Geophysical Research Abstracts
Vol. 15, EGU2013-6218, 2013
EGU General Assembly 2013

Drop size distribution retrieval for global precipitation measurement mission: a candidate algorithm

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Abstract

Electromagnetic wave propagation through precipitation media and their scattering by precipitation particles is essential towards understanding both space-borne and ground-based radar observations. The distribution of particle sizes [drop size distribution (DSD)] as well as particle scattering model is of central importance determining the electromagnetic scattering properties of precipitation media. The size distribution describes the probability density function of precipitation drop sizes. The estimation of the drop size distribution (DSD) parameters of precipitation particles helps to achieve more accurate estimation of precipitation rate. One of the scientific objectives of dual frequency precipitation radar DPR on board the Global Precipitation Measurement (GPM) mission core satellite is to improve the accuracy of DSD parameters.

The dual-frequency precipitation radar DPR on board the GPM satellite will operate at Ku- and Ka- bands. In comparison to the Tropical Rainfall Measuring Mission (TRMM) precipitation radar, 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 provide the possibility to retrieve two independent DSD parameters, namely median volume diameter (Do) and normalized intercept parameter (Nw), at each resolution volume along the height.

There have been a number of dual-frequency methods proposed for the DPR radar. One of them is based on reflectivity, which is corrected for attenuation, and DSD parameters are inferred by non-Rayleigh scattering. It can be formulated either in integral equations or a first-order differential equation (Meneghini et al, 1997, 2002). One known error in the dual frequency retrieval 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. 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. The retrieved DSDs show good comparisons with the simulation truth. Seto et al (2012) proposed an algorithm for GPM-DPR retrieval called HB-DFR method combining the Histchfeld-Bordan's attenuation correction method (Histchfeld and Bordan, 1954) and the dual-frequency ratio method (Meneghini et al., 1997). In this paper, the performance of the hybrid method will be compared with the HB-DFR method. Second generation airborne precipitation (APR-2) radar data will be used for algorithm evaluation.