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Microwave scattering from frozen hydrometeors: for what size parameters the actual shape is of influence?

F. Teschl, W. L. Randeu, and R. Teschl
Graz University of Technology, Institute of Broadband Communications, Graz, Austria (franz.teschl@tugraz.at)

For more than a decade, scattering of microwaves from non-spherical ice particles is a field of active research. One reason lies in the interest to remotely sense precipitation from space. For climate studies it is especially important to measure precipitation globally. Radar networks can detect only a small part of the global precipitation. One idea is to detect frozen hydrometeors with radiometers working at millimeter wavelength. This requires a radiative transfer model in which the assumed scattering parameters are fundamental.
Another reason for calculating scattering of microwaves from non-spherical ice particles is the interest to use millimeter wave radars for the remote sensing of clouds. Millimeter wave radars are especially sensitive to cloud ice crystals and water droplets. Ice particles are dominant scatterers in cirrus clouds which play a significant role in the earth's radiation budget. For such considerations especially the backscattering characteristics of ice crystals are of interest.

An often used method to calculate scattering from arbitrarily shaped particles is the discrete dipole approximation (DDA). In this study the applicability of a new DDA code for calculating scattering parameters (scattering cross section, absorption cross section, and asymmetry factor) of frozen hydrometeors at microwave frequencies has been tested. By comparing the DDA results of spheres with the correct Mie solution it was analyzed how many dipoles per wavelength have to be used to reach a certain accuracy. Further scattering parameters of single ice crystals were calculated from 1 to 300 GHz to investigate what influence shape and orientation have, and up to what size parameter (characteristic dimension of the hydrometeor over wavelength) equal volume ice spheres are suitable for approximation.

In previous studies it has been reported that the actual shape has an influence on scattering and absorption for size parameters > 2.5. The results of this study show that for a variety of crystal types this is already true for size parameters > 1.