Dual-polarization computations of snow at various radar frequencies

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Modeling of the electromagnetic scattering by hydrometeors is an ongoing problem, which has for long suffered from the absence of accurate methodologies and computations. Recent studies involving multi-frequency observations with both ground-based and space-based geometries has shown that simple approximations for hydrometeors may not produce adequate results, especially at higher microwave frequencies. At the resonance region, particle shape has a strong influence on the backscattering properties. Due to the large morphological variation of snow, it is therefore crucial to study the impact of particle morphology on backscattering properties. To take into account the particle morphology in modeling backscattering, we use the discrete-dipole approximation, which approximates the particle as a cubic lattice of polarizable dipoles.

In addition to the advances in modeling, the availability of operational and research radars has increased at different radar frequencies covering the long-wave region in the S band (2.7 GHz) to the short-wave region in the W band (94.0 GHz) with many intermediate frequency bands, such as C, X, Ku, and Ka. As many of these radars provide dual-polarization measurements, a combination of measurements involving different frequencies and polarizations can improve the identification of snow type.

In this study, we make a comprehensive investigation of how the dual-polarization characteristics at different radar frequencies (S, C, X, Ku, Ka, and W bands) vary for different types of snow. The motivation is to find how sensitive certain backscattering characteristics are on particle morphology, and how different combinations of polarization and radar frequency can enhance this sensitivity. The modeling results are compared to ground-based radar measurements to check the validity of the methods.