GPM/DPR V5 algorithm

Toshio Iguchi
NICT
JPST teleference
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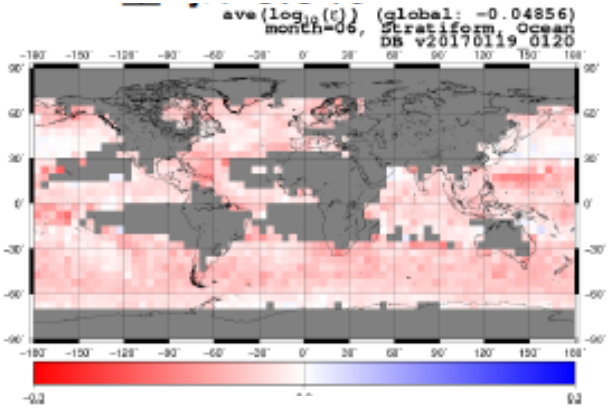
Major changes that affect R estimates in V5

- Calibration change in L1 (Positive effect)
  - Zm increases from V4 by
    - KuPR: +1.3 dB, KaPR(MS): +1.2 dB, KaPR(HS): +1.2 dB
- Introduction of DSD database for single-freq. algorithms (Ku-only and Ka-only, DPR outer swath) (Negative effect)
  - Used as the new default R-Dm relationships
  - Given at every 5 deg by 5deg box every month
  - Categorized by land-ocean, stratiform-convective
  - Based on DSD estimates from DPR algorithm

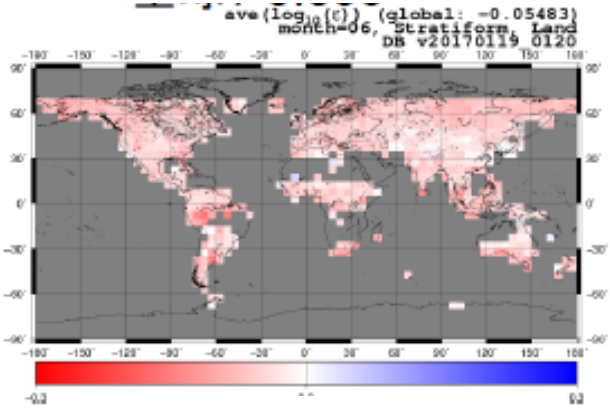
Average of DSD parameter log10(ε)

