



## **Microwave single scattering of preferential oriented ice crystals**

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Cloud ice and frozen precipitation are significant variables in climate studies. The distribution of ice clouds influences the Earth's radiation budget, while frozen precipitation plays an important role in the global hydrological cycle. Satellite remote sensing provides the means to measure these variables globally. Some existing and future satellite missions include both active and passive microwave sensors. In active and passive microwave remote sensing of cloud ice and snowfall, the scattering properties of the particles at the specified centimeter and millimeter wavelengths are fundamental.

To calculate scattering and absorption parameters of single ice crystals or snowflakes at microwave frequencies, volume discretization methods are used. The Discrete Dipole Approximation (DDA) is probably recognized most useful for this purpose since it can handle arbitrarily shaped particles and various materials. However the modeling of frozen precipitation and cloud particles can be demanding and scattering calculations at microwave frequencies are computational expensive.

In the last years a few databases have been established that contain single scattering properties of simple and sometimes idealized cloud ice- and precipitation particles. Generally the particles were assumed to be randomly orientated and therefore the scattering parameters are averaged over all orientations. In fact snowflakes and cloud ice particles often show a random orientation. However when falling many ice crystals exhibit a preferred orientation.

This study calculates scattering and absorption parameters (scattering-, backscattering-, and absorption cross section as well as asymmetry factor) of several planar ice crystals that have been modeled using known relationships for their dimension. The calculations have been carried out with a freely available software code implementing the DDA. The investigated frequency range spans from 1 to 300 GHz. The orientation of the planar ice crystals was not assumed to be fully random, but to be distributed around the horizontal plane. The results are given for Earth-incident angles of existing and future satellite missions.