRateUn (4-byte float, array size: ltH x lnH x ns):
Estimated surface liguid precipitation rate unconditioned. To obtain rate conditioned on precipitation, divide by the probability. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipTotRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of total estimated surface precipitation. Special values are defined as:
-9999.9 Missing value

estimSurfPrecipLiqRateProb (4-byte float, array size: ltH x lnH x ns):
Probability of liquid estimated surface precipitation. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3CMBT_H_
#define _TK_3CMBT_H_

#ifndef _L3CMBT_G2_NEARSURFPRECIPTOTRATEDIURNAL_
#define _L3CMBT_G2_NEARSURFPRECIPTOTRATEDIURNAL_

typedef struct {
    int count[24][2][1440][536];
    float mean[24][2][1440][536];
    float stdev[24][2][1440][536];
} L3CMBT_G2_NEARSURFPRECIPTOTRATEDIURNAL;

#endif

#ifndef _L3CMBT_G2_PRECIPTOTLOGNW_
```

```
#define _L3CMBT_G2_PRECIPTOTLOGNW_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMBT_G2_PRECIPTOTLOGNW;

#endif

#ifndef _L3CMBT_G2_PRECIPTOTDM_
#define _L3CMBT_G2_PRECIPTOTDM_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMBT_G2_PRECIPTOTDM;

#endif

#ifndef _L3CMBT_G2_CLOUDLIQWATERCONTENT_
#define _L3CMBT_G2_CLOUDLIQWATERCONTENT_

typedef struct {
    int count[16][2][1440][536];
    float mean[16][2][1440][536];
    float stdev[16][2][1440][536];
} L3CMBT_G2_CLOUDLIQWATERCONTENT;

#endif

#ifndef _L3CMBT_G2_PRECIPLIQWATERCONTENT_
#define _L3CMBT_G2_PRECIPLIQWATERCONTENT_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMBT_G2_PRECIPLIQWATERCONTENT;

#endif
```

```
#ifndef _L3CMBT_G2_PRECIPTOTWATERCONTENT_
#define _L3CMBT_G2_PRECIPTOTWATERCONTENT_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMBT_G2_PRECIPTOTWATERCONTENT;

#endif

#ifndef _L3CMBT_G2_PRECIPLIQRATE_
#define _L3CMBT_G2_PRECIPLIQRATE_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMBT_G2_PRECIPLIQRATE;

#endif

#ifndef _L3CMBT_G2_PRECIPTOTRATE_
#define _L3CMBT_G2_PRECIPTOTRATE_

typedef struct {
    int count[3][16][2][1440][536];
    float mean[3][16][2][1440][536];
    float stdev[3][16][2][1440][536];
} L3CMBT_G2_PRECIPTOTRATE;

#endif

#ifndef _L3CMBT_G2_OPTEST_OESURFEMISSIVITY_
#define _L3CMBT_G2_OPTEST_OESURFEMISSIVITY_

typedef struct {
    int count[9][2][1440][536];
    float mean[9][2][1440][536];
} L3CMBT_G2_OPTEST_OESURFEMISSIVITY;

#endif
```

```
#ifndef _L3CMBT_G2_OPTEST_OECOLUMNCLOUDLIQWATER_
#define _L3CMBT_G2_OPTEST_OECOLUMNCLOUDLIQWATER_

typedef struct {
    int count[2][1440][536];
    float mean[2][1440][536];
} L3CMBT_G2_OPTEST_OECOLUMNCLOUDLIQWATER;

#endif

#ifndef _L3CMBT_G2_OPTEST_OESKINTEMPERATURE_
#define _L3CMBT_G2_OPTEST_OESKINTEMPERATURE_

typedef struct {
    int count[2][1440][536];
    float mean[2][1440][536];
} L3CMBT_G2_OPTEST_OESKINTEMPERATURE;

#endif

#ifndef _L3CMBT_G2_OPTEST_OETENMETERWINDSPEED_
#define _L3CMBT_G2_OPTEST_OETENMETERWINDSPEED_

typedef struct {
    int count[2][1440][536];
    float mean[2][1440][536];
} L3CMBT_G2_OPTEST_OETENMETERWINDSPEED;

#endif

#ifndef _L3CMBT_G2_OPTEST_OECOLUMNWATERVAPOR_
#define _L3CMBT_G2_OPTEST_OECOLUMNWATERVAPOR_

typedef struct {
    int count[2][1440][536];
    float mean[2][1440][536];
} L3CMBT_G2_OPTEST_OECOLUMNWATERVAPOR;

#endif

#ifndef _L3CMBT_G2_OPTEST_
#define _L3CMBT_G2_OPTEST_
```

```
typedef struct {
    L3CMBT_G2_OPTEST_OECOLUMNWATERVAPOR OEcolumnWaterVapor;
    L3CMBT_G2_OPTEST_OETENMETERWINDSPEED OEtenMeterWindSpeed;
    L3CMBT_G2_OPTEST_OESKINTEMPERATURE OEskinTemperature;
    L3CMBT_G2_OPTEST_OECOLUMNCLOUDLIQWATER OEcolumnCloudLiqWater;
    L3CMBT_G2_OPTEST_OESURFEMISSIVITY OEsurfEmissivity;
} L3CMBT_G2_OPTEST;

#endif

#ifndef _L3CMBT_G2_
#define _L3CMBT_G2_

typedef struct {
    L3CMBT_G2_OPTEST OptEst;
    L3CMBT_G2_PRECIPTOTRATE precipTotRate;
    L3CMBT_G2_PRECIPLIQRATE precipLiqRate;
    L3CMBT_G2_PRECIPTOTWATERCONTENT precipTotWaterContent;
    L3CMBT_G2_PRECIPLIQWATERCONTENT precipLiqWaterContent;
    L3CMBT_G2_CLOUDLIQWATERCONTENT cloudLiqWaterContent;
    L3CMBT_G2_PRECIPTOTDM precipTotDm;
    L3CMBT_G2_PRECIPTOTLOGNW precipTotLogNw;
    int precipAllObs[16][2][1440][536];
    L3CMBT_G2_NEARSURFPRECIPTOTRATEDIURNAL nearSurfPrecipTotRateDiurnal;
    int nearSurfPrecipTotRateDiurnalAllObs[24][2][1440][536];
    float nearSurfPrecipTotRateUn[2][1440][536];
    float nearSurfPrecipLiqRateUn[2][1440][536];
    float nearSurfPrecipTotRateProb[2][1440][536];
    float nearSurfPrecipLiqRateProb[2][1440][536];
    float estimSurfPrecipTotRateUn[2][1440][536];
    float estimSurfPrecipLiqRateUn[2][1440][536];
    float estimSurfPrecipTotRateProb[2][1440][536];
    float estimSurfPrecipLiqRateProb[2][1440][536];
} L3CMBT_G2;

#endif

#ifndef _L3CMBT_G1_NEARSURFPRECIPTOTRATEDIURNAL_
#define _L3CMBT_G1_NEARSURFPRECIPTOTRATEDIURNAL_

typedef struct {
    int count[24][3][2][72][28];
    float mean[24][3][2][72][28];
```

```
    float stdev[24][3][2][72][28];
} L3CMBT_G1_NEARSURFPRECIPTOTRATEDIURNAL;

#endif

#ifndef _L3CMBT_G1_PRECIPTOTLOGNW_
#define _L3CMBT_G1_PRECIPTOTLOGNW_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMBT_G1_PRECIPTOTLOGNW;

#endif

#ifndef _L3CMBT_G1_PRECIPTOTDM_
#define _L3CMBT_G1_PRECIPTOTDM_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMBT_G1_PRECIPTOTDM;

#endif

#ifndef _L3CMBT_G1_CLOUDLIQWATERCONTENT_
#define _L3CMBT_G1_CLOUDLIQWATERCONTENT_

typedef struct {
    int count[3][16][2][72][28];
    float mean[3][16][2][72][28];
    float stdev[3][16][2][72][28];
    int hist[30][3][16][2][72][28];
} L3CMBT_G1_CLOUDLIQWATERCONTENT;

#endif

#ifndef _L3CMBT_G1_PRECIPLIQWATERCONTENT_
#define _L3CMBT_G1_PRECIPLIQWATERCONTENT_
```

```
typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMBT_G1_PRECIPLIQWATERCONTENT;

#endif

#ifndef _L3CMBT_G1_PRECIPTOTWATERCONTENT_
#define _L3CMBT_G1_PRECIPTOTWATERCONTENT_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMBT_G1_PRECIPTOTWATERCONTENT;

#endif

#ifndef _L3CMBT_G1_PRECIPLIQRATE_
#define _L3CMBT_G1_PRECIPLIQRATE_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMBT_G1_PRECIPLIQRATE;

#endif

#ifndef _L3CMBT_G1_PRECIPTOTRATE_
#define _L3CMBT_G1_PRECIPTOTRATE_

typedef struct {
    int count[3][3][16][2][72][28];
    float mean[3][3][16][2][72][28];
    float stdev[3][3][16][2][72][28];
    int hist[30][3][3][16][2][72][28];
} L3CMBT_G1_PRECIPTOTRATE;
```

```
#endif

#ifndef _L3CMBT_G1_OPTEST_OESURFEMISSIVITY_
#define _L3CMBT_G1_OPTEST_OESURFEMISSIVITY_

typedef struct {
    int count[9][2][72][28];
    float mean[9][2][72][28];
} L3CMBT_G1_OPTEST_OESURFEMISSIVITY;

#endif

#ifndef _L3CMBT_G1_OPTEST_OECOLUMNCLOUDLIQWATER_
#define _L3CMBT_G1_OPTEST_OECOLUMNCLOUDLIQWATER_

typedef struct {
    int count[2][72][28];
    float mean[2][72][28];
} L3CMBT_G1_OPTEST_OECOLUMNCLOUDLIQWATER;

#endif

#ifndef _L3CMBT_G1_OPTEST_OESKINTEMPERATURE_
#define _L3CMBT_G1_OPTEST_OESKINTEMPERATURE_

typedef struct {
    int count[2][72][28];
    float mean[2][72][28];
} L3CMBT_G1_OPTEST_OESKINTEMPERATURE;

#endif

#ifndef _L3CMBT_G1_OPTEST_OETENMETERWINDSPEED_
#define _L3CMBT_G1_OPTEST_OETENMETERWINDSPEED_

typedef struct {
    int count[2][72][28];
    float mean[2][72][28];
} L3CMBT_G1_OPTEST_OETENMETERWINDSPEED;

#endif
```

```
#ifndef _L3CMBT_G1_OPTEST_OECOLUMNWATERVAPOR_
#define _L3CMBT_G1_OPTEST_OECOLUMNWATERVAPOR_

typedef struct {
    int count[2][72][28];
    float mean[2][72][28];
} L3CMBT_G1_OPTEST_OECOLUMNWATERVAPOR;

#endif

#ifndef _L3CMBT_G1_OPTEST_
#define _L3CMBT_G1_OPTEST_

typedef struct {
    L3CMBT_G1_OPTEST_OECOLUMNWATERVAPOR OEcolumnWaterVapor;
    L3CMBT_G1_OPTEST_OETENMETERWINDSPEED OEtenMeterWindSpeed;
    L3CMBT_G1_OPTEST_OESKINTEMPERATURE OEskinTemperature;
    L3CMBT_G1_OPTEST_OECOLUMNCLOUDLIQWATER OEcolumnCloudLiqWater;
    L3CMBT_G1_OPTEST_OESURFEMISSIVITY OEsurfEmissivity;
} L3CMBT_G1_OPTEST;

#endif

#ifndef _L3CMBT_G1_
#define _L3CMBT_G1_

typedef struct {
    L3CMBT_G1_OPTEST OptEst;
    L3CMBT_G1_PRECIPTOTRATE precipTotRate;
    L3CMBT_G1_PRECIPLIQRATE precipLiqRate;
    L3CMBT_G1_PRECIPTOTWATERCONTENT precipTotWaterContent;
    L3CMBT_G1_PRECIPLIQWATERCONTENT precipLiqWaterContent;
    L3CMBT_G1_CLOUDLIQWATERCONTENT cloudLiqWaterContent;
    L3CMBT_G1_PRECIPTOTDM precipTotDm;
    L3CMBT_G1_PRECIPTOTLOGNW precipTotLogNw;
    int precipAllObs[3][16][2][72][28];
    L3CMBT_G1_NEARSURFPRECIPTOTRATEDIURNAL nearSurfPrecipTotRateDiurnal;
    int nearSurfPrecipTotRateDiurnalAllObs[24][3][2][72][28];
    float nearSurfPrecipTotRateUn[2][72][28];
    float nearSurfPrecipLiqRateUn[2][72][28];
    float nearSurfPrecipTotRateProb[2][72][28];
    float nearSurfPrecipLiqRateProb[2][72][28];
    float estimSurfPrecipTotRateUn[2][72][28];
```

```
    float estimSurfPrecipLiqRateUn[2][72][28];
    float estimSurfPrecipTotRateProb[2][72][28];
    float estimSurfPrecipLiqRateProb[2][72][28];
} L3CMBT_G1;

#endif

#ifndef _L3CMBT_GRIDS_
#define _L3CMBT_GRIDS_

typedef struct {
    L3CMBT_G1 G1;
    L3CMBT_G2 G2;
} L3CMBT_GRIDS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3CMBT_G2_NEARSURFPRECIPTOTRATEDIURNAL/
    INTEGER*4 count(536,1440,2,24)
    REAL*4 mean(536,1440,2,24)
    REAL*4 stdev(536,1440,2,24)
END STRUCTURE

STRUCTURE /L3CMBT_G2_PRECIPTOTLOGNW/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMBT_G2_PRECIPTOTDM/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMBT_G2_CLOUDLIQWATERCONTENT/
    INTEGER*4 count(536,1440,2,16)
    REAL*4 mean(536,1440,2,16)
    REAL*4 stdev(536,1440,2,16)
```

```
END STRUCTURE

STRUCTURE /L3CMBT_G2_PRECIPLIQWATERCONTENT/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMBT_G2_PRECIPTOTWATERCONTENT/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMBT_G2_PRECIPLIQRATE/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMBT_G2_PRECIPTOTRATE/
    INTEGER*4 count(536,1440,2,16,3)
    REAL*4 mean(536,1440,2,16,3)
    REAL*4 stdev(536,1440,2,16,3)
END STRUCTURE

STRUCTURE /L3CMBT_G2_OPTEST_OESURFEMISSIVITY/
    INTEGER*4 count(536,1440,2,9)
    REAL*4 mean(536,1440,2,9)
END STRUCTURE

STRUCTURE /L3CMBT_G2_OPTEST_OECOLUMNCLOUDLIQWATER/
    INTEGER*4 count(536,1440,2)
    REAL*4 mean(536,1440,2)
END STRUCTURE

STRUCTURE /L3CMBT_G2_OPTEST_OESKINTEMPERATURE/
    INTEGER*4 count(536,1440,2)
    REAL*4 mean(536,1440,2)
END STRUCTURE

STRUCTURE /L3CMBT_G2_OPTEST_OETENMETERWINDSPEED/
    INTEGER*4 count(536,1440,2)
```

```
    REAL*4 mean(536,1440,2)
END STRUCTURE

STRUCTURE /L3CMBT_G2_OPTEST_OECOLUMNWATERVAPOR/
    INTEGER*4 count(536,1440,2)
    REAL*4 mean(536,1440,2)
END STRUCTURE

STRUCTURE /L3CMBT_G2_OPTEST/
    RECORD /L3CMBT_G2_OPTEST_OECOLUMNWATERVAPOR/ OEcolumnWaterVapor
    RECORD /L3CMBT_G2_OPTEST_OETENMETERWINDSPEED/ OEtenMeterWindSpeed
    RECORD /L3CMBT_G2_OPTEST_OESKINTEMPERATURE/ OEskinTemperature
    RECORD /L3CMBT_G2_OPTEST_OECOLUMNCLOUDLIQWATER/ OEcolumnCloudLiqWater
    RECORD /L3CMBT_G2_OPTEST_OESURFEMISSIVITY/ OEsurfEmissivity
END STRUCTURE

STRUCTURE /L3CMBT_G2/
    RECORD /L3CMBT_G2_OPTEST/ OptEst
    RECORD /L3CMBT_G2_PRECIPTOTRATE/ precipTotRate
    RECORD /L3CMBT_G2_PRECIPLIQRATE/ precipLiqRate
    RECORD /L3CMBT_G2_PRECIPTOTWATERCONTENT/ precipTotWaterContent
    RECORD /L3CMBT_G2_PRECIPLIQWATERCONTENT/ precipLiqWaterContent
    RECORD /L3CMBT_G2_CLOUDLIQWATERCONTENT/ cloudLiqWaterContent
    RECORD /L3CMBT_G2_PRECIPTOTDM/ precipTotDm
    RECORD /L3CMBT_G2_PRECIPTOTLOGNW/ precipTotLogNw
    INTEGER*4 precipAllObs(536,1440,2,16)
    RECORD /L3CMBT_G2_NEARSURFPRECIPTOTRATEDIURNAL/ nearSurfPrecipTotRateDiurnal
    INTEGER*4 nearSurfPrecipTotRateDiurnalAllObs(536,1440,2,24)
    REAL*4 nearSurfPrecipTotRateUn(536,1440,2)
    REAL*4 nearSurfPrecipLiqRateUn(536,1440,2)
    REAL*4 nearSurfPrecipTotRateProb(536,1440,2)
    REAL*4 nearSurfPrecipLiqRateProb(536,1440,2)
    REAL*4 estimSurfPrecipTotRateUn(536,1440,2)
    REAL*4 estimSurfPrecipLiqRateUn(536,1440,2)
    REAL*4 estimSurfPrecipTotRateProb(536,1440,2)
    REAL*4 estimSurfPrecipLiqRateProb(536,1440,2)
END STRUCTURE

STRUCTURE /L3CMBT_G1_NEARSURFPRECIPTOTRATEDIURNAL/
    INTEGER*4 count(28,72,2,3,24)
    REAL*4 mean(28,72,2,3,24)
    REAL*4 stdev(28,72,2,3,24)
END STRUCTURE
```

```
STRUCTURE /L3CMBT_G1_PRECIPTOTLOGNW/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMBT_G1_PRECIPTOTDM/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMBT_G1_CLOUDLIQWATERCONTENT/
    INTEGER*4 count(28,72,2,16,3)
    REAL*4 mean(28,72,2,16,3)
    REAL*4 stdev(28,72,2,16,3)
    INTEGER*4 hist(28,72,2,16,3,30)
END STRUCTURE

STRUCTURE /L3CMBT_G1_PRECIPLIQWATERCONTENT/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMBT_G1_PRECIPTOTWATERCONTENT/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMBT_G1_PRECIPLIQRATE/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE
```

```
STRUCTURE /L3CMBT_G1_PRECIPTOTRATE/
    INTEGER*4 count(28,72,2,16,3,3)
    REAL*4 mean(28,72,2,16,3,3)
    REAL*4 stdev(28,72,2,16,3,3)
    INTEGER*4 hist(28,72,2,16,3,3,30)
END STRUCTURE

STRUCTURE /L3CMBT_G1_OPTEST_OESURFEMISSIVITY/
    INTEGER*4 count(28,72,2,9)
    REAL*4 mean(28,72,2,9)
END STRUCTURE

STRUCTURE /L3CMBT_G1_OPTEST_OECOLUMNCLOUDLIQWATER/
    INTEGER*4 count(28,72,2)
    REAL*4 mean(28,72,2)
END STRUCTURE

STRUCTURE /L3CMBT_G1_OPTEST_OESKINTEMPERATURE/
    INTEGER*4 count(28,72,2)
    REAL*4 mean(28,72,2)
END STRUCTURE

STRUCTURE /L3CMBT_G1_OPTEST_OETENMETERWINDSPEED/
    INTEGER*4 count(28,72,2)
    REAL*4 mean(28,72,2)
END STRUCTURE

STRUCTURE /L3CMBT_G1_OPTEST_OECOLUMNWATERVAPOR/
    INTEGER*4 count(28,72,2)
    REAL*4 mean(28,72,2)
END STRUCTURE

STRUCTURE /L3CMBT_G1_OPTEST/
    RECORD /L3CMBT_G1_OPTEST_OECOLUMNWATERVAPOR/ OEcolumnWaterVapor
    RECORD /L3CMBT_G1_OPTEST_OETENMETERWINDSPEED/ OEtenMeterWindSpeed
    RECORD /L3CMBT_G1_OPTEST_OESKINTEMPERATURE/ OEskinTemperature
    RECORD /L3CMBT_G1_OPTEST_OECOLUMNCLOUDLIQWATER/ OEcolumnCloudLiqWater
    RECORD /L3CMBT_G1_OPTEST_OESURFEMISSIVITY/ OEsurfEmissivity
END STRUCTURE

STRUCTURE /L3CMBT_G1/
    RECORD /L3CMBT_G1_OPTEST/ OptEst
    RECORD /L3CMBT_G1_PRECIPTOTRATE/ precipTotRate
```

```
    RECORD /L3CMBT_G1_PRECIPLIQRATE/ precipLiqRate
    RECORD /L3CMBT_G1_PRECIPTOTWATERCONTENT/ precipTotWaterContent
    RECORD /L3CMBT_G1_PRECIPLIQWATERCONTENT/ precipLiqWaterContent
    RECORD /L3CMBT_G1_CLOUDLIQWATERCONTENT/ cloudLiqWaterContent
    RECORD /L3CMBT_G1_PRECIPTOTDM/ precipTotDm
    RECORD /L3CMBT_G1_PRECIPTOTLOGNW/ precipTotLogNw
    INTEGER*4 precipAllObs(28,72,2,16,3)
    RECORD /L3CMBT_G1_NEARSURFPRECIPTOTRATEDIURNAL/ nearSurfPrecipTotRateDiurnal
    INTEGER*4 nearSurfPrecipTotRateDiurnalAllObs(28,72,2,3,24)
    REAL*4 nearSurfPrecipTotRateUn(28,72,2)
    REAL*4 nearSurfPrecipLiqRateUn(28,72,2)
    REAL*4 nearSurfPrecipTotRateProb(28,72,2)
    REAL*4 nearSurfPrecipLiqRateProb(28,72,2)
    REAL*4 estimSurfPrecipTotRateUn(28,72,2)
    REAL*4 estimSurfPrecipLiqRateUn(28,72,2)
    REAL*4 estimSurfPrecipTotRateProb(28,72,2)
    REAL*4 estimSurfPrecipLiqRateProb(28,72,2)
END STRUCTURE

