Exploring Variability of Radar Backscattering Cross Sections of Dendrites

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Botta et al. (2012, in progress) developed a database of backscattering cross sections at X-, Ka- and W-bands of dendrites with different masses, maximum dimensions, and shapes. Based on this database we developed a two parameter model that captures most of the variability within it. The first parameter is the sum of the phase across all parts of a particle as observed far from the particle, which relates to coherence effects between different parts of a particle. This "phase" parameter captures most of the variability in the backscattering cross sections that are due to differences in the masses, maximum dimensions, shapes and orientations of the dendrites. The second parameter relates to self-interactions between different parts of a dendrite that are relatively close together, which alter the electric field strength inside the particle. This "internal" parameter explains secondary variability within the database of backscattering cross sections due to different structures within the dendrites. Backscattering cross sections estimated by a computationally inexpensive model based on these two parameters are compared with those from the database. Among all the backscattering cross sections from dendrites with different mass, maximum dimension, shape and orientation, 94.8% of them have differences between model and GMM results that are less than 0.5 dB, 4.9% between 0.5 dB to 1.0 dB, and 0.3% larger than 1.0 dB, with a maximum error of 5.9 dB. We show that the variability within the database is due to the mass, maximum dimension, orientation and internal structure of the dendrites. This implies that, amongst other things, ice microphysical models must predict these characteristics of dendrites, especially their internal structure, if their particle properties are intended for forward modeling of radar backscattering cross sections with subsequent comparisons to radar observations.