Example: June

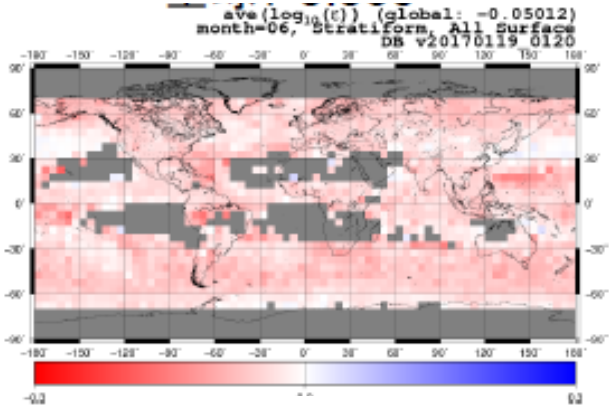
① Strat, Ocean
Global: -0.049



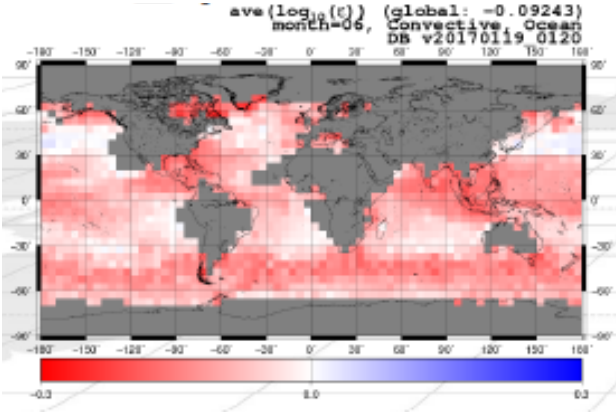
② Strat, Land
Global: -0.0455



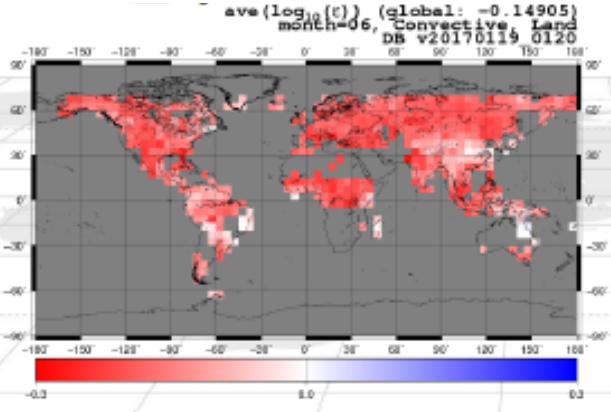
③ Strat, All surf types
Global: -0.050



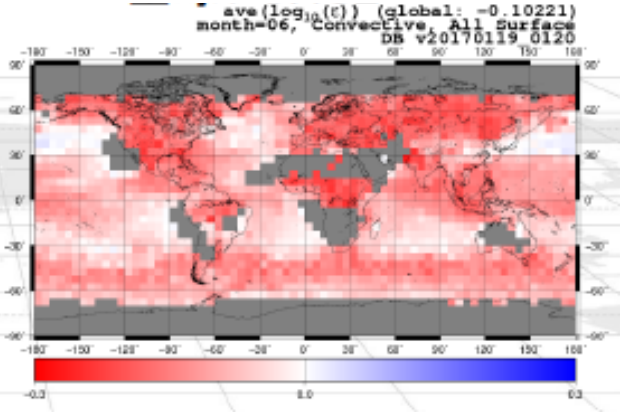
④ Conv, Ocean
Global: -0.092



⑤ Conv, Land
Global: -0.149

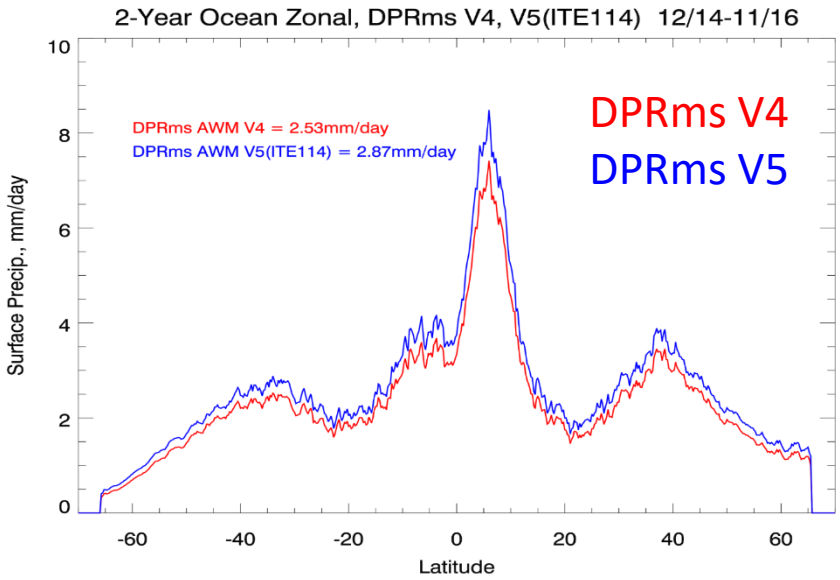


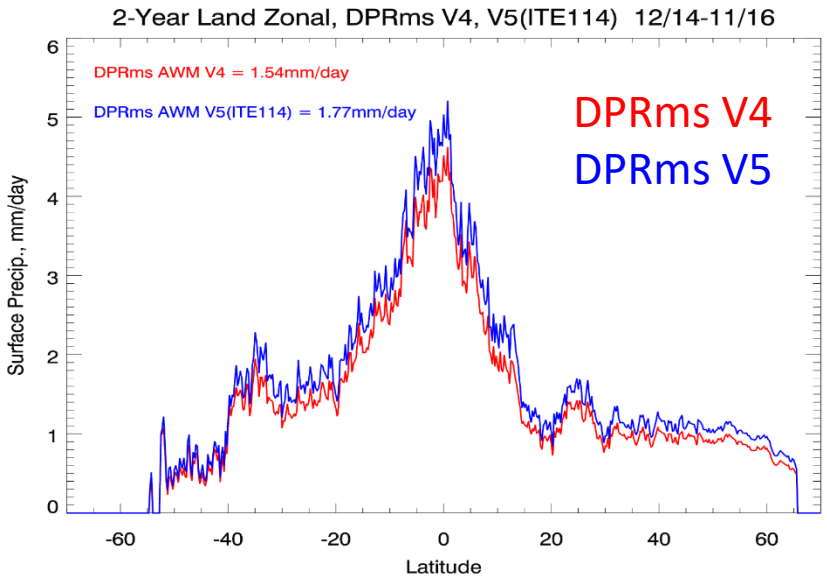
⑥ Conv, All surf types
Global: -0.102

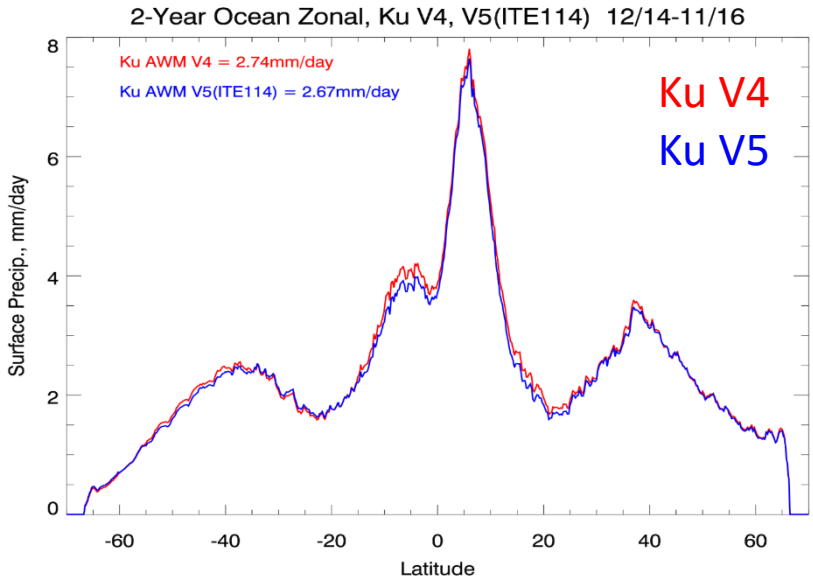


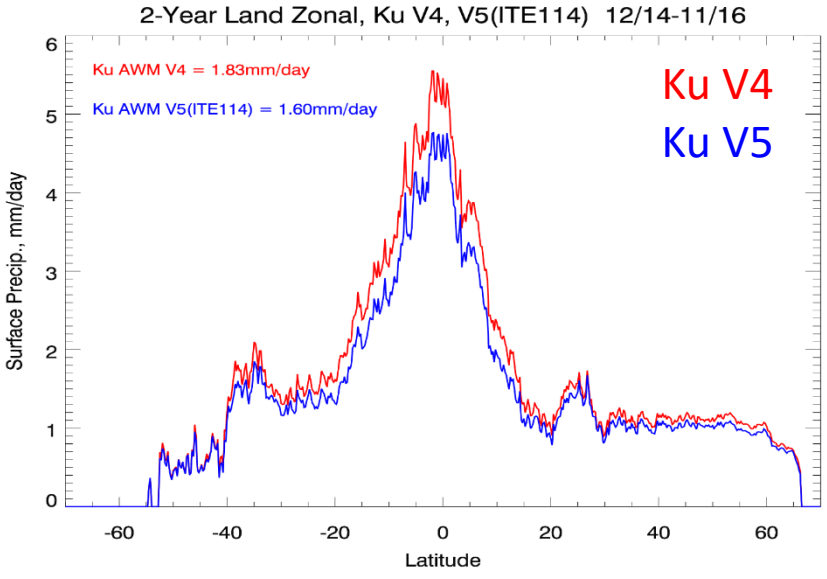
2-Year Zonals V4 & V5

(J. Kwiatkowski)





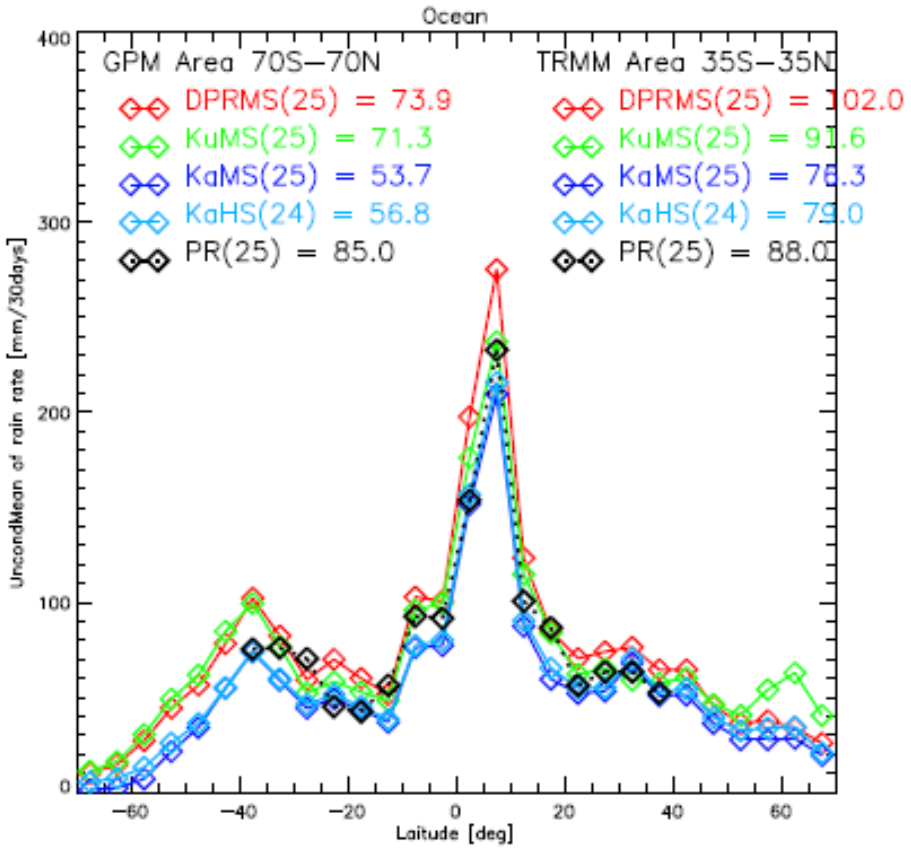




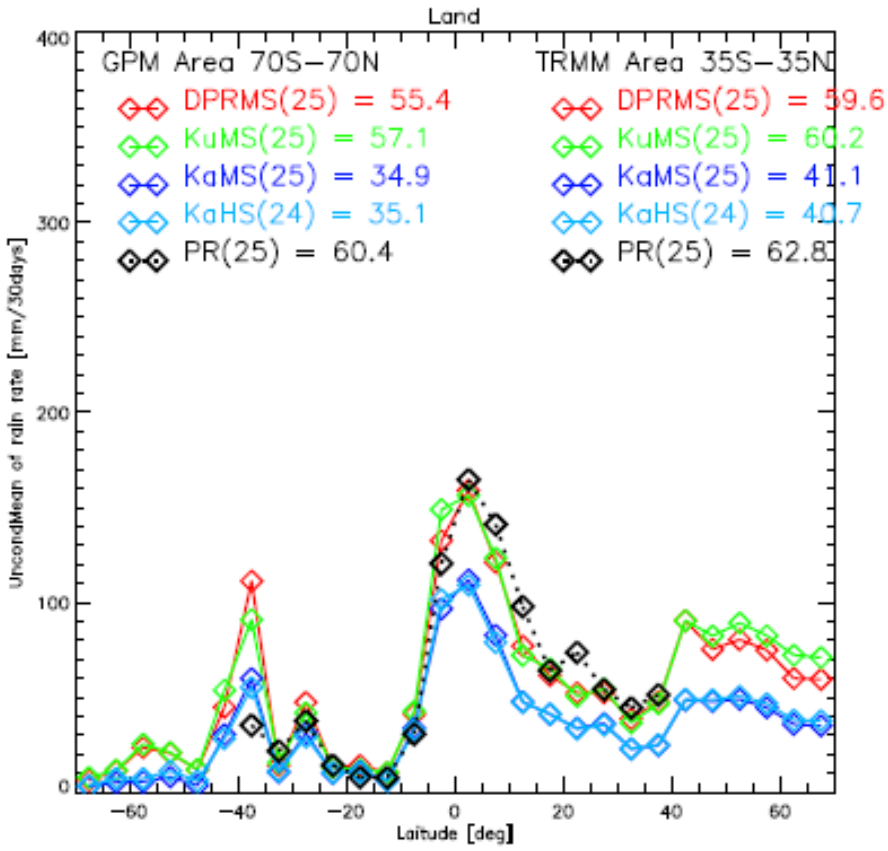
DPR V5 (ITE114) and PR V8 in the inner swath

