DPR algorithm status

Nobuhiro Takahashi
&
DPR algorithm team

PMM meeting 5 Nov. 2019

outline

- Status on DPR algorithm for **V06X**
  - experimental product of full swath KuPR and KaPR
    - Basically, no major change from V06A, but only expand dual-frequency algorithm to outer swath
    - Application of Dual-frequency method for outer swath (KuPR + KaHS) for Level 2
    - Add outer swath products for Level 3
  - Test products: **ITE716**
    - some algorithms were evaluated by **ITE714**
  - Current status: under evaluation
  - **This version will be released after getting approval from JPST**
- V07 (next version up)
  - Next major update
  - Due date of algorithm submission: April 2021

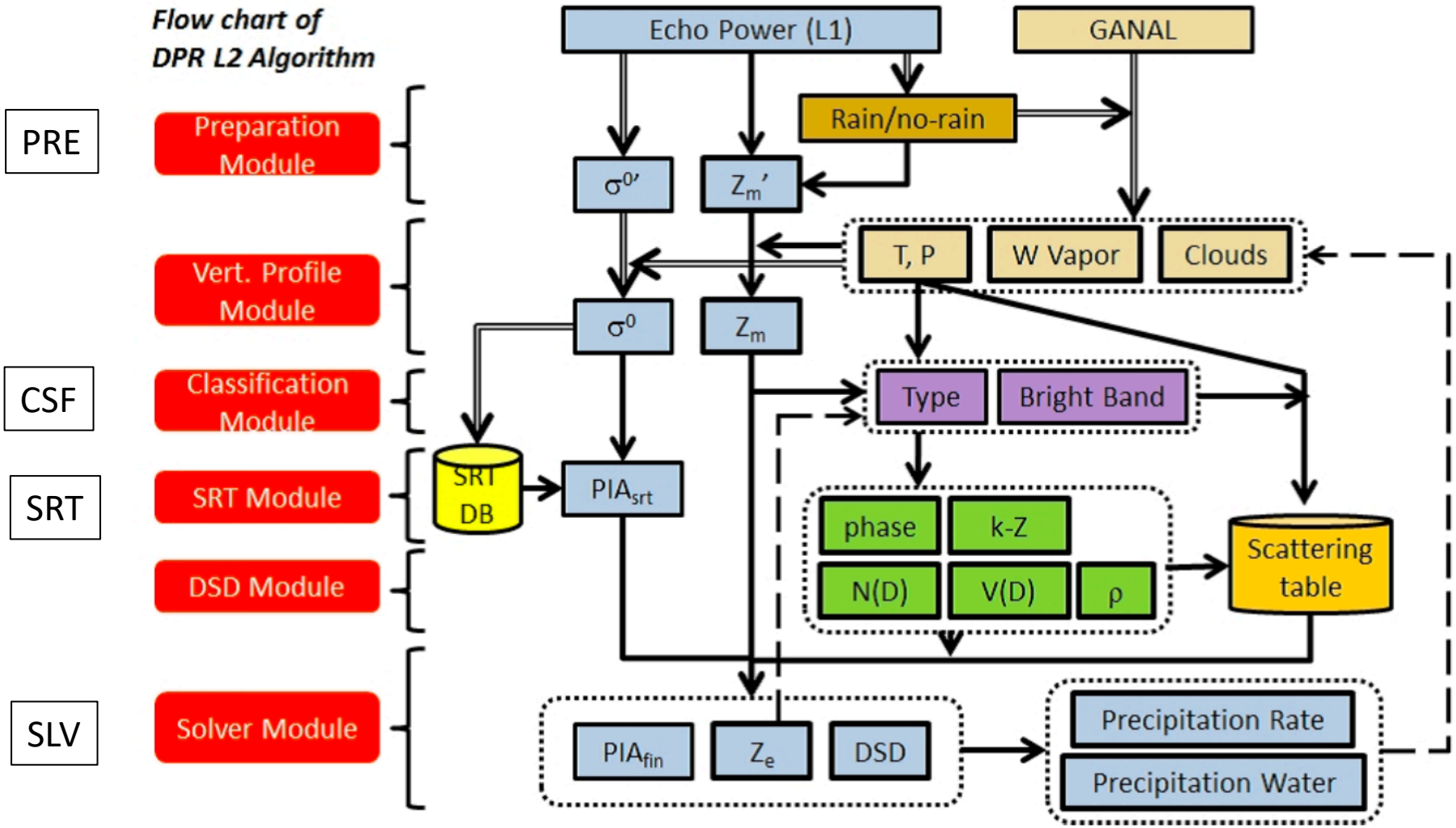

Figure 3.1-1 DPR algorithm flow

Update summary of V06X L2

Module	item
<over all>	File structure
PRE (Kubota and Masaki)	co-location of KaHS and Ku for outer swath data Interpolate data of KaHS profile to 125 m intervals Clutter rejection algorithm for KaHS (outer swath)
CSF (Awaka, Chandra and Le)	Modification of slope method for BB
	Expand dual-freq. method to outer swath
	New output: flagMLquality
	new experimental products: a) flagGraupelHail b) binMixedPhaseTop
SRT (Meneghini and Kim)	Expand dual-freq. method for outer swath
	Development of database for temporal reference of outer swath
SLV (Seto)	Expand dual-freq. method to outer swath

Planned updates for V07

Module	item
<over all>	**Improvement of issues from V06A and V06X**
PRE	rain/no-rain classification
CSF	Improvement of dual-freq. method
	(new) experimental product:
SRT	SRT DB update
SLV	improvement of land precipitation *<epsilon: variable in vertical>* *<PSD model>*

Update summary of V06X L2

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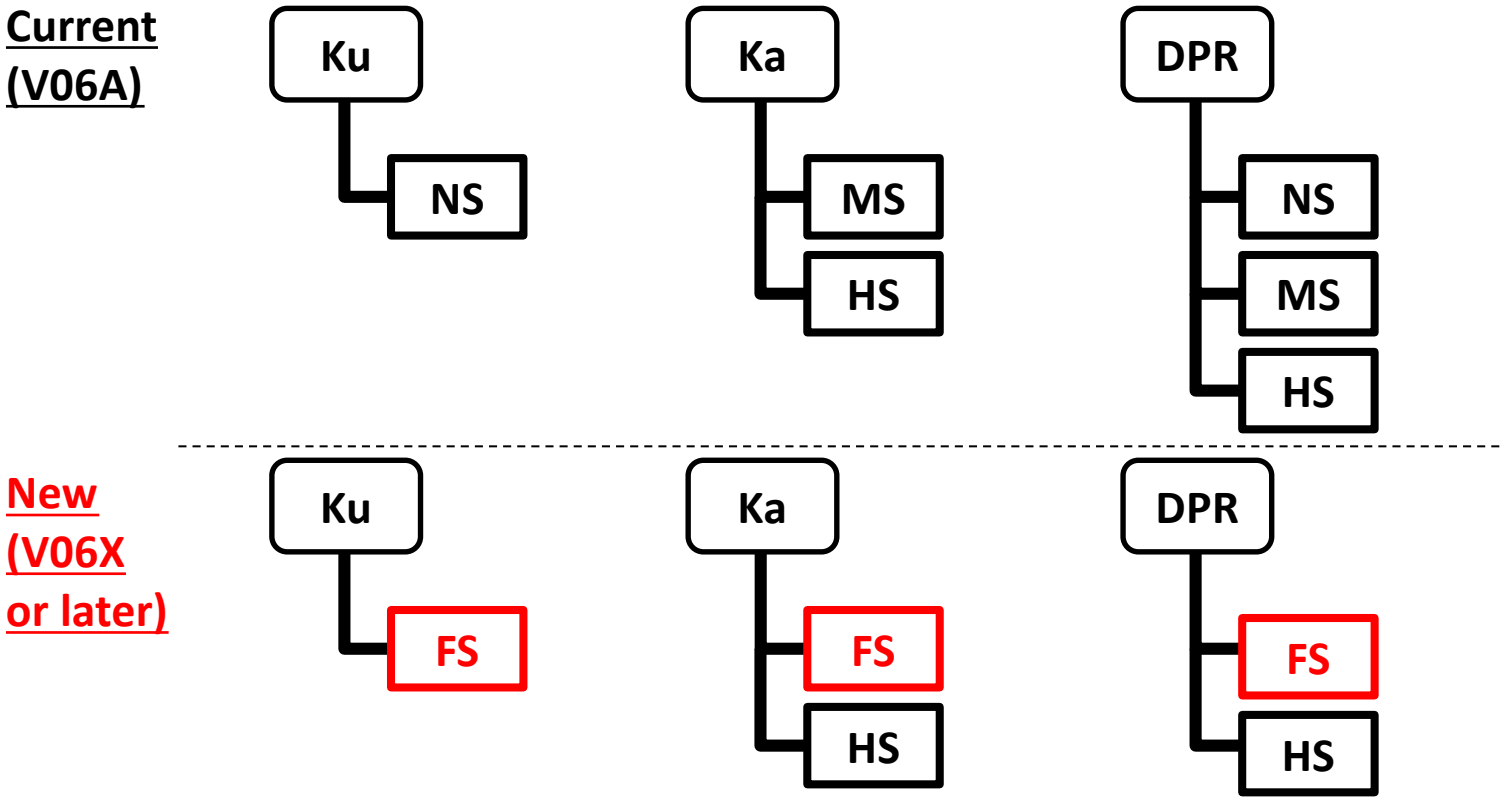
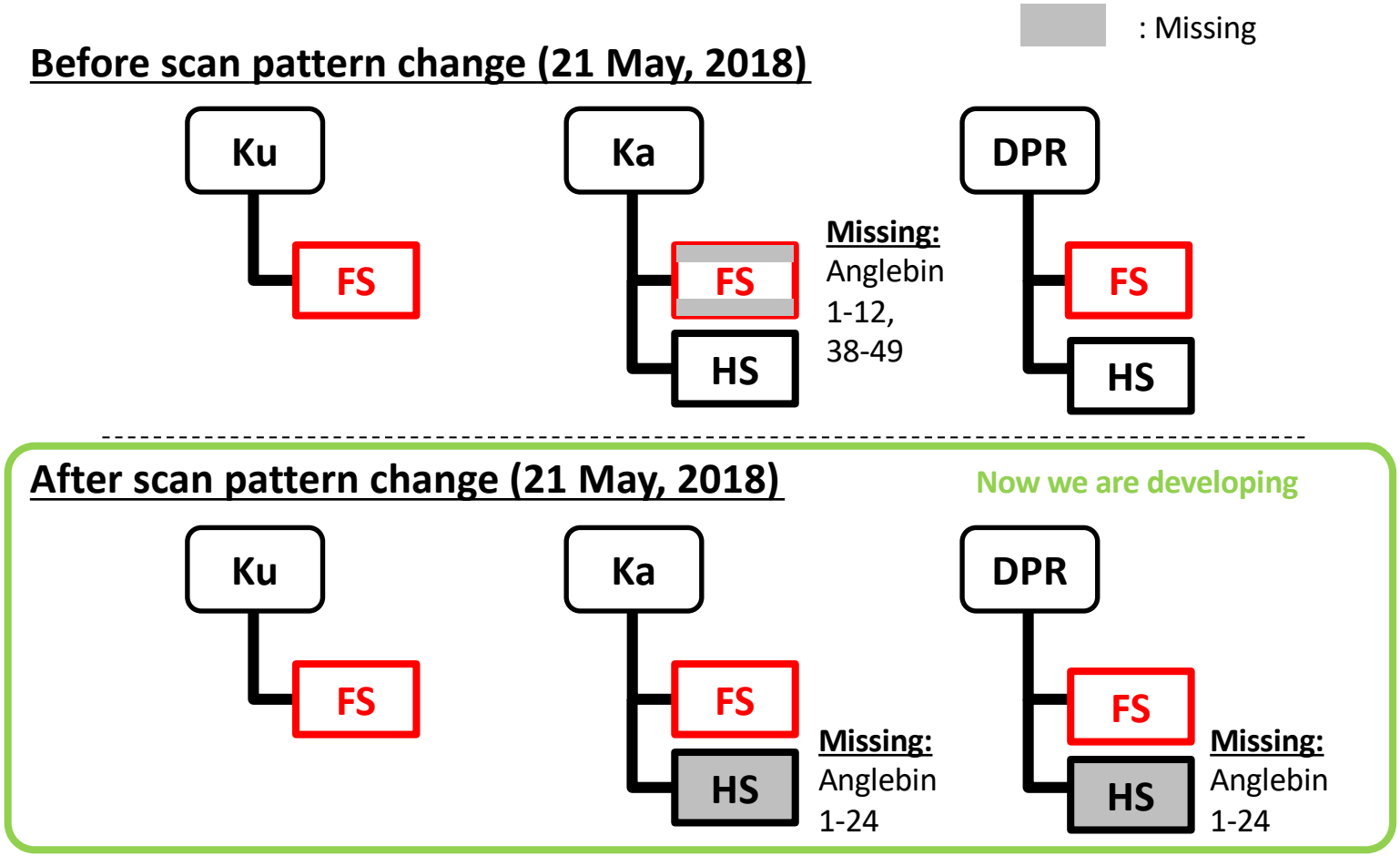
1. File structure



