GPM Level 3 GPROF Version 07 Information

Version 07 Release Notes:

This Level 3 GPROF Version 07 release involves the following changes from the previous (Version 05) release:

1. Product format change:
   Added dimension variables such as lat, lon, layer, lat_bnds, lon_bnds, layer_bnds. Removed cloudIce variable but added graupel and latentHeating variables.

2. Total number of precipitation pixels (npixPrecipitation):
   In Version 05, pixels with pixelStatus=0 and surfacePrecipitation > 0 are counted as precipitation pixels. In Version 07, pixels with pixelStatus=0, surfacePrecipitation > 0 and precipitationYesNoFlag=1 are counted as precipitation pixels.

Description:

The L3GPROF algorithm provides monthly and daily mean precipitation and related retrieved parameters from the Level 2 GPROF precipitation profiling algorithm for the GPM core and constellation satellites.

Each L3GPROF product contains global 0.25° x 0.25° gridded monthly/daily unconditional means and pixel counts. Monthly product filenames start with 3A-MO or 3A-CLIM-MO, and daily product filenames start with 3A-DAY or 3A-CLIM-DAY.

For example:
3A-MO.GPM.GMI.GRID2021R1.20161201-S000000-E235959.12.V07A.HDF5
3A-DAY.GPM.GMI.GRID2021R1.20161201-S000000-E235959.336.V07A.HDF5
3A-CLIM-MO.GPM.GMI.GRID2021R1.20161201-S000000-E235959.12.V07A.HDF5
3A-CLIM-DAY.GPM.GMI.GRID2021R1.20161201-S000000-E235959.336.V07A.HDF5

Current available L3GPROF V07 products are listed in the following table:

Product ID	Radiometer	Satellite
3GPROF	AMSR2	GCOM-W1
3GPROF	ATMS	NPP NOAA20
3GPROF	GMI	GPM
3GPROF	MHS	NOAA-18 NOAA-19 METOP-A METOP-B METOP-C
3GPROF	SSMI/S	F16 F17 F18 F19

Product ID	Radiometer	Satellite
3GPROF	TMI	TRMM
3GPROF	AMSR-E	AQUA
3GPROF	AMSU-B	NOAA-15 NOAA-16 NOAA-17
3GPROF	SSMI	F08 F10 F11 F13 F14 F15

Because this product is an accumulation of the Level 2 GPROF retrieval products, much more information is available via the GPROF Level 2 ATBD and file specification documents.

Product Content:

All L3GPROF products have the same data structure and are in HDF5 format. Accumulations are done for each grid over the desired accumulation period (a month or a day), and only pixels with pixelStatus=0 (indicates that the pixel is valid and has a retrieval) in the L2 input files are included in the calculation.

nlat=720 Number of 0.25° grid intervals of latitude from 90° S to 90° N.
nlon=1440 Number of 0.25° grid intervals of longitude from 180° W to 180° E.
nlayer=28 Number of profiling layers. The top of each layer is 0.5, 1.0, 1.5, ...9.5, 10.0, 11.0, ...18.0 Km. The layer tops are heights above the Earth's surface.

npixTotal (4-byte integer, array size: nlat x nlon):
The total number of pixels for each grid.

npixPrecipitation (4-byte integer, array size: nlat x nlon):
The total number of pixels with *surfacePrecipitation > 0* and *precipitationYesNoFlag=1* for each grid.

surfacePrecipitation (4-byte float, array size: nlat x nlon, unit: mm/hr):
The mean of the instantaneous precipitation rate at the surface for each grid.
totalPrecip = sum of surface precipitation
surfacePrecipitation = totalPrecip /npixTotal

convectivePrecipitation (4-byte float, array size: nlat x nlon, unit: mm/hr):
The mean of the instantaneous convective precipitation rate at the surface for each grid.
totalConvectPrecip = sum of convective precipitation
convectivePrecipitation = totalConvectPrecip /npixTotal

frozenPrecipitation (4-byte float, array size: nlat x nlon, unit: mm/hr):
The mean of the instantaneous frozen precipitation rate at the surface for each grid.
totalFrozenPrecip = sum of frozen precipitation
frozenPrecipitation = totalFrozenPrecip /npixTotal

rainWaterPath (4-byte float, array size: nlat x nlon, unit: kg/m^2):
The mean of the total integrated rain water in the vertical atmospheric column for each grid.

