

A triple frequency approach to retrieve microphysical snowfall parameters

S. Kneifel, R. Bennartz, M.S. Kulie, J. Leinonen, D. Moisseev, T. Nousiainen, J. Tyynelä

The derivation of snowfall quantities like snowfall rate or snow water content from single frequency radar measurements (e.g. at Ka, Ku or W-band) is known to be prone to large uncertainties. This is due to the fact that a specific Z_e value can be obtained by many different combinations of microphysical snowfall parameters like size distribution, particle habit or orientation. Several studies already reported that significant improvements can be obtained by using radar observations at two frequencies which one in the Rayleigh scattering region and the other in the Mie scattering region (e.g. Ka and W band).

In this study we present scattering simulations for Ku, Ka and W-band for various theoretical snow particle models including spheres, spheroids, idealized single ice particles and realistic snow aggregates. The single scattering simulations are further integrated over various particle size distributions in order to capture natural variability. The simulations reveal that aggregate snow – particularly at larger particle sizes – produces significant different Z_e signatures in the triple frequency space if compared to spheroid models. In fact, specific triple frequency signatures can only be explained by the aggregate particle habits. Thus, the simultaneous measurements at such a triple frequency combination would further improve the derivation of particle size and habit of the observed snowfall. Sensitivity studies have been performed including different cut-off values for the size distribution as well as an analysis of attenuation effects on the results. Finally we will present an analysis of airborne observational triple frequency data which compare very well with the simulations highlighting the potential of the method for future snowfall studies.