STRUCTURE /L3CMBT_GRIDS/
    RECORD /L3CMBT_G1/ G1
    RECORD /L3CMBT_G2/ G2
END STRUCTURE
```

5.57 3GSMAPH5 - GSMaP Hourly

3GSMAPH, "GSMaP Hourly", provides precipitation estimates at 0.1 degrees by the Global Satellite Mapping of Precipitation (GSMaP). GSMaP provides high-precision, high-resolution global precipitation maps using satellite data. The PI is JAXA. The granule size is 1 hour. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	1800	Number of 0.1^o grid intervals of latitude from 90^o S to 90^o N.
nlon	3600	Number of 0.1^o grid intervals of longitude from 180^o W to 180^o E.
n8	8	Number 8.

Figure 1154 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

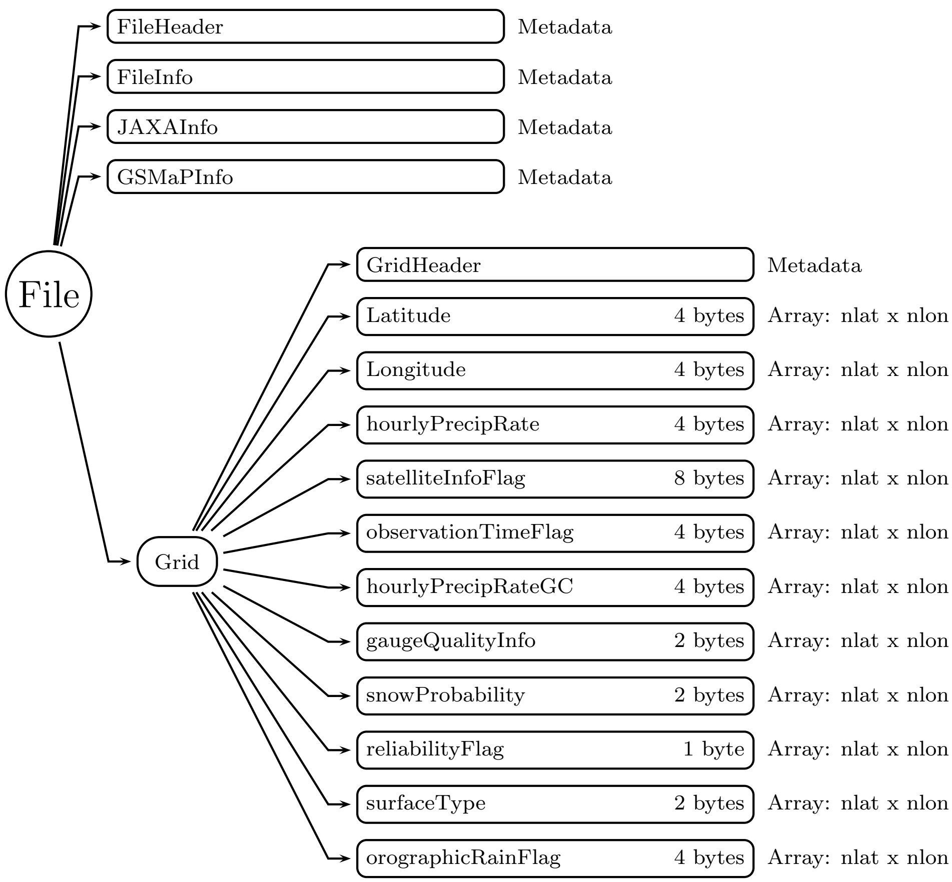


Figure 1154: Data Format Structure for 3GSMAPH5, GSMaP Hourly

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

GSMaPInfo (Metadata):
GSMaPinfo contains metadata required by GSMaP. Used by GSMaP products only. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

Latitude (4-byte float, array size: nlat x nlon):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nlat x nlon):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

hourlyPrecipRate (4-byte float, array size: nlat x nlon):
hourlyPrecipRate indicates hourly precipitation rate at each pixel. Unit is [mm/hr]. Negative value denotes missing in observation data or no precipitation rate was retrieved within microwave algorithms. Detailed description for missing data is shown below.

```
Value    Description
(0.0 or positive) Hourly precipitation rate [mm/hr].
-4       Missing due to sea ice within microwave algorithms.
-8       Missing due to low temperature within microwave algorithms.
-9999.9  Missing due to no observation by IR and/or microwave sensor.
```

satelliteInfoFlag (8-byte integer, array size: nlat x nlon):
satelliteInfoFlag indicates the information of all satellite/sensor which are used in estimation of precipitation rate at each pixel during one-hour time period. Data are stored in signed 8-byte integer (64-bit). Satellite and sensor name are assigned to each bit.

If the flag shows value of 0, there is no satellite observation by both microwave and geo-stationary IR sensor. Missing value is defined as -99. Negative values indicates no microwave radiometer observation at that pixel. Below is a list of pixel values, bit, and corresponding instrument.

Value	Bit	Sensor Category	Satellite/Sensor
1	0	Infrared Imager aboard Geo-stationary meteorological satellite	NOAA/CPC Globally Merged IR data
2	1	Microwave radiometer (imager/sounder) aboard low orbital satellite	TRMM/TMI
4	2		GPM-Core/GMI
8	3		Megha-Tropiques/MADRAS
16	4		Megha-Tropiques/SAPHIR
32	5		ADEOS-II/AMSR
64	6		Aqua/AMSR-E
128	7		GCOM-W1/AMSR2
256	8		GCOM-W2/AMSR2 f/o (TBD)
512	9		GCOM-W3/AMSR2 f/o (TBD)
1024	10		DMSP-F11/SSM/I
2048	11		DMSP-F13/SSM/I
4096	12		DMSP-F14/SSM/I
8192	13		DMSP-F15/SSM/I
16384	14		DMSP-F16/SSMIS
32768	15		DMSP-F17/SSMIS
65536	16		DMSP-F18/SSMIS
131072	17		DMSP-F19/SSMIS
262144	18		DMSP-F20/SSMIS
524288	19		NOAA-15/AMSU-A/B
1048576	20		NOAA-16/AMSU-A/B
2097152	21		NOAA-17/AMSU-A/B
4194304	22		NOAA-18/AMSU-A/MHS
8388608	23		NOAA-19/AMSU-A/MHS
16777216	24		NPP/ATMS
33554432	25		JPSS-1/ATMS
67108864	26		MetOp-A/AMSU-A/MHS
134217728	27		MetOp-B/AMSU-A/MHS
268435456	28		MetOp-C/AMSU-A/MHS
	29-63	Spare	Spare

observationTimeFlag (4-byte float, array size: nlat x nlon):

observationTimeFlag indicates relative time of nearest microwave radiometer (imager/sounder) observation to start time of the file at each pixel. Data are stored in 4-byte float. Value of 0 means start time of the file (HH in file name). Missing value is defined as -9999.9. Detailed description is below.

```
Value          Description

0 LE X LT 1    If value is positive and smaller
               than 1,  microwave radiometer
               observation  is available at the
               pixel during  current one-hour
               period. X indicates  relative
               observation time of latest
               microwave radiometer,  and is
               stored as difference from the
               start time of the file.  For
               example, if UTC of the file (HH)
               = 01 and X = 0.2,  observation
               time of the pixel will be 01:12
               UTC.

1 LE X         If value is equal to or larger
               than 1,  NO microwave radiometer
               observation  is available at the
               pixel during  time period of the
               file. X indicates  relative
               observation time of coming
               microwave radiometer,  and stored
               as differences from the start
               time of the file.  For example,
               if UTC of the file (HH) = 01 and
               X= 2.5, coming observation time
               of microwave radiometer at the
               pixel will be 3:30 UTC.

X LT 0         If value is negative, NO
               microwave radiometer observation
               is available at the pixel during
               time period of the file. X (X LT
               0) indicates relative observation
               time of latest microwave
               radiometer, and stored as
               differences from the start time
```

```
of the file.  For example, if UTC
of the file (HH) = 01
and X = -2.5, latest
observation time of microwave
radiometer at the pixel will be
22:30 UTC of previous day. X =
-9999.9 No microwave observation
(Missing)
```

hourlyPrecipRateGC (4-byte float, array size: nlat x nlon):
hourlyPrecipRateGC indicates hourly precipitation rate that was corrected by rain gauge data (NOAA CPC Unified Gauge-Based Analysis of Global Daily Precipitation, in daily and 0.5-degree grid) at each pixel. Data are stored in 4-byte float. Unit is [mm/hr]. Missing value is defined as -9999.9.

gaugeQualityInfo (2-byte integer, array size: nlat x nlon):
gaugeQualityInfo indicates the number of gauge data in original 0.5-degree pixel and daily, which was used in calculation of hourlyPrecipRateGC. Data are stored in 4-byte integer. Unit is [counts/day]. Missing value is defined as -9999.

snowProbability (2-byte integer, array size: nlat x nlon):
Probability of snow in percent. Data are stored in 2-byte integer. Range is 0 to 100. Missing value is defined as -9999.

reliabilityFlag (1-byte integer, array size: nlat x nlon):
TBD

surfaceType (2-byte integer, array size: nlat x nlon):
TBD

orographicRainFlag (4-byte integer, array size: nlat x nlon):
TBD

C Structure Header file:

```
#ifndef _TK_3GSMAPH5_H_
#define _TK_3GSMAPH5_H_

#ifndef _L3GSMAPH5_GRID_
#define _L3GSMAPH5_GRID_

typedef struct {
    float Latitude[3600][1800];
    float Longitude[3600][1800];
    float hourlyPrecipRate[3600][1800];
    long long satelliteInfoFlag[3600][1800];
```

```
    float observationTimeFlag[3600][1800];
    float hourlyPrecipRateGC[3600][1800];
    short gaugeQualityInfo[3600][1800];
    short snowProbability[3600][1800];
    signed char reliabilityFlag[3600][1800];
    short surfaceType[3600][1800];
    int orographicRainFlag[3600][1800];
} L3GSMAPH5_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GSMAPH5_GRID/
    REAL*4 Latitude(1800,3600)
    REAL*4 Longitude(1800,3600)
    REAL*4 hourlyPrecipRate(1800,3600)
    INTEGER*8 satelliteInfoFlag(1800,3600)
    REAL*4 observationTimeFlag(1800,3600)
    REAL*4 hourlyPrecipRateGC(1800,3600)
    INTEGER*2 gaugeQualityInfo(1800,3600)
    INTEGER*2 snowProbability(1800,3600)
    BYTE reliabilityFlag(1800,3600)
    INTEGER*2 surfaceType(1800,3600)
    INTEGER*4 orographicRainFlag(1800,3600)
END STRUCTURE
```

5.58 3GSMAPM5 - GSMaP Monthly

3GSMAPM, "GSMaP Monthly", provides precipitation estimates at 0.1 degrees by the Global Satellite Mapping of Precipitation (GSMaP). GSMaP provides high-precision, high-resolution global precipitation maps using satellite data. The PI is JAXA. The granule size is 1 month. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	1800	Number of 0.1^o grid intervals of latitude from 90^o S to 90^o N.
nlon	3600	Number of 0.1^o grid intervals of longitude from 180^o W to 180^o E.

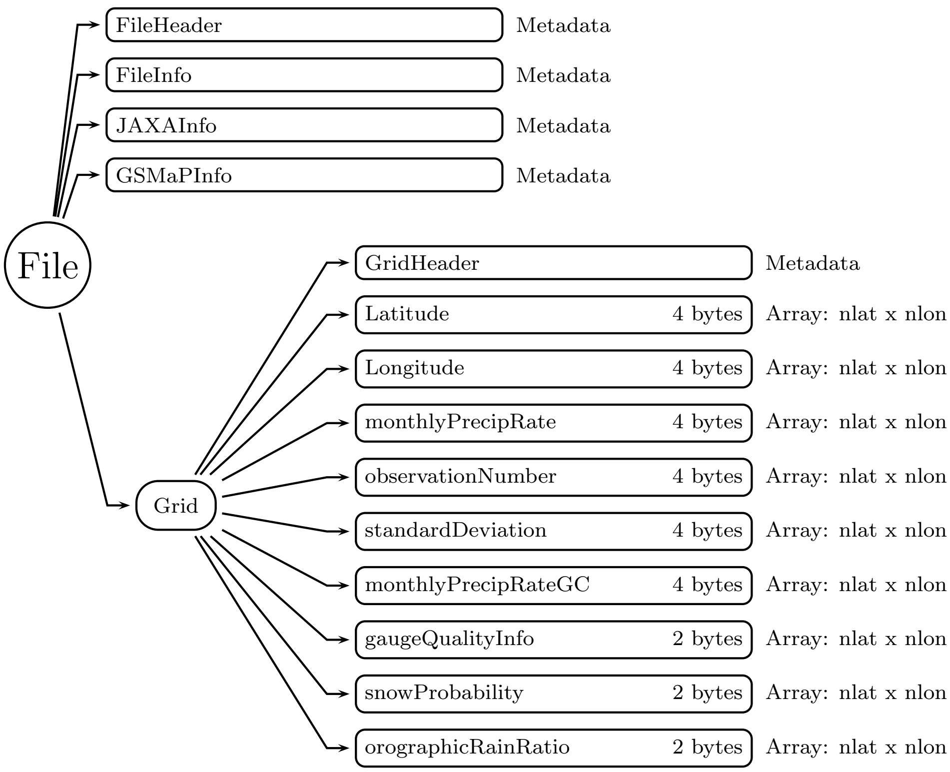


Figure 1155: Data Format Structure for 3GSMAPM5, GSMaP Monthly

Figure 1155 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

GSMaPInfo (Metadata):
GSMaPinfo contains metadata required by GSMaP. Used by GSMaP products only. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

Latitude (4-byte float, array size: nlat x nlon):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nlat x nlon):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

monthlyPrecipRate (4-byte float, array size: nlat x nlon):
monthlyPrecipRate indicates monthly precipitation rate at each pixel. Unit is [mm/hr]. Negative value denotes missing in observation data or no precipitation rate was retrieved within microwave algorithms. Detailed description for missing data is shown below.

```
Value    Description
(0.0 or positive) Monthly precipitation rate [mm/hr].
-4       Missing due to sea ice within microwave algorithms.
-8       Missing due to low temperature within microwave algorithms.
-9999.9  Missing due to no observation by IR and/or microwave sensor.
```

observationNumber (4-byte integer, array size: nlat x nlon):
observationNumber indicates the number of observation that was used in the estimation of monthly mean precipitation rate at each pixel during one month. Data are stored in 4-byte integer. Unit is [counts/month]. Missing value is defined as -9999.

standardDeviation (4-byte float, array size: nlat x nlon):
standardDeviation indicates monthly standard deviation of precipitation rate at each pixel. Data are stored in 4-byte float. Unit is [mm/hr]. Missing value is defined as -9999.9.

monthlyPrecipRateGC (4-byte float, array size: nlat x nlon):
monthlyPrecipRateGC indicates monthly mean precipitation rate of hourlyPrecipRateGC. Data are stored in 4-byte float. Unit is [mm/hr]. Missing value is defined as -9999.9.

gaugeQualityInfo (2-byte integer, array size: nlat x nlon):
gaugeQualityInfo indicates the number of gauge data in original 0.5-degree pixel, which was used in calculation of monthlyPrecipRateGC. Data are stored in 4-byte integer. Unit is [counts/month]. Missing value is defined as -9999. Special values are defined as:
-9999 Missing value

snowProbability (2-byte integer, array size: nlat x nlon):
Probability of snow in percent. Data are stored in 2-byte integer. Range is 0 to 100. Missing value is defined as -9999.

orographicRainRatio (2-byte integer, array size: nlat x nlon):
TBD

C Structure Header file:

```
#ifndef _TK_3GSMAPM5_H_
#define _TK_3GSMAPM5_H_

#ifndef _L3GSMAPM5_GRID_
#define _L3GSMAPM5_GRID_

typedef struct {
    float Latitude[3600][1800];
    float Longitude[3600][1800];
    float monthlyPrecipRate[3600][1800];
    int observationNumber[3600][1800];
    float standardDeviation[3600][1800];
    float monthlyPrecipRateGC[3600][1800];
    short gaugeQualityInfo[3600][1800];
    short snowProbability[3600][1800];
    short orographicRainRatio[3600][1800];
} L3GSMAPM5_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GSMAPM5_GRID/
    REAL*4 Latitude(1800,3600)
    REAL*4 Longitude(1800,3600)
    REAL*4 monthlyPrecipRate(1800,3600)
    INTEGER*4 observationNumber(1800,3600)
    REAL*4 standardDeviation(1800,3600)
    REAL*4 monthlyPrecipRateGC(1800,3600)
    INTEGER*2 gaugeQualityInfo(1800,3600)
    INTEGER*2 snowProbability(1800,3600)
    INTEGER*2 orographicRainRatio(1800,3600)
END STRUCTURE
```

5.59 3IMERGHH - IMERG 30-minute

3IMERGHH, "IMERG 30-minute", provides precipitation estimates at 0.1 degrees by the Integrated Multi-satellitE Retrievals for GPM (IMERG). IMERG is intended to intercalibrate, merge, and interpolate satellite microwave precipitation estimates, together with microwave-calibrated infrared (IR) satellite estimates, and precipitation gauge analyses. The PI is Dr. George Huffman. The granule size is 30 minutes. The following sections describe the structure and contents of the format.

Dimension definitions:

nv	2	Number of time bounds.
lonv	2	Number of longitude bounds.
latv	2	Number of latitude bounds.
time	var	Number of times in data set.
lon	3600	Number of 0.1^o grid intervals of longitude from 180^o W to 180^o E.
lat	1800	Number of 0.1^o grid intervals of latitude from 90^o S to 90^o N.

Figure 1156 through Figure 1157 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

time (4-byte integer, array size: time):
Representative time of data in seconds since 1980-01-06 00:00:00 UTC. The calculation of time does not add leap seconds. The difference due to leap seconds grows with time and in 2019 is less than 30 seconds.

lon (4-byte float, array size: lon):
Longitude at the center of 0.1^o grid intervals of longitude from 180^o W to 180^o E.

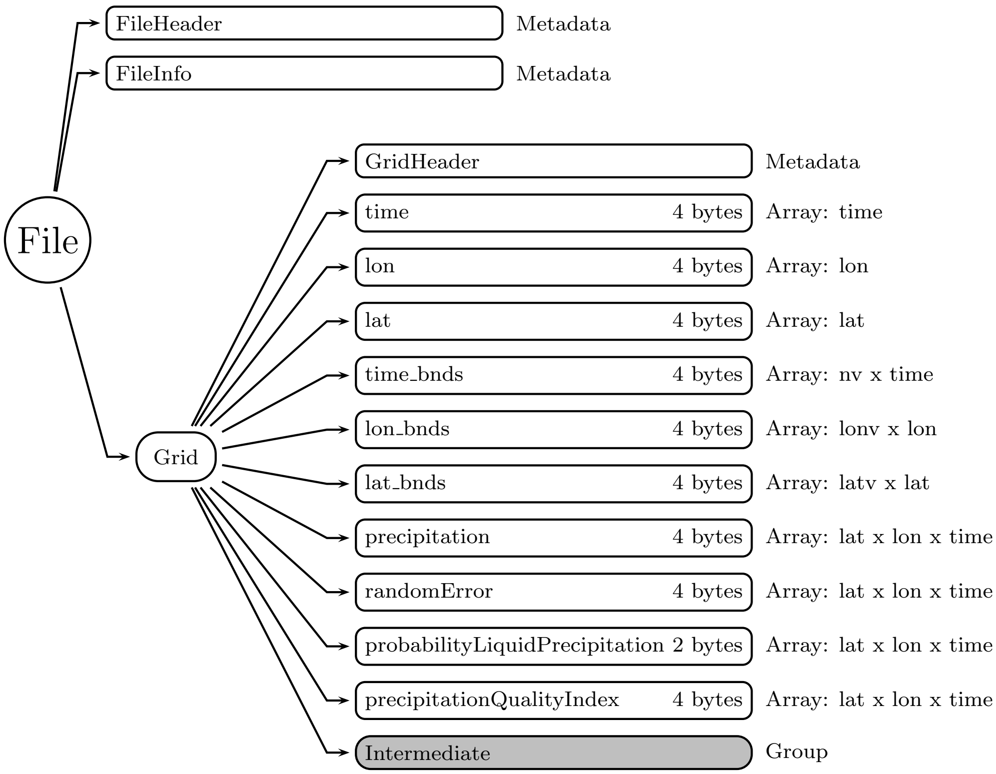


Figure 1156: Data Format Structure for 3IMERGHH, IMERG 30-minute

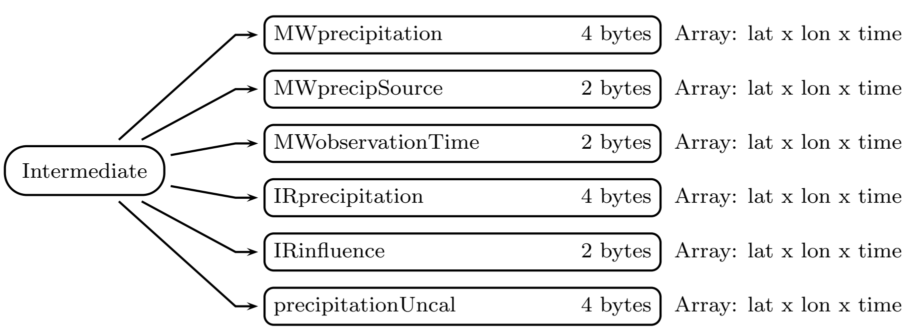


Figure 1157: Data Format Structure for 3IMERGHH, Intermediate

lat (4-byte float, array size: lat):
Latitude at the center of 0.1^o grid intervals of latitude from 90^o S to 90^o N.

time_bnds (4-byte integer, array size: nv x time):
Start and stop time of the data. The calculation of time does not add leap seconds. The difference due to leap seconds grows with time and in 2019 is less than 30 seconds. Values range from 0 to 2147000000 seconds since 1980-01-06 00:00:00 UTC. Special values are defined as:
-9999 Missing value

lon_bnds (4-byte float, array size: lonv x lon):
Longitude of the west and east edges of the grid boxes. Values range from -180 to 180 degrees_east. Special values are defined as:
-9999.9 Missing value

lat_bnds (4-byte float, array size: latv x lat):
Latitude of the south and north edges of the grid boxes. Values range from -90 to 90 degrees_north. Special values are defined as:
-9999.9 Missing value

precipitation (4-byte float, array size: lat x lon x time):
Precipitation estimate using gauge calibration over land. Values range from 0 to 200 mm/hr. Special values are defined as:
-9999.9 Missing value

randomError (4-byte float, array size: lat x lon x time):
Random error estimate of precipitation. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

probabilityLiquidPrecipitation (2-byte integer, array size: lat x lon x time):
Probability of liquid precipitation. 0=definitely frozen. 100=definitely liquid. 50=equal probability frozen or liquid. This field is globally complete and provided irrespective of the presence of precipitation. Values range from 0 to 100 percent.

precipitationQualityIndex (4-byte float, array size: lat x lon x time):
Estimated quality of precipitation where 0 is worse and 1 is better. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

Intermediate (Group)

MWprecipitation (4-byte float, array size: lat x lon x time):
Instananeous microwave-only precipitation estimate covering the current 30-minute period. Values range from 0 to 200 mm/hr. Special values are defined as:
-9999.9 Missing value

MWprecipSource (2-byte integer, array size: lat x lon x time):

