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Principle of GPM dual frequency precipitation radar retrieval

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TRMM PR has been a successful mission to provide, for the first time, global vertical profile of rain storms. However, the accuracy of the DSD retrieval as well as the rainfall estimates from single-frequency radar without polarization capabilities, such as TRMM PR, is restricted by the reliability of the surface reference technique and the uncertainties associated with the assumed k-Z and Z-R relations. Global Precipitation Measurement (GPM) is poised to be the next generation observations from space after the TRMM mission, planned to be launched in 2013. One major goal is to provide accurate precipitation measurement around the globe (±65º latitude) every 2 to 4 hours. The GPM mission is centered on the deployment of a core observatory satellite with an active dual-frequency radar DPR, operating at Ku and Ka bands. The Ka band channel is added to help achieve more sensitivity to light rain and ice where little DSD information could be achieved at low and moderate rain rates (10 mm/h or less). Two independent observations from DPR provides the possibility to retrieve two independent DSD parameters, namely D0 and Nw, at each resolution volume along the height while no variation of Nw could be obtained along the height from TRMM PR. The difference of radar reflectivity at two frequencies (Dual frequency ratio) allows us to examine the DSD parameters for the melting and frozen particles as well.

There have been a number of dual-frequency methods proposed for the DPR radar. They can be categorized into two types: one is the standard dual-frequency method based on the conversion of differential attenuation to rain rate; the other is based on reflectivity, which is corrected for attenuation, and DSD parameters are inferred by non-Rayleigh scattering. The latter can be formulated either in integral equations or a first-order differential equation. Using the integral equation, the two DSD parameters Do and Nw can be solved at each bin gate on the assumed microphysical models for regions of hydrometeors. One known error in the dual frequency retrievals is the bi-valued problem when retrieving median volume diameter Do from DFR for rain region. Rose and Chandrasekar (2006), remedied the bi-valued problem by assuming a linear Do as well as Nw model in rain. The algorithm with the linear assumption was tested by Le et al (2009) based on the whole vertical profile including rain, melting and ice through a hybrid method. Forward method is applied to ice and melting ice region to avoid large attenuation while linear assumption is applied in rain region. No SRT information is needed in this algorithm. It uses an iteration procedure to optimize DSD parameters at the bottom of rain region by constructing the cost function along the whole vertical profile. This retrieval algorithm is tested using airborne observations.