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Is it possible to find average snow scattering properties that can be applied globally? A first attempt using Self-similar Rayleigh Gans Theory and a new aggregation model

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The assimilation of all-sky radiance data requires a fast and accurate radiative transfer model capable of simulating the scattering and absorption effects of hydrometeors. In the past decade, complex Discrete Dipole Approximation (DDA) scattering calculations have demonstrated that commonly used simplifications in frozen particle shape (i.e., sphere and spheroids) are insufficient for representing the snow scattering properties across multiple microwave frequencies and that the internal snowflake microstructure plays an important role in the definition of the scattering effects. Nonetheless, abandoning the simplified spheroidal shape model opens a whole new problem that is deciding which ice particle shape is the most realistic out of the enormous variety of natural ice particles.
Recently, microphysical schemes used in weather models have made a lot of progress in representing the natural variability of snow properties. The consistency of scattering calculations with such spread of assumptions is difficult to ensure with DDA datasets.
The Self-Similar Rayleigh-Gans Approximation (SSRGA) has been developed as a tool to estimate the scattering properties of self-similar ensembles of snowflakes. The power of SSRGA relies on the fact that it takes the form of an analytic function and can easily calculate the scattering properties of realistically shaped snowflakes for various sizes, mass-size relations, aspect-ratios and for any frequency.
Using a realistic snow particle model, we have derived the SSRGA parameters of various types of snowflakes. We have tested the simulated scattering properties against a long-term dataset of multi-frequency ground-based radar measurements. The particle habit that most consistently matched our observations is a snow aggregate composed of a mixture of dendrites and columnar prisms. The results of this study also confirm that it is possible to constrain the microwave scattering properties of frozen particles by means of a statistical comparison of simulated and observed microwave measurements.

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