

Monitoring of ice cloud forming aerosols at the Jungfrauoch: automation of HINC for continuous INP monitoring

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1. Project description

The limited knowledge of aerosol-cloud interactions introduces large uncertainties when simulating the radiative forcing in climate models. The physical and optical properties, as well as the evolution of precipitation of a cloud heavily depends on the hydrometeor phase. One pathway to form ice crystals in the troposphere is via ice nucleating particles (INPs) which make up only a tiny fraction of all tropospheric aerosols. For accurate climate forecasts and projections, the parametrization of cloud processes and information such as the concentrations of INPs are needed. Presently, no automated INP counter is available and the data acquisition still requires a human operator.

To address this restriction, the current project aims to build and deploy a fully automated online ice nucleation particle counter, through an adaptation of an existing custom-built instrument, the Horizontal Ice Nucleation Chamber (HINC), called HINC-Auto. HINC has successfully been used to detect INP concentrations during numerous field campaigns. HINC-Auto will be collecting data at the High Altitude Research Station Jungfrauoch (JFJ) by mid-2020 with the goal of publishing the data in near real-time on a public website. It also will be indicated whether the JFJ experiences free tropospheric or atmospheric boundary layer conditions and whether the air masses contain Saharan dust or not.

In the second phase of the project, the measurements of HINC-Auto will be used to investigate three specific research questions:

- I. What is the diurnal and seasonal variability of INP concentrations at the JFJ?
- II. How do anthropogenic aerosols influence the INP concentrations in the troposphere?
- III. What is the seasonal frequency and contribution of Saharan dust to the INP concentrations at the JFJ?

These research questions arose during previous studies as they are important in understanding the connection between INPs and ice

formation within clouds. However, the missing availability of a monitoring INP counter resulted in a case study analysis with too little data to conclusively address these questions. HINC-Auto, developed for long-term monitoring, will provide the needed data and allow a robust response to the stated research questions.

In early 2019 HINC-Auto got build and characterized in the laboratory environment at ETH in Zurich. In August 2019, the newly developed chamber was tested for the first time at the JFJ. The automation worked well and allowed to sample for >95% of the available time. Yet, the sensitivity in means of the level of detection of the chamber is not at the desired level. Further research at Zurich is performed in order to improve the sensitivity. The next JFJ – campaign is scheduled for February 2020.

Collaborating partners / networks

Drs. Ch. Zellweger, M. Steinbacher, M. Vollmer and S. Reimann, EMPA, Dübendorf

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Scientific publications and public outreach 2019

Refereed journal articles and their internet access

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HINC-Auto at Jungfrauoch. Picture by Cyril Brunner, ETH Zürich.