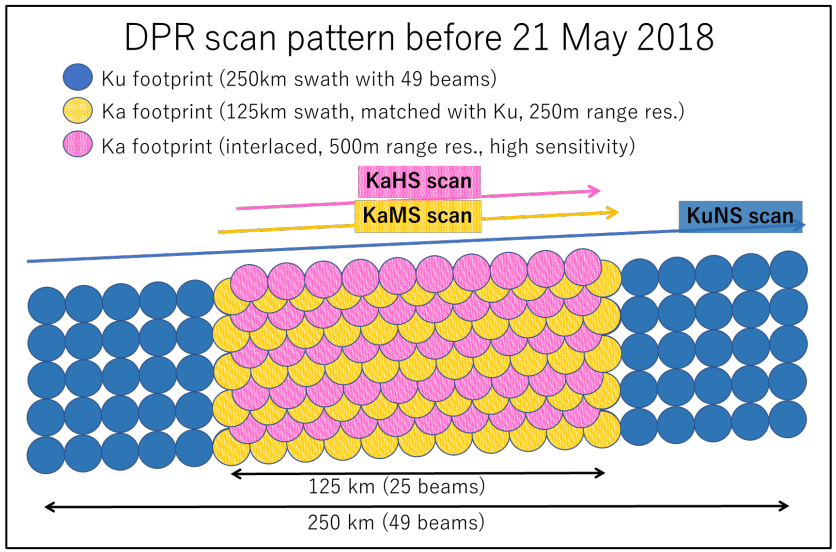
- Implementation of a new Group ‘FS’(Full Scan).
- ‘FS’ has 49 angle-bins and 176 range-bins for each scan.



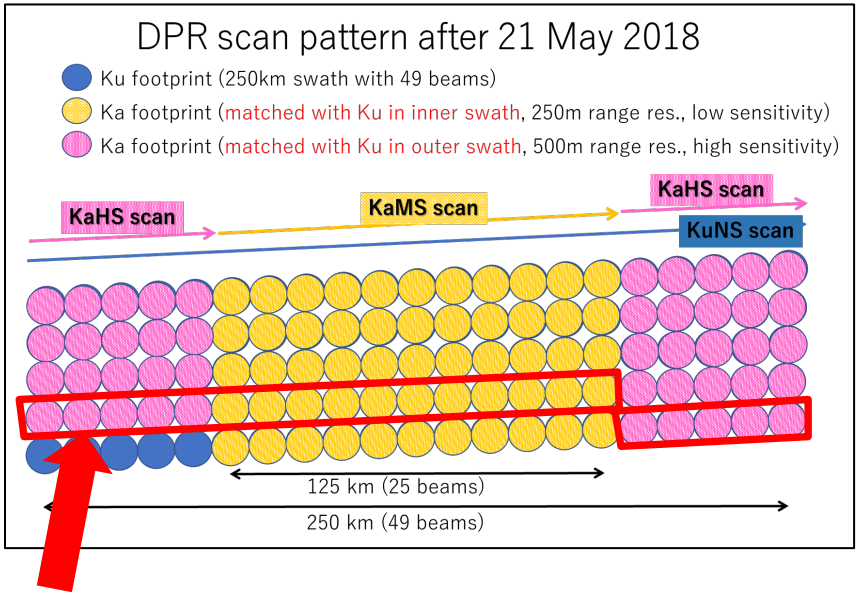
- We can keep the same format even if the KaPR scan pattern was changed.

Change in scan pattern and co-location of footprints

Before May 21, 2018



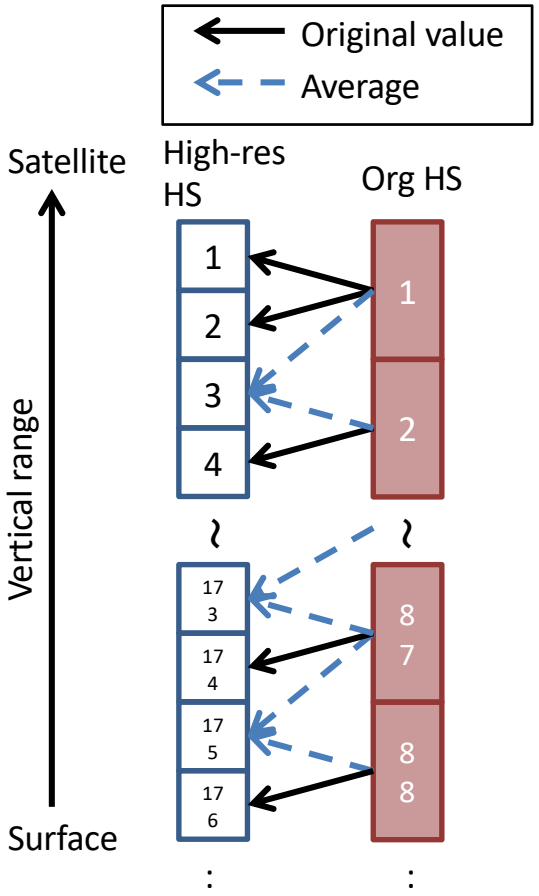
After May 21, 2018



This area of data are stored at the same scan number in V06A.
this discrepancy is improved in V06X .
(Co-located product in V06X.)

Interpolation of KaHS in vertical range

KuPR & KaMS: 250 m range resolution and 125 m range sampling.
KaHS: 500 m range resolution and 250 m range sampling.
For dual frequency algorithm KaHS must have 125 m range intervals.



High resolution HS Rangebin number	Org HS Rangebin number
1	1
2	1
3	mean(1+2)
4	2
5	mean(2+3)
～	～
173	mean(86+87)
174	87
175	mean(87+88)
176	88
:	:

- INP/PRE module prepared interpolated HS.
- Doubled values were stored in variables storing a kind of bin number（e.g. binEllipsoid）.

Update summary of V06X L2

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Update of the CSF module:

- Introduced a filter to the re-classification of stratiform type by the Slope method (ku-band module) so that to avoid the appearance of very high Near Surface rainfall rate. A threshold is chosen to be 20.0 mm/h at the CSF output but more than 20.0 mm/h can appear at the SLV output.

- Appropriate parameter values are selected and used for processing the outer swath dual frequency data by the DFRm method. (Prof. Chandra and Dr. Le.)

