Geophysical Research Abstracts, Vol. 8, 10912, 2006
SRef-ID: 1607-7962/gra/EGU06-A-10912

A Model of Mm-wave Scattering by Aggregates of Cylindrical Ice Hydrometeors

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Spaceborne mm-wave radiometric measurements offer the potential to observe snowfall at high latitudes. There is thus a need for a relatively simple representation of mm-wave scattering parameters of snow that can be incorporated into algorithms to retrieve snowfall from remotely sensed mm-wave brightness temperature measurements. A space-borne W-band cloud radar on CloudSat will also be able to observe snow. Simple representations of the mm-wave back-scattering parameters of randomly oriented aggregates of prisms or columns will also be needed to retrieve snow from such radar measurements.

The extinction coefficients, asymmetry factors and back-scattering phase functions describing scattering by randomly oriented finite blunt cylinders were derived from a T-Matrix scattering model. Those parameters for aggregates of more elongated cylinders were also computed from the Discrete Dipole Approximation. These extinction coefficients, asymmetry factors and back-scatter phase functions were then approximated by simple analytical functions of an effective phase delay (EPD) parameter that only depended on the frequency and the ratio of the volume to the projected area of the cylindrical aggregates. This permitted consideration of numerous aggregate shapes.

The results of this analysis were applied to measurements of mm-wave extinction, radar reflectivity and from other snow mass vs size measurements obtained during the SNOW-TWO field experiment. Although the simultaneity of the various measurements were not well documented, the theoretical results fall within the range of measurement uncertainty. Samples of the extinction coefficient and asymmetry fac-

tor needed to compute 183 GHz brightness temperatures from clouds containing randomly oriented aggregates of ice cylinders were also computed.