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The effects of roughness model on scattering properties of ice crystals

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A common approach to modeling optical effects of ice crystals' small-scale surface roughness is to use the randomly tilted facets model. We investigate how the choice of the model for facet angular distribution affects the optical properties of the crystals. The study is based on a database of polarized light scattering properties of ice crystals calculated to support the analysis and interpretation of measurements of the airborne Research Scanning Polarimeter. The database was computed using the Geometrics Optics (GO) code developed by Macke et al. (1996). We use hexagonal plates and columns with aspect ratios of columns varying between 1 and 50 with 26 geometrically increasing steps. The aspect ratios of plates are the inverse of those for columns, for a total of 51 aspect ratios. Two models of surface roughness are used. The GO code includes a model of microscale surface roughness based on the uniform angular distribution of titled facets. In this model a single roughness parameter determines the maximum facet tilt. An alternative model of surface roughness based on Weibull statistics was suggested by Shcherbakov et al (2006). In this model two parameters determine the shape and width of the tilt distribution. The width parameter plays a role similar to the roughness parameter of the uniform distribution. The two models are used to calculate scattering matrices for the above set of aspects ratio and crystal sizes while the roughness parameter is varied between 0 and 0.7 in steps of 0.05. We find that in general for a given value of roughness parameter the choice of the model only feebly affects the asymmetry parameter and the degree of linear polarization. More pronounced differences are observed in the phase function at 5 to 20 degrees scattering angle, where the uniform tilt model produces a plateau while such a plateau is not present in the Weibull model results. Thus the use of the later model may be preferable. Here, we furthermore explore the influence of the Weibull shape parameter on the asymmetry parameter, degree of linear polarization and the phase function.

References

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