esurf, June 2014

Ocean



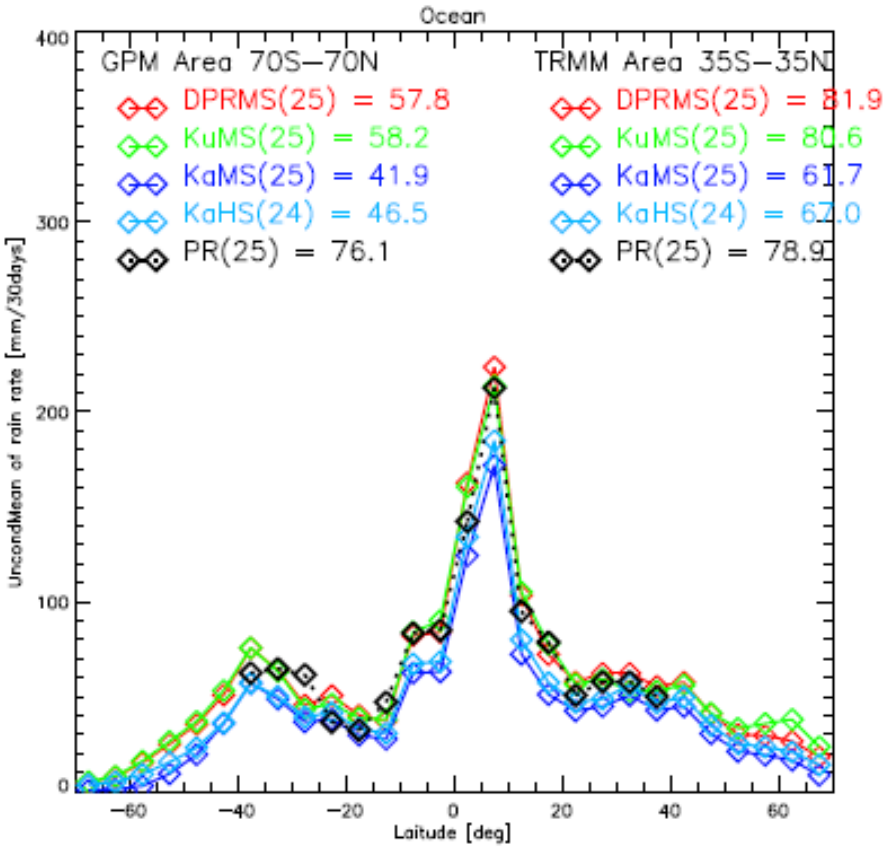
Land



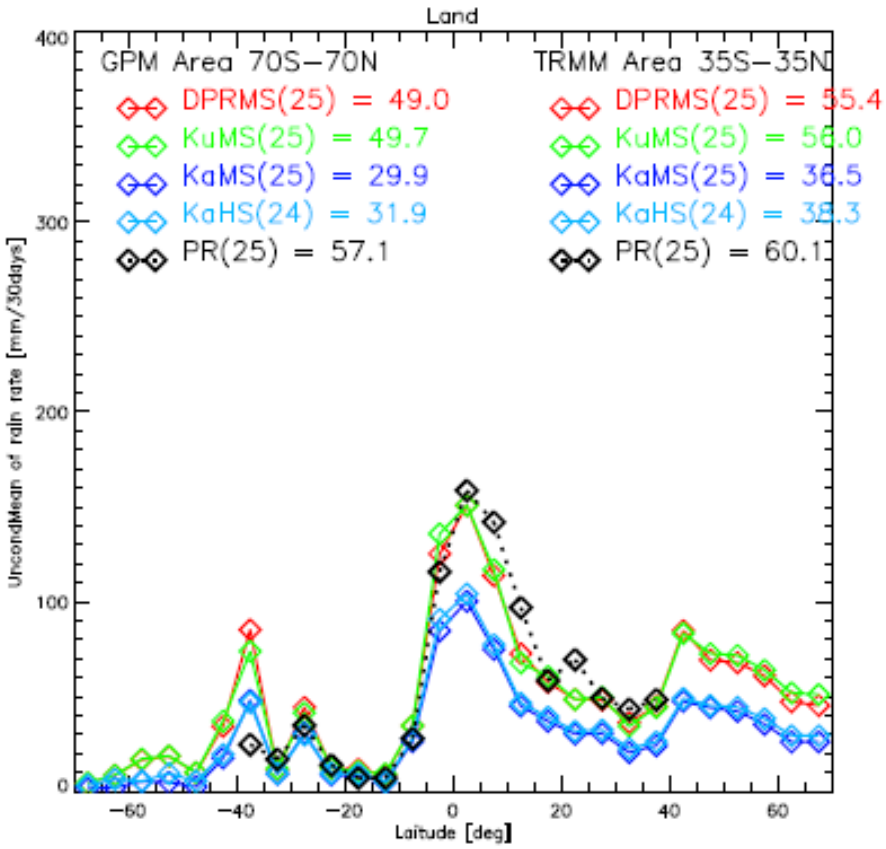
DPR V5 (ITE114) and PR V8 in the inner swath

2 km, June 2014

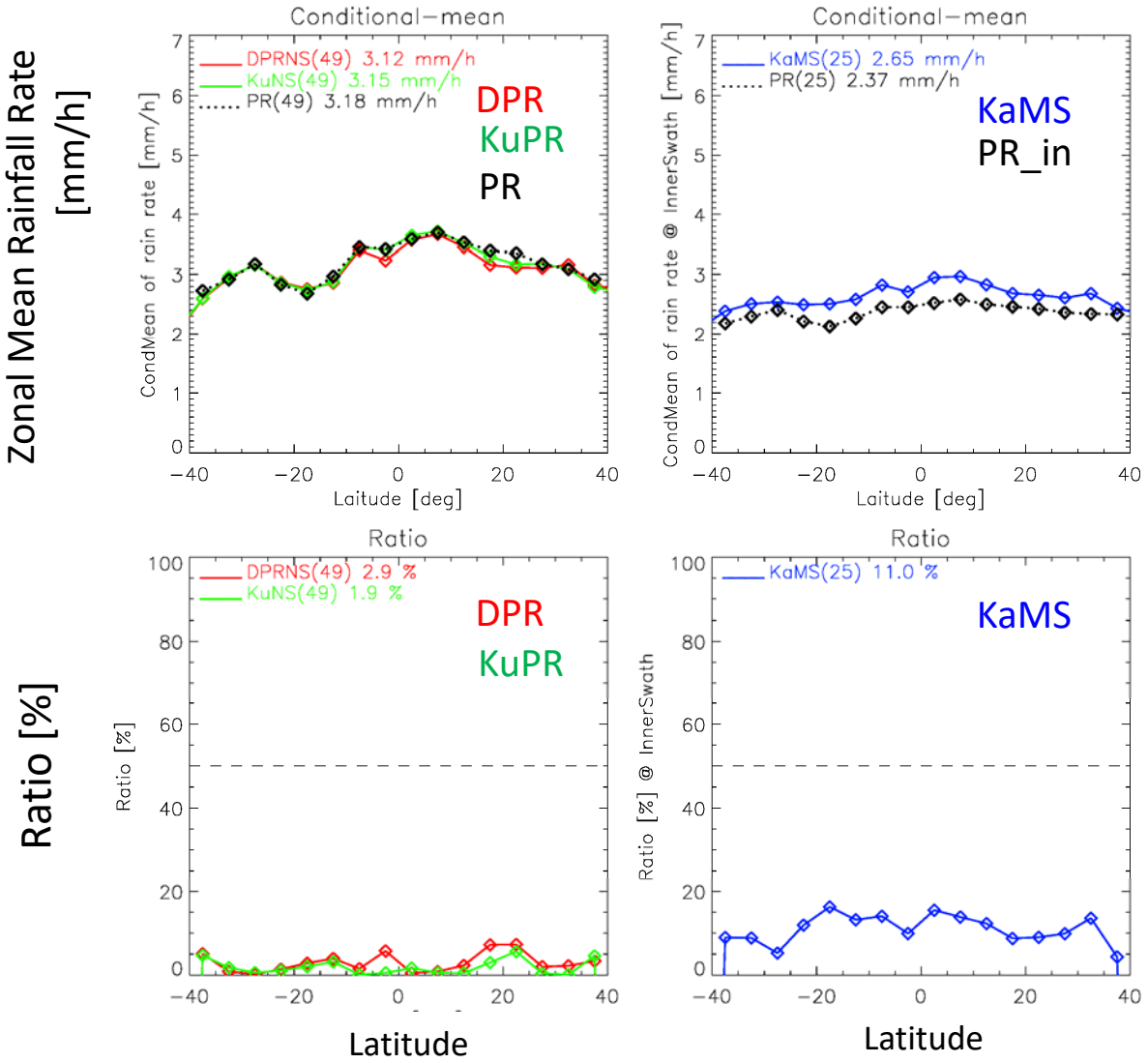
Ocean



Land



Conditional Statistics (Intermediate rain)

