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Airborne measurement of tropospheric ice nuclei aerosols using the Portable Ice Nucleation Chamber (PINC)

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Ice clouds and mixed phase clouds have different microphysical and radiative properties that need to be assessed in order to understand their impact on the climate. Indeed, on one hand ice crystals found in the ice phase have the ability to scatter incoming solar radiation and absorb terrestrial radiation. On the other hand, about 70% of the tropical precipitation forms via the ice-phase, this means an impact on the hydrological cycle. Investigation of the ability of an aerosol to act as Ice Nuclei (IN) requires knowledge of the thermodynamics conditions, i.e. relative humidity and temperature at which this aerosol form ice crystal.

The PerformPINC project was a research campaign within the Education & Training program of the EUropean Fleet for Airborne Research (EUFAR). The project objectives were to measure the number concentration of IN in free and upper troposphere using the Portable Ice Nucleation Chamber (PINC) recently developed by the Institute for Atmospheric Climate Sciences at the ETH Zürich, and thus as a primary objective, testing the technical performance of the instrument during in-situ airborne measurements at different conditions within the chamber. The PINC is the portable version of the Zurich Ice Nucleation Chamber (ZINC) (Stetzer et al., 2008) and is meant for in-situ measurements. Both ZINC and PINC follow the same principle as the Continuous Flow Diffusion Chamber of the Colorado University (Rogers, 1988) that has proven to be of good performance in previous airborne in-situ campaigns (DeMott et al., 2003a). Unlike the CFDC, the PINC has a flat design composed of a main chamber, and an evaporation part. The cooling system of the PINC is also different and consists for the warm side of two BD120 compressors mounted in parallel. For the cold side, it is four BD120 compressors in parallel mounted to another BD120 compressor in serial, thus allowing us to reach lower temperature than the warm side.

Aerosols are collected through an inlet where an impactor is connected in order to remove bigger particles that could be ice crystals. The aerosol load is layered between 2 dry sheath air flows as it entered the main chamber where both walls are iced with a thin layer and maintained at 2 different temperatures in order to create supersaturation with respect to ice (and water depending of the temperatures set for both walls). At the exit of the main chamber, the sample is then entering the evaporation part which removes water droplets and let only ice crystals and smaller particles going through the Optical Particle Counter (OPC) where particles and ice crystals are counted.

The campaign took place from the 4th till the 10th of May 2008, in Hohn, GERMANY. PINC was onboard the Learjet, a scientific research aircraft of the airplane operator Enviscope, along with other instruments developed by the University of Frankfurt and the University of Mainz. The primary objective of the campaign is totally fulfilled i.e. that from a technical point of view, PINC proved to work reliably and temperatures of 226K inside the chamber could be reached which is below -38°C the threshold of homogeneous freezing. This is of relevance as homogeneous freezing process is more important in the formation of cirrus (DeMott et al., 2003a). Moreover PINC never encountered any problem during the four flights, and worked very well at the different altitude and pressure variations, this for more than 2 hours/flight. Nevertheless due to the scarcity of IN in the upper troposphere, the second objective was not totally fulfilled due to noise/background problem. In consequence we will only show the data of a part of the last flight (9th of May 2008), which was over Sweden and Norway, and where the IN background concentration was around 2 to 3 particles/litre for an outside average concentration of 40 particles/cc.

References:

DeMott, P. J., Czizco, D. J., Prenni, A. J., Murphy, D. M., Kreidenweis, S. M., Thomson, D. S.,Borys R., and Rogers, D. C., (2003a), Measurements of the Concentration and Composition of Nuclei for Cirrus Formation, Proc. Natl Acad. Sci. USA 100(25):14655–14660

Rogers, D. C. (1988), Development of a Continuous Flow Thermal Gradient Diffusion Chamber for Ice Nucleation Studies, Atmos. Res. 22:149–181.

Stetzer, O., Baschek, B., Lüönd, F., Lohmann, U. (2008), The Zurich Ice Nucleation Chamber (ZINC)-A New Instrument to Investigate Atmospheric Ice Formation, Aerosol Science and Technology, 42:64–74, 2008