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# A developing precipitation retrieval algorithm for the GPM/DPR and the TRMM/PR

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The core satellite of the Global Precipitation Measurement (GPM) mission, which is scheduled to be launched in 2014, will carry the Dual-frequency Precipitation Radar (DPR). DPR is a successor of the single-frequency Precipitation Radar (PR) currently working on the Tropical Rainfall Measuring Mission (TRMM) satellite.

Precipitation radar measurement depends on drop size distribution (DSD) rather than precipitation rates. Generally, DSD is assumed to follow an exponential or a Gamma distribution with two unknown parameters. Here, DSD can be represented on a 2-dimensional plane. For a single-frequency radar measurement, as two parameters cannot be determined, an empirical power law between radar reflectivity factor Z and rain rate R (Z-R relationship) is used. Assuming Z-R relationship is equivalent to constraining DSD on a 1-dimenisonal curve. In the standard algorithm of PR, an empirical power law between specific attenuation k and Z (k-Z relationship) is given to correct attenuation (Hitschfeld-Bordan method; HB method). Assuming k-Z relationship is also equivalent to constraining DSD on another 1-dimensional curve. Fortunately, space-borne or air-borne radars such as PR can measure surface backscattering cross section and surface reference technique (SRT) is applied to estimate path integrated attenuation (PIA). By referring to PIA estimates, k-Z relationship can be adjusted. However, the adjustment depends on the accuracy of SRT, and is applied simultaneously for all range bins. Therefore, DSD cannot have 2-dimensional degrees of freedom. The accuracy of DSD estimation by PR depends on not only the accuracy of Z but the accuracy of constraints such as k-Z relationship.

In a developing algorithm for DPR, k-Z relation is assumed and the HB method is applied for each frequency. Once attenuation-corrected radar reflectivity factor Ze is given at both frequencies, the dual-frequency ratio (DFR) of Ze's is calculated, and DSD parameters are retrieved easily from the DFR (DFR method). However, the retrieved DSD generally does not agree with assumed k-Z relations. Then, k-Z relations are adjusted to fit the DSD. The HB method and DFR method can be applied again by using the adjusted k-Z relations. By iterating a combination of the HB method and the DFR method, k-Z relations are improved. This is termed HB-DFR method (Seto et al. 2013). Though k-Z relations are adjusted simultaneously for all range bins using SRT method, this method can adjust k-Z relation at a range bin independently of other range bins. Therefore, in this method, DSD is represented on a 2-dimensinal plane.

This method has no big differences from other dual-frequency retrieval methods in terms of the performance for dual-frequency measurement. But, this method can be smoothly applied to single-frequency measurement or the case that some range bins lack either of dual-frequency measurements, just by setting that DFR method and adjustment of k-Z relation are not applied for range bins without dual-frequency measurements. By the DPR, dual-frequency measurements are limited to inner swath of normal scans. In outer swath and in interleaved scans, single-frequency measurement by KuPR or KaPR is available. To have seamless 2-dimensional estimates of precipitation, this method is suitable. In the future, the DPR algorithm is applied to the PR measurements to produce long-term dataset with temporally constant quality.

Keywords: precipitation, radar, DSD, GPM, TRMM, DPR