totalRainWaterPath = sum of rain water path
rainWaterPath = totalRainWaterPath /npixTotal

cloudWaterPath (4-byte float, array size: nlat x nlon, unit: kg/m^2):
The mean of the total integrated cloud water in the vertical atmospheric column for each grid.

totalCloudWaterPath = sum of cloud water path
cloudWaterPath = totalCloudWaterPath /npixTotal

iceWaterPath (4-byte float, array size: nlat x nlon, unit: kg/m^2):
The mean of the total integrated ice water in the vertical atmospheric column for each grid.

totalIceWaterPath = sum of ice water path
iceWaterPath = totalIceWaterPath /npixTotal

rainWater (4-byte float, array size: nlat x nlon x nlayer, unit: g/m^3):
The mean of the rain water content for each grid at each vertical layer.

A pixel's rain water content value is recovered from the following L2 GPROF parameters:

cn=profileNumber(s) ; s is the specie index, for rainWater s=1
T=temp2mIndex;
cp=clusterProfiles(s,T,layer,cn)
cs=profileScale(s)
rain water content = cs*cp

totalRainWater = sum of rain water content
rainWater = totalRainWater/npixTotal

cloudWater (4-byte float, array size: nlat x nlon x nlayer, unit: g/m^3):
The mean of the cloud liquid water content for each grid at each vertical layer.

A pixel's cloud liquid water content value is recovered from the following L2 parameters:

cn=profileNumber(s) ; s is the specie index, for cloudWater s=2
T=temp2mIndex;
cp=clusterProfiles(s,T,layer,cn)
cs=profileScale(s)
cloud liquid water content = cs*cp

totalCloudWater = sum of cloud liquid water content
cloudWater = totalCloudWater/npixTotal

snow (4-byte float, array size: nlat x nlon x nlayer, unit: g/m^3):
The mean of the snow liquid water content for each grid at each vertical layer.

A pixel's snow liquid water content value is recovered from the following L2 parameters:

cn=profileNumber(s) ; s is the specie index, for snow s=3
T=temp2mIndex;
cp=clusterProfiles(s,T,layer,cn)
cs=profileScale(s)
snow liquid water content = cs*cp

totalSnow = sum of snow liquid water content
snow = totalSnow/npixTotal

graupel (4-byte float, array size: nlat x nlon x nlayer, unit: g/m^3):
The mean of the graupel liquid water content for each grid at each vertical layer.

A pixel's graupel liquid water content value is recovered from the following L2 parameters:

cn=profileNumber(s) ; s is the specie index, for graupel s=4
T=temp2mIndex;
cp=clusterProfiles(s,T,layer,cn)
cs=profileScale(s)
graupel liquid water content = cs*cp

totalGraupel = sum of graupel liquid water content
graupel = totalGraupel/npixTotal

latentHeating (4-byte float, array size: nlat x nlon x nlayer, unit: K/hr):
The mean of the latent heating for each grid at each vertical layer.

A pixel's latent heating value is recovered from the following L2 parameters:

cn=profileNumber(s) ; s is the specie index, for latentHeating s=5
T=temp2mIndex;
cp=clusterProfiles(s,T,layer,cn)
cs=profileScale(s)
latent heating = cs*cp

totalLatentHeating = sum of latent heating
latentHeating = totalLatentHeating/npixTotal

surfaceTypeIndex (4-byte integer, array size: nlat x nlon):
Indicates the type of surface (Range 1 – 99) for each grid. The surfaceTypeIndex has a value of 60 if that grid contains pixels with different surfaceTypeIndex values.