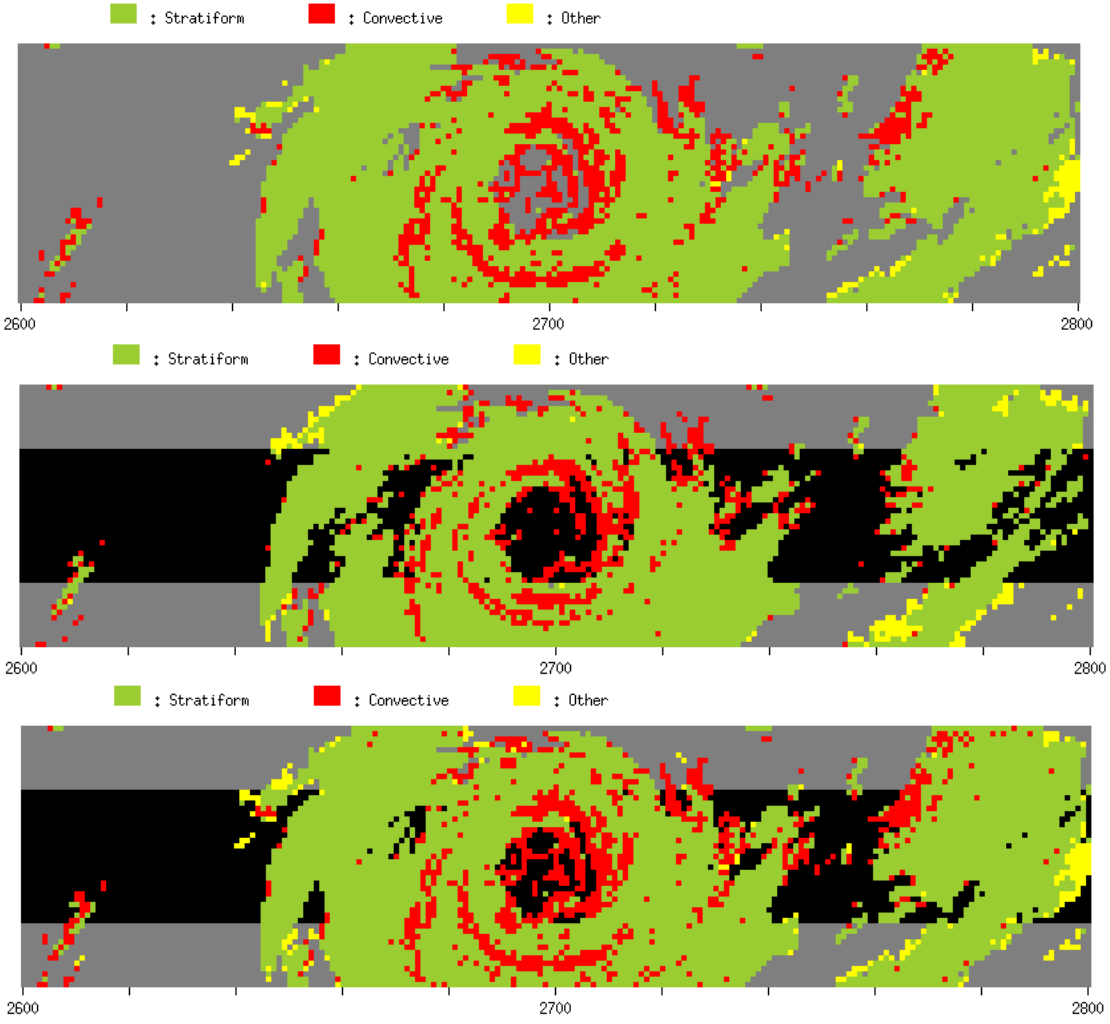
- New items relating to flagHeavyIcePrecip are added (Ku, Ka, and DPR):
  binHeavyIcePrecipTop
  binHeavyIcePrecipBottom
  nHeavyIcePrecip
  where nHeavyIcePrecip means the number of HIP between binHeavyIcePrecipTop and binHeavyIcePrecipBottom.

- The following new item is added to the CSF output:
  flagMLquality
  Melting layer detection from dual frequency method will be modified to improve detection frequency in the next possible version and the product of "flagMLquality" will be updated accordingly.

New Experimental output items are added:

a) flagGraupelHail (Prof. Chanrda and Dr. Le.)

b) binMixedPhaseTop (Dr. Iguchi.)



Orbit: 031343 (2019/09/04)
Scans: 2600-2800

Here V6X means the data obtained by JAXA 2019-1018 GPM DPR codes.

V6X Ku

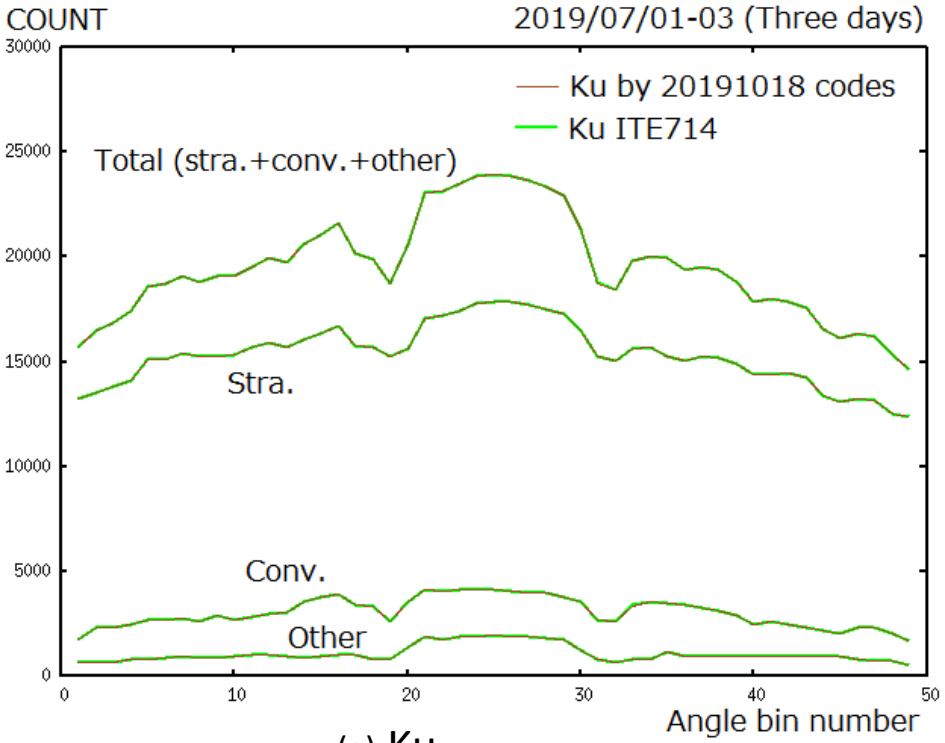
V6X Ka

In V6X, HS Ka data fill the outer swath.

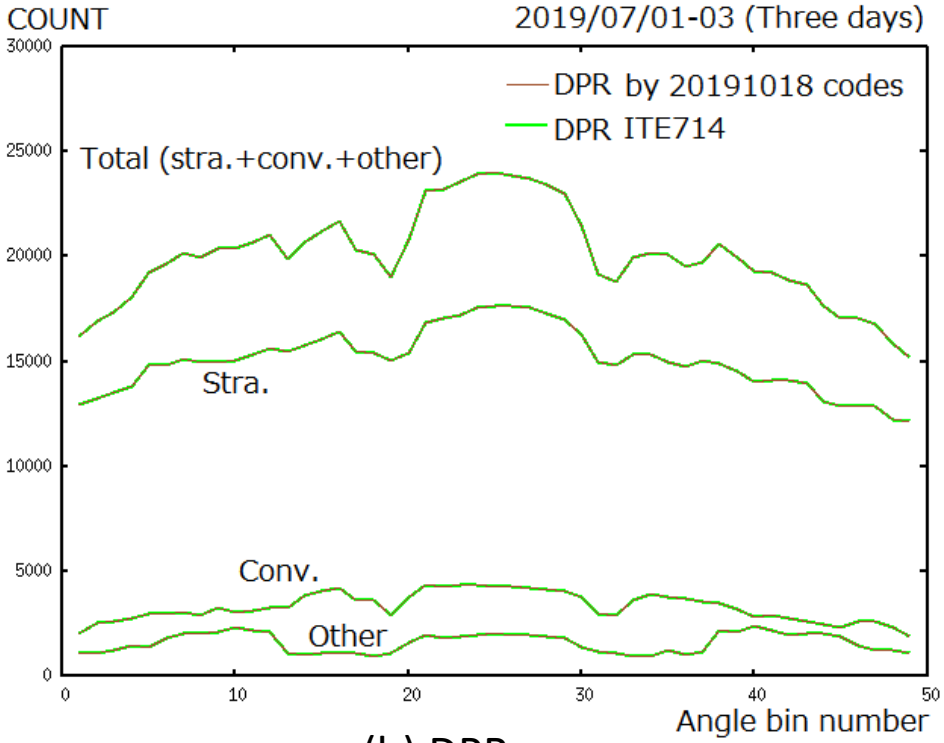
Rain Type Map

V6X DPR

Small differences are observed between Ku-band map and DPR map.



