A New DSD Algorithm for the Dual-Frequency Wind Profiler

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The vertical structure of rain drop size distribution (DSD) and its variability are important parameters for the retrievals of rainfall rate and the determination of atmospheric latent heating that drive our climate. However, the uncertainties in the DSD estmation has so far presented the fundamental limitation on how well such atmospheric quantities can be determined. The microwave dual-frequency wind profiler has the promise to be the "profiling distrometer" that measures DSD vertical structures. It operates at UHF and VHF channels that are sensitive to clear air turbulence and turbulence-modulated precipitation, respectively. Hence, the UHF spectrum can be deconvolved with clear air spectrum from VHF channels to get a new UHF spectrum that represents the precipitation spectrum in still air. This new UHF spectrum, which can then be converted to raindrop size distribution based on the relation that governs the terminal velocity of raindrop.

In the past, the deconvolutions are mostly based on the parameterized DSD with certain analytical format, such as Gamma function. This introduces two problems in DSD retrieval. (1) The rain DSD and its mean terminal velocity are related via a nonlinear function. In other words, the wind profiler would not be able to discriminate DSD in the small or large rain drop ranges, which results in non-uniqueness and instability in the wind profile algorithm; (2) Gamma function is not always the best presentation of realistic DSD in question, which could lead to diverged solutions in the Doppler spectrum domain.

To address these two issues, we have recently developed a new deconvolution procedure based on discretized DSD, which is similar to the binned DSD of distrometer. Since we can group all the very small or very large drops in a two separate bins, we avoid the non-uniqueness of the solution in the retrievals. In addition, no constrain is imposed on different size bins, thus the solution always converges in the Doppler spectrum domain. We will present some results using this new algorithm, as well as their comparison with results from existing algorithm.

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