```
MWprecipSource values are as follows:
      0 = no observation
      1 = TMI
      2 = TCI
      3 = AMSR-2
      4 = SSMI (F13,F14,F15)
      5 = SSMIS
      6 = AMSU
      7 = MHS
      8 = Megha-Tropiques
      9 = GMI
      10 = GCI
      11 = ATMS
      12 = AIRS
      13 = TOVS
      14 = CrlS
      15 = AMSR-E
      16 = SSMI (F11)
      17 = future microwave scanner
      18 = future microwave scanner
      19 = future microwave scanner
      20 = SAPHIR
      21 = future microwave sounder
      22 = future microwave sounder
      23 = future microwave sounder
      24 = future microwave sounder
```

Satellite ID of the instantaneous microwave-only precipitation estimate covering the current 30-minute period. Values range from 0 to 24.

MWobservationTime (2-byte integer, array size: lat x lon x time):
Observation time (from the beginnning of the current half hour) of the instantaneous microwave-only precipitation estimate covering the current 30-minute period. Values range from 0 to 29 minutes. Special values are defined as:
-9999 Missing value

IRprecipitation (4-byte float, array size: lat x lon x time):
Microwave-calibrated IR precipitation estimate covering the current 30-minute period. Values range from 0 to 200 mm/hr. Special values are defined as:
-9999.9 Missing value

IRinfluence (2-byte integer, array size: lat x lon x time):
IR weighting in the final precipitation estimate. The values range from 0 to 100, where

0 is no IR weighting and 100 is entirely based on IR. A value of 0 is provided as well in areas of no precipitation.

precipitationUncal (4-byte float, array size: lat x lon x time):
Precipitation estimate with no gauge calibration. Values range from 0 to 200 mm/hr. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3IMERGHH_H_
#define _TK_3IMERGHH_H_

#ifndef _L3IMERGHH_INTERMEDIATE_
#define _L3IMERGHH_INTERMEDIATE_

typedef struct {
    float MWprecipitation[1][3600][1800];
    short MWprecipSource[1][3600][1800];
    short MWobservationTime[1][3600][1800];
    float IRprecipitation[1][3600][1800];
    short IRinfluence[1][3600][1800];
    float precipitationUncal[1][3600][1800];
} L3IMERGHH_INTERMEDIATE;

#endif

#ifndef _L3IMERGHH_GRID_
#define _L3IMERGHH_GRID_

typedef struct {
    int time[1];
    float lon[3600];
    float lat[1800];
    int time_bnds[1][2];
    float lon_bnds[3600][2];
    float lat_bnds[1800][2];
    float precipitation[1][3600][1800];
    float randomError[1][3600][1800];
    short probabilityLiquidPrecipitation[1][3600][1800];
    float precipitationQualityIndex[1][3600][1800];
    L3IMERGHH_INTERMEDIATE Intermediate;
} L3IMERGHH_GRID;
```

```
#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3IMERGHH_INTERMEDIATE/
    REAL*4 MWprecipitation(1800,3600,1)
    INTEGER*2 MWprecipSource(1800,3600,1)
    INTEGER*2 MWobservationTime(1800,3600,1)
    REAL*4 IRprecipitation(1800,3600,1)
    INTEGER*2 IRinfluence(1800,3600,1)
    REAL*4 precipitationUncal(1800,3600,1)
END STRUCTURE

STRUCTURE /L3IMERGHH_GRID/
    INTEGER*4 time(1)
    REAL*4 lon(3600)
    REAL*4 lat(1800)
    INTEGER*4 time_bnds(2,1)
    REAL*4 lon_bnds(2,3600)
    REAL*4 lat_bnds(2,1800)
    REAL*4 precipitation(1800,3600,1)
    REAL*4 randomError(1800,3600,1)
    INTEGER*2 probabilityLiquidPrecipitation(1800,3600,1)
    REAL*4 precipitationQualityIndex(1800,3600,1)
    RECORD /L3IMERGHH_INTERMEDIATE/ Intermediate
END STRUCTURE
```

5.60 3IMERGM - IMERG monthly

3IMERGM, "IMERG monthly", provides precipitation estimates at 0.1 degrees by the Integrated Multi-satellitE Retrievals for GPM (IMERG). IMERG is intended to intercalibrate, merge, and interpolate satellite microwave precipitation estimates, together with microwave-calibrated infrared (IR) satellite estimates, and precipitation gauge analyses. The PI is Dr. George Huffman. The granule size is 1 month. The following sections describe the structure and contents of the format.

Dimension definitions:

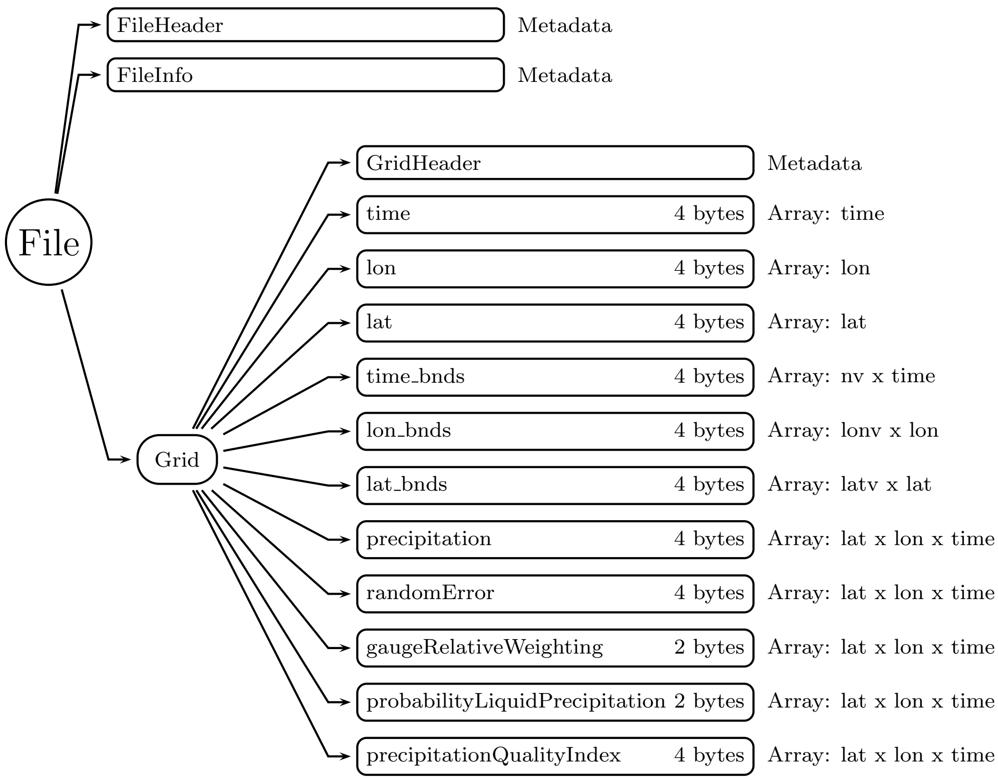


Figure 1158: Data Format Structure for 3IMERGM, IMERG monthly

nv	2	Number of time bounds.
lonv	2	Number of longitude bounds.
latv	2	Number of latitude bounds.
time	var	Number of times in data set.
lon	3600	Number of 0.1^o grid intervals of longitude from 180^o W to 180^o E.
lat	1800	Number of 0.1^o grid intervals of latitude from 90^o S to 90^o N.

Figure 1158 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

time (4-byte integer, array size: time):
Representative time of data in seconds since 1980-01-06 00:00:00 UTC. The calculation of time does not add leap seconds. The difference due to leap seconds grows with time and in 2019 is less than 30 seconds.

lon (4-byte float, array size: lon):
Longitude at the center of 0.1^o grid intervals of longitude from 180^o W to 180^o E.

lat (4-byte float, array size: lat):
Latitude at the center of 0.1^o grid intervals of latitude from 90^o S to 90^o N.

time_bnds (4-byte integer, array size: nv x time):
Start and stop time of the data. The calculation of time does not add leap seconds. The difference due to leap seconds grows with time and in 2019 is less than 30 seconds. Values range from 0 to 2147000000 seconds since 1980-01-06 00:00:00 UTC. Special values are defined as:
-9999 Missing value

lon_bnds (4-byte float, array size: lonv x lon):
Longitude of the west and east edges of the grid boxes. Values range from -180 to 180 degrees_east. Special values are defined as:
-9999.9 Missing value

lat_bnds (4-byte float, array size: latv x lat):
Latitude of the south and north edges of the grid boxes. Values range from -90 to 90 degrees_north. Special values are defined as:
-9999.9 Missing value

precipitation (4-byte float, array size: lat x lon x time):
Precipitation estimate using gauge calibration over land. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

randomError (4-byte float, array size: lat x lon x time):
Random error estimate of precipitation. Values range from 0 to 1000 mm/hr. Special values are defined as:
-9999.9 Missing value

gaugeRelativeWeighting (2-byte integer, array size: lat x lon x time):
Surface gauge weighting in the final precipitation estimate. The values range from 0 to 100, where 0 is no gauge weighting and 100 is entirely based on gauge. Values range from 0 to 100 percent. Special values are defined as:
-9999 Missing value

probabilityLiquidPrecipitation (2-byte integer, array size: lat x lon x time):
Probability of liquid precipitation. 0=definitely frozen. 100=definitely liquid. 50=equal

probability frozen or liquid. This field is globally complete and provided irrespective of the presence of precipitation. Values range from 0 to 100 percent.

precipitationQualityIndex (4-byte float, array size: lat x lon x time):
Estimated quality of precipitation where 0 is worse and 3000 is better. Values range from 0 to 3000. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3IMERGM_H_
#define _TK_3IMERGM_H_

#ifndef _L3IMERGM_GRID_
#define _L3IMERGM_GRID_

typedef struct {
    int time[1];
    float lon[3600];
    float lat[1800];
    int time_bnds[1][2];
    float lon_bnds[3600][2];
    float lat_bnds[1800][2];
    float precipitation[1][3600][1800];
    float randomError[1][3600][1800];
    short gaugeRelativeWeighting[1][3600][1800];
    short probabilityLiquidPrecipitation[1][3600][1800];
    float precipitationQualityIndex[1][3600][1800];
} L3IMERGM_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3IMERGM_GRID/
    INTEGER*4 time(1)
    REAL*4 lon(3600)
    REAL*4 lat(1800)
    INTEGER*4 time_bnds(2,1)
    REAL*4 lon_bnds(2,3600)
    REAL*4 lat_bnds(2,1800)
    REAL*4 precipitation(1800,3600,1)
```

```
    REAL*4 randomError(1800,3600,1)
    INTEGER*2 gaugeRelativeWeighting(1800,3600,1)
    INTEGER*2 probabilityLiquidPrecipitation(1800,3600,1)
    REAL*4 precipitationQualityIndex(1800,3600,1)
END STRUCTURE
```

5.61 2HSLH - Spectral Latent Heating

2HSLH, "Spectral Latent Heating," produces latent heating, Q1-QR, and Q2 profiles from DPR rain. The PI is Dr. Takayabu and the Co-PI is Dr. Shige. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

Figure 1159 through Figure 1161 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

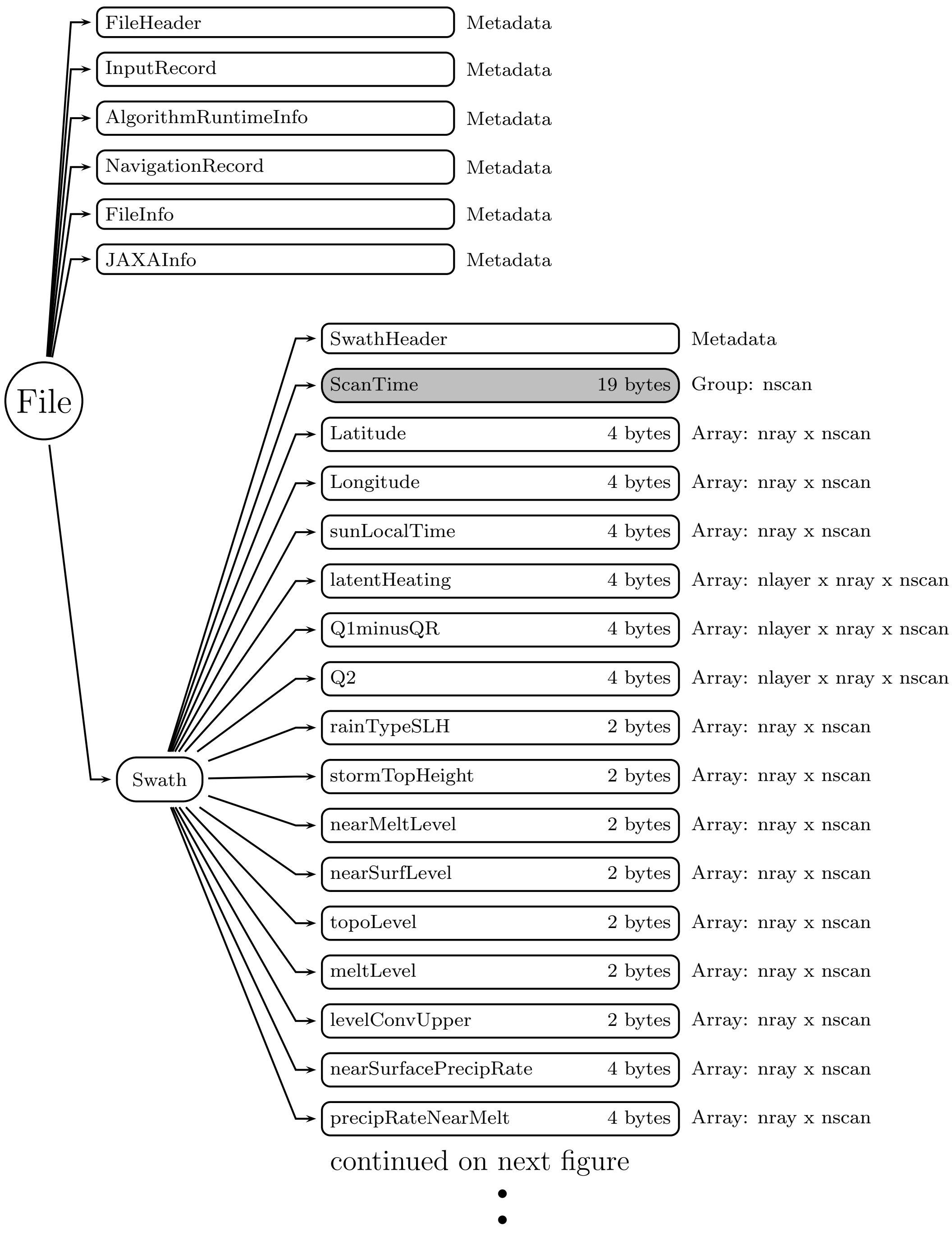


Figure 1159: Data Format Structure for 2HSLH, Spectral Latent Heating

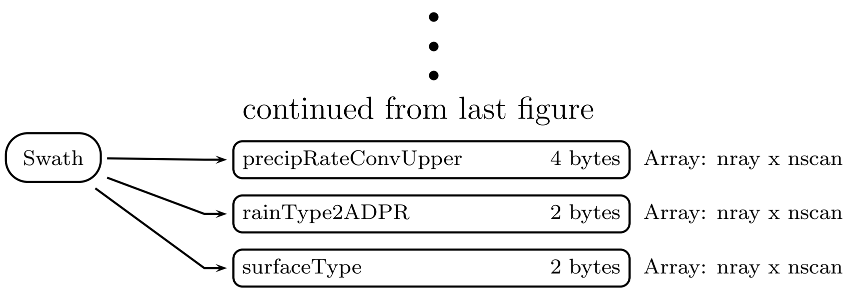


Figure 1160: Data Format Structure for 2HSLH, Spectral Latent Heating

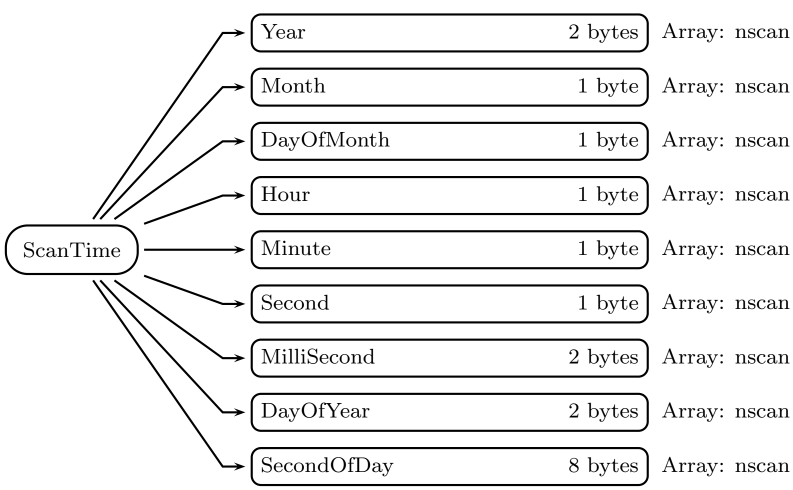


Figure 1161: Data Format Structure for 2HSLH, ScanTime

Swath (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:

-9999.9 Missing value

latentHeating (4-byte float, array size: nlayer x nray x nscan):
Latent Heating. Values range from -400 to 400 K/hr. Special values are defined as:

-9999.9 Missing value

Q1minusQR (4-byte float, array size: nlayer x nray x nscan):
Q1 - QR. Values range from -400 to 400 K/hr. Special values are defined as:

-9999.9 Missing value

Q2 (4-byte float, array size: nlayer x nray x nscan):
Apparent moisture sink. Values range from -400 to 400 K/hr. Special values are defined as:

-9999.9 Missing value

rainTypeSLH (2-byte integer, array size: nray x nscan):
Rain type decided by SLH. SLH decides if the FOV is tropical or mid-latitude based on the monthly precpitation regime database. The decision is not based on fixed latitude. Values are as follows:

```
  0: No precipitation - all latitudes
  1: Convective - tropical
  2: Shallow stratiform - tropical
  3: Deep stratiform - tropical
  4: Deep stratiform with low melting level - tropical
  5: Intermediary - tropical
  6: Other - tropical
110: Convective - mid-latitude
121: Shallow stratiform - mid-latitude
122: Deep stratiform, downward decreasing - mid-latitude
```

```
   123: Deep stratiform, downward increasing - mid-latitude
   124: Deep stratiform, subzero - mid-latitude
   160: Other - mid-latitude
   900: Tibet, winter mid-lat etc. (masked)
   910: Suspicious extreme (masked)
 -9999: Missing value
```

stormTopHeight (2-byte integer, array size: nray x nscan):
Height of storm top. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

nearMeltLevel (2-byte integer, array size: nray x nscan):
TBD. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

nearSurfLevel (2-byte integer, array size: nray x nscan):
Level of near surface rain. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

topoLevel (2-byte integer, array size: nray x nscan):
Level of topography. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

meltLevel (2-byte integer, array size: nray x nscan):
TBD. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

levelConvUpper (2-byte integer, array size: nray x nscan):
TBD. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

nearSurfacePrecipRate (4-byte float, array size: nray x nscan):
Precipitation rate at the near surface. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateNearMelt (4-byte float, array size: nray x nscan):
TBD. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateConvUpper (4-byte float, array size: nray x nscan):
TBD. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

rainType2ADPR (2-byte integer, array size: nray x nscan):
Rain Type from 2ADPR. Special values are defined as:
-9999 Missing value

surfaceType (2-byte integer, array size: nray x nscan):
TBD. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_2HSLH_H_
#define _TK_2HSLH_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2HSLH_SWATH_
#define _L2HSLH_SWATH_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float sunLocalTime[49];
    float latentHeating[49][80];
    float Q1minusQR[49][80];
    float Q2[49][80];
    short rainTypeSLH[49];
    short stormTopHeight[49];
    short nearMeltLevel[49];
    short nearSurfLevel[49];
    short topoLevel[49];
    short meltLevel[49];
    short levelConvUpper[49];
    float nearSurfacePrecipRate[49];
    float precipRateNearMelt[49];
    float precipRateConvUpper[49];
```

```
    short rainType2ADPR[49];
    short surfaceType[49];
} L2HSLH_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2HSLH_SWATH/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    REAL*4 latentHeating(80,49)
    REAL*4 Q1minusQR(80,49)
    REAL*4 Q2(80,49)
    INTEGER*2 rainTypeSLH(49)
    INTEGER*2 stormTopHeight(49)
    INTEGER*2 nearMeltLevel(49)
    INTEGER*2 nearSurfLevel(49)
    INTEGER*2 topoLevel(49)
    INTEGER*2 meltLevel(49)
    INTEGER*2 levelConvUpper(49)
    REAL*4 nearSurfacePrecipRate(49)
    REAL*4 precipRateNearMelt(49)
    REAL*4 precipRateConvUpper(49)
    INTEGER*2 rainType2ADPR(49)
    INTEGER*2 surfaceType(49)
END STRUCTURE
```