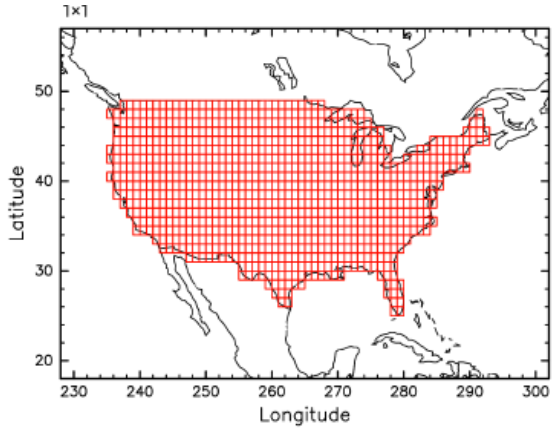


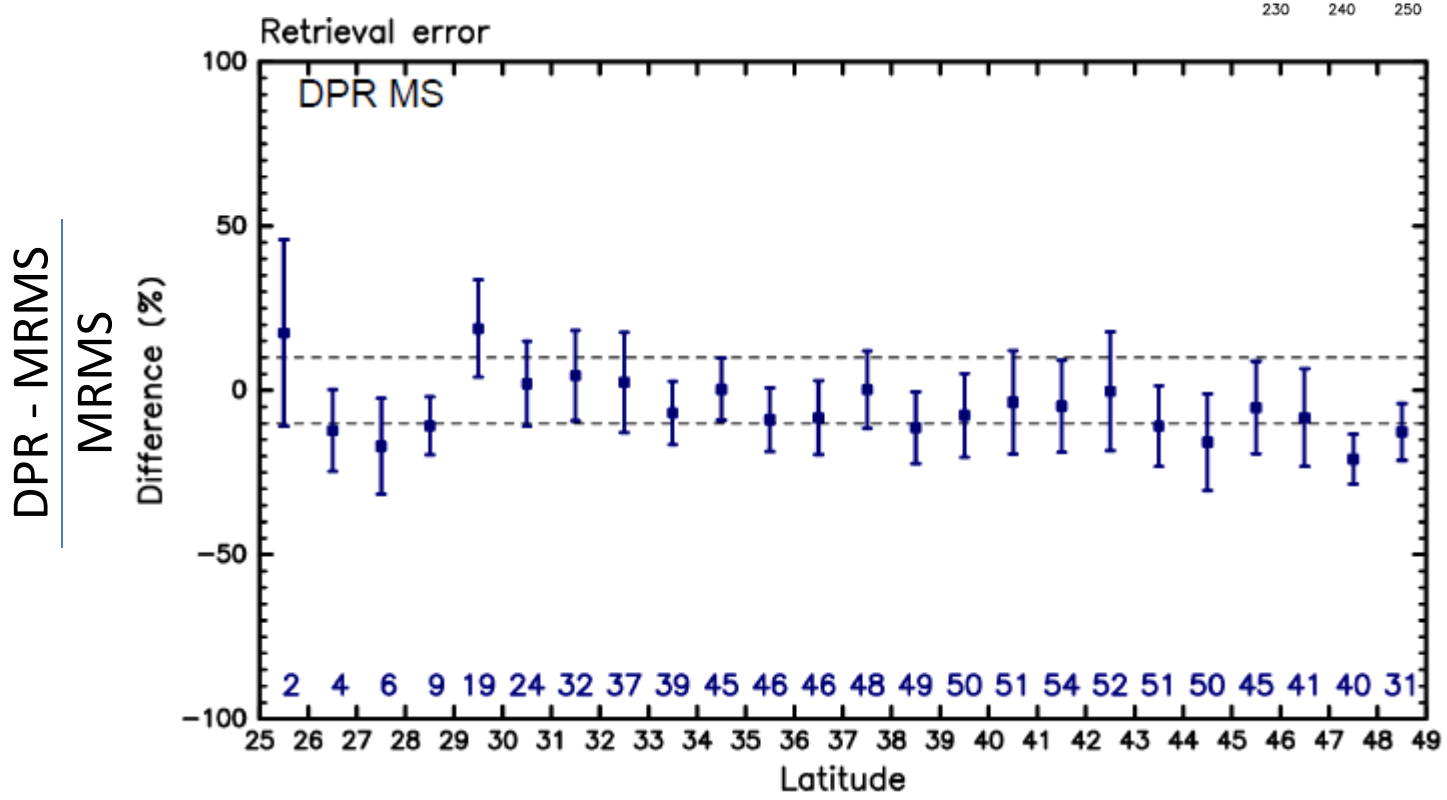
- Conditions:
  0.7 - 30.0 [mm/hr] @ Ku, DPR, PR
  0.7 - 10.0 [mm/hr] @ Ka, PR_Inner
- Ratio
  |DPR - PR| / (DPR + PR) x 200 [%]

- Data:
  June & July, 2104
  Ocean
  5 deg boxes
  2 km high
  DPR V5, PR V8

Zonal rain comparison: DPR(MS) (ITE113) and MRMS MNQ

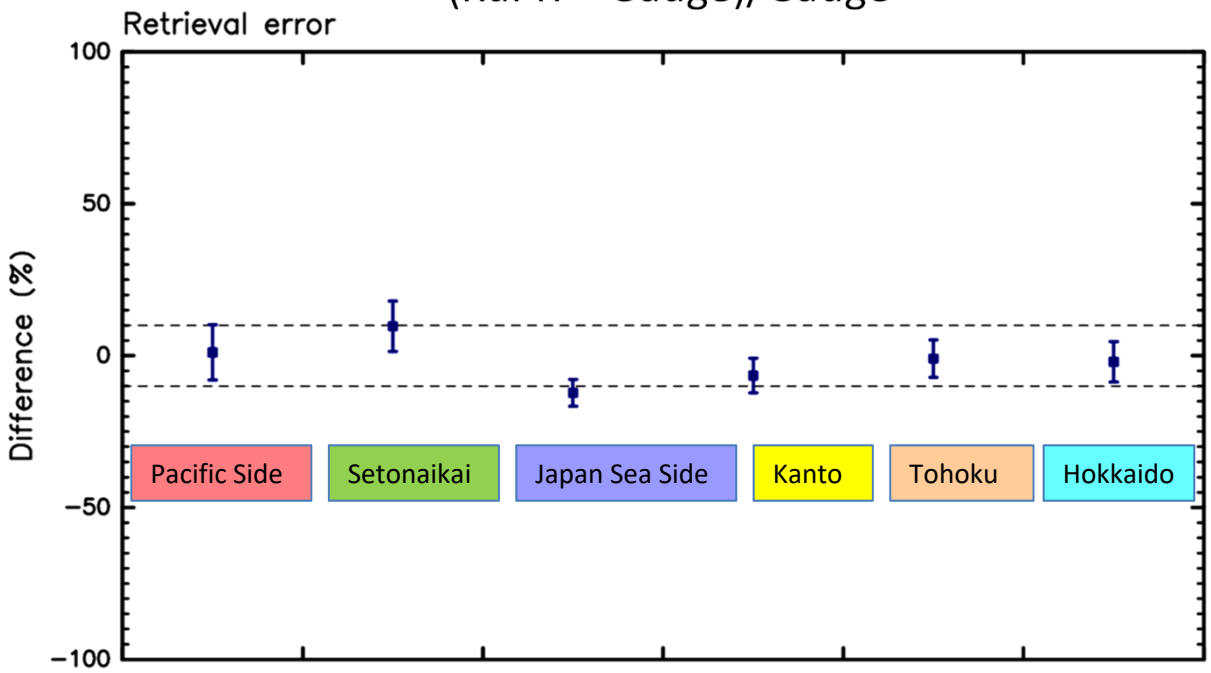
- June 2014 – May 2015
- MRMS: 0.01 deg, hourly data,
  - DPR overpass time only





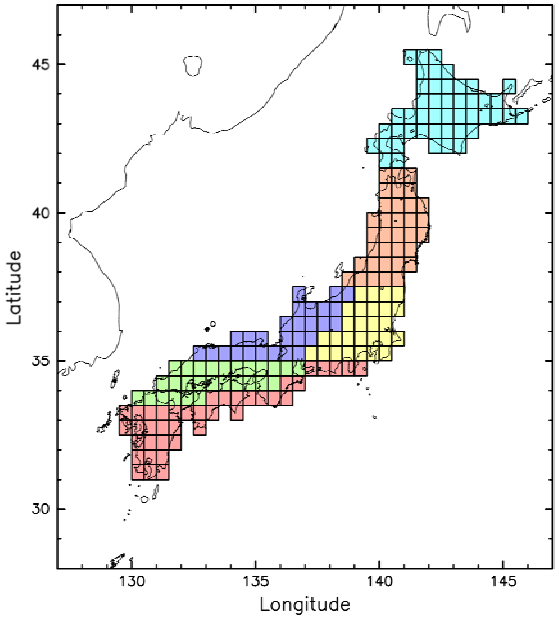
Comparisons of KuPR rain estimates with AMeDAS rain gauge data

(KuPR – Gauge)/Gauge



6 areas

1. Hokkaido (No. of boxes: 45)
2. Tohoku (34)
3. Kanto (27)
4. Sea of Japan side (27)
5. Inland Sea area (27)
6. Pacific Ocean side (39)

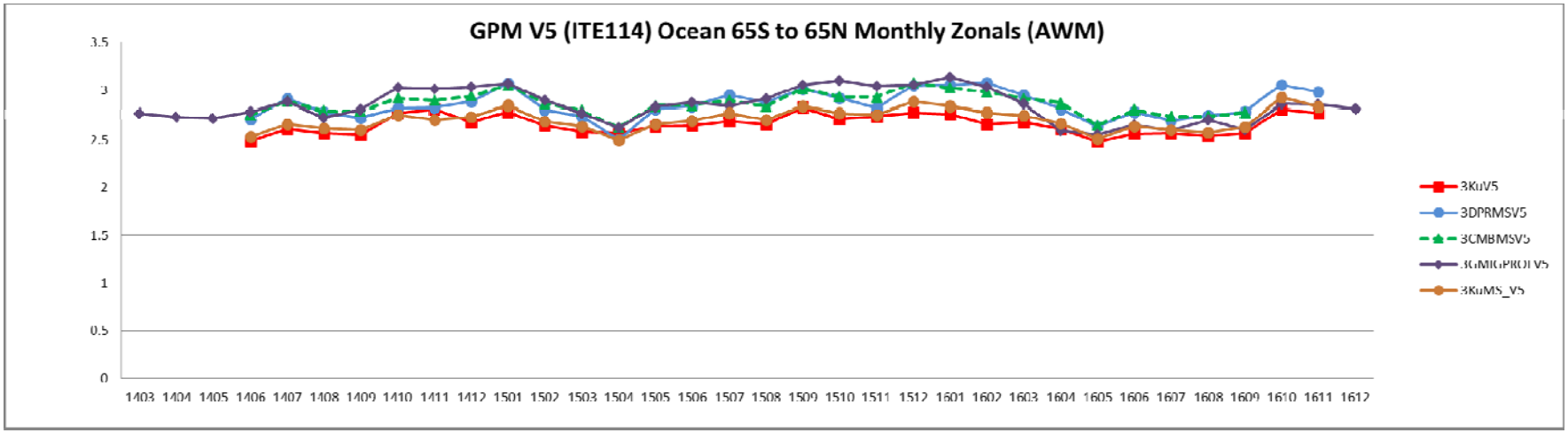


- Two years of data from June 2014 to May 2016
- AMeDAS data at overpasses only
- Gauge data are 10 min data immediately after the overpasses
- Rain total is estimated at each 0.5 × 0.5 deg. box, and means and standard deviations of 6 colored areas are calculated.
- To exclude snow fall data, if the surface temperature is below 6 degrees, data in that box are not used.

