Triple-frequency radar observations: What can they really tell us about snowfall properties?

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Although snowfall is undoubtedly of major importance for the water cycle at high latitudes and for our understanding of cold rain formation, snowfall microphysics is still a big challenge for atmospheric modelers and observationalists. One reason is the enormous variability of snowfall properties including for example various habits ranging from single ice crystals and snow aggregates to rimed particles.

In recent years, the increasing number of available snow and ice particle scattering models suggested that a combination of three radar frequencies which cover the Rayleigh scattering regime up to the Mie scattering regime could help to untangle at least certain classes of snowfall like aggregates or graupel-like particles. Recent observations from airborne and ground-based campaigns confirmed the general existence of different regimes in the triple-frequency space similar to those predicted by the scattering models. In this contribution we will show first results from a campaign in Finland where ground-based triple-frequency (X-, Ka-, and W-band) radar observations were for the first time analyzed in combination with a comprehensive set of collocated in-situ observations. The three analyzed case studies cover a wide range of snowflake habits and densities (degrees of riming). The observed triple-frequency signatures are in general agreement with former studies but also reveal unexpected new features: In addition to open, low-density aggregates, rimed particles populate in distinctly different regions and show high sensitivity on the change in bulk snowfall density. Therefore, we can conclude that triple-frequency radar observations bear the potential to constrain some key parameters of snowfall microphysics like median mass diameter or bulk snowfall density. We will further present first results of a recent triple-frequency campaign in Germany which was

aimed to exploit the additional information that can be gained by combining triple-frequency observations with scanning X-Band radar polarimetry.