5.62 3GSLH - Gridded Orbital Spectral Latent Heating

3GSLH, "Gridded Orbital Spectral Latent Heating", produces 0.5^o x 0.5^o latent heating, Q1-QR, and Q2 profiles from DPR rain. The PI is Dr. Takayabu and the Co-PI is Dr. Shige. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	268	Number of 0.5^o grid intervals of latitude from 67^oN to 67^oS.
nlon	720	Number of 0.5^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

Figure 1162 through Figure 1164 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

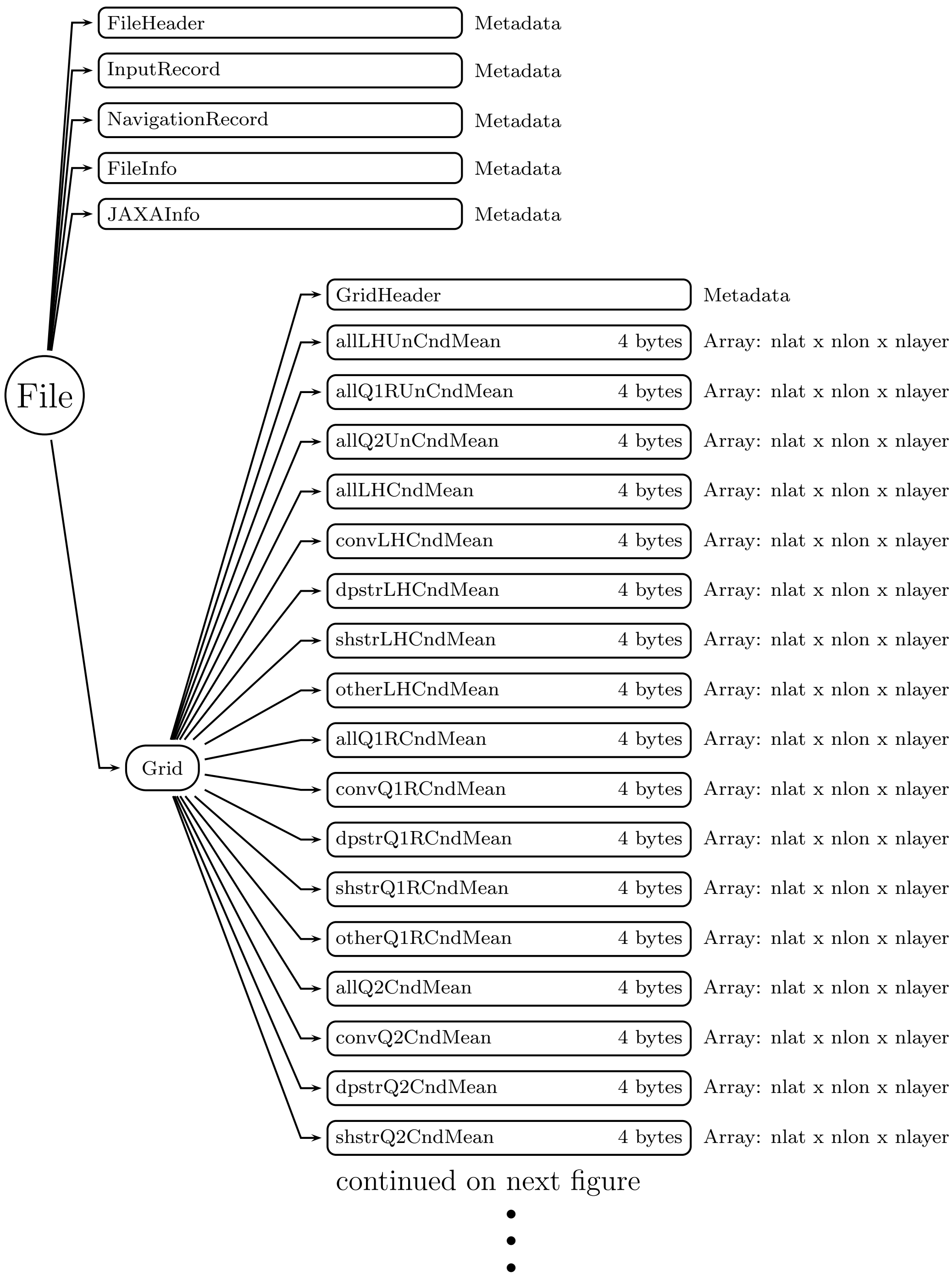


Figure 1162: Data Format Structure for 3GSLH, Gridded Orbital Spectral Latent Heating

continued from last figure

Grid

Name	Size	Type
otherQ2CndMean	4 bytes	Array: nlat x nlon x nlayer
allPix	2 bytes	Array: nlat x nlon x nlayer
precipPix	2 bytes	Array: nlat x nlon x nlayer
convPix	2 bytes	Array: nlat x nlon x nlayer
dpstrPix	2 bytes	Array: nlat x nlon x nlayer
shstrPix	2 bytes	Array: nlat x nlon x nlayer
otherPix	2 bytes	Array: nlat x nlon x nlayer
GridTime		Group

Figure 1163: Data Format Structure for 3GSLH, Gridded Orbital Spectral Latent Heating

GridTime

Name	Size	Type
Year	2 bytes	Array: nlat x nlon
Month	1 byte	Array: nlat x nlon
DayOfMonth	1 byte	Array: nlat x nlon
Hour	1 byte	Array: nlat x nlon
Minute	1 byte	Array: nlat x nlon
Second	1 byte	Array: nlat x nlon
MilliSecond	2 bytes	Array: nlat x nlon
DayOfYear	2 bytes	Array: nlat x nlon

Figure 1164: Data Format Structure for 3GSLH, GridTime

allLHUnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating: all pixel unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allQ1RUnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1-QR: all pixel unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allQ2UnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2: all pixel unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating all pixel mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating deep-stratiform and shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating shallow conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR all pixel mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR deep-stratiform and shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR shallow conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 all pixel mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 deep-stratiform and shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 shallow conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allPix (2-byte integer, array size: nlat x nlon x nlayer):
All pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:
-9999 Missing value

precipPix (2-byte integer, array size: nlat x nlon x nlayer):
The number of precipitating pixels in the 0.5^o x 0.5^o box. (= convPix + dpstrPix + shstrPix + otherPix) Special values are defined as:
-9999 Missing value

convPix (2-byte integer, array size: nlat x nlon x nlayer):
Convective pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:

-9999 Missing value

dpstrPix (2-byte integer, array size: nlat x nlon x nlayer):
Deep-stratiform and shallow-stratiform pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:
-9999 Missing value

shstrPix (2-byte integer, array size: nlat x nlon x nlayer):
Shallow pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:
-9999 Missing value

otherPix (2-byte integer, array size: nlat x nlon x nlayer):
Other pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:
-9999 Missing value

GridTime (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3GSLH_H_
#define _TK_3GSLH_H_

#ifndef _L3GSLH_GRIDTIME_
#define _L3GSLH_GRIDTIME_

typedef struct {
    short Year[720][268];
    signed char Month[720][268];
    signed char DayOfMonth[720][268];
    signed char Hour[720][268];
    signed char Minute[720][268];
    signed char Second[720][268];
    short MilliSecond[720][268];
    short DayOfYear[720][268];
} L3GSLH_GRIDTIME;

#endif

#ifndef _L3GSLH_GRID_
#define _L3GSLH_GRID_

typedef struct {
    float allLHUnCndMean[80][720][268];
    float allQ1RUnCndMean[80][720][268];
    float allQ2UnCndMean[80][720][268];
    float allLHCndMean[80][720][268];
    float convLHCndMean[80][720][268];
    float dpstrLHCndMean[80][720][268];
    float shstrLHCndMean[80][720][268];
    float otherLHCndMean[80][720][268];
    float allQ1RCndMean[80][720][268];
    float convQ1RCndMean[80][720][268];
    float dpstrQ1RCndMean[80][720][268];
    float shstrQ1RCndMean[80][720][268];
    float otherQ1RCndMean[80][720][268];
    float allQ2CndMean[80][720][268];
    float convQ2CndMean[80][720][268];
    float dpstrQ2CndMean[80][720][268];
    float shstrQ2CndMean[80][720][268];
    float otherQ2CndMean[80][720][268];
```

```
    short allPix[80][720][268];
    short precipPix[80][720][268];
    short convPix[80][720][268];
    short dpstrPix[80][720][268];
    short shstrPix[80][720][268];
    short otherPix[80][720][268];
    L3GSLH_GRIDTIME GridTime;
} L3GSLH_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GSLH_GRIDTIME/
    INTEGER*2 Year(268,720)
    BYTE Month(268,720)
    BYTE DayOfMonth(268,720)
    BYTE Hour(268,720)
    BYTE Minute(268,720)
    BYTE Second(268,720)
    INTEGER*2 MilliSecond(268,720)
    INTEGER*2 DayOfYear(268,720)
END STRUCTURE

STRUCTURE /L3GSLH_GRID/
    REAL*4 allLHUnCndMean(268,720,80)
    REAL*4 allQ1RUnCndMean(268,720,80)
    REAL*4 allQ2UnCndMean(268,720,80)
    REAL*4 allLHCndMean(268,720,80)
    REAL*4 convLHCndMean(268,720,80)
    REAL*4 dpstrLHCndMean(268,720,80)
    REAL*4 shstrLHCndMean(268,720,80)
    REAL*4 otherLHCndMean(268,720,80)
    REAL*4 allQ1RCndMean(268,720,80)
    REAL*4 convQ1RCndMean(268,720,80)
    REAL*4 dpstrQ1RCndMean(268,720,80)
    REAL*4 shstrQ1RCndMean(268,720,80)
    REAL*4 otherQ1RCndMean(268,720,80)
    REAL*4 allQ2CndMean(268,720,80)
    REAL*4 convQ2CndMean(268,720,80)
    REAL*4 dpstrQ2CndMean(268,720,80)
```

```
    REAL*4 shstrQ2CndMean(268,720,80)
    REAL*4 otherQ2CndMean(268,720,80)
    INTEGER*2 allPix(268,720,80)
    INTEGER*2 precipPix(268,720,80)
    INTEGER*2 convPix(268,720,80)
    INTEGER*2 dpstrPix(268,720,80)
    INTEGER*2 shstrPix(268,720,80)
    INTEGER*2 otherPix(268,720,80)
    RECORD /L3GSLH_GRIDTIME/ GridTime
END STRUCTURE
```

5.63 3HSLH - Monthly Spectral Latent Heating

3HSLH, "Monthly Spectral Latent Heating", produces 0.5^o x 0.5^o latent heating, Q1-QR, and Q2 profiles from DPR rain. The PI is Dr. Takayabu and the Co-PI is Dr. Shige. The granule size is one month. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	268	Number of 0.5^o grid intervals of latitude from 67^oS to 67^oN.
nlon	720	Number of 0.5^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.
one	1	One.

Figure 1165 through Figure 1167 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

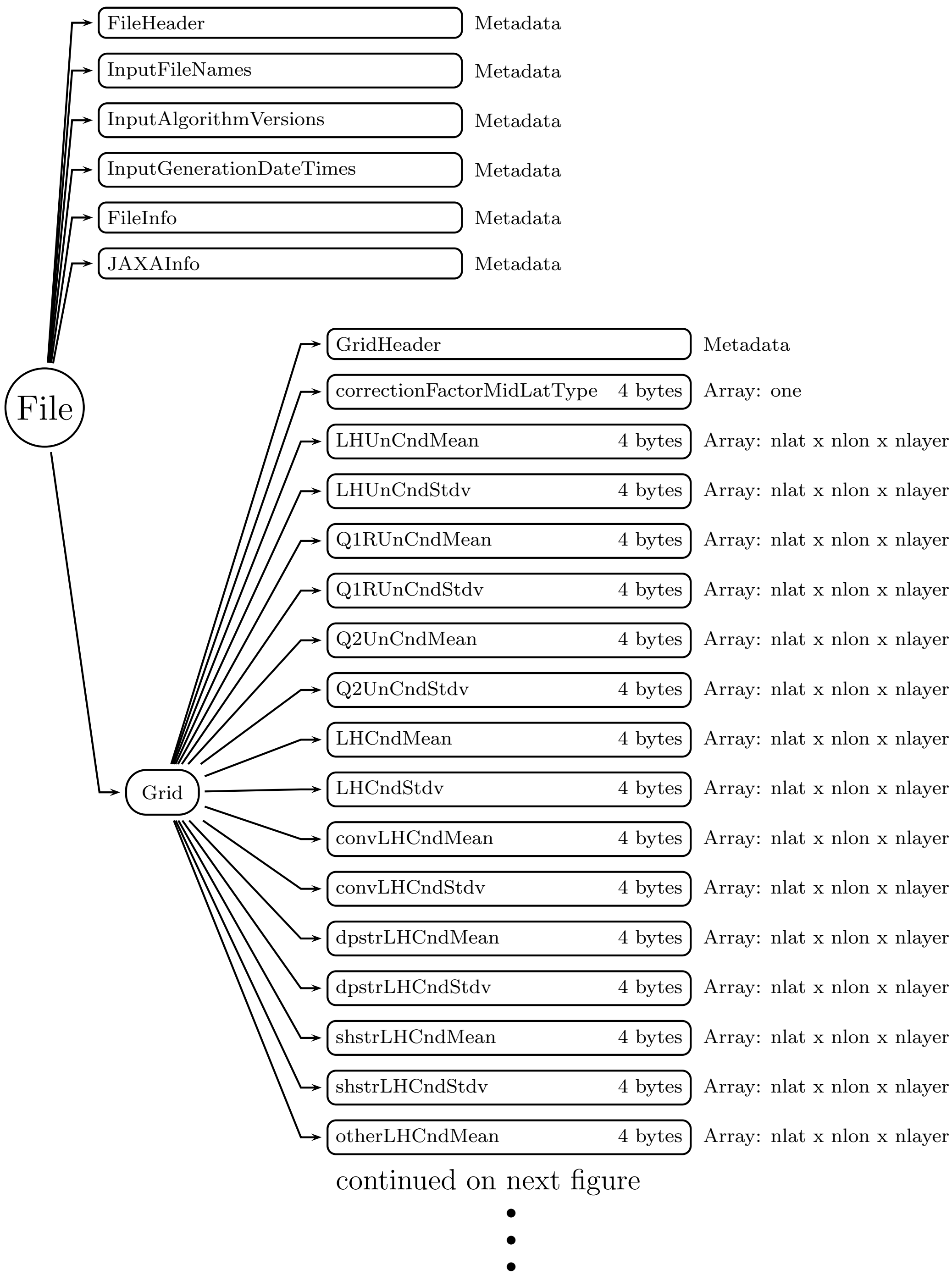


Figure 1165: Data Format Structure for 3HSLH, Monthly Spectral Latent Heating

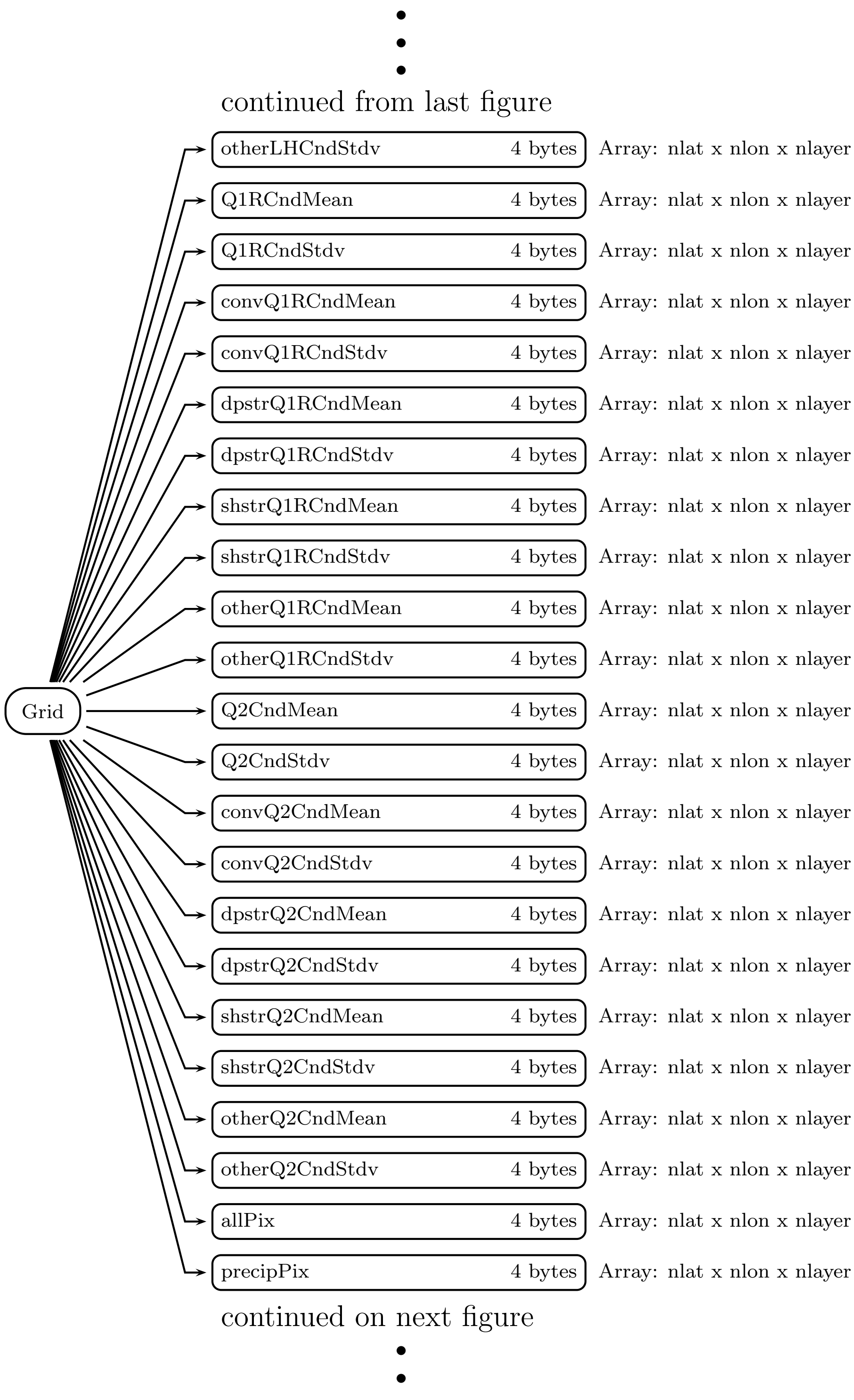


Figure 1166: Data Format Structure for 3HSLH, Monthly Spectral Latent Heating

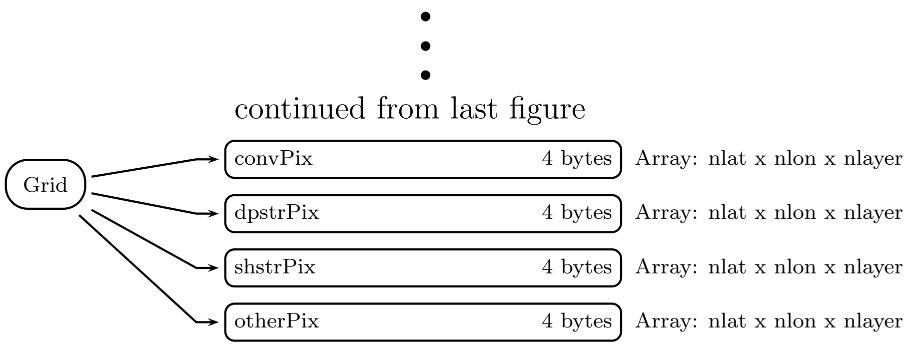


Figure 1167: Data Format Structure for 3HSLH, Monthly Spectral Latent Heating

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

correctionFactorMidLatType (4-byte float, array size: one):
TBD. Special values are defined as:
-9999.9 Missing value

LHUnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

LHUnCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating unconditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q1RUnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q1RUnCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR unconditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2UnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2UnCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 unconditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

LHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

LHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convLHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating convective conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating deep-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrLHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating deep-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrLHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating shallow-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherLHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating other conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR convective conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR deep-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR deep-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR shallow-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR other conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 convective conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 deep-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 deep-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 shallow-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 other conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allPix (4-byte float, array size: nlat x nlon x nlayer):
All pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

precipPix (4-byte float, array size: nlat x nlon x nlayer):
The number of precipitating pixels. (= convPix + dpstrPix + shstrPix + otherPix) Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

convPix (4-byte float, array size: nlat x nlon x nlayer):
Convective pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

dpstrPix (4-byte float, array size: nlat x nlon x nlayer):
Deep-stratiform pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

shstrPix (4-byte float, array size: nlat x nlon x nlayer):
Shallow-stratiform pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

otherPix (4-byte float, array size: nlat x nlon x nlayer):
Other pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3HSLH_H_
#define _TK_3HSLH_H_

#ifndef _L3HSLH_GRID_
```

```
#define _L3HSLH_GRID_

typedef struct {
    float correctionFactorMidLatType[1];
    float LHUnCndMean[80][720][268];
    float LHUnCndStdv[80][720][268];
    float Q1RUnCndMean[80][720][268];
    float Q1RUnCndStdv[80][720][268];
    float Q2UnCndMean[80][720][268];
    float Q2UnCndStdv[80][720][268];
    float LHCndMean[80][720][268];
    float LHCndStdv[80][720][268];
    float convLHCndMean[80][720][268];
    float convLHCndStdv[80][720][268];
    float dpstrLHCndMean[80][720][268];
    float dpstrLHCndStdv[80][720][268];
    float shstrLHCndMean[80][720][268];
    float shstrLHCndStdv[80][720][268];
    float otherLHCndMean[80][720][268];
    float otherLHCndStdv[80][720][268];
    float Q1RCndMean[80][720][268];
    float Q1RCndStdv[80][720][268];
    float convQ1RCndMean[80][720][268];
    float convQ1RCndStdv[80][720][268];
    float dpstrQ1RCndMean[80][720][268];
    float dpstrQ1RCndStdv[80][720][268];
    float shstrQ1RCndMean[80][720][268];
    float shstrQ1RCndStdv[80][720][268];
    float otherQ1RCndMean[80][720][268];
    float otherQ1RCndStdv[80][720][268];
    float Q2CndMean[80][720][268];
    float Q2CndStdv[80][720][268];
    float convQ2CndMean[80][720][268];
    float convQ2CndStdv[80][720][268];
    float dpstrQ2CndMean[80][720][268];
    float dpstrQ2CndStdv[80][720][268];
    float shstrQ2CndMean[80][720][268];
    float shstrQ2CndStdv[80][720][268];
    float otherQ2CndMean[80][720][268];
    float otherQ2CndStdv[80][720][268];
    float allPix[80][720][268];
    float precipPix[80][720][268];
    float convPix[80][720][268];
```

```
    float dpstrPix[80][720][268];
    float shstrPix[80][720][268];
    float otherPix[80][720][268];
} L3HSLH_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3HSLH_GRID/
    REAL*4 correctionFactorMidLatType(1)
    REAL*4 LHUnCndMean(268,720,80)
    REAL*4 LHUnCndStdv(268,720,80)
    REAL*4 Q1RUnCndMean(268,720,80)
    REAL*4 Q1RUnCndStdv(268,720,80)
    REAL*4 Q2UnCndMean(268,720,80)
    REAL*4 Q2UnCndStdv(268,720,80)
    REAL*4 LHCndMean(268,720,80)
    REAL*4 LHCndStdv(268,720,80)
    REAL*4 convLHCndMean(268,720,80)
    REAL*4 convLHCndStdv(268,720,80)
    REAL*4 dpstrLHCndMean(268,720,80)
    REAL*4 dpstrLHCndStdv(268,720,80)
    REAL*4 shstrLHCndMean(268,720,80)
    REAL*4 shstrLHCndStdv(268,720,80)
    REAL*4 otherLHCndMean(268,720,80)
    REAL*4 otherLHCndStdv(268,720,80)
    REAL*4 Q1RCndMean(268,720,80)
    REAL*4 Q1RCndStdv(268,720,80)
    REAL*4 convQ1RCndMean(268,720,80)
    REAL*4 convQ1RCndStdv(268,720,80)
    REAL*4 dpstrQ1RCndMean(268,720,80)
    REAL*4 dpstrQ1RCndStdv(268,720,80)
    REAL*4 shstrQ1RCndMean(268,720,80)
    REAL*4 shstrQ1RCndStdv(268,720,80)
    REAL*4 otherQ1RCndMean(268,720,80)
    REAL*4 otherQ1RCndStdv(268,720,80)
    REAL*4 Q2CndMean(268,720,80)
    REAL*4 Q2CndStdv(268,720,80)
    REAL*4 convQ2CndMean(268,720,80)
    REAL*4 convQ2CndStdv(268,720,80)
```

```
    REAL*4 dpstrQ2CndMean(268,720,80)
    REAL*4 dpstrQ2CndStdv(268,720,80)
    REAL*4 shstrQ2CndMean(268,720,80)
    REAL*4 shstrQ2CndStdv(268,720,80)
    REAL*4 otherQ2CndMean(268,720,80)
    REAL*4 otherQ2CndStdv(268,720,80)
    REAL*4 allPix(268,720,80)
    REAL*4 precipPix(268,720,80)
    REAL*4 convPix(268,720,80)
    REAL*4 dpstrPix(268,720,80)
    REAL*4 shstrPix(268,720,80)
    REAL*4 otherPix(268,720,80)
END STRUCTURE
```

