**Improvements in DPR Path-Attenuation Estimates**

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**Introduction**

To achieve adequate resolution from space within the constraints of antenna size, the spaceborne weather radar requires the use of higher frequencies (13.6, 35.5 GHz) than those used for ground-based operation (3 to 5 GHz). Use of the higher frequency, however, introduces signal attenuation that must be corrected before accurate estimates of meteorological parameters can be made. With the introduction of dual-frequency operation on the DPR, the goal is to devise and evaluate new methods of attenuation correction that offer the possibility of improved accuracy relative to the single-frequency correction methods.

Accurate estimates of path integrated attenuation (PIA) along the radar beam have been found to be critically important in estimating characteristics of the precipitation using data from the TRMM Precipitation Radar (PR) and the GPM Dual-Frequency Precipitation Radar (DPR). For the dual-frequency DPR data in the inner swath (125 km), improvements in the accuracy of path attenuation estimates can be made by comparing the differential-frequency surface cross section, δσ=σ(Ka)-σ(Ku), measured inside and outside the raining area. As the DPR scanning is expected to be changed in May 2018, so that dual-frequency data are available over the full swath (245 km), the dual-frequency surface reference technique (DSRT) will be modified and tested for this new scan geometry.

Another potential improvement in estimating path attenuation is to merge the SRT with the Hitschfeld-Bordan (HB) method of attenuation correction. The two approaches are complementary in the sense that the SRT performs better at high rain rates while the HB performs well in light rain, where the attenuation is small. Formulation and testing of single- and dual-frequency hybrid estimates are being pursued by adding new code and new output variables to existing operational codes. A critical element in forming the hybrid estimate is a better characterization of the error structure of each method since the weight of each contribution to the hybrid is inversely proportional to the error variance. To address this issue, measured raindrop size distributions are being used to simulate the measured radar reflectivity factors at Ku/Ka-band through the raining medium. Use of these data in the various methods provides estimates of the error variance. In the case of the differential path attenuation estimate, an extension of the two-component hybrid estimate can be made by adding a third method, the standard dual-frequency method, which has the advantage of being less affected by non-uniform beamfilling.

**Current Status**

As the DPR data is processed both in a single-frequency and dual-frequency mode, both single- and dual-frequency attenuation correction procedures have been implemented in the current algorithm. Improved performance of the dual-frequency version of the surface reference method relative to the single frequency counterpart has been shown.

While the DPR retrievals of rain rate and parameters of the drop size distribution generally compare well to ground radar estimates, there are a number of improvements that can be made to the DPR algorithms. Path attenuation estimates from the SRT show estimates that are sometimes too large, leading to overestimates in attenuation correction and rainfall rate. While the dual-frequency version of the method provides better accuracy, these retrievals are presently confined to the inner swath. Once the DPR scan pattern is changed so that dual-frequency data are available over the full swath (245 km), the SRT will be modified and tested for this new scan geometry. Another potential improvement is to merge the SRT with the Hitschfeld-Bordan (HB) method of attenuation correction.

**Work Plan**

The purpose of attenuation correction is to provide radar reflectivity data to the retrieval module that is directly related to the hydrometeors that are present at each height level. Although the DPR retrieval module appears to be working well, it rests on certain assumptions as to the uniformity of certain parameters of the particle drop size distribution along the illuminated path. Alternative formulations have been proposed with fewer restrictions and, under the certain circumstances, should provide better retrievals of the particle size distributions. These formulations, however, can become unstable at the lighter rain rates and in cases where the particle size distributions consists primarily of small raindrops. The challenge is to combine the different approaches into a retrieval module that provides more information regarding the particle size distribution while avoiding instabilities.