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Radar retrievals of the particle size distribution using double-moment normalisation

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1 Extended Abstract

The particle size distribution (PSD) of precipitation describes the concentration and size of falling hydrometeors. The PSD is important because most precipitation variables of interest can be derived from it. The PSD, whether known or assumed, is used when interpreting radar data and in microphysical schemes employed in numerical weather modelling. PSDs are highly variable in space and time, and variability in the microstructure of precipitation contributes to uncertainty in modelling and observations. In recent years several methods have been investigated for remote retrieval of the PSD from polarimetric radar data.

Here, we present a summary of retrieval methods that use a representation of the PSD called double-moment normalisation, in which the entire PSD is represented using a constant shape function and variability is represented by fluctuation in two statistical moments of the PSD [1]. Since the shape function is static, the task of PSD retrieval becomes that of quantifying two PSD moments from radar data.

In this presentation we summarise methods that use this approach for the retrieval of the raindrop size distribution and the hail size (number) distribution, discuss the implications, and pay tribute to the role of Prof. V. N. Bringi in development of these techniques.

For rain, we discuss a technique [2] in which moments of the raindrop size distribution (DSD) are retrieved from polarimetric variables and the whole DSD is reconstructed using the double-moment normalisation technique. The advantages of the technique is that no particular shape of the DSD is prescribed and by choosing different target moments the technique can be adapted to focus on particular parts of the DSD [3].

For hail, we discuss a technique that employs a generalized additive model trained on data from the Swiss hail sensor network to estimate the two empirical moments of the hail size number distribution (HSND). The model uses polarimetric features such as the echo-top height of the 50 dBZ reflectivity and the volume of the region with a cross-correlation coefficient below 0.97. The modeled moments are combined with a fitted generalized gamma function to retrieve the HSND. This method is further validated against independent hail observations, including drone-based photogrammetry and crowd-sourced reports, demonstrating promising high-resolution (1 km, 5 min) radar-based retrievals of HSND and related metrics such as kinetic energy.

References

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