5.64 2HSLHT - Spectral Latent Heating

2HSLHT, "Spectral Latent Heating," produces latent heating, Q1-QR, and Q2 profiles from PR rain. The PI is Dr. Takayabu and the Co-PI is Dr. Shige. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

Figure 1168 through Figure 1170 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

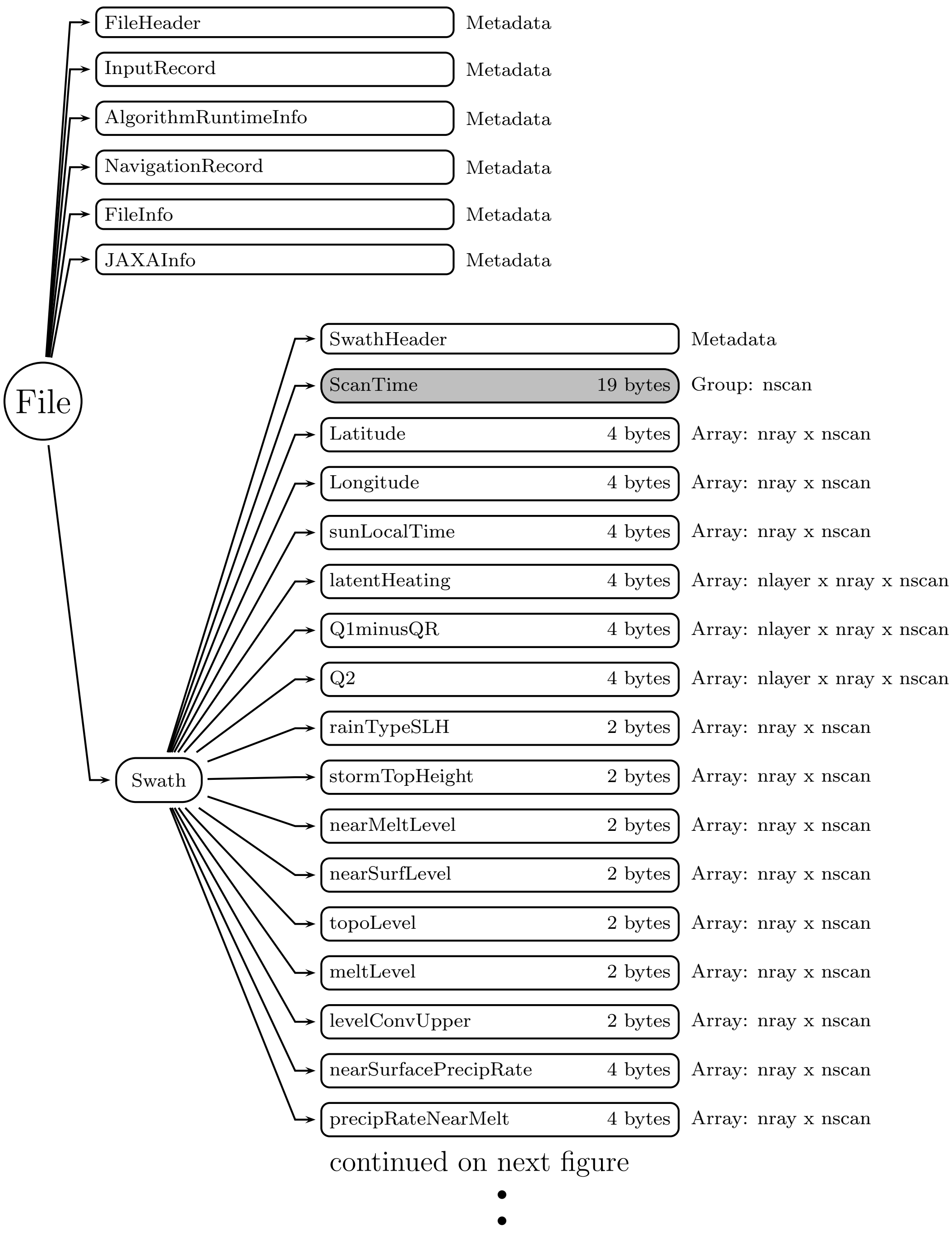


Figure 1168: Data Format Structure for 2HSLHT, Spectral Latent Heating

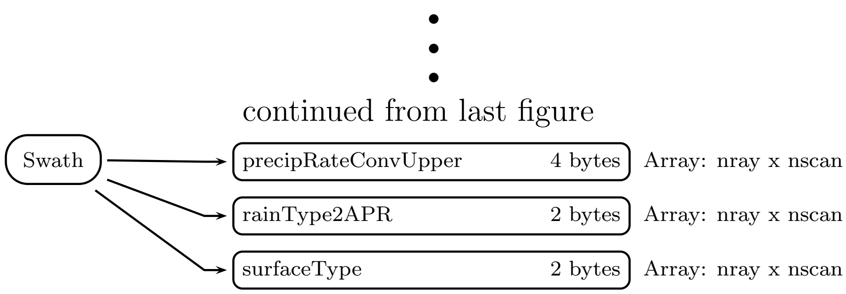


Figure 1169: Data Format Structure for 2HSLHT, Spectral Latent Heating

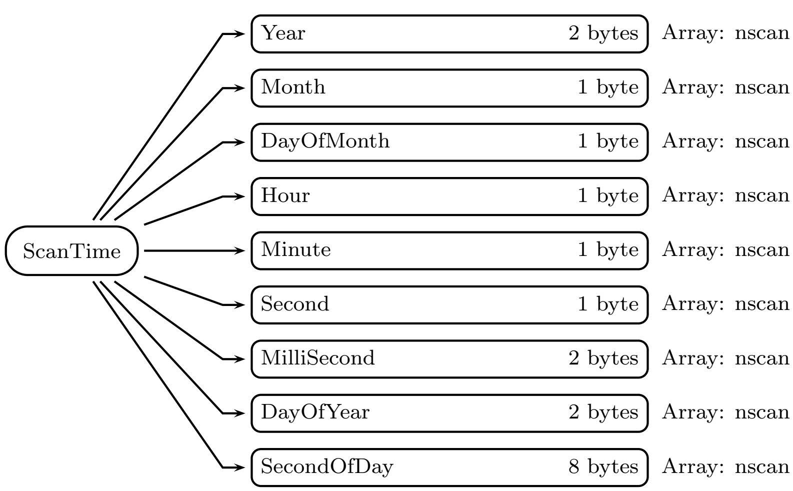


Figure 1170: Data Format Structure for 2HSLHT, ScanTime

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

Swath (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

sunLocalTime (4-byte float, array size: nray x nscan):
The local hour angle of the Sun at the pixel location, where 0 is midnight and 12 is local noon when the Sun crosses the local meridian. Also known as apparent solar time at any location. In V7 TMI and GMI products will have values but partner products will be filled with the missing value. Values range from 0 to 24 hours. Special values are defined as:
-9999.9 Missing value

latentHeating (4-byte float, array size: nlayer x nray x nscan):
Latent Heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q1minusQR (4-byte float, array size: nlayer x nray x nscan):
Q1 - QR. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2 (4-byte float, array size: nlayer x nray x nscan):
Apparent moisture sink. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

rainTypeSLH (2-byte integer, array size: nray x nscan):
Rain type decided by SLH. SLH decides if the FOV is tropical or mid-latitude based on the monthly precpitation regime database. The decision is not based on fixed latitude. Values are as follows:

```
       0: No precipitation - all latitudes
       1: Convective - tropical
       2: Shallow stratiform - tropical
       3: Deep stratiform - tropical
       4: Deep stratiform with low melting level - tropical
       5: Intermediary - tropical
       6: Other - tropical
     110: Convective - mid-latitude
     121: Shallow stratiform - mid-latitude
     122: Deep stratiform, downward decreasing - mid-latitude
     123: Deep stratiform, downward increasing - mid-latitude
     124: Deep stratiform, subzero - mid-latitude
     160: Other - mid-latitude
     900: Tibet, winter mid-lat etc. (masked)
     910: Suspicious extreme (masked)
   -9999: Missing value
```

stormTopHeight (2-byte integer, array size: nray x nscan):
Height of storm top. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

nearMeltLevel (2-byte integer, array size: nray x nscan):
Height of melting layer. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

nearSurfLevel (2-byte integer, array size: nray x nscan):
Level of near surface rain. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

topoLevel (2-byte integer, array size: nray x nscan):
Level of topography. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

meltLevel (2-byte integer, array size: nray x nscan):
Climatological melting level. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

levelConvUpper (2-byte integer, array size: nray x nscan):
Climatological freezing level. Values range from 0 to 32000 m. Special values are defined as:
-9999 Missing value

nearSurfacePrecipRate (4-byte float, array size: nray x nscan):
Precipitation rate at the near surface. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateNearMelt (4-byte float, array size: nray x nscan):
Precipitation rate at the melting level. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateConvUpper (4-byte float, array size: nray x nscan):
Precipitation rate at the freezing level. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

rainType2APR (2-byte integer, array size: nray x nscan):
Rain Type from 2APR. Special values are defined as:
-9999 Missing value

surfaceType (2-byte integer, array size: nray x nscan):
Method from 2APR. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_2HSLHT_H_
#define _TK_2HSLHT_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2HSLHT_SWATH_
#define _L2HSLHT_SWATH_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
```

```
    float Longitude[49];
    float sunLocalTime[49];
    float latentHeating[49][80];
    float Q1minusQR[49][80];
    float Q2[49][80];
    short rainTypeSLH[49];
    short stormTopHeight[49];
    short nearMeltLevel[49];
    short nearSurfLevel[49];
    short topoLevel[49];
    short meltLevel[49];
    short levelConvUpper[49];
    float nearSurfacePrecipRate[49];
    float precipRateNearMelt[49];
    float precipRateConvUpper[49];
    short rainType2APR[49];
    short surfaceType[49];
} L2HSLHT_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2HSLHT_SWATH/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 sunLocalTime(49)
    REAL*4 latentHeating(80,49)
```

```
    REAL*4 Q1minusQR(80,49)
    REAL*4 Q2(80,49)
    INTEGER*2 rainTypeSLH(49)
    INTEGER*2 stormTopHeight(49)
    INTEGER*2 nearMeltLevel(49)
    INTEGER*2 nearSurfLevel(49)
    INTEGER*2 topoLevel(49)
    INTEGER*2 meltLevel(49)
    INTEGER*2 levelConvUpper(49)
    REAL*4 nearSurfacePrecipRate(49)
    REAL*4 precipRateNearMelt(49)
    REAL*4 precipRateConvUpper(49)
    INTEGER*2 rainType2APR(49)
    INTEGER*2 surfaceType(49)
END STRUCTURE
```

5.65 3GSLHT - Gridded Orbital Spectral Latent Heating

3GSLHT, "Gridded Orbital Spectral Latent Heating", produces 0.5^o x 0.5^o latent heating, Q1-QR, and Q2 profiles from PR rain. The PI is Dr. Takayabu and the Co-PI is Dr. Shige. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	268	Number of 0.5^o grid intervals of latitude from 67^oS to 67^oN.
nlon	720	Number of 0.5^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

Figure 1171 through Figure 1173 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

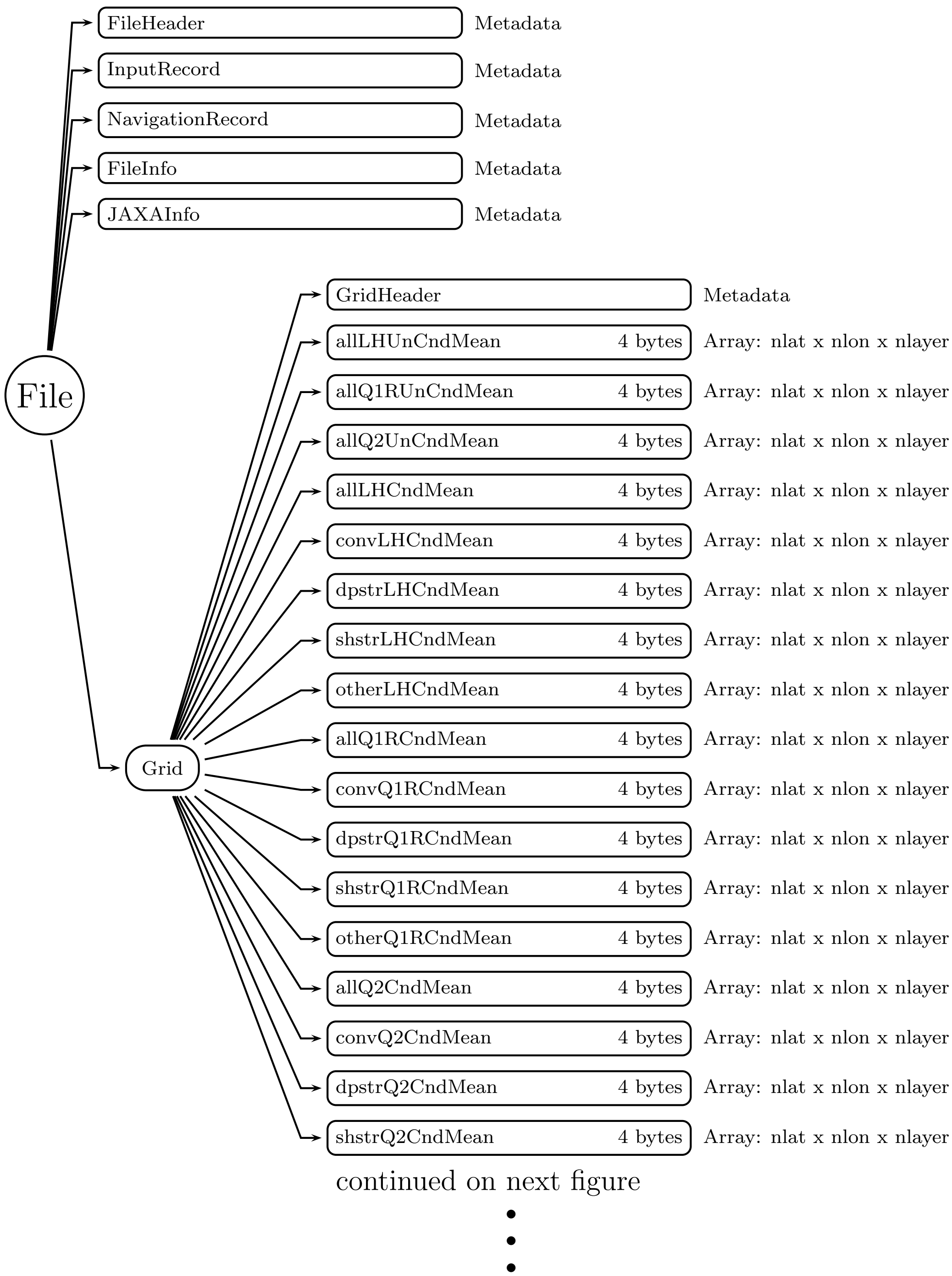


Figure 1171: Data Format Structure for 3GSLHT, Gridded Orbital Spectral Latent Heating

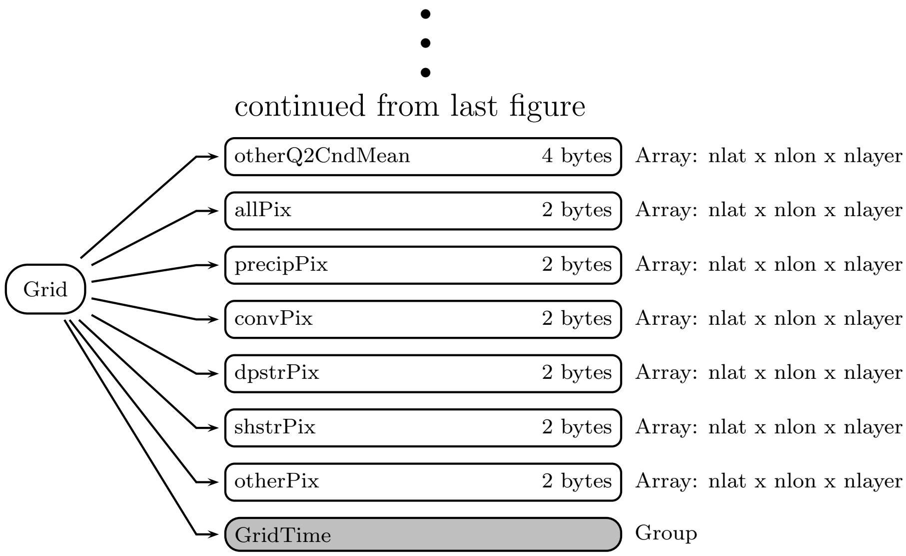


Figure 1172: Data Format Structure for 3GSLHT, Gridded Orbital Spectral Latent Heating

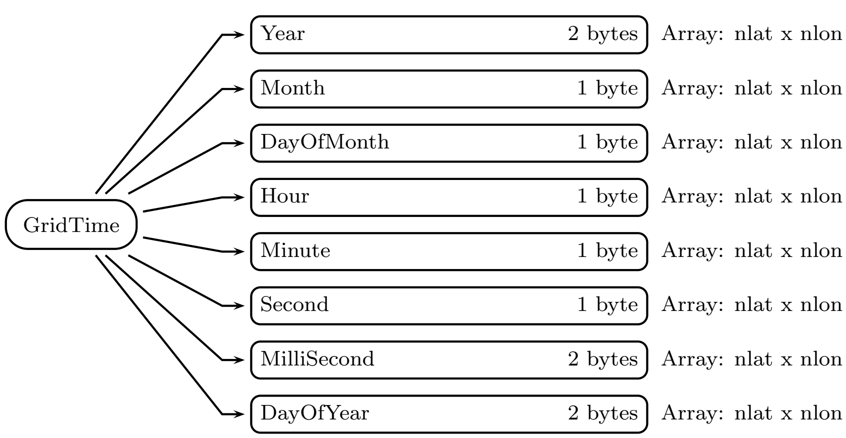


Figure 1173: Data Format Structure for 3GSLHT, GridTime

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

allLHUnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating: all pixel unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allQ1RUnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1-QR: all pixel unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allQ2UnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2: all pixel unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating all pixel mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating deep-stratiform and shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating shallow conditional mean. Values range from -400 to 400 K/hr. Special

values are defined as:
-9999.9 Missing value

otherLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR all pixel mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR deep-stratiform and shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR shallow conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 all pixel mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 deep-stratiform and shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 shallow conditional mean. Values range from -400 to 400 K/hr. Special values are

defined as:
-9999.9 Missing value

otherQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allPix (2-byte integer, array size: nlat x nlon x nlayer):
All pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:
-9999 Missing value

precipPix (2-byte integer, array size: nlat x nlon x nlayer):
The number of precipitating pixels in the 0.5^o x 0.5^o box. (= convPix + dpstrPix + shstrPix + otherPix) Special values are defined as:
-9999 Missing value

convPix (2-byte integer, array size: nlat x nlon x nlayer):
Convective pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:
-9999 Missing value

dpstrPix (2-byte integer, array size: nlat x nlon x nlayer):
Deep-stratiform and shallow-stratiform pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:
-9999 Missing value

shstrPix (2-byte integer, array size: nlat x nlon x nlayer):
Shallow pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:
-9999 Missing value

otherPix (2-byte integer, array size: nlat x nlon x nlayer):
Other pixel counts in the 0.5^o x 0.5^o box. Special values are defined as:
-9999 Missing value

GridTime (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3GSLHT_H_
#define _TK_3GSLHT_H_

#ifndef _L3GSLHT_GRIDTIME_
#define _L3GSLHT_GRIDTIME_

typedef struct {
    short Year[720][268];
    signed char Month[720][268];
    signed char DayOfMonth[720][268];
    signed char Hour[720][268];
    signed char Minute[720][268];
    signed char Second[720][268];
    short MilliSecond[720][268];
    short DayOfYear[720][268];
} L3GSLHT_GRIDTIME;

#endif

#ifndef _L3GSLHT_GRID_
#define _L3GSLHT_GRID_

typedef struct {
    float allLHUnCndMean[80][720][268];
```

```
    float allQ1RUnCndMean[80][720][268];
    float allQ2UnCndMean[80][720][268];
    float allLHCndMean[80][720][268];
    float convLHCndMean[80][720][268];
    float dpstrLHCndMean[80][720][268];
    float shstrLHCndMean[80][720][268];
    float otherLHCndMean[80][720][268];
    float allQ1RCndMean[80][720][268];
    float convQ1RCndMean[80][720][268];
    float dpstrQ1RCndMean[80][720][268];
    float shstrQ1RCndMean[80][720][268];
    float otherQ1RCndMean[80][720][268];
    float allQ2CndMean[80][720][268];
    float convQ2CndMean[80][720][268];
    float dpstrQ2CndMean[80][720][268];
    float shstrQ2CndMean[80][720][268];
    float otherQ2CndMean[80][720][268];
    short allPix[80][720][268];
    short precipPix[80][720][268];
    short convPix[80][720][268];
    short dpstrPix[80][720][268];
    short shstrPix[80][720][268];
    short otherPix[80][720][268];
    L3GSLHT_GRIDTIME GridTime;
} L3GSLHT_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GSLHT_GRIDTIME/
    INTEGER*2 Year(268,720)
    BYTE Month(268,720)
    BYTE DayOfMonth(268,720)
    BYTE Hour(268,720)
    BYTE Minute(268,720)
    BYTE Second(268,720)
    INTEGER*2 MilliSecond(268,720)
    INTEGER*2 DayOfYear(268,720)
END STRUCTURE
```

```
STRUCTURE /L3GSLHT_GRID/
    REAL*4 allLHUnCndMean(268,720,80)
    REAL*4 allQ1RUnCndMean(268,720,80)
    REAL*4 allQ2UnCndMean(268,720,80)
    REAL*4 allLHCndMean(268,720,80)
    REAL*4 convLHCndMean(268,720,80)
    REAL*4 dpstrLHCndMean(268,720,80)
    REAL*4 shstrLHCndMean(268,720,80)
    REAL*4 otherLHCndMean(268,720,80)
    REAL*4 allQ1RCndMean(268,720,80)
    REAL*4 convQ1RCndMean(268,720,80)
    REAL*4 dpstrQ1RCndMean(268,720,80)
    REAL*4 shstrQ1RCndMean(268,720,80)
    REAL*4 otherQ1RCndMean(268,720,80)
    REAL*4 allQ2CndMean(268,720,80)
    REAL*4 convQ2CndMean(268,720,80)
    REAL*4 dpstrQ2CndMean(268,720,80)
    REAL*4 shstrQ2CndMean(268,720,80)
    REAL*4 otherQ2CndMean(268,720,80)
    INTEGER*2 allPix(268,720,80)
    INTEGER*2 precipPix(268,720,80)
    INTEGER*2 convPix(268,720,80)
    INTEGER*2 dpstrPix(268,720,80)
    INTEGER*2 shstrPix(268,720,80)
    INTEGER*2 otherPix(268,720,80)
    RECORD /L3GSLHT_GRIDTIME/ GridTime
END STRUCTURE
```

