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Single scattering from frozen hydrometeors at microwave frequencies

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Scattering of electromagnetic waves by homogeneous and coated spherical particles only can be computed in a mathematically exact way using the conventional Mie-theory or its modifications. However, many frozen hydrometeors have non-spherical overall shapes and lack a spherically symmetric internal structure. They exist in a huge variety of shapes and exhibit different mixtures of ice, water and air. Therefore in radar meteorology, the ability to accurately compute scattering by non-spherical particles in order to clearly understand the effects of particle nonsphericity on scattering patterns is desirable.

In this study single scattering parameters like radar cross section, scattering cross section and absorption cross section were calculated for frozen hydrometeors using different scattering methods. The particles were modeled as hexagonal plates, columns, needles and dendrites as well as rather spherical graupel particles. Also arbitrarily shaped particles were modeled from their contour images, recorded by a 2D-video-distrometer. The calculations were carried out over a wide range of centimeter- and millimeter-wavelengths, from 1 GHz to 100 GHz.

The study results show that for arbitrary frozen hydrometeors smaller than 1/10 of the wavelength, exclusively their ice volume is crucial for scattering and absorption. The results also indicate that for nearly spherical particles like graupel consisting of a mixture of ice and air, equivolumetric ice spheres can be used as approximations even up to particle diameters of a half wavelength.