What clouds make GMI and DPR rain rate estimates differ in summer?

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Purpose of this study

❑ Although GMI and DPR instantaneous rain estimates agree quite well, there are some interesting differences between the two rain retrievals.

❑ We examine the differences as a function of rain types, by asking: what cloud structures are associated with

✓ miss-detection by either one or the other instrument

✓ Overestimation by one of the instruments with respect to the other

Data used in this study

GMI and DPR in multiple resolutions

⇩

select only PR pixels that fall within the 10-GHz TMI Field-Of-View

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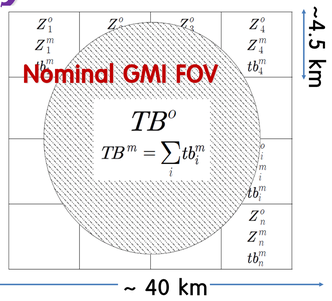
Convolve PR RRs using 19-GHz antenna gain function

⇩

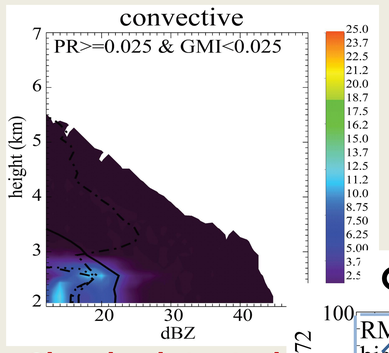
Compare collocated instantaneous RRs from GMI and DPR for two summers in global as a function of rain types



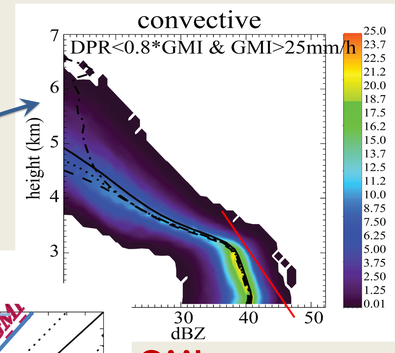
Rain types are determined using convective (stratiform) areal fraction

$$\text{category} = \begin{cases} 1(\text{convective}) & \text{convF} \geq 0.5 \\ 2(\text{stratiform}) & \text{stratF} \geq 0.5 \\ 3(\text{mixed}) & \text{if, convF} < 0.5 \text{ and stratF} < 0.5. \\ & \text{except convF} = 0 \text{ and stratF} = 0 \\ 4(\text{residual}) & \text{convF} = 0 \text{ and stratF} = 0 \end{cases}$$

- The raining clouds detected by DPR alone show that a majority of the clouds have weak radar reflectivity (less than 20 dBZ) extending from near the surface to a few km altitude.
- These clouds are unlikely to have distinct ice layer.
- Accordingly, these clouds seem to be classified as nonrainy pixels by GMI due to weak emission signal from liquid layer.



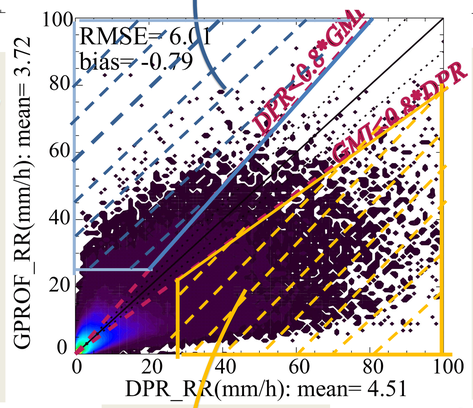
Clouds detected by DPR only



GMI overestimation

-Compared to the DPR overestimation, these clouds do not show a strong increase of radar reflectivity in rain layer.
-In addition, there is a possibility of having evaporation of rain drops near surface layer.
-Hence, DPR algorithm might underestimate rain rate compared to GMI for these clouds.

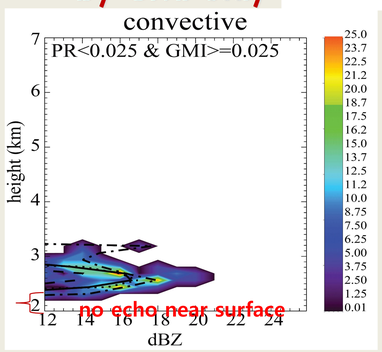
convective



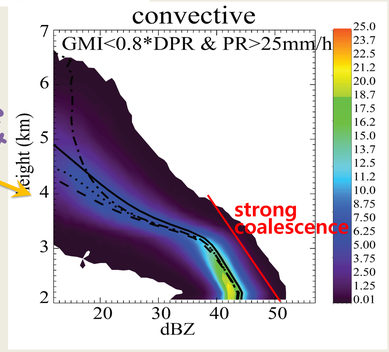
Clouds detected by GMI only

DPR overestimation

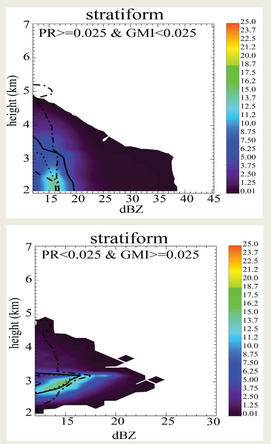
-The raining clouds detected only by GMI have relatively strong radar reflectivities overhanging above the surface but no radar echoes observed near the surface by DPR.
-Hence, only GMI can recognize these as non-rainy pixels.