5.66 3HSLHT - Monthly Spectral Latent Heating

3HSLHT, "Monthly Spectral Latent Heating", produces 0.5^o x 0.5^o latent heating, Q1-QR, and Q2 profiles from PR rain. The PI is Dr. Takayabu and the Co-PI is Dr. Shige. The granule size is one month. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	268	Number of 0.5^o grid intervals of latitude from 67^oS to 67^oN.
nlon	720	Number of 0.5^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.
one	1	One.

Figure 1174 through Figure 1176 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

correctionFactorMidLatType (4-byte float, array size: one):
TBD. Special values are defined as:
-9999.9 Missing value

LHUnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

LHUnCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating unconditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q1RUnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR unconditional mean. Values range from -400 to 400 K/hr. Special values are

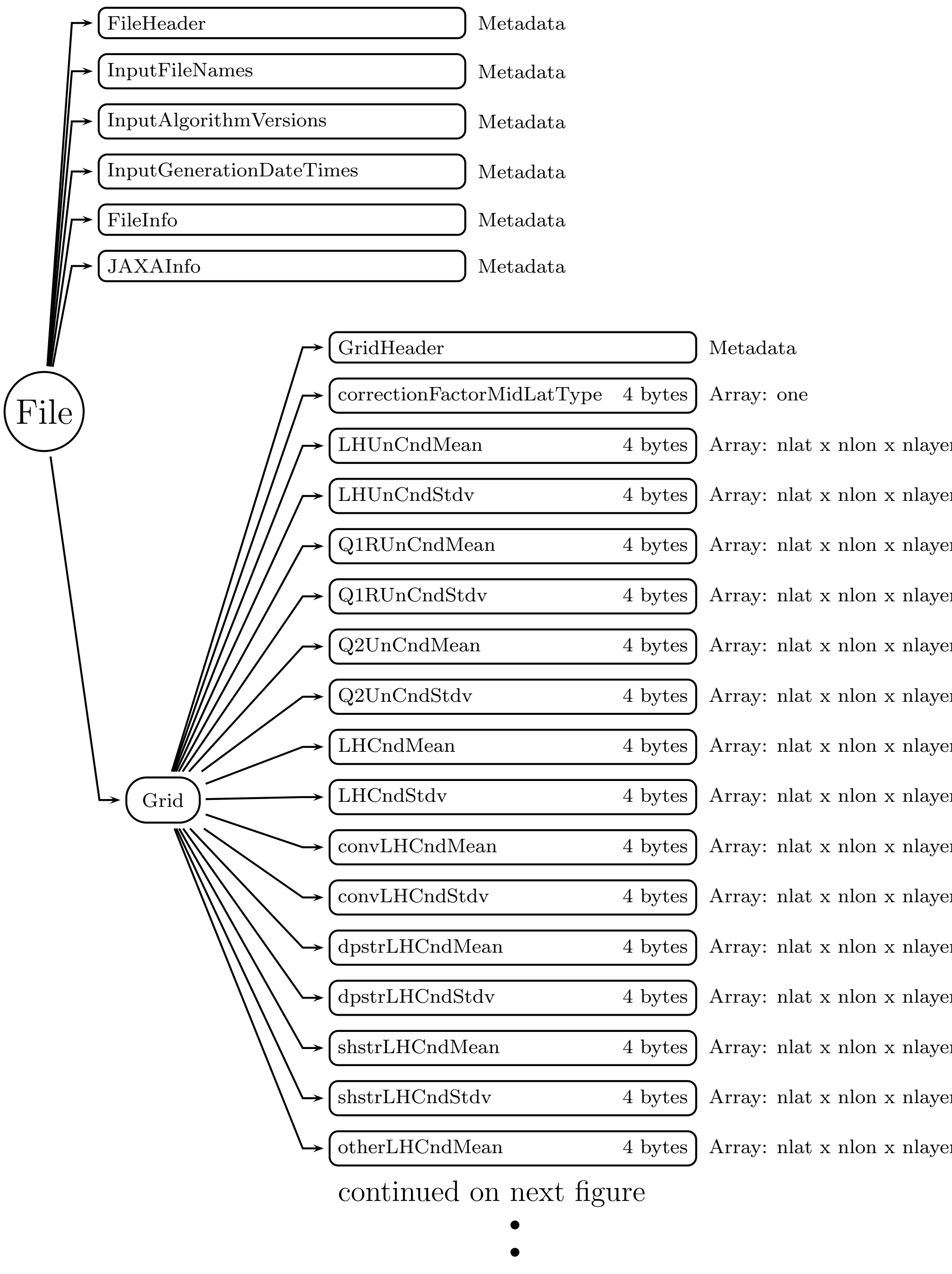


Figure 1174: Data Format Structure for 3HSLHT, Monthly Spectral Latent Heating

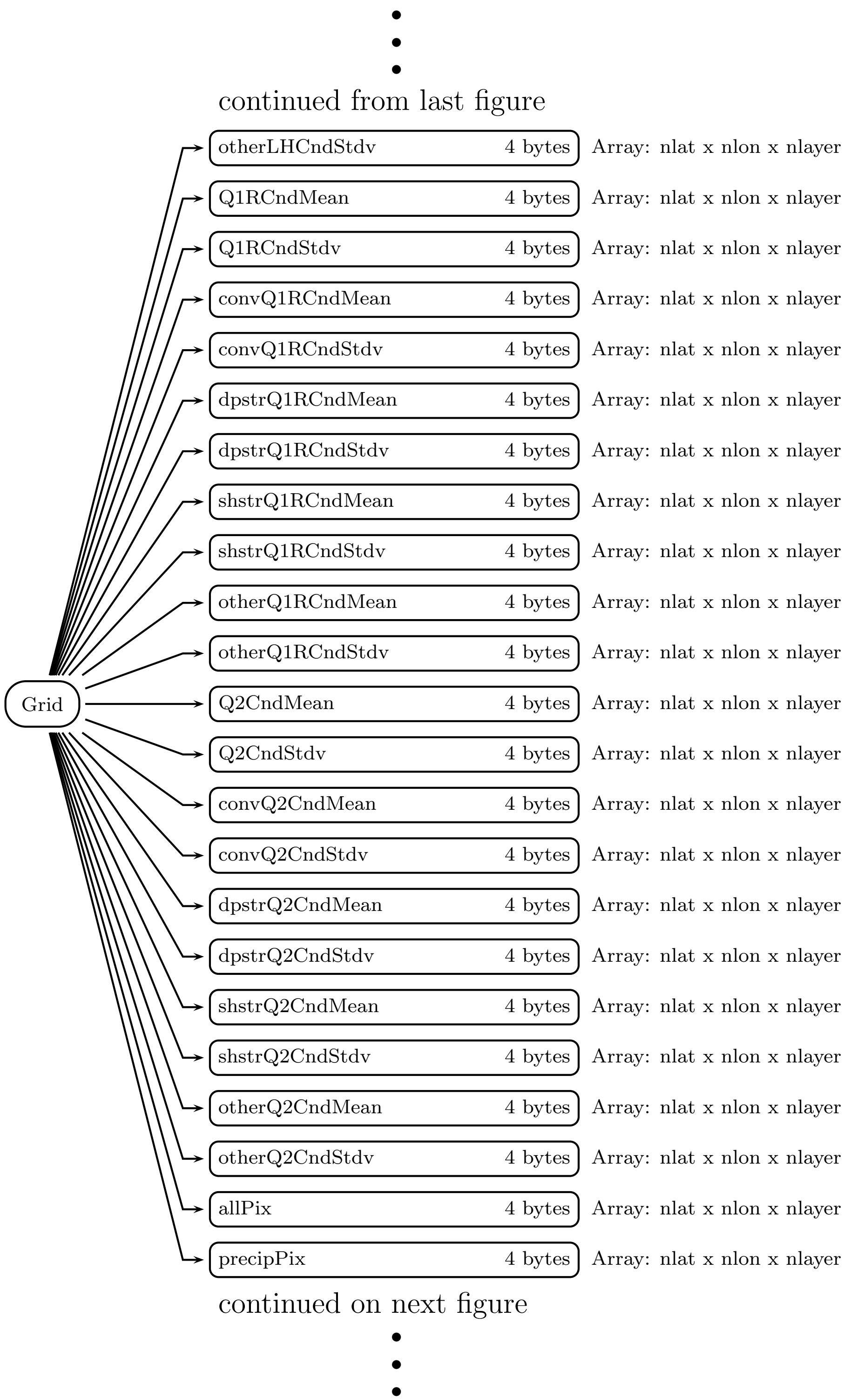


Figure 1175: Data Format Structure for 3HSLHT, Monthly Spectral Latent Heating

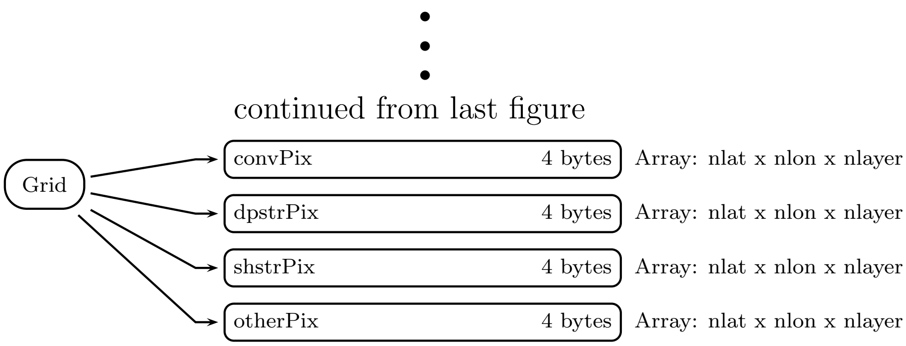


Figure 1176: Data Format Structure for 3HSLHT, Monthly Spectral Latent Heating

defined as:
-9999.9 Missing value

Q1RUnCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR unconditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2UnCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 unconditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2UnCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 unconditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

LHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

LHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convLHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating convective conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating deep-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrLHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating deep-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrLHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating shallow-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherLHCndMean (4-byte float, array size: nlat x nlon x nlayer):
Latent heating other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherLHCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Latent heating other conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR convective conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR deep-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR deep-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR shallow-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ1RCndMean (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ1RCndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q1 - QR other conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

Q2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 convective conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

convQ2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 convective conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 deep-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

dpstrQ2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 deep-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 shallow-stratiform conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

shstrQ2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 shallow-stratiform conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ2CndMean (4-byte float, array size: nlat x nlon x nlayer):
Q2 other conditional mean. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

otherQ2CndStdv (4-byte float, array size: nlat x nlon x nlayer):
Q2 other conditional standard deviation. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

allPix (4-byte float, array size: nlat x nlon x nlayer):
All pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

precipPix (4-byte float, array size: nlat x nlon x nlayer):
The number of precipitating pixels. (= convPix + dpstrPix + shstrPix + otherPix) Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

convPix (4-byte float, array size: nlat x nlon x nlayer):
Convective pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

dpstrPix (4-byte float, array size: nlat x nlon x nlayer):
Deep-stratiform pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

shstrPix (4-byte float, array size: nlat x nlon x nlayer):
Shallow-stratiform pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

otherPix (4-byte float, array size: nlat x nlon x nlayer):
Other pixel counts. Values range from 0 to 2000000000. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3HSLHT_H_
#define _TK_3HSLHT_H_

#ifndef _L3HSLHT_GRID_
#define _L3HSLHT_GRID_

typedef struct {
    float correctionFactorMidLatType[1];
    float LHUnCndMean[80][720][268];
    float LHUnCndStdv[80][720][268];
    float Q1RUnCndMean[80][720][268];
    float Q1RUnCndStdv[80][720][268];
    float Q2UnCndMean[80][720][268];
    float Q2UnCndStdv[80][720][268];
    float LHCndMean[80][720][268];
    float LHCndStdv[80][720][268];
    float convLHCndMean[80][720][268];
    float convLHCndStdv[80][720][268];
    float dpstrLHCndMean[80][720][268];
    float dpstrLHCndStdv[80][720][268];
    float shstrLHCndMean[80][720][268];
    float shstrLHCndStdv[80][720][268];
    float otherLHCndMean[80][720][268];
    float otherLHCndStdv[80][720][268];
    float Q1RCndMean[80][720][268];
    float Q1RCndStdv[80][720][268];
    float convQ1RCndMean[80][720][268];
    float convQ1RCndStdv[80][720][268];
    float dpstrQ1RCndMean[80][720][268];
    float dpstrQ1RCndStdv[80][720][268];
    float shstrQ1RCndMean[80][720][268];
    float shstrQ1RCndStdv[80][720][268];
    float otherQ1RCndMean[80][720][268];
```

```
    float otherQ1RCndStdv[80][720][268];
    float Q2CndMean[80][720][268];
    float Q2CndStdv[80][720][268];
    float convQ2CndMean[80][720][268];
    float convQ2CndStdv[80][720][268];
    float dpstrQ2CndMean[80][720][268];
    float dpstrQ2CndStdv[80][720][268];
    float shstrQ2CndMean[80][720][268];
    float shstrQ2CndStdv[80][720][268];
    float otherQ2CndMean[80][720][268];
    float otherQ2CndStdv[80][720][268];
    float allPix[80][720][268];
    float precipPix[80][720][268];
    float convPix[80][720][268];
    float dpstrPix[80][720][268];
    float shstrPix[80][720][268];
    float otherPix[80][720][268];
} L3HSLHT_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3HSLHT_GRID/
    REAL*4 correctionFactorMidLatType(1)
    REAL*4 LHUnCndMean(268,720,80)
    REAL*4 LHUnCndStdv(268,720,80)
    REAL*4 Q1RUnCndMean(268,720,80)
    REAL*4 Q1RUnCndStdv(268,720,80)
    REAL*4 Q2UnCndMean(268,720,80)
    REAL*4 Q2UnCndStdv(268,720,80)
    REAL*4 LHCndMean(268,720,80)
    REAL*4 LHCndStdv(268,720,80)
    REAL*4 convLHCndMean(268,720,80)
    REAL*4 convLHCndStdv(268,720,80)
    REAL*4 dpstrLHCndMean(268,720,80)
    REAL*4 dpstrLHCndStdv(268,720,80)
    REAL*4 shstrLHCndMean(268,720,80)
    REAL*4 shstrLHCndStdv(268,720,80)
    REAL*4 otherLHCndMean(268,720,80)
    REAL*4 otherLHCndStdv(268,720,80)
```