(a) Ku

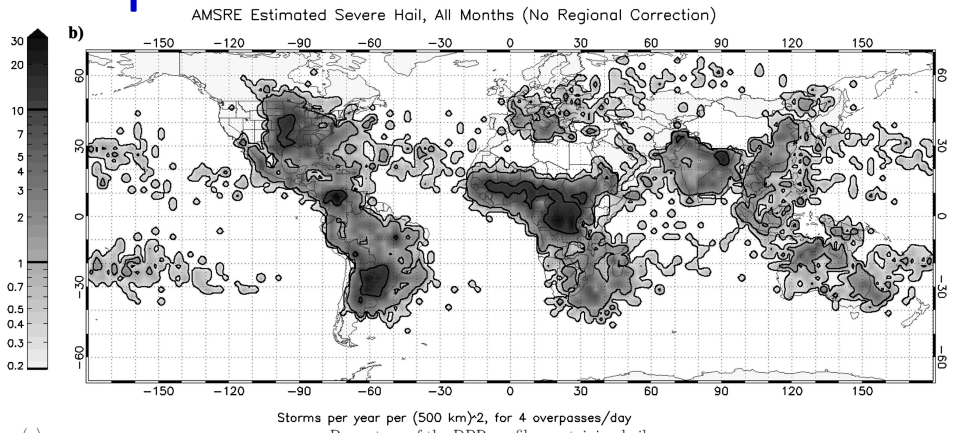


(b) DPR

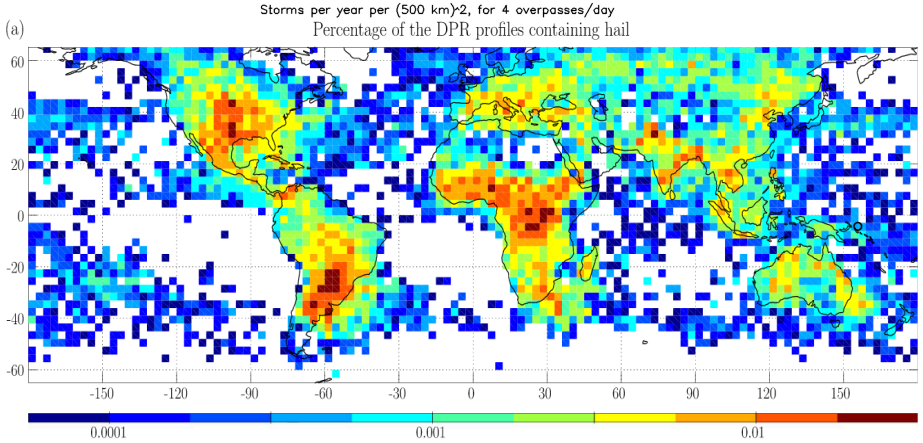
Based on three-day data, rain type counts by JAXA's 20191018 codes and those of ITE714 are almost the same.

The figures that follow show ITE714 results only.

Graupel and Hail identification algorithm (Chandra and Le)

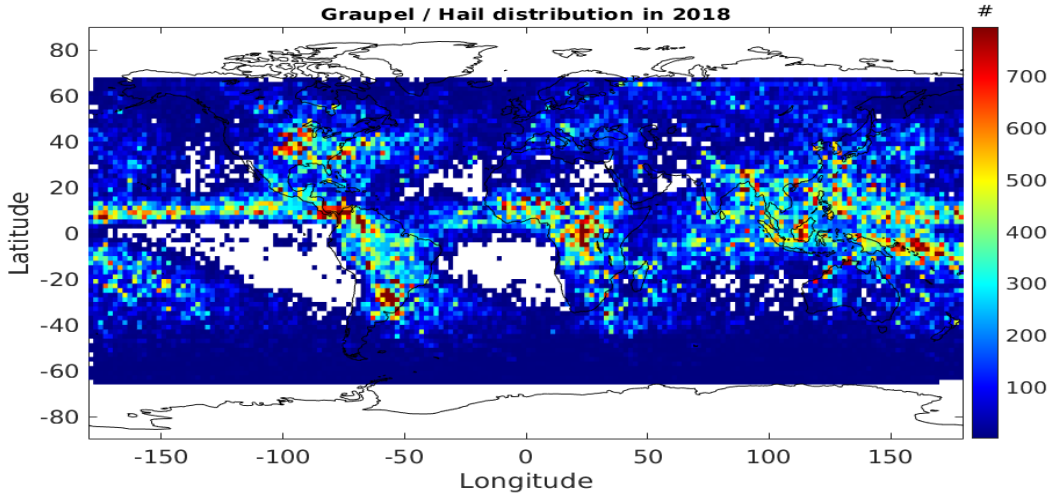


Hailstorm frequency of occurrence estimated from Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E), 36-GHz polarization-corrected temperature (PCT) , from 2003–2010. Units are storms per 500 kilometers squared per year, using 2.5° grid spacing and bilinear interpolation (Cecil and Blankenship2012).



Global map of the fraction of the DPR profiles that contain hail based on combined method of radar and radiometer of GPM from year 2014 to 2016 using 3° grid. The parameters used are the Zku_mix and PCT at 36.6 and 10.7 GHz from GMI. (Mroz et al, 2017)

The mixed-phase reflectivity is defined as the average over the 4-km layer of measured reflectivity (in linear units) above-10 degree.



- The spatial patterns of DPR profile counts with hail and graupel are generally consistent with satellite-based estimates from radiometer or combined.
- Peaks of occurrence are at e.g., equatorial Africa, the equatorial and subtropical Americas, the Pampas of Argentina, the Himalayan Forelands, Indonesia.
- Bottom is for Graupel and Hail, and above two plots are for hail only.

Update summary of V06X L2

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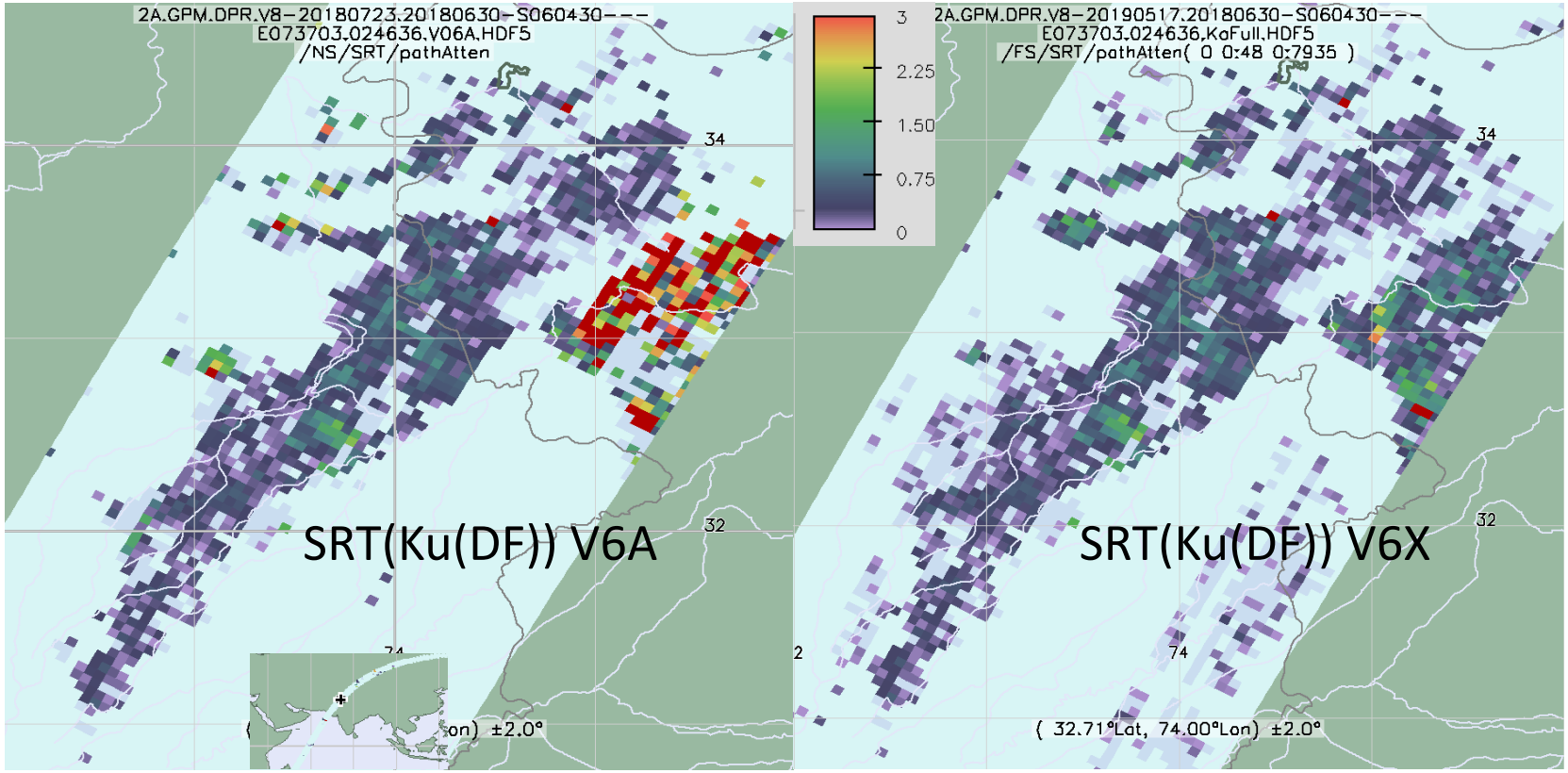
SRT

- Application of dual-freq. estimation for outer swath
- Temporal Reference Files for V6X/V7
  - KuNS -> KuFS (same)
  - KaMS -> KaFS (13 to 25 angle bins)
  - DPRMS-> DPRFS (13 to 25 angle bins)
  - KaHS -> KaHS (same)

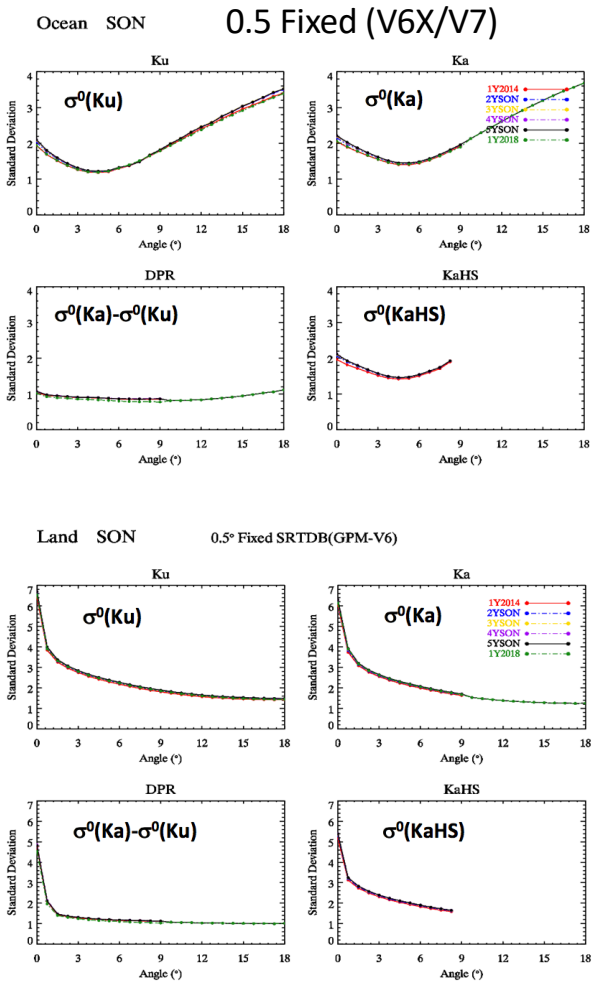
  - Goal is to use 0.25 deg variable grid for all temporal tables