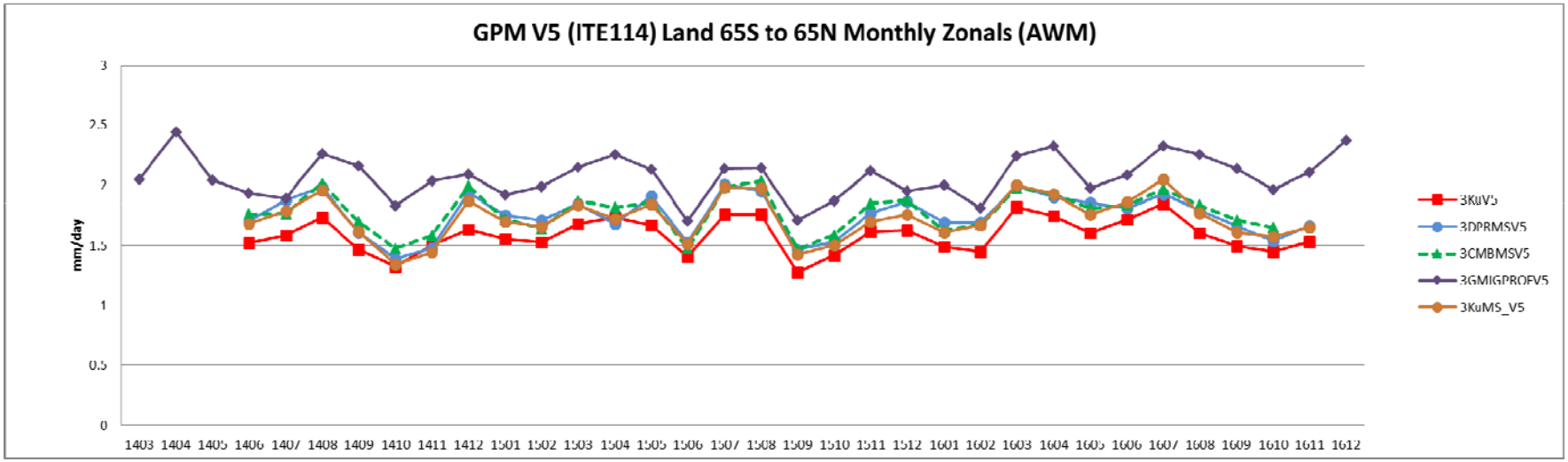
GPM V5 Test Products

KuMS is the Ku ifovs within the DPR MS scan

Ocean



Land



Major observations

- DPR(MS)'s Rain estimates agree well with MRMS.
  - The increase of DPR estimates is mainly by the increase of Zm due to the calibration change.
- KuPR V5 decreased, but it now agrees better with the corresponding DPR estimates than V4, especially in the inner swath.
  - The decrease of KuPR V5 is a result of change in the initial default DSD parameter.
- Agreement in R, but disagreement in D_m between DPR and MRMS remains as an issue.

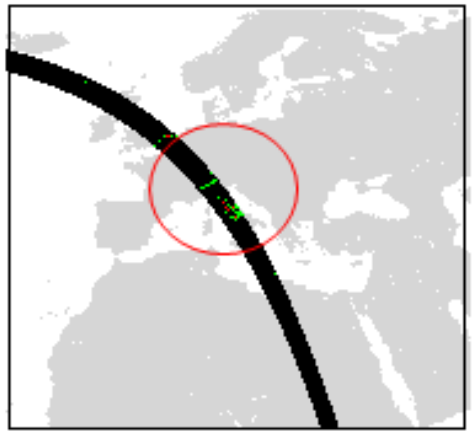
Minor changes in V5

- Calibration adjustment to remove small trend and range dependence in L2
- Addition of “flagSigmaZeroSaturation” and “snowIceCover” flags in Preparation module and new surface types (sea-ice and snow-covered land) in the look-up tables for SRT
- Increase of the upper limit of D_m from 3 mm to 5 mm for Ku-only and DPR outer swath
- Conditions for extending the lowest valid echo to the surface
  - (Precip echoes at more than 23 range bins)

  -> (Liquid precip echoes at more than 7 range bins)
- Adjustment of sidelobe cancelation parameters
- Improvement in the Classification Mode
  - zFactorCorrected is used instead of zFactorNPcorrected to identify convective storm in the second loop.
  - A new threshold is introduced to avoid misidentification of stratiform rain with BB as convective.
  - Convective winter storms with ocean (lake) effect are flagged.
- Introduction of new flags
  - flagHeavyIcePrecip, flagSurfaceSnowfall, flagAnvil

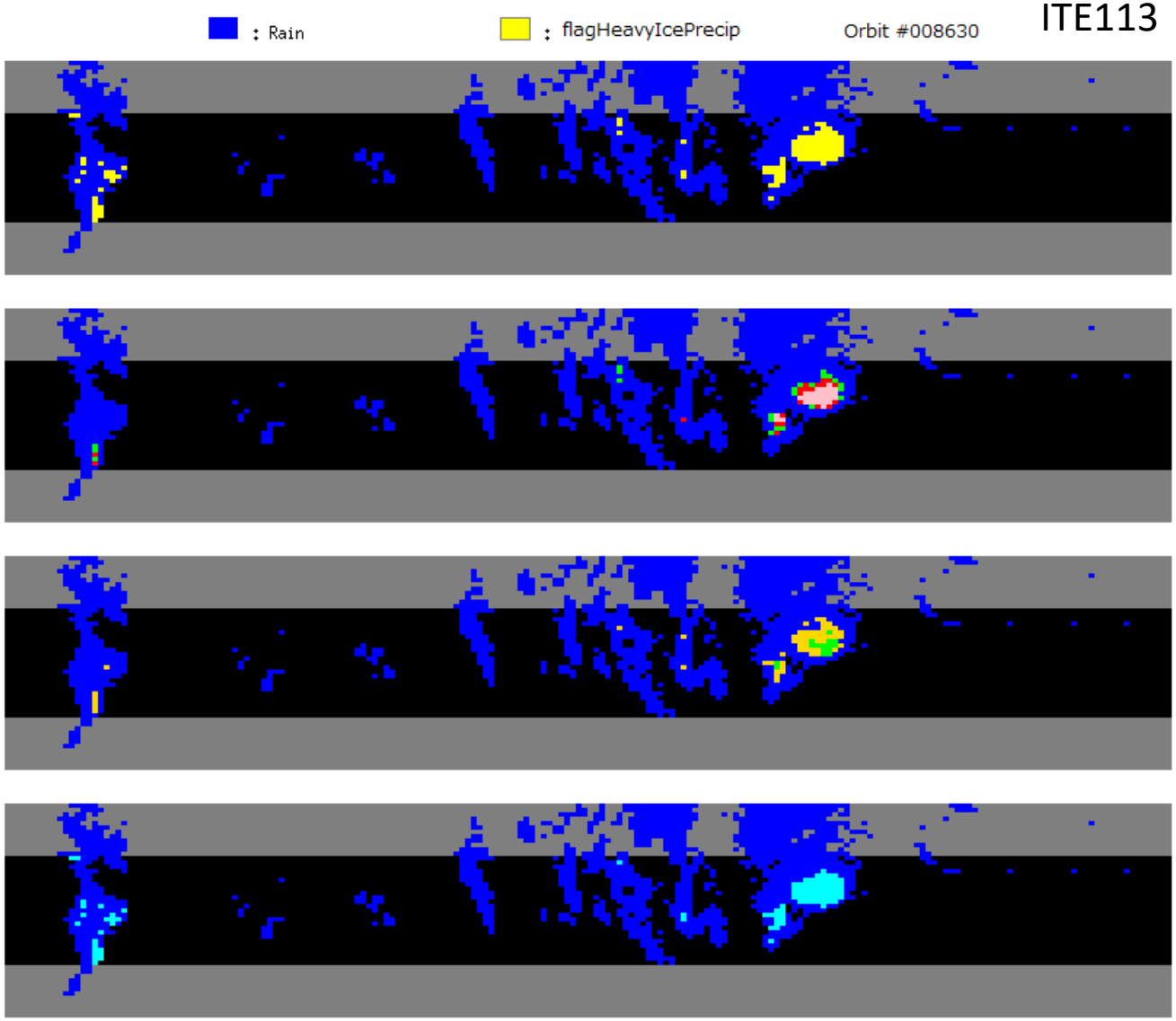
flagHeavyIcePrecip
near Napoli, 05 September 2015

