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Measurements of Ice Nuclei properties at the Jungfraujoch using the Portable Ice Nucleation Chamber (PINC)

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Ice clouds and mixed-phase clouds have different microphysical properties. Both affect the climate in various ways. Ice phase present in these clouds have the ability to scatter the incoming solar radiation and absorb terrestrial radiation differently from water droplets. Ice is also responsible for most of the precipitation in the mid-latitudes. Ice crystals can be formed via two main processes: homogeneous and heterogeneous ice nucleation. Investigation of thermodynamic conditions at which ice nuclei (IN) trigger nucleation and their number concentrations is necessary in order to understand the formation of the ice phase in the atmosphere.

In order to investigate the presence of IN in the free troposphere, the Institute for Atmospheric and Climate Sciences of the ETH Zurich has recently designed a new chamber: the Portable Ice Nucleation Chamber (PINC), which is the field version of the Zurich Ice Nucleation Chamber (Stetzer et al., 2008). Both chambers follow the principle of a "continuous flow diffusion chamber" (Rogers, 1988) and can measure the number concentration of IN at different temperatures and relative humidities. Aerosols are collected through an inlet where an impactor removes larger particles that could be counted as ice crystals. The aerosol load is layered between two dry sheath air flows as it enters the main chamber. Both walls of the chamber are covered with a thin layer of ice and maintained at two different temperatures in order to create supersaturation with respect to ice (and with respect to water in case of a larger temperature difference between the walls). At the exit of the main chamber, the sample goes throught the evaporation part that is kept saturated with respect to ice. There, water droplets evaporate and only ice crystals and smaller aerosol particles are counted by the Optical Particle Counter (OPC) at the bottom of the chamber.

The high alpine research station Jungfraujoch is located at 3580 m a.s.l. It is mainly in undisturbed free troposphere, but is also influenced by the Planetary Boundary Layer (PBL) especially in summer. The probability of Saharan Dust Events (SDE) at the Jungfraujoch is usually high from March to July (Collaud Coen et al., 2004). Two campaigns have been performed during this period in order to investigate the influence of a SDE on the IN number concentration and properties: PINC II took place from February 23rd to March 16th, 2009 and PINC III from June 3rd to 17th, 2009. The operating conditions inside the chamber during both campaigns were –31°C with relative humidities with respect to ice and water of 127% and 91%, respectively. During the first campaign, no SDE were detected and the average number concentration of IN was <10 particles/liter. Two SDE of different intensity occurred during the second campaign on June 15th and 16th where significantly higher IN number concentrations have been observed. We found that the larger the particles are, the more efficient they are as IN especially during SDE.

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