- Large overestimate on right-side of swath (V6A, left) is eliminated in V6X, (right), by use of dual-freq data
- Some Ka-band surface clutter evident over mountainous region (lower right)

SRT DB Update

- Temporal Reference Files for V6X/V7
  - Inner swath
    - Ku/Ka/DPR : 5 years observation from V06A
    - KaHS : 4 years from V06A
  - Outer swath
    - Ku : 5 years observation from V06A
    - Ka/DPR : 1 year (2018-2019) from ITE704
  - 4 Files are ready to use
    - Temporal_0.5F_5YJJA2018_6S_KaFull_UF.bin
    - Temporal_0.5F_5YSON2018_6S_KaFull_UF.bin
    - Temporal_0.5F_5YDJF2019_6S_KaFull_UF.bin
    - Temporal_0.5F_5YMAM2019_6S_KaFull_UF.bin
- SRT codes have been updated so that they now read temporal data over the full swath



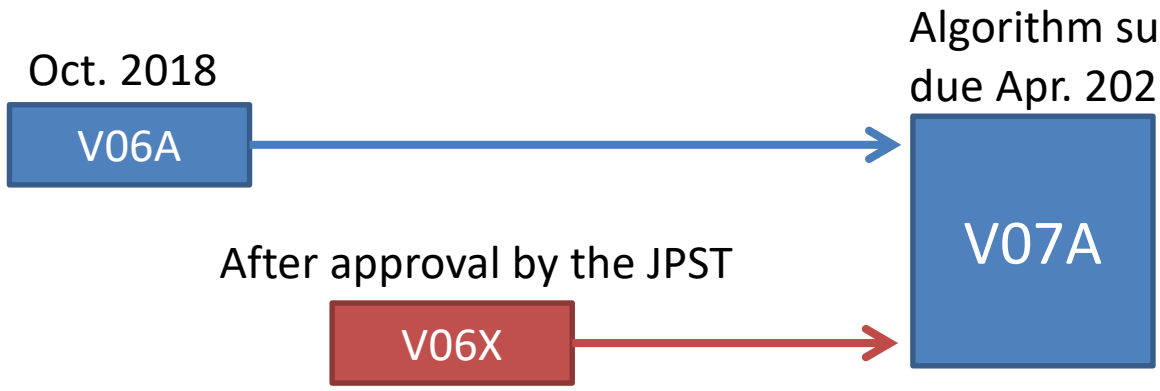
L3 Status

- To maintain continuity with previous products, we have kept the previous 5 ‘channels’ and added 2 new ‘channels’

Old (V6)	New (V6X/V7)
1. KuNS	KuFS
2. KaMS	KaMS
3. KaHS	KaHS (fill with missing after 5/2018, obs)
4. DPRMS	DPRMS
5. KuMS	KuMS
6. ----	KaFS (fill with missing before 5/2018, new)
7. ----	DPRFS (fill with missing before 5/2018, new)

- New L3 toolkit from the PPS team reflects these changes
- Code is now being tested, but at present, it is not running – code is now running (HK)

Plan for DPR-L2 data distribution



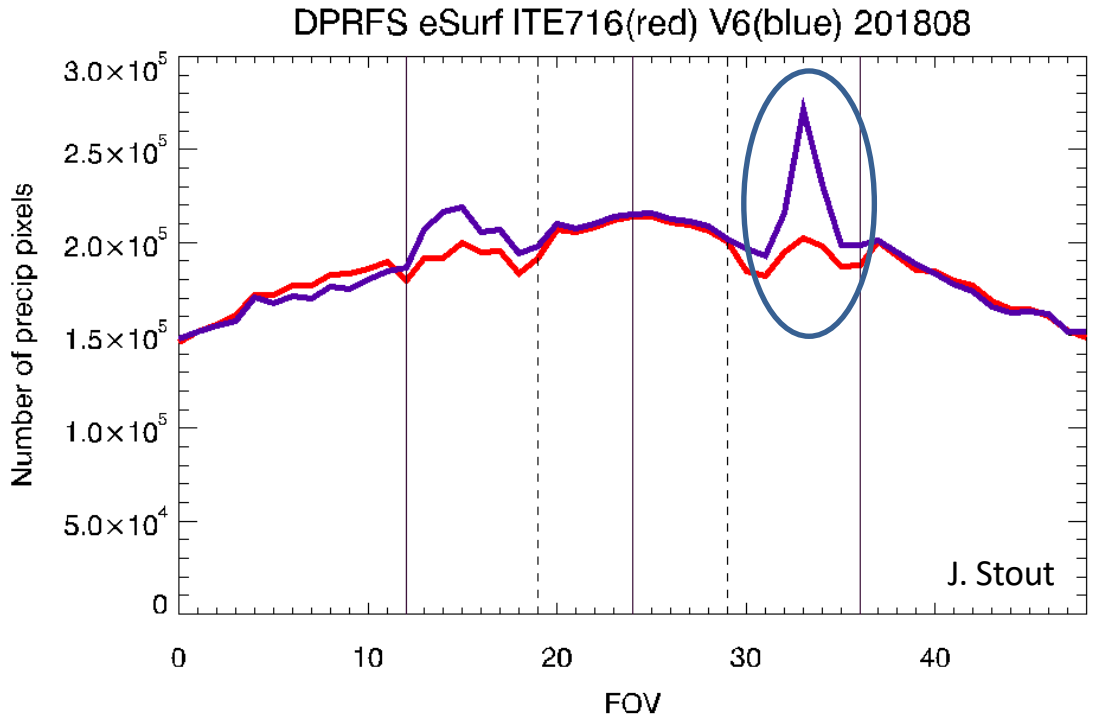
- "Experimental product"=V06X
  - ➢ V06X will be processed only after May 2018
    - ✓ V06X algorithm will not correspond before May 2018.
  - ➢ After approvals of the JPST, V06X products will be distributed to the public from the NASA/PPS and the JAXA/EORC.
    - ✓ V06X and V06A will be processed parallelly.

Evaluation of V06X

- Algorithms work properly
  - Number of precipitation pixels is good
  - Inner swath precipitation is good
- Discrepancy between V06A and V06X at outer swath
  - Angle bin dependency of difference between V06A and V06X of R
    - Reliability factor of SRT and epsilon also show unexpected behavior
  - Detailed algorithm tuning is needed

PPS

ITE716 DPR Precip. Statistics R>0 Detection



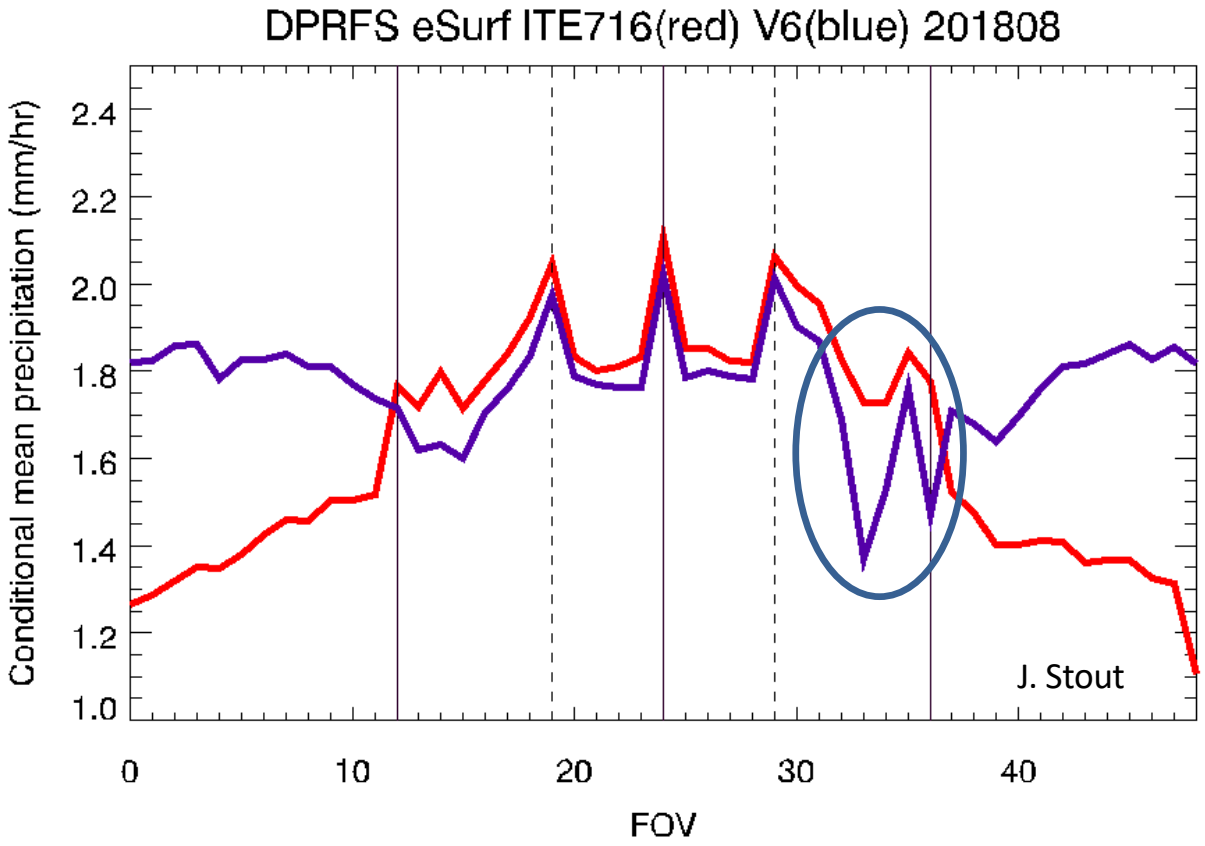
Counting Est.Surf.R > 0.