2015/09/05
Orbit #008630



Only data above the -10 deg C are used to detect HeavyIcePrecip

ITE113



flagHeavyIcePrecip

=

Ku decision

Z(ku) > 45 dBZ
45 >= Z(ku) > 40 dBZ
40 >= Z(ku) > 35 dBZ

+

Ka decision

Z(ka) > 40 dBZ
40 >= Z(ka) > 35 dBZ
35 >= Z(ka) > 30 dBZ

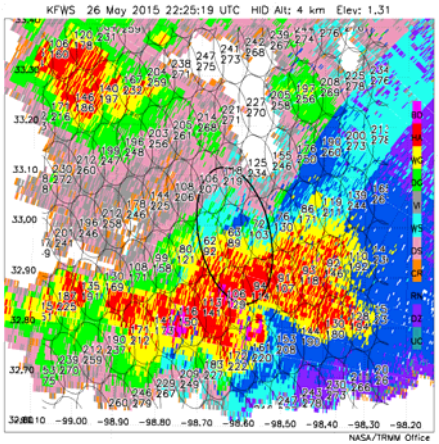
+

DFRm decision

Z(ku) > 27 dBZ and
DFRm > 7 dB

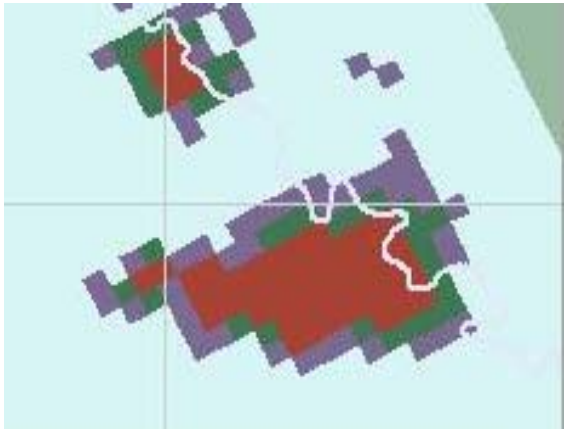
flagHeavyIcePrecip
Ft. Worth, 26 May 2015

(Courtesy of D. Cecil)

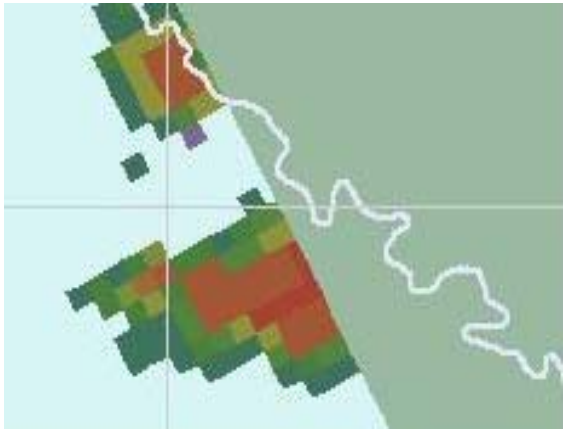


GV (Hail, wet and dry graupel)

KaPR (30, 35 dBZ)

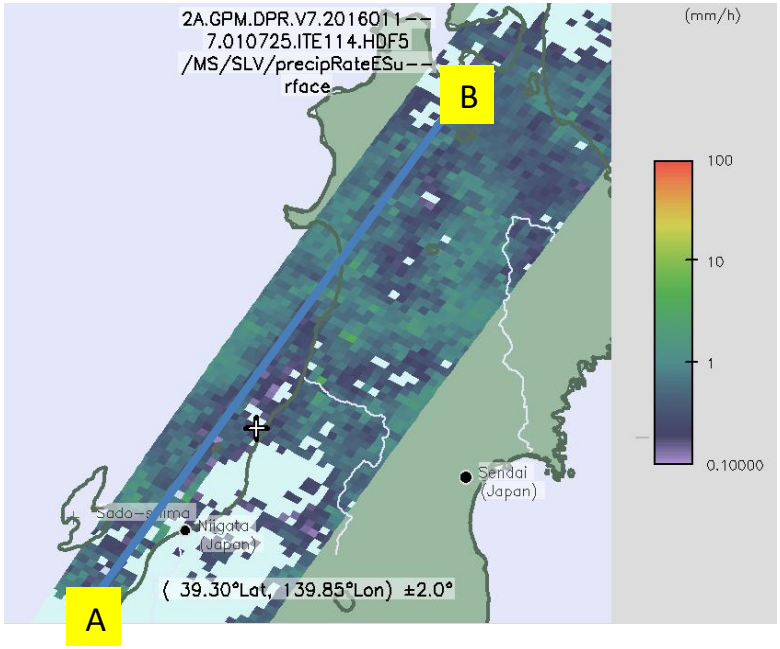


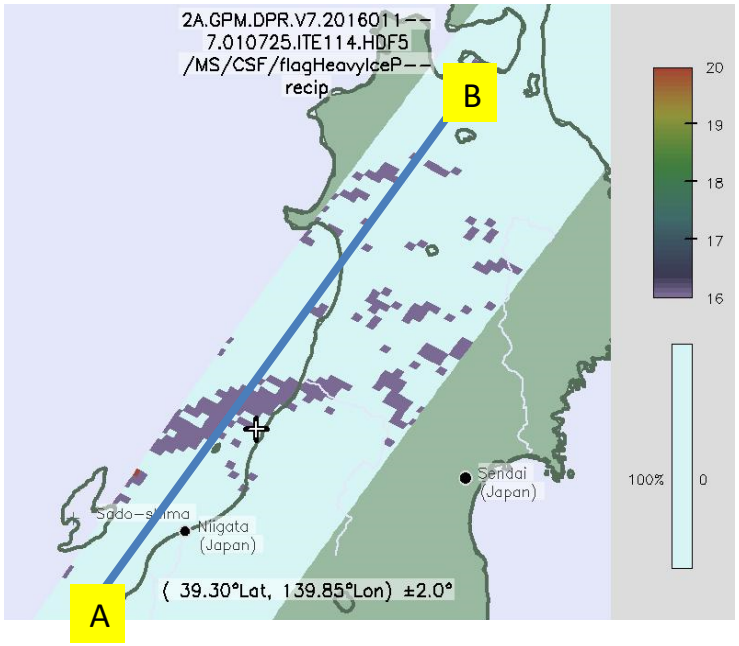
KuPR (35, 40 ,45 dBZ)

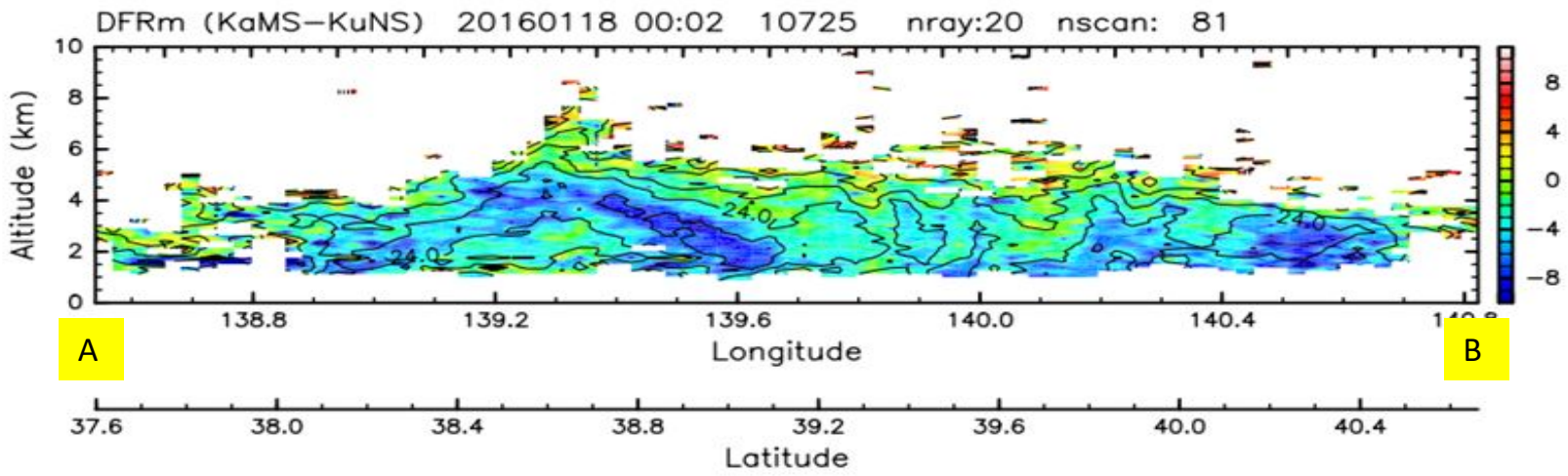


DPR (DFRm + KuPR + KaPR)

