Improvements in Noise Estimates by the Spaceborne Precipitation Radar for Use as a Radiometer

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Purpose

This study develops a signal judgement for improving the measurement accuracy of brightness temperature by the spaceborne precipitation radar for use as a radiometer. Since the radar viewed from space measures the thermal emission from precipitation over the oceans, the brightness temperature at the radar's frequency is utilized for the precipitation estimates as an additional constraint. The radar brightness temperature also gives the sea ice concentration (SIC) estimates with 5-km/15-km spatial solution.

Summary

The radar brightness temperature is derived as a new observational variable. To improve the measurement accuracy of the radar brightness temperature, the new signal judgement is developed. The result provides a SIC data by the radar. This study also develops the radar-only radar/radiometer precipitation estimates, which mitigates outlier erroneously estimated at off-nadir over the oceans.

Data and method

KuPR/KaPR level-1 V05 and level-2 V06 products provided by the JAXA are analyzed.

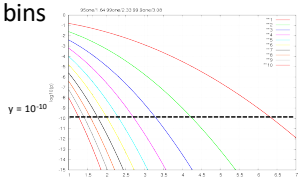
a) Equivalent probability for different successive range bins

$$P_r(\mathrm{dBm}) - P_n(\mathrm{dBm}) > n(m)\times\sqrt{\sigma_r^2+\sigma_n^2}, \qquad \sigma = \frac{5.57}{\sqrt{N}}$$

m	1	2	3	4	5	6	7	8	9
n	6.36	4.26	3.31	2.73	2.33	2.02	1.78	1.58	1.42

Reference of detection threshold (m = 5 and n = 2.33)

False probability of fading noise as signal



$$y = G(n)^m = \left(\frac{1}{2}\left[1-\mathrm{erf}\left(\frac{n}{\sqrt{2}}\right)\right]\right)^m, \qquad n = \sqrt{2}\,\mathrm{erf}^{-1}\left(1-2y^{\frac{1}{m}}\right)$$

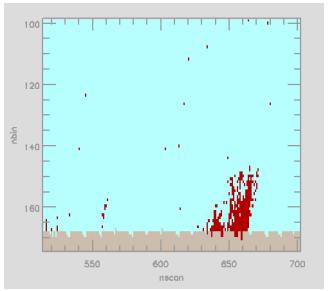
b) 3d-moving average detection

$$P_r(\mathrm{dBm}) - \overline{P_n}(\mathrm{dBm}) > m(n=1)\times\sqrt{\overline{\sigma_r^2}+\overline{\sigma_n^2}}$$

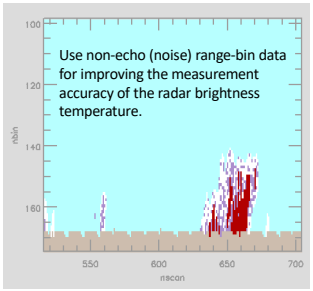
The 3d-moving average enables detection of weak signals widely distributing at not only 1d but also 3d.

Example:

KuPR V06A (Z_{min} ~ 15 dBZ)



New (Z_{min} ~ 12 dBZ)



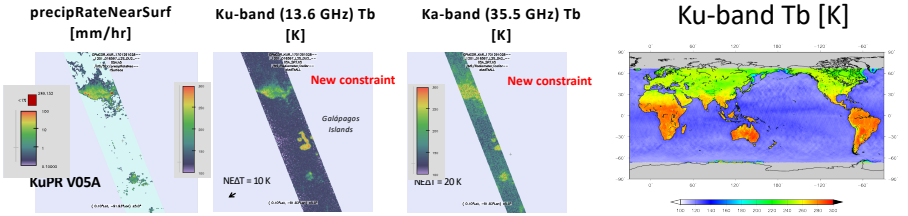
Angle-bin #25 of GPMCOR_KUR_1806300604_0737_024636_L2S_DU2_06A.h5

This study also additionally judges strange signals such as sidelobe clutter.

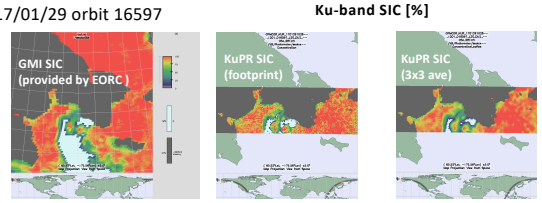
New precipitation judgment improves detectability and reliability.
The new method will be adopted in the next version (V07).

Results estimated as the radar brightness temperature

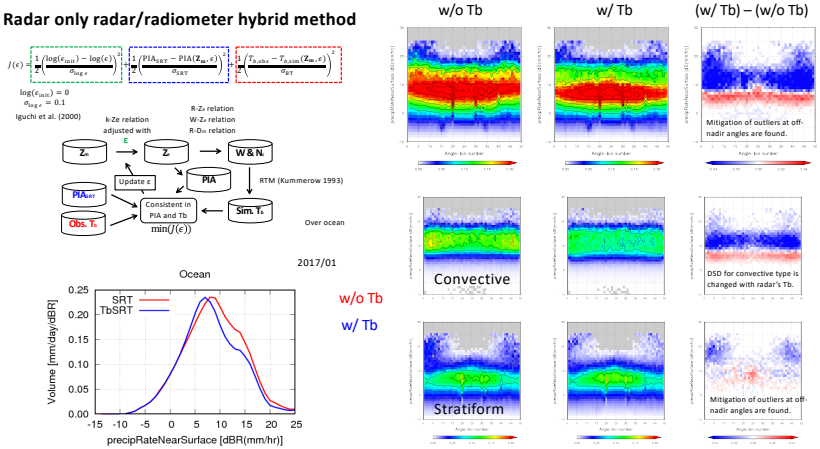
2017/01 (flagPrecip = 0)



2017/01/29 orbit 16597



Impacts of the brightness temperature on the precipitation estimates



References

1) T. Iguchi et al., 2000 "Rain-Profiling Algorithm for the TRMM Precipitation Radar". 2) C. Kummerow 1993, "On the accuracy of the Eddington approximation for radiative transfer in the microwave Frequencies"