Precip counts per angle show persistent feature of peak at ifov 33 is mitigated in V06X.

From PRE clutter rejection improvements

PPS

ITE716 DPR Precip. Statistics Cond Est. Surf.

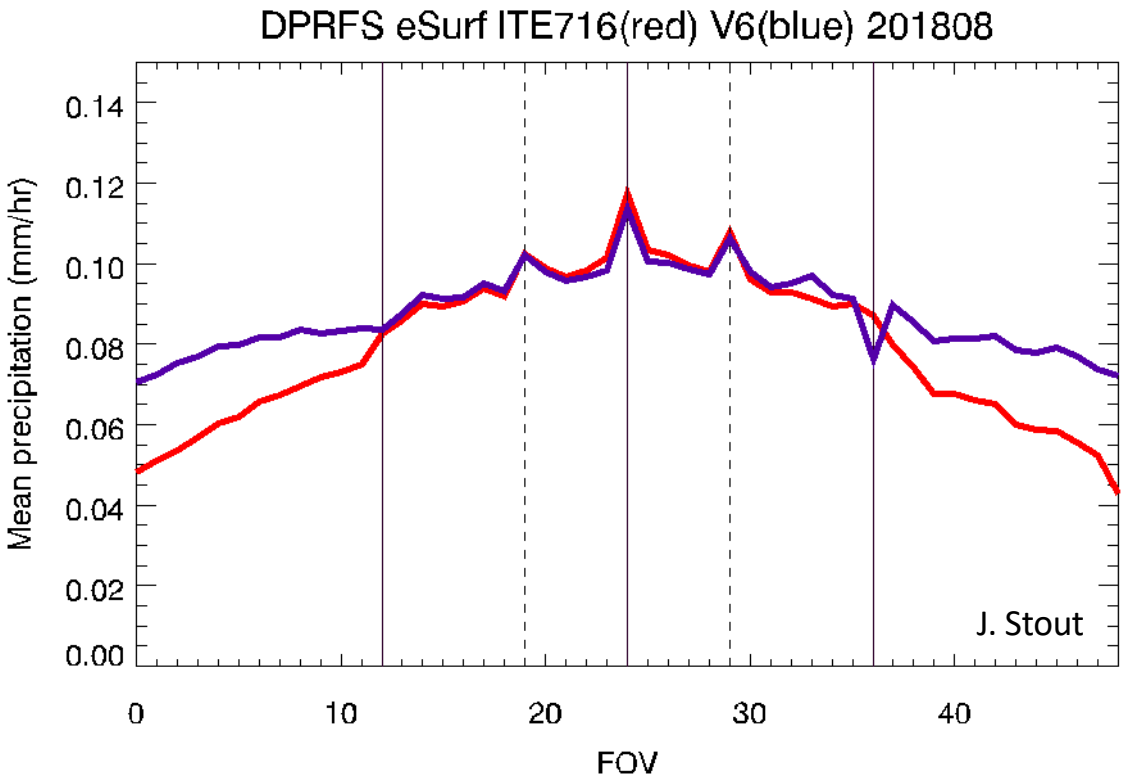


Persistent features of decreases around rays 33 and 35 are gone.

Conditional estimates at outer ifovs are much lower than V06.

PPS

ITE716 DPR Precip. Statistics UnCond. Est. Surf.



Unconditional estimates at outer ifovs are lower than V06. ~ 20%.

Impact to bulk statistics pending.

Planned updates in V07

Module	item
<over all>	**Improvement of issues from V06A and V06X**
PRE	rain/no-rain classification
CSF	Improvement of dual-freq. method
	update new experimental products
SRT	SRT DB update
SLV	improvement of precipitation estimation over land *<epsilon: variable in vertical>* *<PSD model>*

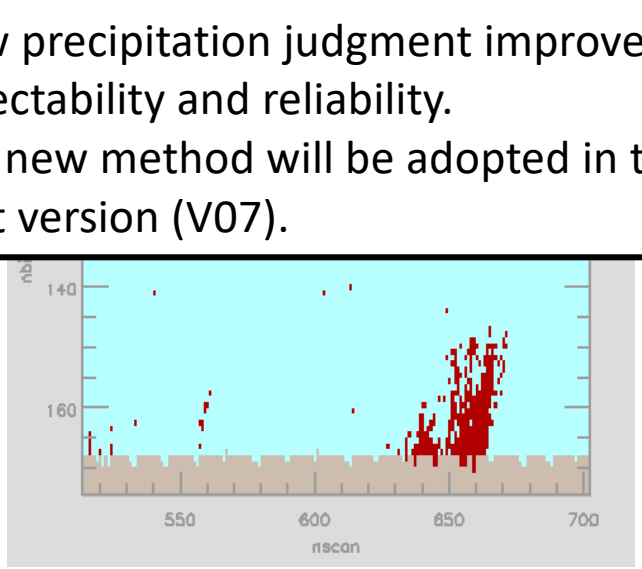
By K. Kanemaru from NICT

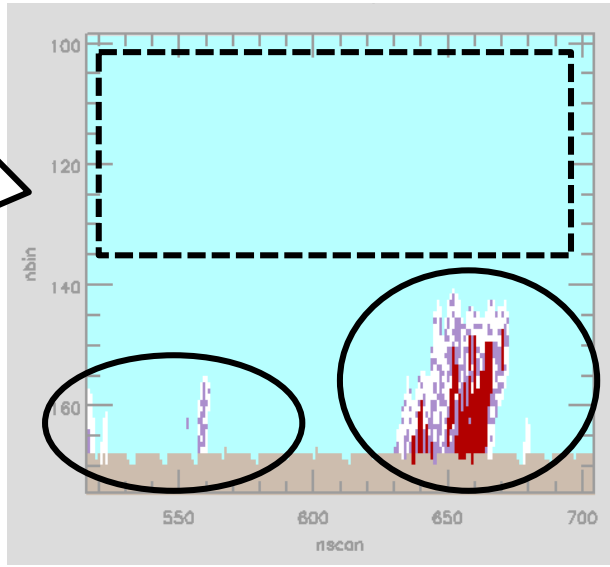
Improvement of precipitation judgement

KuPR V06A (Z_{min} ~ 15 dBZ)

New (Z_{min} ~ 12 dBZ)

New precipitation judgment improves detectability and reliability.
The new method will be adopted in the next version (V07).



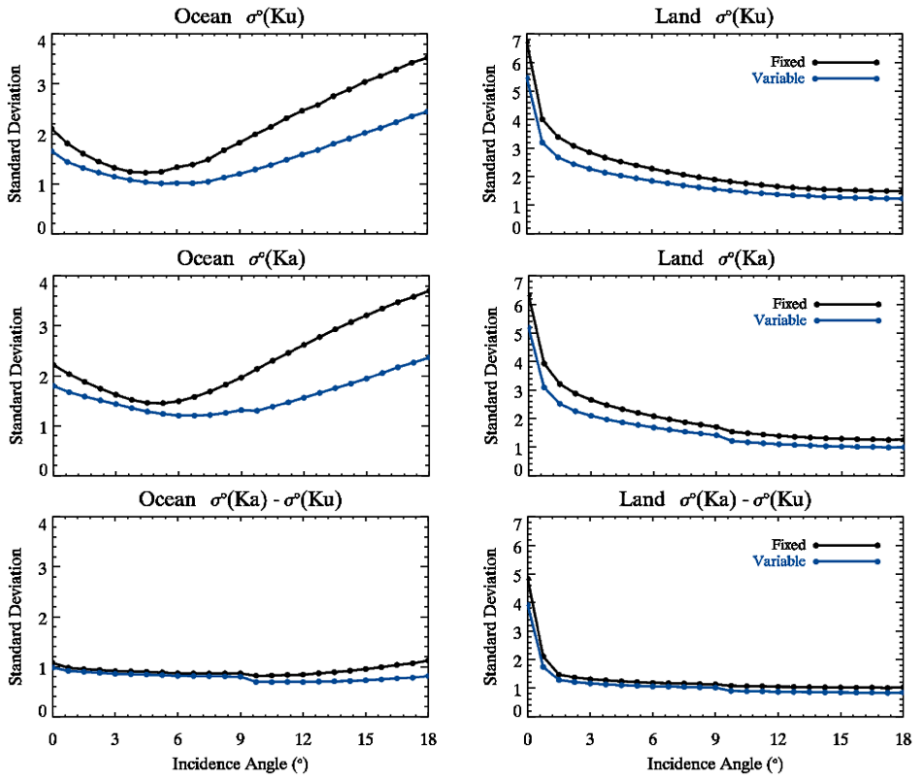


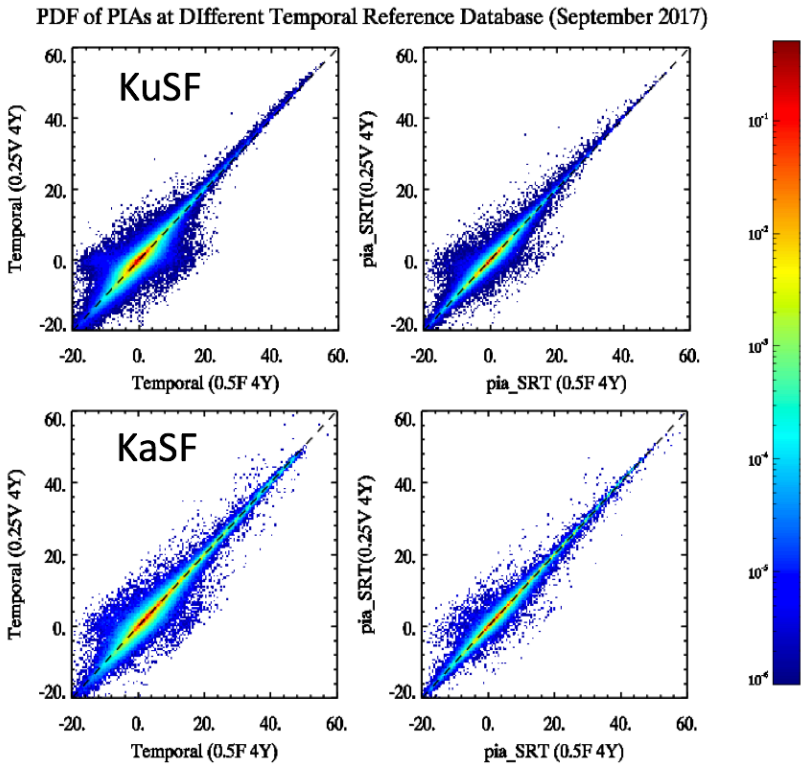
Angle-bin #25 of GPMCOR_KUR_1806300604_0737_024636_L2S_DU2_06A.h5