flagHeavyIcePrecip
North Eastern Japan, 18 January 2016

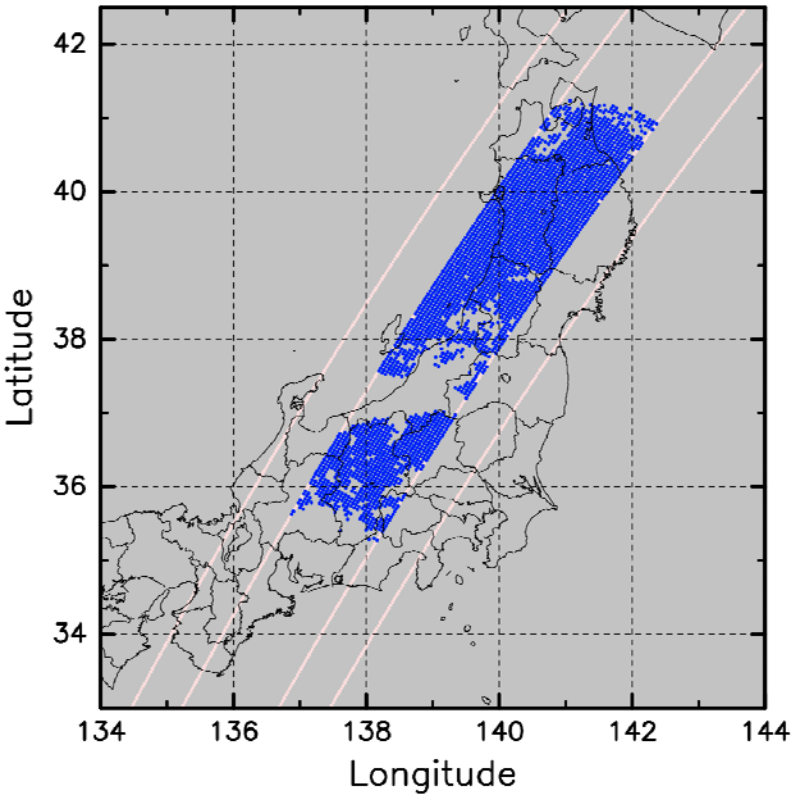




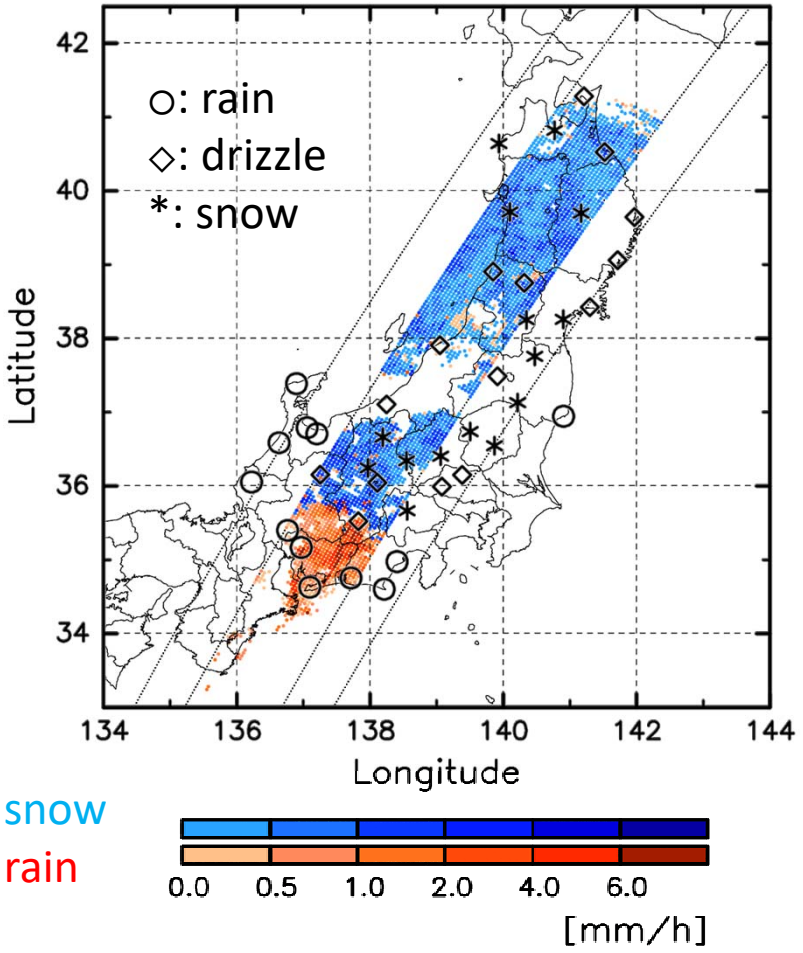


flagSurfaceSnowfall
North Eastern Japan, 18 January 2016

Pixels with flagSurfaceSnowfall



flagSurfaceSnowfall and surface observation

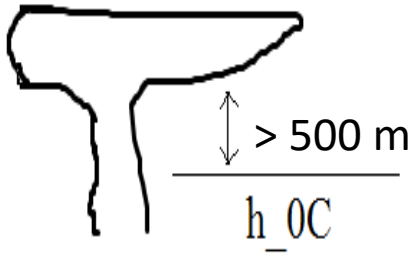


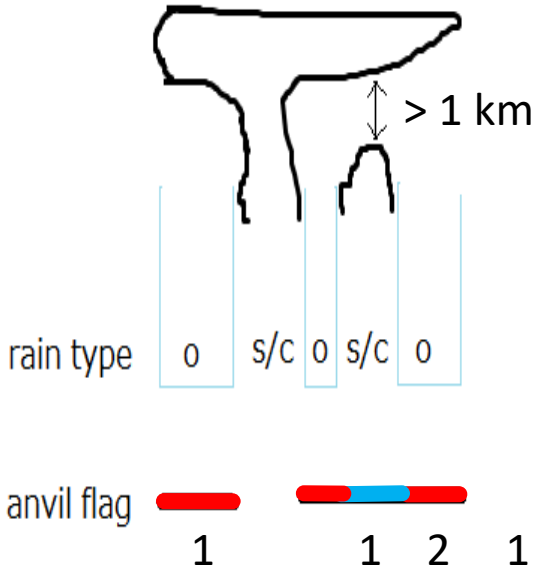
flag Anvil

flagAnvil is set when

- Some echo above 0C + 500 m
- No echoes (Z < 15 dBZ) for more than 1 km below the bottom of the anvil echo
- Anvil1: No significant echo below anvil
- Anvil2: Some echo exists below anvil

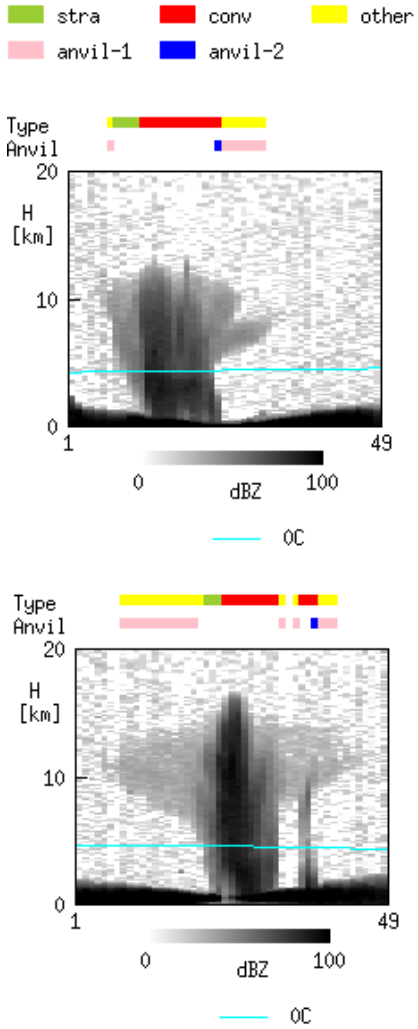
Definition of anvil





flagAnvil is
unsigned char [angle bin]
(Ku-only, Ka-only, Dual-freq.)
Independent of rain type flag.

Anvil flag should be independent of rain type flag (see below)

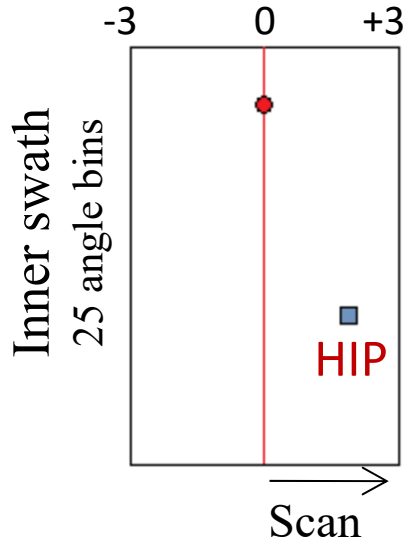


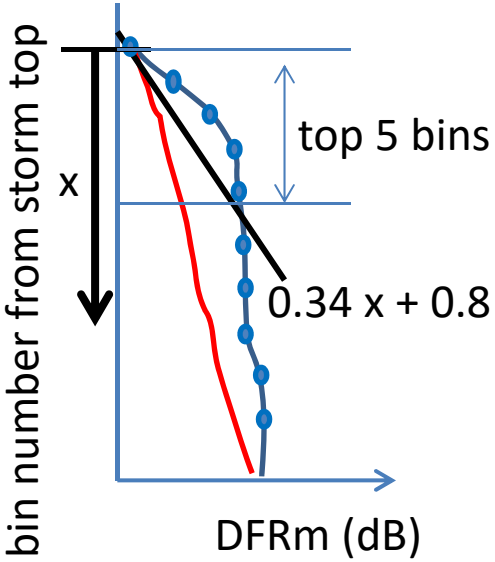
Detection of convective storms in winter

Use extended a DFRm method

Conditions (winter only)

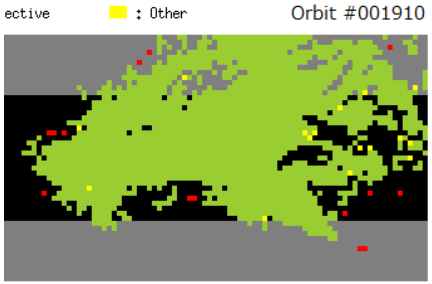
- 0 ℃ height is lower than 1 km
- HIP (Heavy Ice Precipitation) is set in the near-by scans.
  A HIP is set in the inner swath in -3 to +3 scans
  from the scan in question (See figure on the right).
- DFRm exceeds the following value at more than 3 bins
  in the 5 range bins downward from the storm top.
- (2.5 – 0.8) * x / 5.0 + 0.8
  where x is the bin number from the storm top.
- If Zm of KuPR exceed 35 dBZ at any bin in the top 5 bins,
  the strong echo is judged as caused by a BB and the
  pixel is not identified as convective.
- This method may have side-effects and needs further
  examination.

