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0.0.1 Light Scattering by Single Natural Ice Crystals

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During the South Pole Ice Crystal Experiment, angular scattering intensities (ASIs) of single ice crystals formed in natural conditions were measured for the first time with the Polar Nephelometer instrument. The microphysical properties of the ice crystals were simultaneously obtained with a Cloud Particle Imager. The observations of the scattering properties of numerous ice crystals reveal high variability of the ASIs in terms of magnitude and distribution over scattering angles. In order to interpret observed ASIs features lookup tables were computed with a modified ray tracing code, which takes into account the optical geometry of the Polar Nephelometer. The numerical simulations consider a wide range of input parameters for the description of the ice crystal properties (particle orientation, aspect ratio, surface roughness, and internal inclusions). A new model of surface roughness, which assumes the Weibull statistics, is proposed. The simulations reproduce the overwhelming majority of the observed ASIs features and trace very well the quasi-mirror reflection from crystal facets. The

discrepancies observed between the modeled and the experimental data correspond to the rays which pass through the ice crystal and are scattered towards the backward angles. This feature may be attributed to the internal structure of the ice crystals that should be considered in modeling refinements. Despite the very high scattering angle variability of the ASIs features of single events, the mean scattering phase function related to the overall contribution of single events exhibits the well-known scattering feature because the sample correspond to an ensemble of randomly oriented particles of different habits, sizes and aspect ratios. The 22° halo peak is well marked, the feature which is confirmed by the observations made during the experiment. The main observed features are well modeled for scattering angles smaller than about 120°. The observed minimum around 130° and the “ice bow” around 155° are much less pronounced in comparison with the modeling results. This might be the outcome of the discrepancies that was discussed above.