Codes include the following:

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: nlat x nlon):
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 1 and should thus be used with caution for any quantitative analysis. Values range from 0 to 1.

totalQuality0 = total number of pixels with qualityFlag=0
fractionQuality0 = totalQuality0/npixTotal

fractionQuality1 (4-byte float, array size: nlat x nlon):
The fraction of total pixels with qualityFlag equal to 1 (use with caution) for each grid. Values range from 0 to 1.

totalQuality1 = total number of pixels with qualityFlag=1
fractionQuality1 = totalQuality1/npixTotal

fractionQuality2 (4-byte float, array size: nlat x nlon):
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.

totalQuality2 = total number of pixels with qualityFlag=2
fractionQuality2 = totalQuality2/npixTotal

fractionQuality3 (4-byte float, array size: nlat x nlon):
The fraction of total pixels with qualityFlag equal to 3 (use with extreme caution) for each grid. Values range from 0 to 1.

totalQuality3 = total number of pixels with qualityFlag=3
fractionQuality3 = totalQuality3/npixTotal

lon (4-byte float, array size: nlon, unit: degree):
Longitude at the center of 0.25^{o} grid intervals of longitude from 180^{o} W to 180^{o} E. Values range from -180 to 180.

lon_bnds (4-byte float, array size: 2 x nlon, unit: degree):
Longitude of the west and east edges of the grid boxes. Values range from -180 to 180.

lat (4-byte float, array size: nlat, unit: degree):
Latitude at the center of 0.25° grid intervals of latitude from 90° S to 90° N. Values range from -90 to 90.

lat_bnds (4-byte float, array size: 2 x nlat, unit: degree):
Latitude of the south and north edges of the grid boxes. Values range from -90 to 90.

layer (4-byte float, array size: nlayer, unit: Km):
Height at the center of vertical layer. Values range from 0 to 18.

layer_bnds (4-byte float, array size: 2 x nlayer, unit: Km):
Height of the lower and upper edges of the layers. Values range from 0 to 18.

Caveats/Limitations:

The primary limitation of the L3GPROF product is the reliance on a single sensor for each output file, thus limiting the available sampling to two times a day or less, except at high latitudes. In addition, with the exception of the GMI, and TMI sensors, all of the other sensors are in Sun-synchronous orbits, meaning that they observe a given point on the Earth's surface at the same local times each day. Over land regions in particular, this can lead to large sampling errors associated with the diurnal cycle.

Errors due to the limited sampling and differences in the sampling times between Sun-synchronous satellites (e.g., F16, F17, F18, F19, NOAA-18, NOAA-19, NPP, NOAA-20, METOP-A, METOP-B, METOP-C, AQUA, and GCOM-W1) can lead to significant differences in the monthly mean values between satellites/sensors. The sampling errors are largest over land regions with large diurnal cycles in precipitation.

Other sources of error that can significantly impact the L3GPROF products include difficulties over certain surface types such as sea ice, snow, frozen ground, and deserts, and limited sensitivity of the sounder instruments (in particular to light precipitation and/or shallow warm rain systems). The sounders include the ATMS, MHS, and AMSU-B sensors, which do not have channels with sensitivity to the surface and/or lower atmosphere.

References:

1. PPS/Global Precipitation Measurement File Specification for GPM Products.
2. GPM GPROF (Level 2) Algorithm Theoretical Basis Document.

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Acronyms

AMSR2	Advanced Microwave Scanning Radiometer – 2
AMSR-E	AMSR Earth Observing System
AMSU-B	Advanced Microwave Sounding Unit – B
ATBD	Algorithm Theoretical Basis Document
ATMS	Advanced Technology Microwave Sounder
GCOM-W1	Global Change Observation Mission – Water Satellite 1
GMI	GPM Microwave Imager
GPM	Global Precipitation Measurement
GPROF	GPM Profiling Algorithm
HDF	Hierarchical Data Format
L2, L3	Level 2, Level 3
METOP	(European) Meteorological Operational (Satellite) (A, B, and C)
MHS	Microwave Humidity Sounder
NOAA	National Oceanic and Atmospheric Administration
NPP	Suomi National Polar-orbiting Partnership
PPS	Precipitation Processing System
SSMI	Special Sensor for Microwave Imager
SSMI/S	Special Sensor for Microwave Imager/Sounder
TMI	TRMM Microwave Imager
TRMM	Tropical Rainfall Measuring Mission
V05, V07	Version 05, Version 07