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A 3D Polarized Reversed Monte Carlo Radiative Transfer Model for mm and sub-mm Passive Remote Sensing in Cloudy Atmospheres, Davis, C., C. Emde, R. Harwood, *IEEE Trans. on Geoscience and Remote Sensing*, MicroRad'04 Special Issue, in press.

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Summary

This paper introduces a 3D polarized radiative transfer model that has been developed to assess the influence of cirrus clouds on radiances measured by the EOS-MLS instrument. The radiative transfer model uses a reversed Monte Carlo algorithm and has been incorporated in the ARTS 1.1.x software package. The model will be used to study aspects of the scattering problem that are not considered in the existing operational EOS-MLS cloudy-sky forward model, including the influence of non-spherical, oriented hydrometeors and 3D inhomogeneous cloud structure. This paper presents the radiative transfer algorithm and example model results, which demonstrate significant 3D and polarization effects. Although the development of this model was motivated by the EOS-MLS mission, it is also directly applicable to ground-based and down-looking geometries.

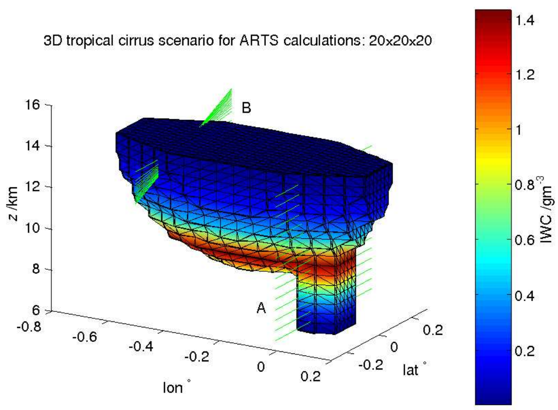

Figure 1: 3D cloud scenario for example results. The correlation of McFarquhar and Heymsfield (1997) was used to obtain particle size distributions corresponding to IWC and temperature. This distribution was divided into 40 size bins for the calculation of single scattering properties. Results are shown for 3 particle types: spheres, prolate spheroids (aspect ratio = 0.5), and oblate cylinders (aspect ratio = 2). Both completely random and horizontal orientations were considered for the prolate spheroids, and for oblate cylinders only horizontal orientation was considered.

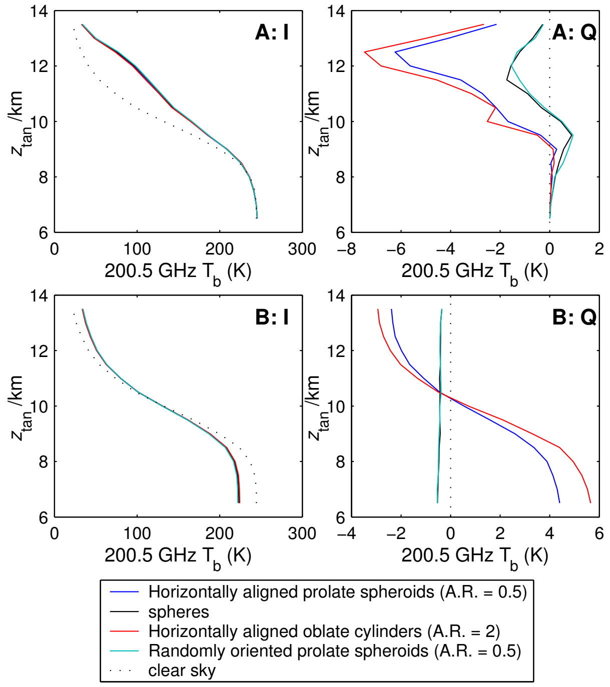

Figure 2: Simulated single sideband EOSMLS radiances, I, and polarization differences, $Q = I_v - I_h$, for 200.5 GHZ. The cloud scenario for these simulations is shown in Fig. 1

Although the example simulations presented here are only intended to illustrate the capabilities of the radiative transfer model, the results suggest that it is important to consider more than one spatial dimension and also polarization when simulating microwave limb sounding measurements. The results showed two significant effects that can not be reproduced by a 1D radiative transfer model: the effect of inhomogeneity of cloud properties in the lat./lon. coordinates, and the location of the cloud field relative to the sensor. The results also showed significant polarization effects due to oriented non-spherical particles. If one were to attempt a 1D representation of the cloud field shown in Fig. 1, with the assumption of equivalent spheres, then the variation in Stokes vector profiles shown in Fig. 2 would be lost.