Improvement of the dual-frequency precipitation retrieval method for a global estimation of Z-R relations

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Abstract Z-R relations between radar reflectivity factor Z and precipitation rate R have been used for operational radar measurements, but the relations are known to be highly variable in time and space and also to be dependent on precipitation types. The Dual-frequency Precipitation Radar (DPR), which will be carried on the core satellite of the Global Precipitation Measurement (GPM) mission hopefully from 2013, is expected to instantaneously estimate the 2-moment drop size distribution function and to finally derive global maps of the coefficients of Z-R relations. For this big goal, it is necessary to develop an accurate retrieval method for DPR. Mardiana et al. developed the iterative backward retrieval method (MA04) without the use of surface reference technique, which may cause significant errors over land. Some previous studies tested MA04 with simple settings of precipitation measurement, and found that MA04 cannot derive the true solution when the precipitation rate is relatively high. In the first part of this study, MA04 was tested with a simulated DPR measurement dataset, which is more realistic than those used in the previous studies. The retrieved surface precipitation rate is evaluated, and it is shown that MA04 has a negative bias which corresponds to 40% of the true precipitation rate. It is also shown that the estimated Zₑ (equivalent radar reflectivity factor) by MA04 tends to be smaller at lower range bins, while the true Zₑ does not change largely along the range. In the second part of this study, based on MA04, three modified retrieval methods are developed and they are tested with the same simulated DPR measurement dataset. To overcome the shortcomings of MA04, constraints to make vertically stable profiles of Zₑ are introduced in the modified methods. In the best method, the bias is limited to 12% of the true precipitation rate.

Key words Z-R relation; drop size distribution; spaceborne radar; DPR; GPM