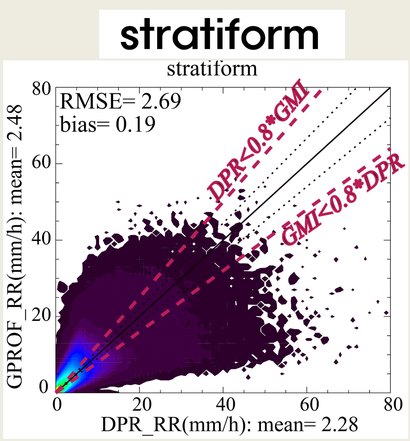
more prevalent

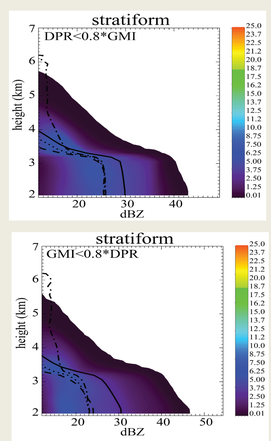


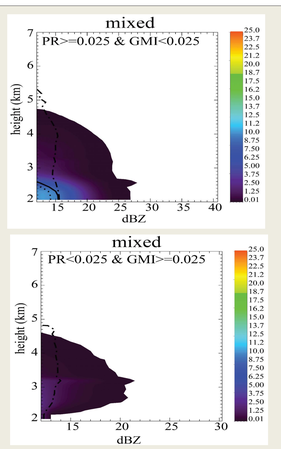
-The radar reflectivity sharply increases toward surface. This is an indication of an active coalescence process in rain layer.
-Meanwhile, GMI emission channels, being more sensitive to the vertical integral of the condensation, are not capable of detecting this coalescence feature, resulting in an underestimation by GMI.
- Despite strong rain intensity, the convective clouds in this category are warm and shallow.



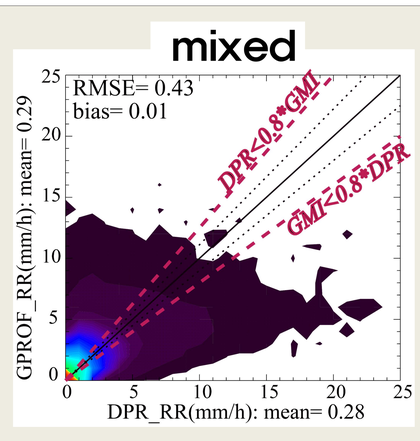
stratiform

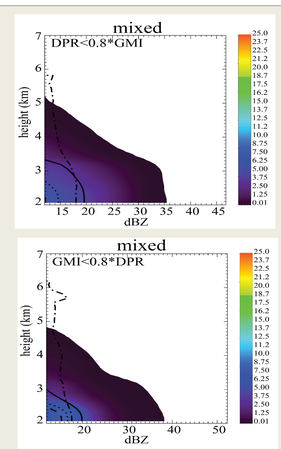






mixed





Summary

Rain detection

▪The raining clouds detected only by DPR show that a majority of these clouds have weak radar reflectivity (less than 20 dBZ) from the surface up to a few km altitude. These clouds seem to be classified as nonrainy pixels by GMI due to weak emission from liquid layer, probably masked by weak scattering above.

▪The raining clouds detected only by GMI have relatively strong radar reflectivities overhanging above the surface but no radar echoes observed near the surface by DPR. Hence, only GMI can recognize these as nonrainy pixels (according to DPR rain is not reaching the surface).

Disagreement between GMI and DPR rain rate – looking at CFADs for points of significant disagreement

▪For the points of relative DPR overestimation, the radar reflectivity sharply increases toward surface. This is an indication of an active coalescence process in the rain layer. Meanwhile, GMI emission channels are not capable of detecting this coalescence feature, as they are mostly responding to the vertical integral of the condensation and thus, are not able to depict the vertical variability, with increase of rain towards the surface. This results in an underestimation by GMI (relative overestimation by DPR).

▪For the points of GMI overestimation, these clouds do not show strong increase of radar reflectivity in rain layer compared to the clouds having the DPR overestimation. Meanwhile, there is a possibility of having evaporation of rain drops near surface layer.

Acknowledgement This study has been supported by the National Meteorological Satellite Center (NMSC) of the Korea Meteorological Administration (KMA)