```
    REAL*4 Q1RCndMean(268,720,80)
    REAL*4 Q1RCndStdv(268,720,80)
    REAL*4 convQ1RCndMean(268,720,80)
    REAL*4 convQ1RCndStdv(268,720,80)
    REAL*4 dpstrQ1RCndMean(268,720,80)
    REAL*4 dpstrQ1RCndStdv(268,720,80)
    REAL*4 shstrQ1RCndMean(268,720,80)
    REAL*4 shstrQ1RCndStdv(268,720,80)
    REAL*4 otherQ1RCndMean(268,720,80)
    REAL*4 otherQ1RCndStdv(268,720,80)
    REAL*4 Q2CndMean(268,720,80)
    REAL*4 Q2CndStdv(268,720,80)
    REAL*4 convQ2CndMean(268,720,80)
    REAL*4 convQ2CndStdv(268,720,80)
    REAL*4 dpstrQ2CndMean(268,720,80)
    REAL*4 dpstrQ2CndStdv(268,720,80)
    REAL*4 shstrQ2CndMean(268,720,80)
    REAL*4 shstrQ2CndStdv(268,720,80)
    REAL*4 otherQ2CndMean(268,720,80)
    REAL*4 otherQ2CndStdv(268,720,80)
    REAL*4 allPix(268,720,80)
    REAL*4 precipPix(268,720,80)
    REAL*4 convPix(268,720,80)
    REAL*4 dpstrPix(268,720,80)
    REAL*4 shstrPix(268,720,80)
    REAL*4 otherPix(268,720,80)
END STRUCTURE
```

5.67 2HCSH - Convective Stratiform Heating

2HCSH, "Convective Stratiform Heating," produces orbital apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. The PI is Dr. Tao. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

Figure 1177 through Figure 1178 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

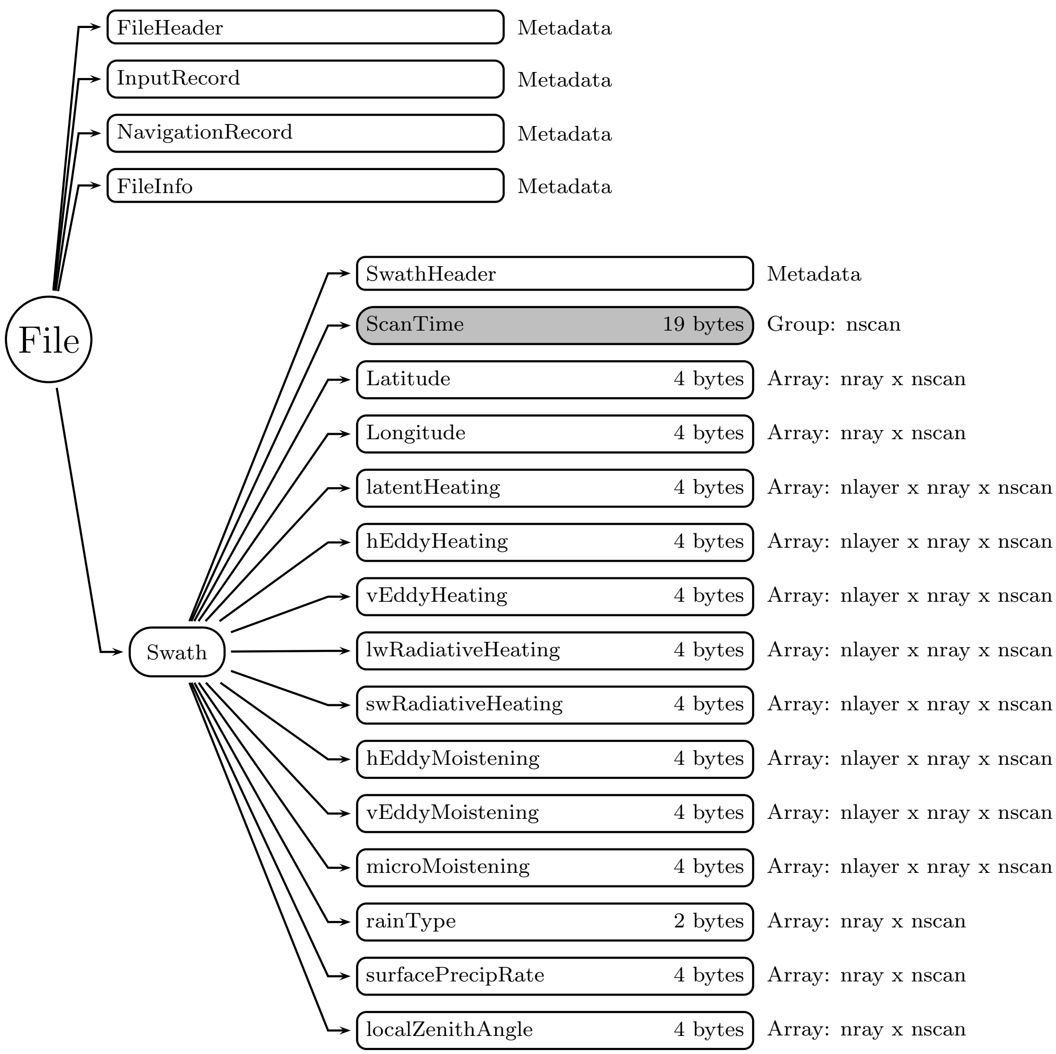


Figure 1177: Data Format Structure for 2HCSH, Convective Stratiform Heating

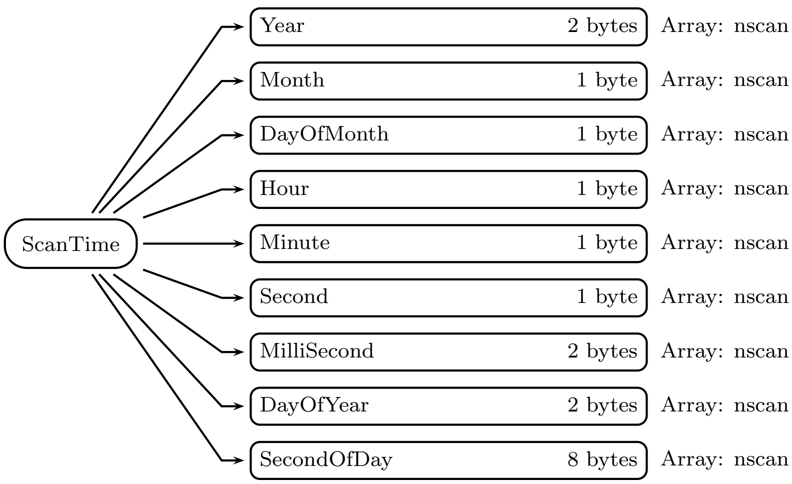


Figure 1178: Data Format Structure for 2HCSH, ScanTime

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Swath (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

latentHeating (4-byte float, array size: nlayer x nray x nscan):
Latent Heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyHeating (4-byte float, array size: nlayer x nray x nscan):
Horizontal eddy flux heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyHeating (4-byte float, array size: nlayer x nray x nscan):
Vertical eddy flux heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

lwRadiativeHeating (4-byte float, array size: nlayer x nray x nscan):
Longwave radiative heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

swRadiativeHeating (4-byte float, array size: nlayer x nray x nscan):
Shortwave radiative heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyMoistening (4-byte float, array size: nlayer x nray x nscan):
Horizontal eddy moistening heating flux. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyMoistening (4-byte float, array size: nlayer x nray x nscan):
Vertical eddy moistening heating flux. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

microMoistening (4-byte float, array size: nlayer x nray x nscan):
Apparent moistening due to microphysical processes. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

rainType (2-byte integer, array size: nray x nscan):
Rain type from Level 2 PR Rain Type. Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nray x nscan):
Mean estimated surface precipitation rate from Level 2 Combined. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

localZenithAngle (4-byte float, array size: nray x nscan):
Local zenith angle. Values are in degrees. Special values are defined as:

-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_2HCSH_H_
#define _TK_2HCSH_H_

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2HCSH_SWATH_
#define _L2HCSH_SWATH_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float latentHeating[49][80];
    float hEddyHeating[49][80];
    float vEddyHeating[49][80];
    float lwRadiativeHeating[49][80];
    float swRadiativeHeating[49][80];
    float hEddyMoistening[49][80];
    float vEddyMoistening[49][80];
    float microMoistening[49][80];
    short rainType[49];
    float surfacePrecipRate[49];
    float localZenithAngle[49];
} L2HCSH_SWATH;
```

```
#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2HCSH_SWATH/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 latentHeating(80,49)
    REAL*4 hEddyHeating(80,49)
    REAL*4 vEddyHeating(80,49)
    REAL*4 lwRadiativeHeating(80,49)
    REAL*4 swRadiativeHeating(80,49)
    REAL*4 hEddyMoistening(80,49)
    REAL*4 vEddyMoistening(80,49)
    REAL*4 microMoistening(80,49)
    INTEGER*2 rainType(49)
    REAL*4 surfacePrecipRate(49)
    REAL*4 localZenithAngle(49)
END STRUCTURE
```

5.68 3GCSH - Gridded Orbital Convective Stratiform Heating from Combined

3GCSH, "Gridded Orbital Convective Stratiform Heating from Combined", produces 0.25^o x 0.25^o orbital apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. The PI is Dr. Wei-Kuo Tao. The granule size is one orbit. The following sections describe the structure and contents of the format.

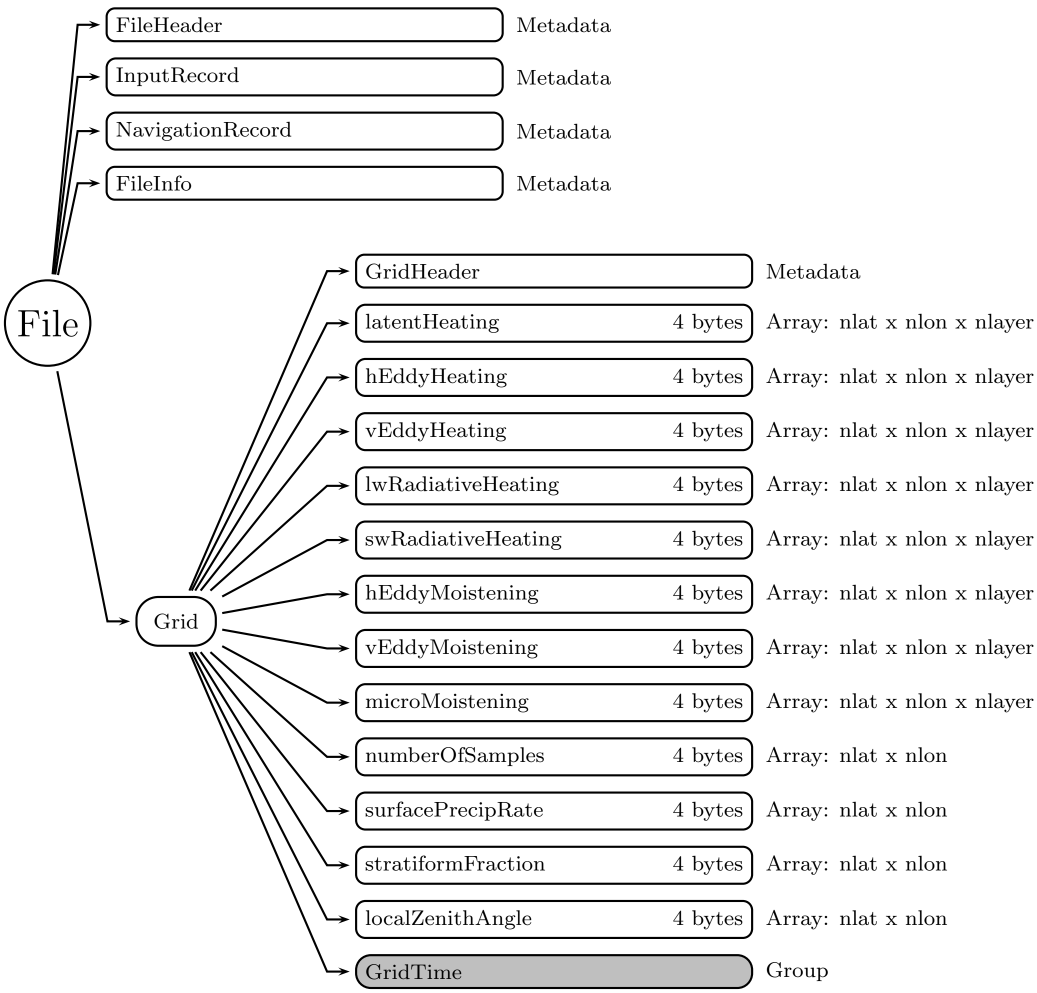


Figure 1179: Data Format Structure for 3GCSH, Gridded Orbital Convective Stratiform Heating from Combined

Dimension definitions:

nlat	536	Number of 0.25^o grid intervals of latitude from 67^{o}S to 67^{o}N.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180^{o}W to 180^{o}E.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

Figure 1179 through Figure 1180 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level

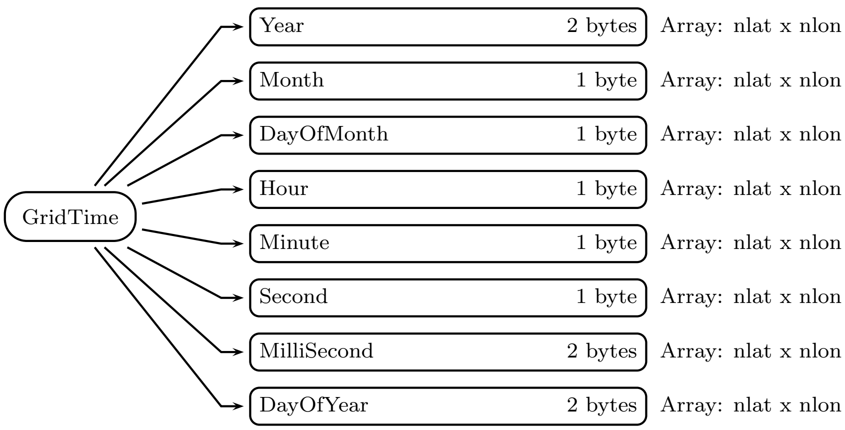


Figure 1180: Data Format Structure for 3GCSH, GridTime

1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

latentHeating (4-byte float, array size: nlat x nlon x nlayer):
Latentheating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Horizontal eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Vertical eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

lwRadiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Longwave radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:

-9999.9 Missing value

swRadiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Shortwave radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:

-9999.9 Missing value

hEddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Horizontal eddy moistening heating flux. Values range from -50 to 100 K/hr. Special values are defined as:

-9999.9 Missing value

vEddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Vertical eddy moistening heating flux. Values range from -50 to 100 K/hr. Special values are defined as:

-9999.9 Missing value

microMoistening (4-byte float, array size: nlat x nlon x nlayer):
Apparent moistening due to microphysical processes. Values range from -50 to 100 K/hr. Special values are defined as:

-9999.9 Missing value

numberOfSamples (4-byte integer, array size: nlat x nlon):
Number of samples in 0.25^o x 0.25^o boxes. Values range from 0 to 500000. Special values are defined as:

-9999 Missing value

surfacePrecipRate (4-byte float, array size: nlat x nlon):
Mean estimated surface precipitation rate from Level 2 Combined. Values range from 0 to 3000 mm/hr. Special values are defined as:

-9999.9 Missing value

stratiformFraction (4-byte float, array size: nlat x nlon):
Ratio of stratiform to total surface rain rate from Level 2 PR. Values range from 0 to 1. Special values are defined as:

-9999.9 Missing value

localZenithAngle (4-byte float, array size: nlat x nlon):
Local zenith angle. Values are in degrees. Special values are defined as:

-9999.9 Missing value

GridTime (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3GCSH_H_
#define _TK_3GCSH_H_

#ifndef _L3GCSH_GRIDTIME_
#define _L3GCSH_GRIDTIME_

typedef struct {
    short Year[1440][536];
    signed char Month[1440][536];
    signed char DayOfMonth[1440][536];
    signed char Hour[1440][536];
    signed char Minute[1440][536];
    signed char Second[1440][536];
```

```
    short MilliSecond[1440][536];
    short DayOfYear[1440][536];
} L3GCSH_GRIDTIME;

#endif

#ifndef _L3GCSH_GRID_
#define _L3GCSH_GRID_

typedef struct {
    float latentHeating[80][1440][536];
    float hEddyHeating[80][1440][536];
    float vEddyHeating[80][1440][536];
    float lwRadiativeHeating[80][1440][536];
    float swRadiativeHeating[80][1440][536];
    float hEddyMoistening[80][1440][536];
    float vEddyMoistening[80][1440][536];
    float microMoistening[80][1440][536];
    int numberOfSamples[1440][536];
    float surfacePrecipRate[1440][536];
    float stratiformFraction[1440][536];
    float localZenithAngle[1440][536];
    L3GCSH_GRIDTIME GridTime;
} L3GCSH_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GCSH_GRIDTIME/
    INTEGER*2 Year(536,1440)
    BYTE Month(536,1440)
    BYTE DayOfMonth(536,1440)
    BYTE Hour(536,1440)
    BYTE Minute(536,1440)
    BYTE Second(536,1440)
    INTEGER*2 MilliSecond(536,1440)
    INTEGER*2 DayOfYear(536,1440)
END STRUCTURE

STRUCTURE /L3GCSH_GRID/
```

```
    REAL*4 latentHeating(536,1440,80)
    REAL*4 hEddyHeating(536,1440,80)
    REAL*4 vEddyHeating(536,1440,80)
    REAL*4 lwRadiativeHeating(536,1440,80)
    REAL*4 swRadiativeHeating(536,1440,80)
    REAL*4 hEddyMoistening(536,1440,80)
    REAL*4 vEddyMoistening(536,1440,80)
    REAL*4 microMoistening(536,1440,80)
    INTEGER*4 numberOfSamples(536,1440)
    REAL*4 surfacePrecipRate(536,1440)
    REAL*4 stratiformFraction(536,1440)
    REAL*4 localZenithAngle(536,1440)
    RECORD /L3GCSH_GRIDTIME/ GridTime
END STRUCTURE
```

5.69 3HCSH - Monthly Convective Stratiform Heating from Combined

3HCSH, "Monthly Convective Stratiform Heating from Combined", produces 0.25^o x 0.25^o monthly apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. The PI is Dr. Wei-Kuo Tao. The granule size is one month. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	536	Number of 0.25^o grid intervals of latitude from 67^oS to 67^oN.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

Figure 1181 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

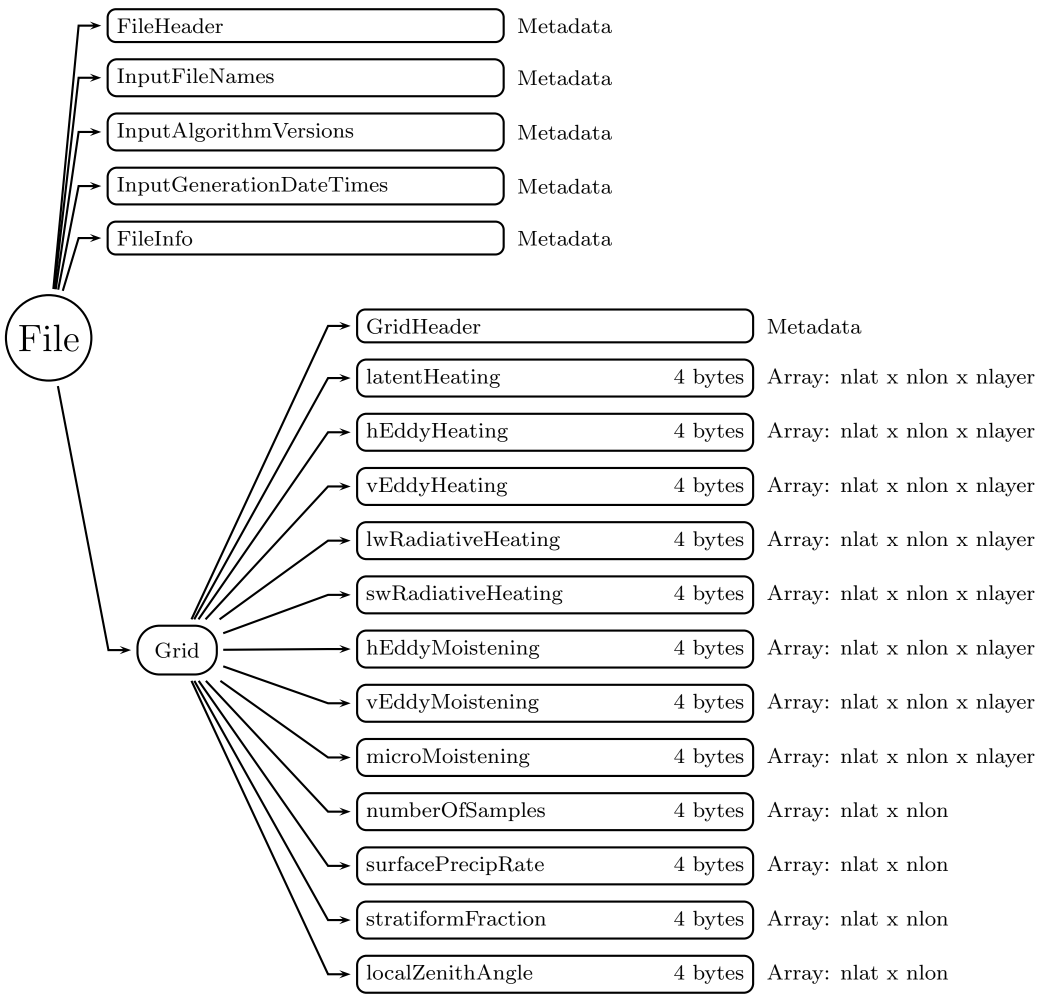


Figure 1181: Data Format Structure for 3HCSH, Monthly Convective Stratiform Heating from Combined

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

latentHeating (4-byte float, array size: nlat x nlon x nlayer):
Latentheating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Horizontal eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Vertical eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

lwRadiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Longwave radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

swRadiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Shortwave radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Horizontal eddy moistening heating flux. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Vertical eddy moistening heating flux. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

microMoistening (4-byte float, array size: nlat x nlon x nlayer):
Apparent moistening due to microphysical processes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

numberOfSamples (4-byte integer, array size: nlat x nlon):
Number of samples in 0.25^o x 0.25^o boxes for one month. Values range from 0 to 500000. Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nlat x nlon):
Monthly estimated surface precipitation rate from Level 3 combined. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

stratiformFraction (4-byte float, array size: nlat x nlon):
Ratio of stratiform to total surface rain rate from Level 3 PR. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

localZenithAngle (4-byte float, array size: nlat x nlon):
Local zenith angle. Values are in degrees. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3HCSH_H_
#define _TK_3HCSH_H_

#ifndef _L3HCSH_GRID_
#define _L3HCSH_GRID_

typedef struct {
    float latentHeating[80][1440][536];
    float hEddyHeating[80][1440][536];
    float vEddyHeating[80][1440][536];
    float lwRadiativeHeating[80][1440][536];
    float swRadiativeHeating[80][1440][536];
    float hEddyMoistening[80][1440][536];
    float vEddyMoistening[80][1440][536];
    float microMoistening[80][1440][536];
    int numberOfSamples[1440][536];
    float surfacePrecipRate[1440][536];
    float stratiformFraction[1440][536];
    float localZenithAngle[1440][536];
} L3HCSH_GRID;
```

```
#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3HCSH_GRID/
    REAL*4 latentHeating(536,1440,80)
    REAL*4 hEddyHeating(536,1440,80)
    REAL*4 vEddyHeating(536,1440,80)
    REAL*4 lwRadiativeHeating(536,1440,80)
    REAL*4 swRadiativeHeating(536,1440,80)
    REAL*4 hEddyMoistening(536,1440,80)
    REAL*4 vEddyMoistening(536,1440,80)
    REAL*4 microMoistening(536,1440,80)
    INTEGER*4 numberOfSamples(536,1440)
    REAL*4 surfacePrecipRate(536,1440)
    REAL*4 stratiformFraction(536,1440)
    REAL*4 localZenithAngle(536,1440)
END STRUCTURE
```

5.70 2HCSHT - Convective Stratiform Heating

2HCSHT, "Convective Stratiform Heating," produces orbital apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. The PI is Dr. Tao. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

Figure 1182 through Figure 1183 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

