Do the rain microphysics provide information on the overlying ice cloud?

Kamil Mroz\\(^1\), Alessandro Battaglia\\(^1\), Stefan Kneifel\\(^2\), and Jose Dias Neto\\(^2\)

\\(^1\)National Centre for Earth Observation, University of Leicester, United Kingdom
\\(^2\)Institute of Geophysics and Meteorology, University of Cologne, Cologne, Germany

This study investigates to what degree the information about the Drop Size Distribution (DSD) of rain can be used to narrow down uncertainty associated with complex ice microphysics. For this purpose, measurements from vertically pointing multi-frequency Doppler radar are thoroughly analysed. Linear Depolarization Ratio information is used to unambiguously separate hydrometeor phases. Within radar volumes where pure rain is identified multi-frequency Doppler spectra are utilised to retrieve a binned DSD with a high degree of confidence (Tridon et al. 2017). By assuming no breakup and negligible interaction between melting particles (Szyrmer and Zawadzki 1999, Olson et al. 2001, Matrosov 2008) the rain drop size distribution closest to the melting region is used to predict the particle size distribution (PSD) in the overlying snow. With these assumptions the resulting shape of the ice PSD depends solely on the hydrodynamical properties of snow that are dictated by its microphysics. Several ice models are considered in the analysis, ranging from aggregates of columns, dendrites, needles and plates to different stages of rimed snow. Their scattering properties are simulated with Self-Similar-Rayleigh-Gans approximation (Leinonen et al. 2018) whereas falling velocities are modelled after Khvorostyanov and Curry (2005). Doppler spectra are simulated for the predicted ice PSD and compared to the measurements above the melting region. Results suggest that, if appropriate snow model used, the predicted reflectivity differs by less than 3 dB from the measured values as has been tentatively suggested by Fabry and Zawadzki (1995).


Y. Matrosov, "Assessment of Radar Signal Attenuation CAUSED by the Melting Hydrometeor Layer,"