How well do triple-frequency radar signatures of simulated and observed melting snowflakes compare?

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The melting of ice particles produce distinctive radiative features at microwave frequencies such as the radar bright-band and increased signal attenuation. An accurate characterization of the scattering properties of melting ice particles is not only relevant for precipitation retrievals from space but also for utilizing the observational fingerprints e.g. for model evaluation.

While the number of scattering datasets for complex snow aggregates and rimed particles is rapidly increasing during recent years, the number of available scattering computations for realistic melting particles is very limited (especially regarding the number of particle sizes, shapes, melted fractions and frequencies included). This is certainly connected to the high complexity of the melting process and the large computational cost of scattering simulations.

In this contribution, we use two scattering datasets of melting snowflakes to calculate triple-frequency radar signatures and linear depolarization ratios. We compare the range of simulated signatures with recent ground-based triple-frequency (X, Ka, W-Band) radar simulations for selected mid-latitude rainfall cases. The scattering simulations reveal an increased radar reflectivity and attenuation. The comparison between the two datasets shows some differences that are connected to the particle modeling algorithm. Although some features in the multifrequency space are well modeled by the scattering databases, none of them seems to be able to entirely match the range of observed values. Experiments with the scattering models provide some initial hints for the reason of the observed discrepancies between the models and the observations.

The comparison with radar observations reveals that current scattering datasets of mixed-phase particles cannot yet fully represent the signature of melting snowflakes and additional work is needed to fully understand the relation between microphysical and scattering properties of mixed-phase precipitation.