SRT DB update for V7

- SRT DB update
  - Goal is to use 0.25 deg variable grid over full swaths for all temporal tables

Preliminary Results : 0.25° Variable Grid SRT DB





Temporal_0.25V_5YSON2018_6S_KaFull_UF.bin

Documentation

- ATBD
  - Updates of the ATBD for V06X product will be necessary by coming V06X product release.
  - Preparation of ATBD in ongoing.

Backup

reliabFactor

- reliabFactor is the ratio of (PIA by SRT) to (standard deviation of surface backscattering cross section)

$$\text{reliabFactor} = \frac{\text{PIA}_{\text{SRT}}}{\sigma_{\text{SRT}}}$$ for single-frequency

$$\text{reliabFactor} = \frac{\delta\text{PIA}_{\text{DSRT}}}{\sigma_{\text{DSRT}}}$$ for dual-frequency

- ε is selected to maximize *E* (single-frequency) or *F* (dual-frequency)

$$E = \frac{(x-\mu_x)^2}{\sigma_x{}^2} + \frac{(\text{PIA}_{\text{SRT}} - \text{PIA}(\varepsilon))^2}{\sigma_{\text{SRT}}{}^2}$$

$x = \log_{10}\varepsilon$ μ_x and σ_x are given by DSD database

$$F = \frac{(x-\mu_x)^2}{\sigma_x{}^2} + \frac{(\delta\text{PIA}_{\text{DSRT}} - \delta\text{PIA}(\varepsilon))^2}{\sigma_{\text{DSRT}}{}^2}$$ +(evaluation by KaPR's Zm)

$x = \log_{10}\varepsilon$ $\mu_x = 0$ $\sigma_x = 0.1$

S. Seto

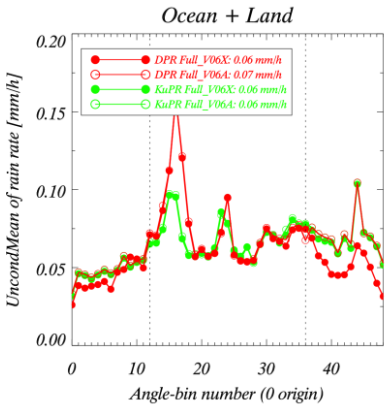
Comparison between JAXA and PPS

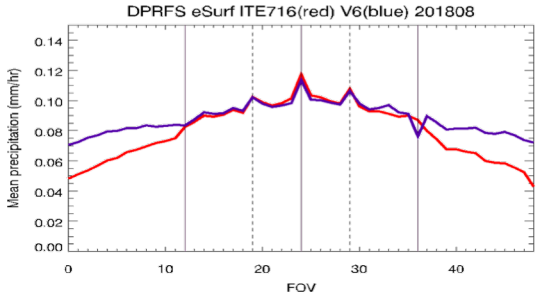
PrecipEsurf

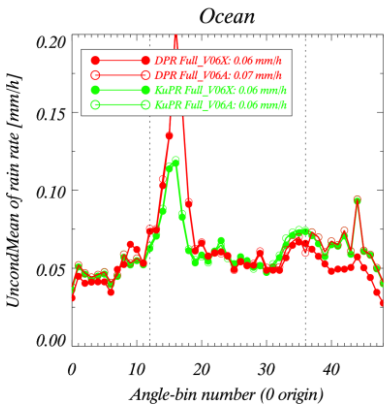
DPR L2 UnConditional Mean V06X(ITE714) vs V06A

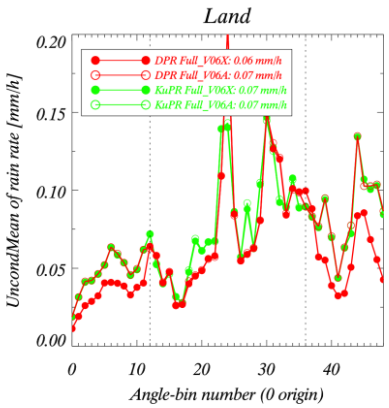
Period : 2018/8 (483 orbits)
Target : precipRateESurface
Swath : Full
Mean : UnConditional-mean

Input (06X_ITE714) :
Ku: N/A
Ka: N/A
DPR: N/A
Input (06A) :
Ku: N/A
Ka: N/A
DPR: N/A







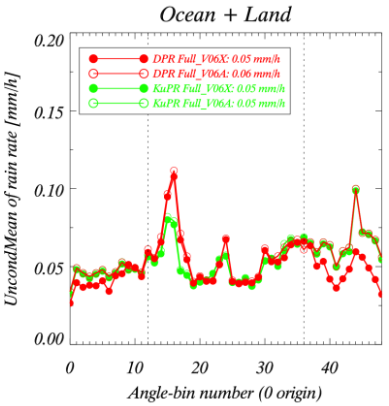


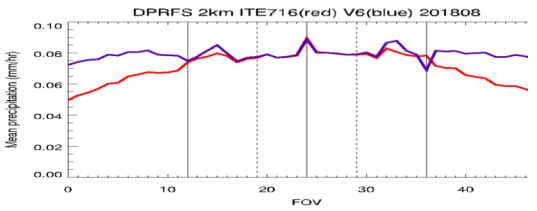
Precip 2km

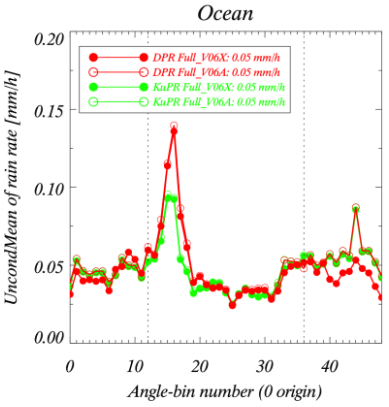
DPR L2 UnConditional Mean V06X(ITE714) vs V06A

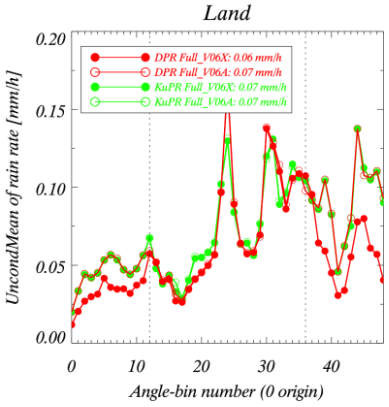
Period : 2018/8 (483 orbits)
Target : precipRate at 2km
Swath : Full
Mean : UnConditional-mean

Input (06X_ITE714) :
Ku: N/A
Ka: N/A
DPR: N/A
Input (06A) :
Ku: N/A
Ka: N/A
DPR: N/A







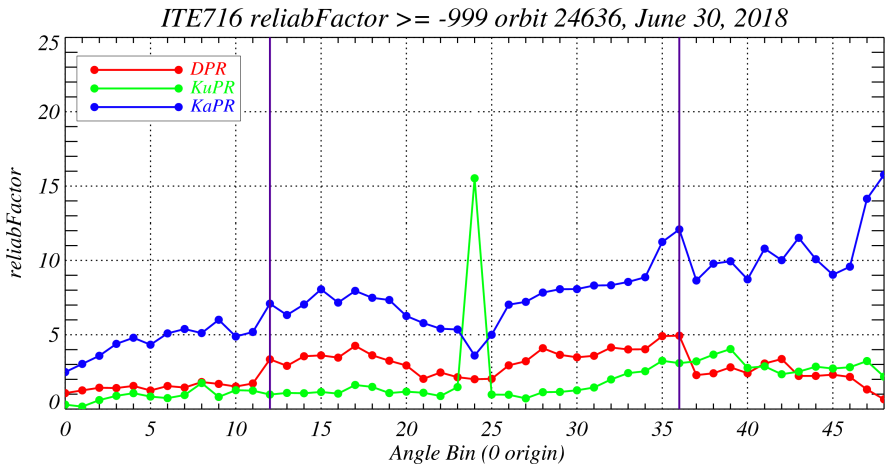


Test for the effect of “Reliability factor”