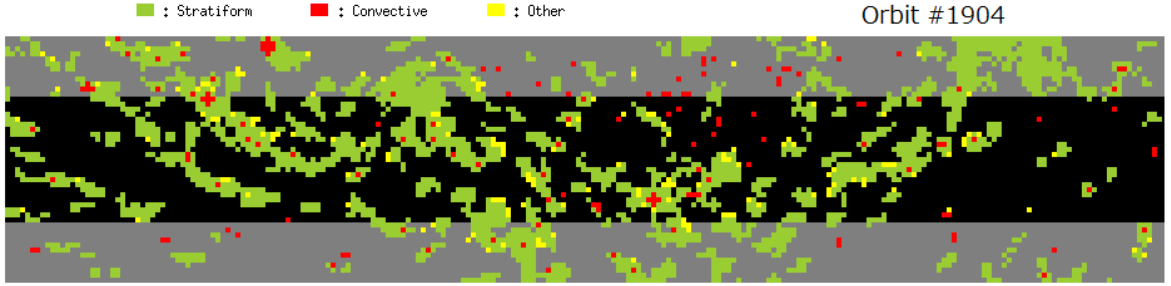




Winter precipitation type by the extended DFRm method (Examples)

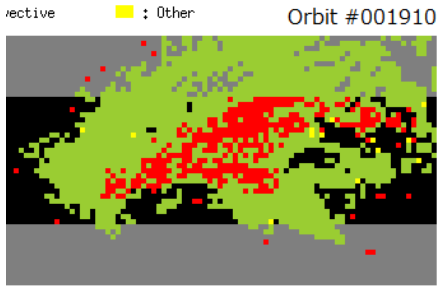
V4



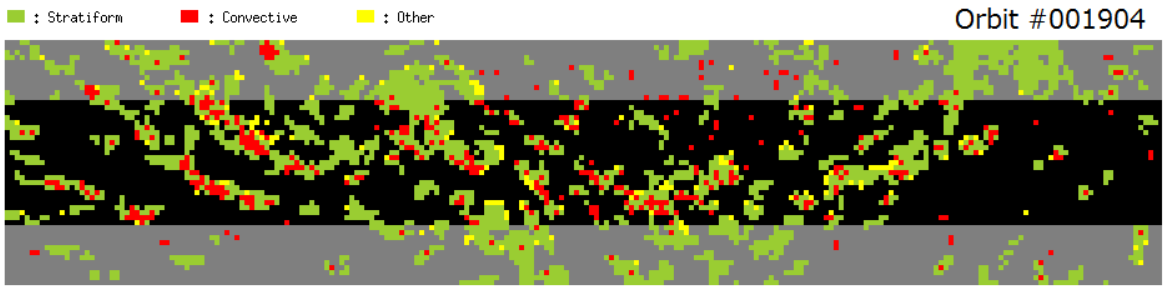


7100

V5



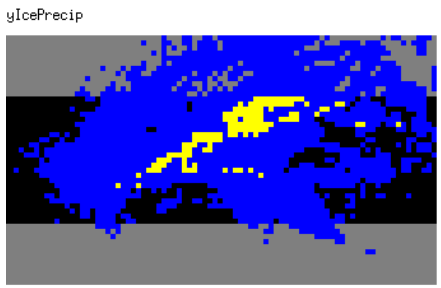
ITE113 (V5)

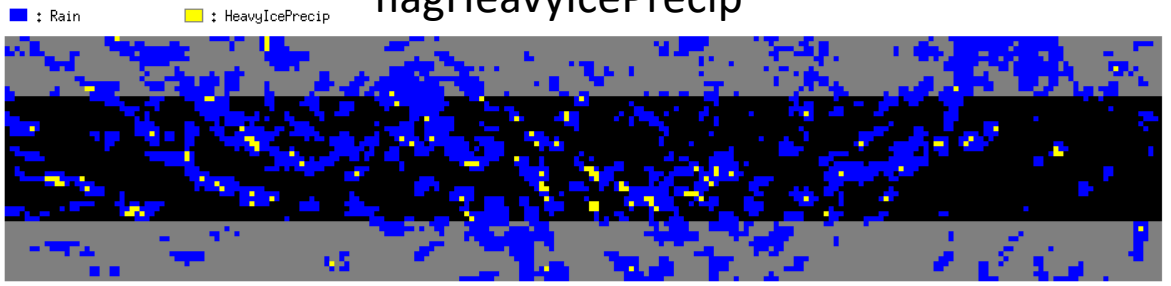


7100

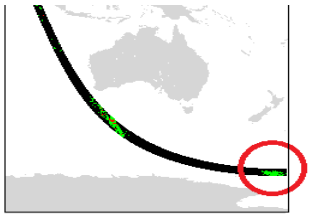
ITE113 (V5)

flagHeavyIcePrecip

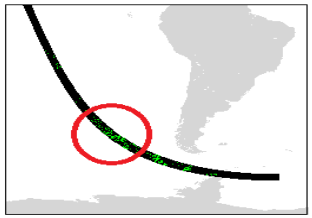




7100

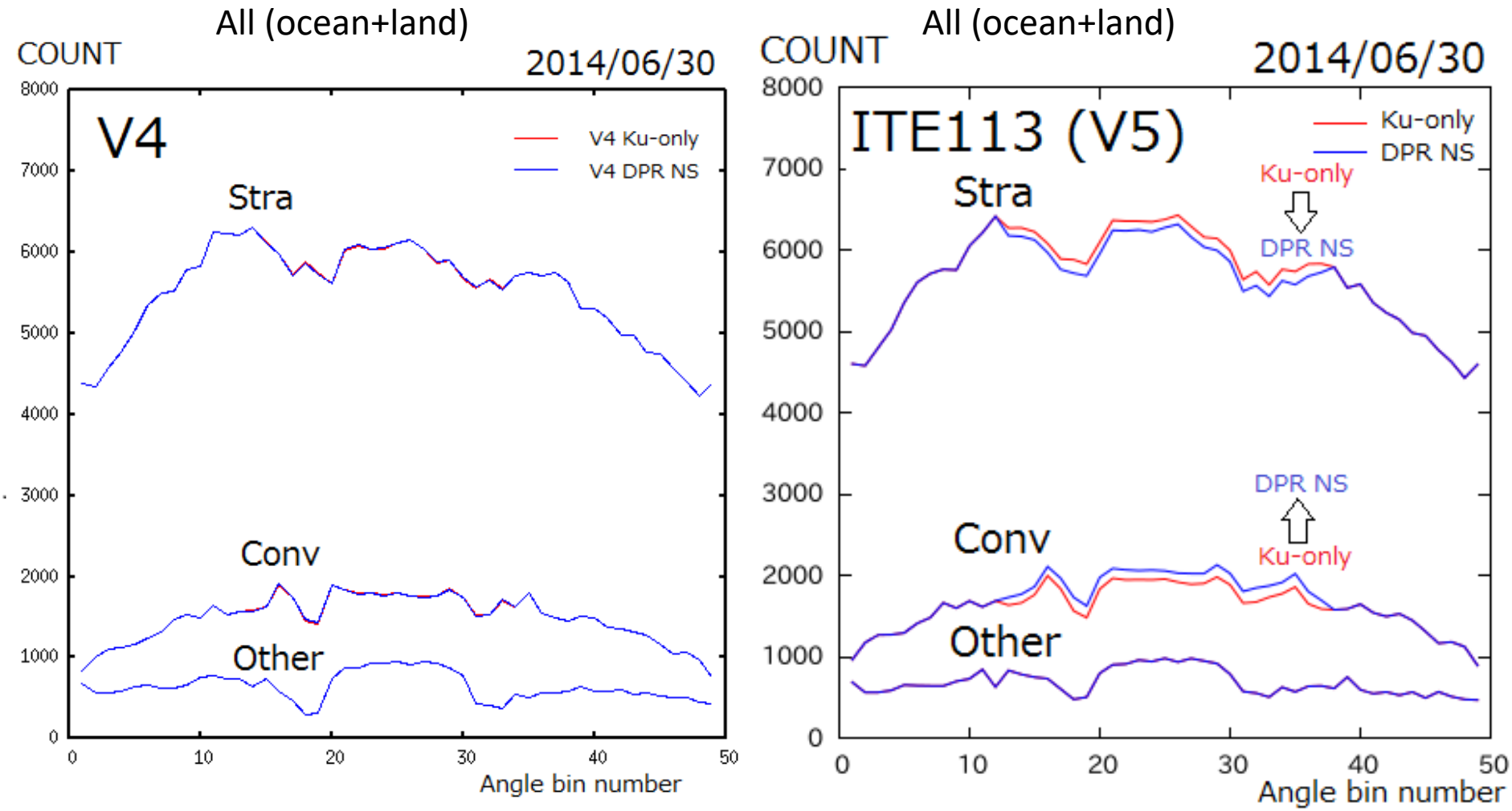


Orbit #1910 (2014/06/30)



Orbit #1904 (2014/06/30)

Increase of convective storms by winter convections



In V4, Ku-only type counts and dual-frequency type counts are almost the same.
In V5, the difference between Ku-only type counts and dual-frequency type counts becomes appreciable because of dual frequency processing.

Summary

- DPR(MS)'s Rain estimates from V5 seem reasonable.
  - Agreement with COMB and GMI is good, too.
- KuPR V5 decreased, but it now agrees better with the corresponding DPR estimates than V4, especially in the inner swath. (The decrease of precipitation estimates over land seems to be slightly too large though.)
- New flags (flagHeavyIcePrecip, flagSurfaceSnowfall, flagAnvil) seem to work reasonably well.
- The code tested in ITE114 can be used to produce V5 products (with minor caveats).