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Ice crystal complexity and its influence on cirrus light scattering properties

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The microphysical properties of ice crystals play an important role in the radiative impact of cirrus clouds as they determine the angular single scattering phase function of the particles and in this way the shortwave bulk optical properties of the clouds. In recent years, satellite observations have provided indirect evidence for highly distorted ice crystal structures in cirrus clouds because featureless phase functions tend to represent best these measurements [1]. Featureless phase functions with a higher degree of side scattering are the general outcome of many theoretical studies assuming surface roughness as distortion parameter [2]. Recent in situ measurements of high resolution forward scattering patterns of individual ice particles with the Small Ice Detector (SID3) indeed indicate prevailing crystal distortion or surface roughness in mid-latitude cirrus clouds [3].
In this contribution, laboratory and field studies on the microphysical and light scattering properties of cirrus ice particles are presented. Ice clouds were generated in the AIDA cloud chamber under controlled thermodynamic conditions that are relevant for the upper troposphere. Ice clouds with different degree of surface roughness were generated in these experiments. In the majority of the cases the angular scattering function was found to be featureless with a high degree of side scattering indicating that already the modest crystal distortion alters the phase function significantly. The chamber results agree well with phase function data collected during several mid-latitude and tropical aircraft cirrus studies. This implies that crystal distortion is dominating the angular light scattering properties of cirrus clouds. Near-backscattering linear and circular particle depolarization ratios were measured as well in the cloud chamber and are presented in this contribution.

References

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