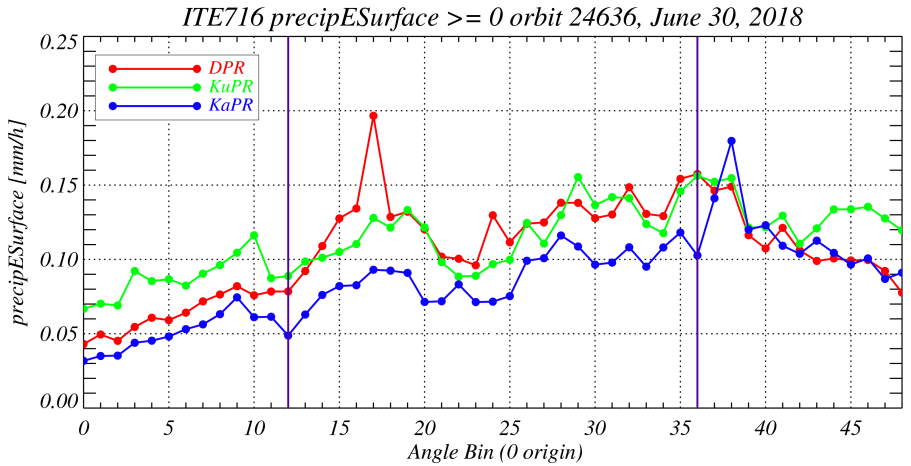
DPR vs. KuPR vs. KaPR

V06X (ITE716)

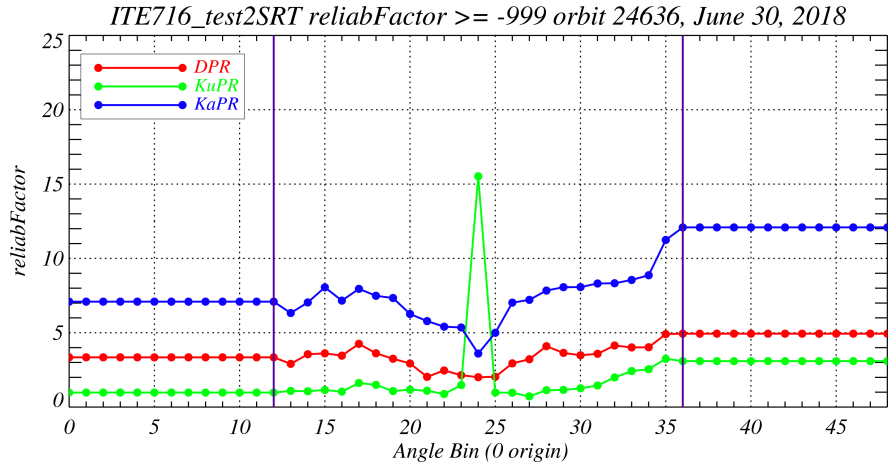
Reliability Factor

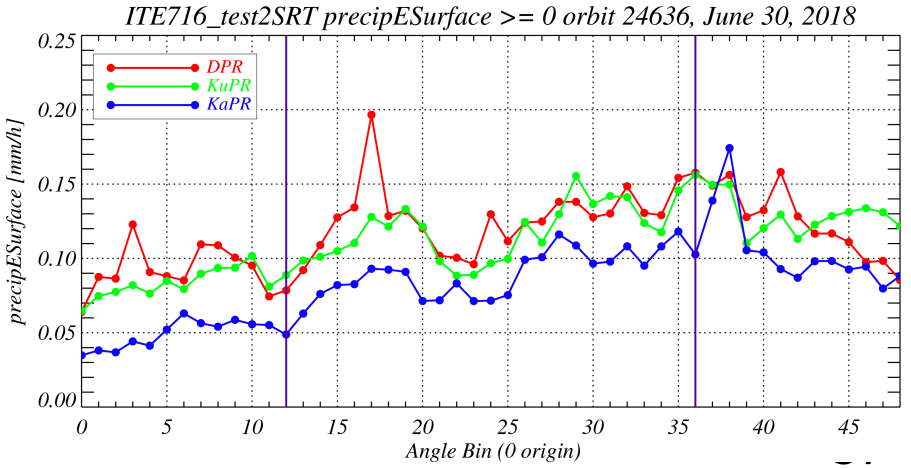


PrecipESurface (mm/h)

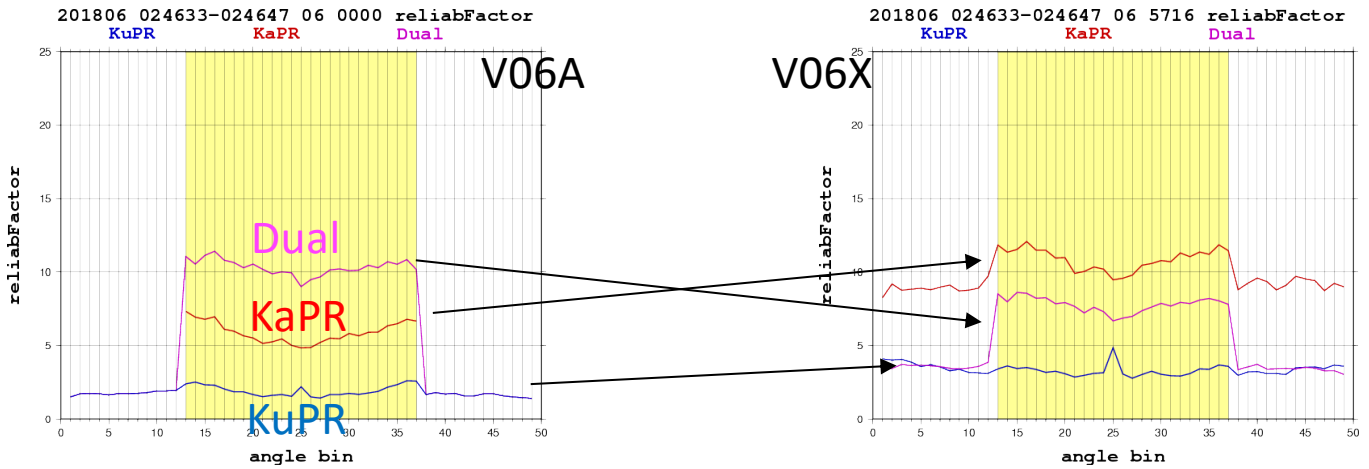


TEST (change Reliability factor)

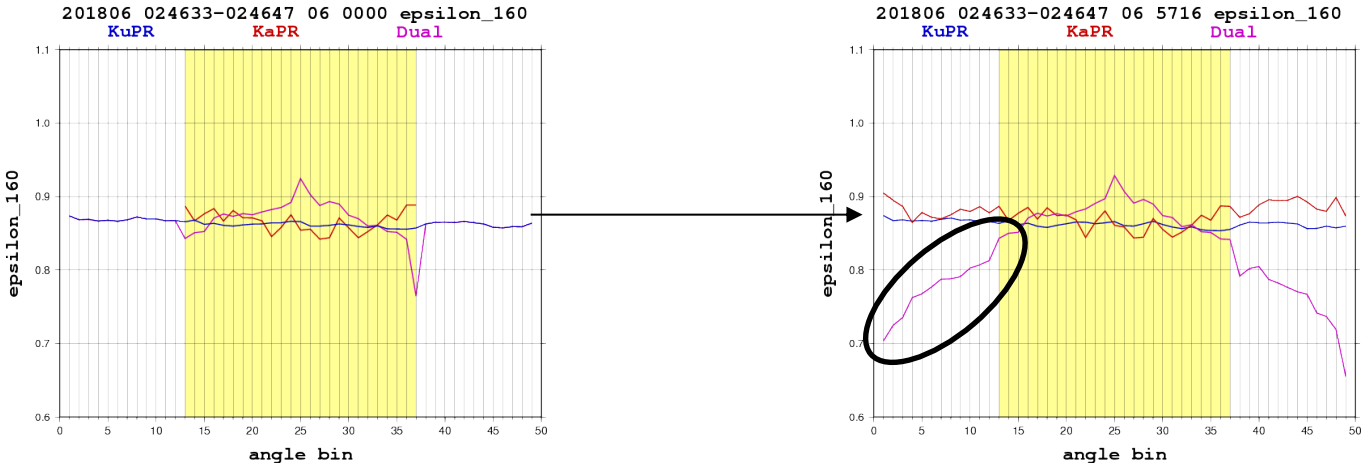




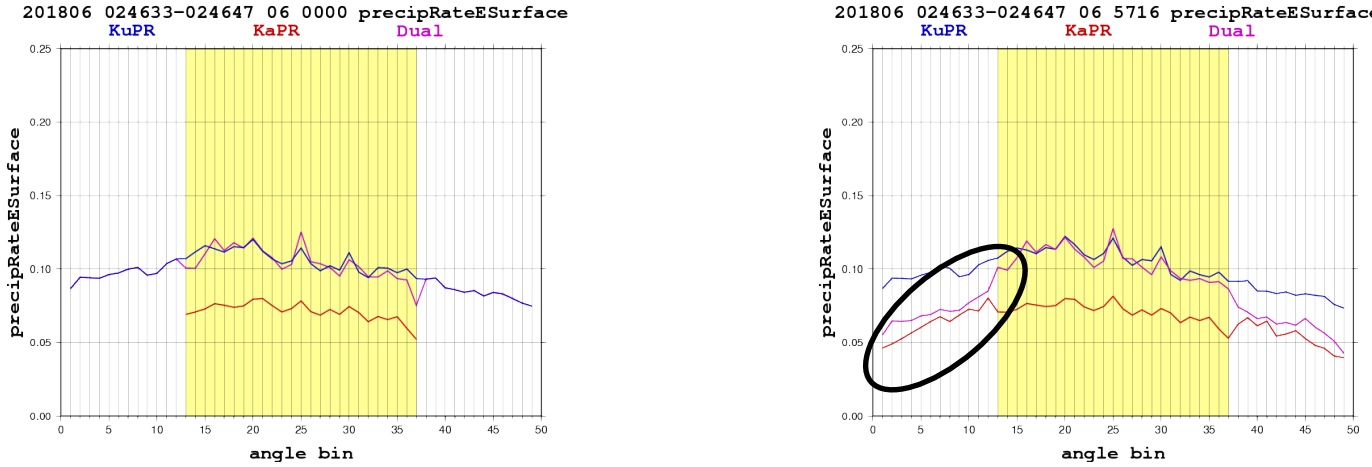
Reliab. Factor



epsilon



Precip. Esurf.



S. Seto