Bridging the knowledge gap between light scattering and microphysics on single atmospheric ice crystals

Franz M. Schnaiter[a,b,*] and Emma P. Järvinen[c]

[a]*Karlsruhe Institute of Technology, Kaiserstraße 12, 76131 Karlsruhe, Germany*
[b]*schnaiTEC GmbH, Oberes Buchenfeld 18, 77736 Zell a. H., Germany*
[c]*National Center for Atmospheric Research, 3090 Center Green Dr., Boulder, CO 80301, USA*

[*]*Presenting author (martin.schnaiter@kit.edu)*

The interaction of shortwave solar radiation with ice particles is an important process in the atmosphere which redistributes solar light on its way to the ground. Therefore, the knowledge of the angular light scattering behavior of atmospheric ice particles is crucial for a reliable calculation of the shortwave radiative transfer in climate models and for retrieving cloud bulk properties from satellites. Much of the current knowledge of the light scattering behavior of atmospheric ice particles is gained from modelling studies, which apply optical models on simplified ice particle morphologies. Although these models have been significantly improved over the last decade, their results are still questionable especially when it comes to the effects of ice crystal complexity like hollowness and surface roughness. This is mainly because there are no in-situ measurements available on single atmospheric ice particles that would allow for a validation from the perspective of fundamental single particle light scattering.

This lack of measurement data was the motivation to develop the Particle Habit Imaging and Polar Scattering (PHIPS) probe [1,2]. The PHIPS takes stereo microscopic bright field images of single atmospheric cloud particles and simultaneously acquires the correlated angular light scattering function. After the demonstration of its full functionality in 2017, the instrument participated in two campaigns targeting mixed-phase and pure ice clouds in high latitudes in 2017 and 2018. A unique and comprehensive data set of the microphysical properties and the correlated light scattering functions of real atmospheric ice particles is now available, and a catalog of individual ice crystals is currently being compiled that will be of high value for modelers developing and applying single particle light scattering models.

In this presentation the PHIPS technology is introduced in detail, followed by an overview of the available single particle data set. First attempts of discussing some of the measured single crystal light scattering functions from a fundamental light scattering perspective are presented. The presentation concludes with an outlook for future instrument upgrades.

References

[1] Abdelmonem, A., E. Järvinen, D. Duft, E. Hirst, S. Vogt, T. Leisner, and M. Schnaiter, 2016: PHIPS-HALO: The airborne Particle Habit Imaging and Polar Scattering probe – Part 1: Design and operation. *Atmos. Meas. Tech*. **9,** 3131–3144.

[2] Schnaiter, M., E. Järvinen, A. Abdelmonem, and T. Leisner, 2018: PHIPS-HALO: the airborne Particle Habit Imaging and Polar Scattering probe – Part 2: Characterization and first results. *Atmos. Meas. Tech*. 11, 341–357.

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