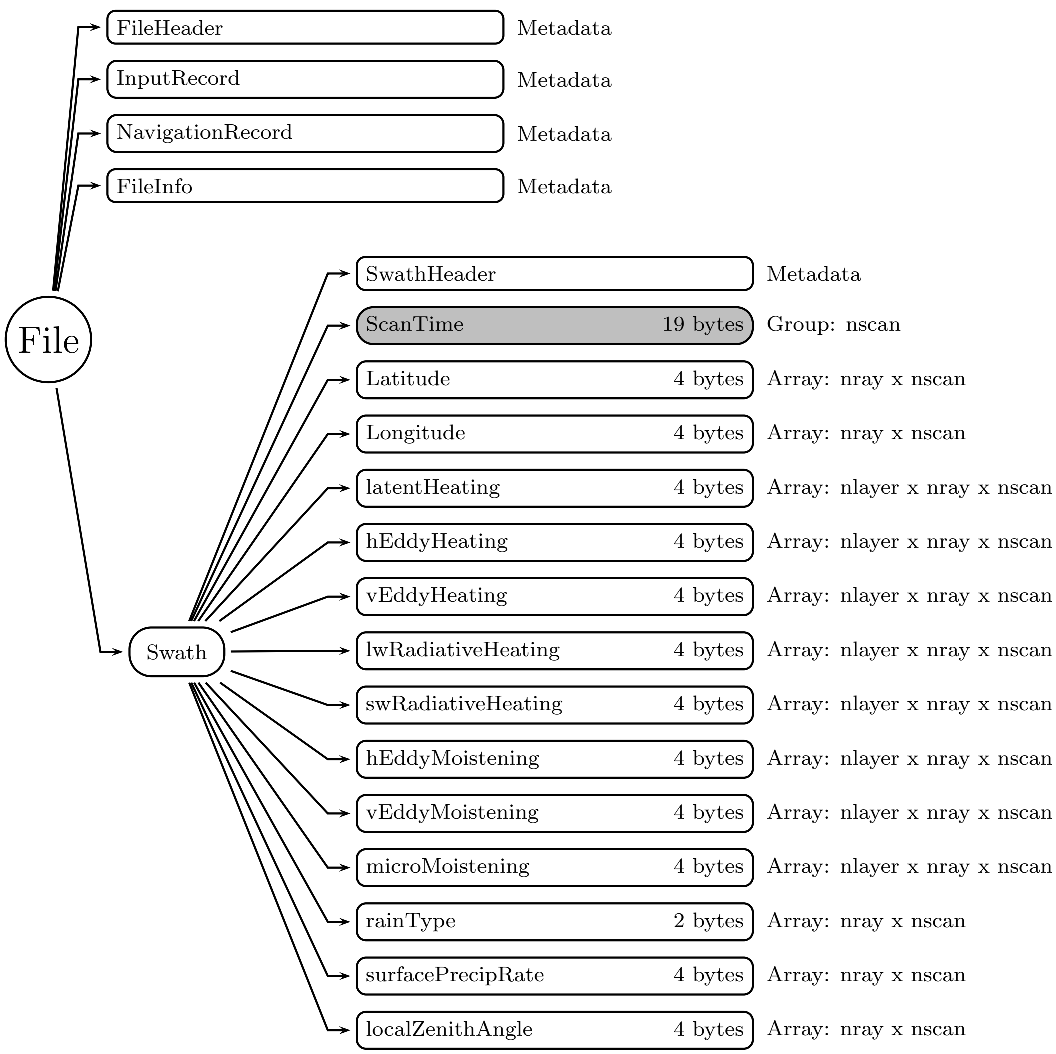


Figure 1182: Data Format Structure for 2HCSHT, Convective Stratiform Heating

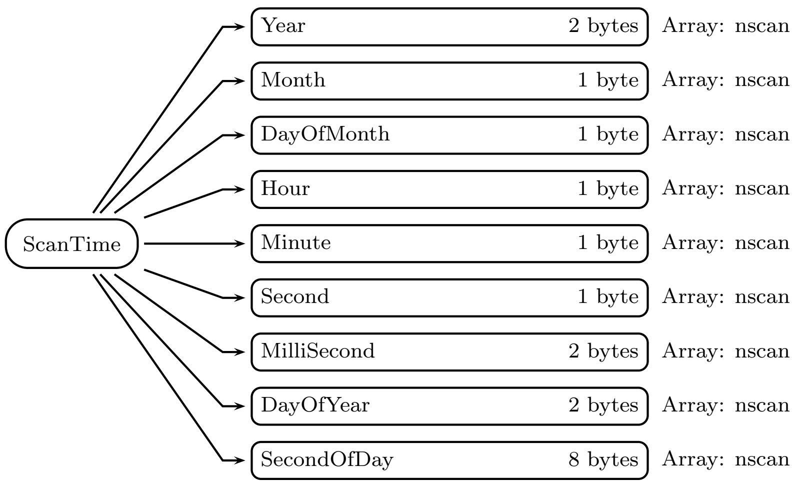


Figure 1183: Data Format Structure for 2HCSHT, ScanTime

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Swath (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: nray x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: nray x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

latentHeating (4-byte float, array size: nlayer x nray x nscan):
Latent Heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyHeating (4-byte float, array size: nlayer x nray x nscan):
Horizontal eddy flux heating. Values range from -400 to 400 K/hr. Special values are

defined as:
-9999.9 Missing value

vEddyHeating (4-byte float, array size: nlayer x nray x nscan):
Vertical eddy flux heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

lwRadiativeHeating (4-byte float, array size: nlayer x nray x nscan):
Longwave radiative heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

swRadiativeHeating (4-byte float, array size: nlayer x nray x nscan):
Shortwave radiative heating. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyMoistening (4-byte float, array size: nlayer x nray x nscan):
Horizontal eddy moistening heating flux. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyMoistening (4-byte float, array size: nlayer x nray x nscan):
Vertical eddy moistening heating flux. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

microMoistening (4-byte float, array size: nlayer x nray x nscan):
Apparent moistening due to microphysical processes. Values range from -400 to 400 K/hr. Special values are defined as:
-9999.9 Missing value

rainType (2-byte integer, array size: nray x nscan):
Rain type from Level 2 PR Rain Type. Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nray x nscan):
Mean estimated surface precipitation rate from Level 2 Combined. Values range from 0 to 500 mm/hr. Special values are defined as:
-9999.9 Missing value

localZenithAngle (4-byte float, array size: nray x nscan):
Local zenith angle. Values are in degrees. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_2HCSHT_H_
#define _TK_2HCSHT_H_
```

```
#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2HCSHT_SWATH_
#define _L2HCSHT_SWATH_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    float latentHeating[49][80];
    float hEddyHeating[49][80];
    float vEddyHeating[49][80];
    float lwRadiativeHeating[49][80];
    float swRadiativeHeating[49][80];
    float hEddyMoistening[49][80];
    float vEddyMoistening[49][80];
    float microMoistening[49][80];
    short rainType[49];
    float surfacePrecipRate[49];
    float localZenithAngle[49];
} L2HCSHT_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2HCSHT_SWATH/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 latentHeating(80,49)
    REAL*4 hEddyHeating(80,49)
    REAL*4 vEddyHeating(80,49)
    REAL*4 lwRadiativeHeating(80,49)
    REAL*4 swRadiativeHeating(80,49)
    REAL*4 hEddyMoistening(80,49)
    REAL*4 vEddyMoistening(80,49)
    REAL*4 microMoistening(80,49)
    INTEGER*2 rainType(49)
    REAL*4 surfacePrecipRate(49)
    REAL*4 localZenithAngle(49)
END STRUCTURE
```

5.71 3GCSHT - Gridded Orbital Convective Stratiform Heating from Combined

3GCSHT, "Gridded Orbital Convective Stratiform Heating from Combined", produces 0.25^o x 0.25^o orbital apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. The PI is Dr. Wei-Kuo Tao. The granule size is one orbit. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	536	Number of 0.25^o grid intervals of latitude from 67^oS to 67^oN.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

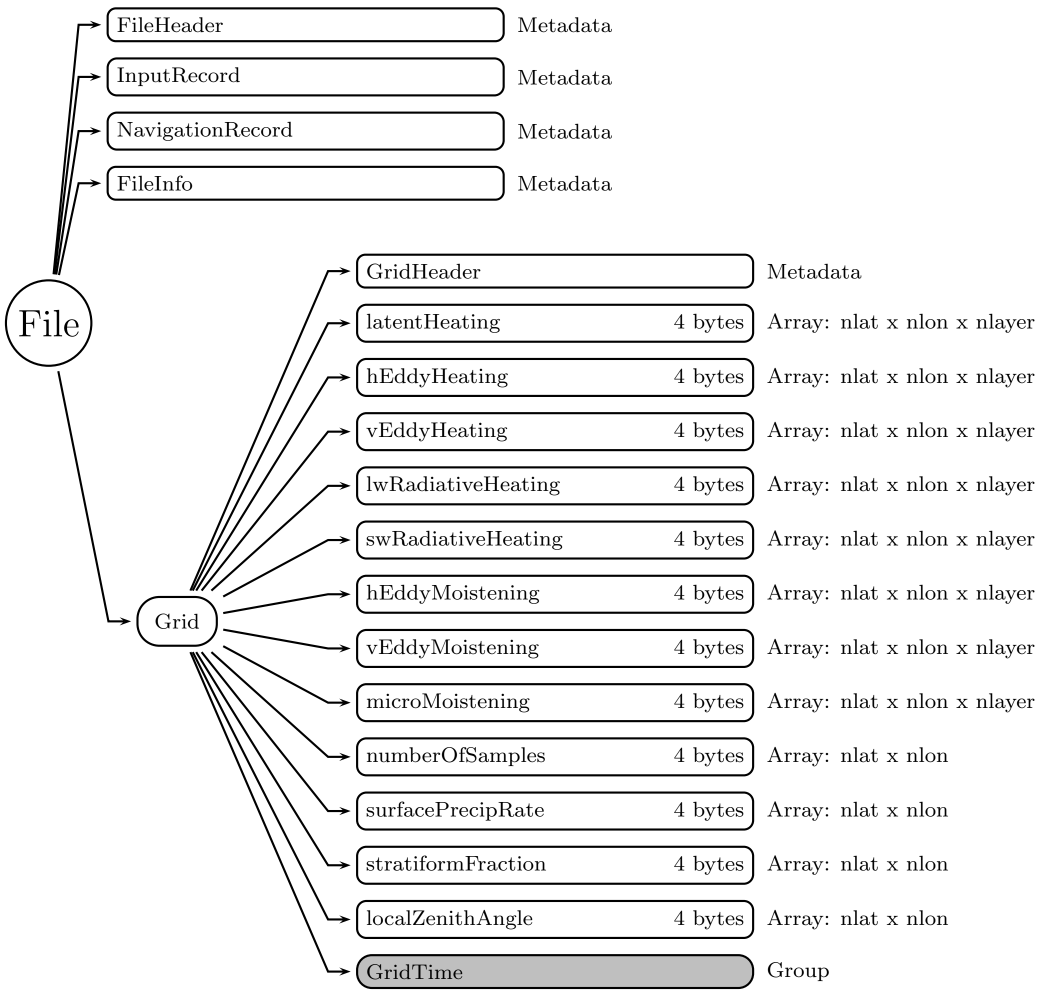


Figure 1184: Data Format Structure for 3GCSHT, Gridded Orbital Convective Stratiform Heating from Combined

Figure 1184 through Figure 1185 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in

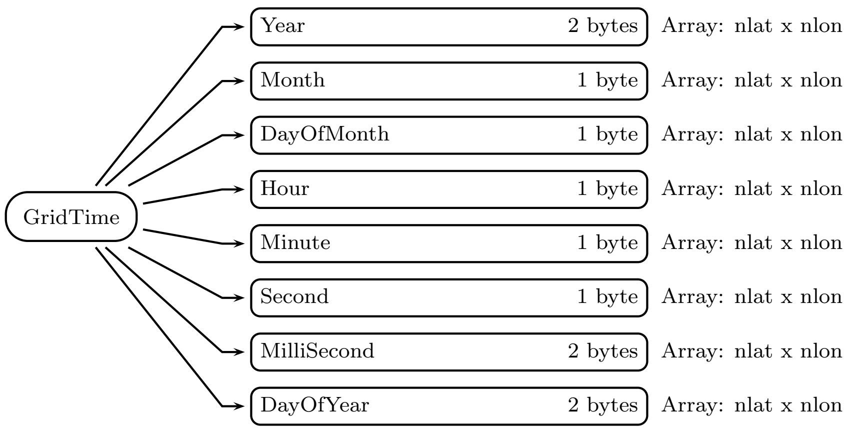


Figure 1185: Data Format Structure for 3GCSHT, GridTime

Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

latentHeating (4-byte float, array size: nlat x nlon x nlayer):
Latentheating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Horizontal eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Vertical eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

lwRadiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Longwave radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

swRadiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Shortwave radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Horizontal eddy moistening heating flux. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Vertical eddy moistening heating flux. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

microMoistening (4-byte float, array size: nlat x nlon x nlayer):
Apparent moistening due to microphysical processes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

numberOfSamples (4-byte integer, array size: nlat x nlon):
Number of samples in 0.25^o x 0.25^o boxes. Values range from 0 to 500000. Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nlat x nlon):
Mean estimated surface precipitation rate from Level 2 Combined. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

stratiformFraction (4-byte float, array size: nlat x nlon):
Ratio of stratiform to total surface rain rate from Level 2 PR. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

localZenithAngle (4-byte float, array size: nlat x nlon):
Local zenith angle. Values are in degrees. Special values are defined as:
-9999.9 Missing value

GridTime (Group)

A UTC time associated with the grid box.

Year (2-byte integer, array size: nlat x nlon):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nlat x nlon):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nlat x nlon):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nlat x nlon):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nlat x nlon):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nlat x nlon):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nlat x nlon):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nlat x nlon):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

C Structure Header file:

```
#ifndef _TK_3GCSHT_H_
#define _TK_3GCSHT_H_

#ifndef _L3GCSHT_GRIDTIME_
#define _L3GCSHT_GRIDTIME_

typedef struct {
    short Year[1440][536];
    signed char Month[1440][536];
    signed char DayOfMonth[1440][536];
    signed char Hour[1440][536];
    signed char Minute[1440][536];
    signed char Second[1440][536];
    short MilliSecond[1440][536];
    short DayOfYear[1440][536];
} L3GCSHT_GRIDTIME;

#endif
```

```
#ifndef _L3GCSHT_GRID_
#define _L3GCSHT_GRID_

typedef struct {
    float latentHeating[80][1440][536];
    float hEddyHeating[80][1440][536];
    float vEddyHeating[80][1440][536];
    float lwRadiativeHeating[80][1440][536];
    float swRadiativeHeating[80][1440][536];
    float hEddyMoistening[80][1440][536];
    float vEddyMoistening[80][1440][536];
    float microMoistening[80][1440][536];
    int numberOfSamples[1440][536];
    float surfacePrecipRate[1440][536];
    float stratiformFraction[1440][536];
    float localZenithAngle[1440][536];
    L3GCSHT_GRIDTIME GridTime;
} L3GCSHT_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3GCSHT_GRIDTIME/
    INTEGER*2 Year(536,1440)
    BYTE Month(536,1440)
    BYTE DayOfMonth(536,1440)
    BYTE Hour(536,1440)
    BYTE Minute(536,1440)
    BYTE Second(536,1440)
    INTEGER*2 MilliSecond(536,1440)
    INTEGER*2 DayOfYear(536,1440)
END STRUCTURE

STRUCTURE /L3GCSHT_GRID/
    REAL*4 latentHeating(536,1440,80)
    REAL*4 hEddyHeating(536,1440,80)
    REAL*4 vEddyHeating(536,1440,80)
    REAL*4 lwRadiativeHeating(536,1440,80)
    REAL*4 swRadiativeHeating(536,1440,80)
```

```
    REAL*4 hEddyMoistening(536,1440,80)
    REAL*4 vEddyMoistening(536,1440,80)
    REAL*4 microMoistening(536,1440,80)
    INTEGER*4 numberOfSamples(536,1440)
    REAL*4 surfacePrecipRate(536,1440)
    REAL*4 stratiformFraction(536,1440)
    REAL*4 localZenithAngle(536,1440)
    RECORD /L3GCSHT_GRIDTIME/ GridTime
END STRUCTURE
```

5.72 3HCSHT - Monthly Convective Stratiform Heating from Combined

3HCSHT, "Monthly Convective Stratiform Heating from Combined", produces 0.25^o x 0.25^o monthly apparent heating profiles from surface convective rainfall rate and surface stratiform rainfall rate. The PI is Dr. Wei-Kuo Tao. The granule size is one month. The following sections describe the structure and contents of the format.

Dimension definitions:

nlat	536	Number of 0.25^o grid intervals of latitude from 67^oS to 67^oN.
nlon	1440	Number of 0.25^o grid intervals of longitude from 180^oW to 180^oE.
nlayer	80	Number of layers at the fixed heights of 0.00-0.25 km, 0.25-0.50 km, ..., 19.50-19.75 km, and 19.75-20.00 km.

Figure 1186 shows the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputFileNames (Metadata):
InputFileNames contains a list of input file names for this granule. See Metadata for GPM Products for details.

InputAlgorithmVersions (Metadata):
InputAlgorithmVersions contains a list of input algorithm versions for this granule. See Metadata for GPM Products for details.

InputGenerationDateTimes (Metadata):
InputGenerationDateTimes contains a list of input generation datetimes. See Metadata for GPM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

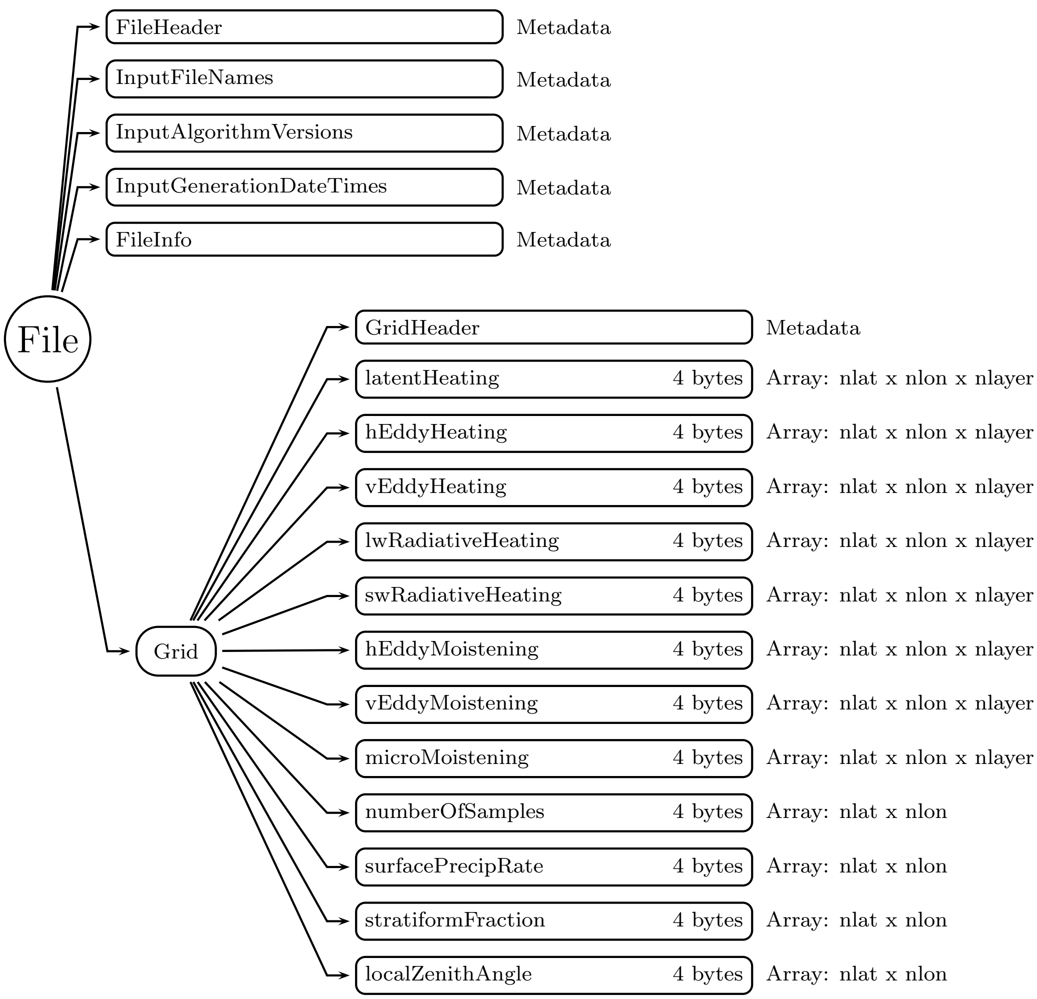


Figure 1186: Data Format Structure for 3HCSHT, Monthly Convective Stratiform Heating from Combined

Grid (Grid)

GridHeader (Metadata):
GridHeader contains metadata defining the grids in the grid structure. See Metadata for GPM Products for details.

latentHeating (4-byte float, array size: nlat x nlon x nlayer):
Latentheating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Horizontal eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyHeating (4-byte float, array size: nlat x nlon x nlayer):
Vertical eddy flux heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

lwRadiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Longwave radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

swRadiativeHeating (4-byte float, array size: nlat x nlon x nlayer):
Shortwave radiative heating. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

hEddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Horizontal eddy moistening heating flux. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

vEddyMoistening (4-byte float, array size: nlat x nlon x nlayer):
Vertical eddy moistening heating flux. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

microMoistening (4-byte float, array size: nlat x nlon x nlayer):
Apparent moistening due to microphysical processes. Values range from -50 to 100 K/hr. Special values are defined as:
-9999.9 Missing value

numberOfSamples (4-byte integer, array size: nlat x nlon):
Number of samples in 0.25^o x 0.25^o boxes for one month. Values range from 0 to 500000.

Special values are defined as:
-9999 Missing value

surfacePrecipRate (4-byte float, array size: nlat x nlon):
Monthly estimated surface precipitation rate from Level 3 combined. Values range from 0 to 3000 mm/hr. Special values are defined as:
-9999.9 Missing value

stratiformFraction (4-byte float, array size: nlat x nlon):
Ratio of stratiform to total surface rain rate from Level 3 PR. Values range from 0 to 1. Special values are defined as:
-9999.9 Missing value

localZenithAngle (4-byte float, array size: nlat x nlon):
Local zenith angle. Values are in degrees. Special values are defined as:
-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_3HCSHT_H_
#define _TK_3HCSHT_H_

#ifndef _L3HCSHT_GRID_
#define _L3HCSHT_GRID_

typedef struct {
    float latentHeating[80][1440][536];
    float hEddyHeating[80][1440][536];
    float vEddyHeating[80][1440][536];
    float lwRadiativeHeating[80][1440][536];
    float swRadiativeHeating[80][1440][536];
    float hEddyMoistening[80][1440][536];
    float vEddyMoistening[80][1440][536];
    float microMoistening[80][1440][536];
    int numberOfSamples[1440][536];
    float surfacePrecipRate[1440][536];
    float stratiformFraction[1440][536];
    float localZenithAngle[1440][536];
} L3HCSHT_GRID;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L3HCSHT_GRID/
    REAL*4 latentHeating(536,1440,80)
    REAL*4 hEddyHeating(536,1440,80)
    REAL*4 vEddyHeating(536,1440,80)
    REAL*4 lwRadiativeHeating(536,1440,80)
    REAL*4 swRadiativeHeating(536,1440,80)
    REAL*4 hEddyMoistening(536,1440,80)
    REAL*4 vEddyMoistening(536,1440,80)
    REAL*4 microMoistening(536,1440,80)
    INTEGER*4 numberOfSamples(536,1440)
    REAL*4 surfacePrecipRate(536,1440)
    REAL*4 stratiformFraction(536,1440)
    REAL*4 localZenithAngle(536,1440)
END STRUCTURE
```