An improvement of the precipitation detection method for the Dual-frequency Precipitation Radar onboard the Global Precipitation Measurement core observatory (GPM/DPR)

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As the only of spaceborne precipitation radar, the Precipitation Radar onboard the Tropical Rainfall Measuring Mission (TRMM) satellite and its successor the Dual-frequency Precipitation Radar (DPR) onboard the Global Precipitation Measurement (GPM) core observatory provides a standard dataset of near-global measurement of three-dimensional precipitation. One of the main targets of the GPM/DPR is light precipitation, especially solid precipitation such as snowfall. To properly and effectively derive those light precipitation, it is important to develop accurate method for the detection of precipitation echoes.

The standard algorithms to derive physical variables for the GPM/DPR rely on the detection of precipitation from observed radar reflectivity profiles. The current precipitation detection method for the GPM/DPR was developed based on that for the TRMM. It uses one-dimensional vertical profiles of radar-received power (Pe) and noise power (Pn). When Pr exceeds Pn by 2.5 times the standard deviation of the echo power (almost equivalent to that of received power) for at least 6 consecutive range bins, the vertical profile is judged to have precipitation echo.

The current method for precipitation detection is designed to avoid contamination of noises at the lowest level possible in subsequent algorithms deriving physical parameters, and so the probability of false detection is about 10^(-7) for a vertical profile and is less than 4% for an orbit that consists of 392,000 profiles. Such a conditioning gives the minimum detectable radar reflectivity Zmin as ~15 dBZ. On the other hand, Hamada and Takayabu (2016, J. Atmos. Oceanic Technol.) indicated that this Zmin value seems to be too conservative for some meteorological analyses, and that lowering the Zmin value of Ku-band radar (a part of the DPR) down to ~12 dBZ can still clearly capture weak but widely spread precipitation echoes around organized precipitation systems. This indicates that the precipitation detection method has some room to be improved without increasing false detection very much.

In this study, we are developing some new methods for precipitation detection. One is an extension of the current one-dimensional method, and based on the fact that the probability of false detection is less likely for a larger received power. By reducing the required number of consecutive range bins for stronger echoes with remaining the probability of false detection the same as the standard method. The other one is a further extension of the extended one-dimensional method, and uses three-dimensional echo distribution. This three-dimensional method is currently a GPM port and a three-dimensional extension of the existing method for Cloud Profiling Radar onboard the CloudSat satellite, but is developing with considering the information on the three-dimensional echo characteristics.

The former one-dimensional algorithm may be suitable for a near-real time retrieval algorithms and latter three-dimensional algorithm is expected to be adopted for some post-processed retrieval algorithms.

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