The New INKA Instrument for the Study of Ice Nucleating Particles

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Ice and mixed phase clouds significantly influence Earth's radiation budget and thus our climate. As ice formation may occur via different pathways and is influenced by a range of parameters, this process is not yet completely understood, which calls for further research of the influencing variables.

From the already developed range of instruments for ice nucleation studies, we chose to adapt the continuous flow diffusion chamber design by Rogers (Rogers, 1988), which was shown to successfully investigate the role of artificial and natural airborne aerosol (DeMott *et al.*, 2003). Here, the sample flows through the ~ 1 cm gap between two concentric columns of different diameter. The column walls are ice coated and held at different temperatures. As temperature and water vapour content increase linearly from the cold to the warm wall, while equilibrium vapour pressure shows exponential temperature dependence, the sample is supersaturated with respect to ice and can also be supersaturated with respect to liquid water.

The new INKA (ice nucleation instrument of the Karlsruhe Institute of Technology) supplements our stationary instrumentation at the AIDA facility, why we were able to build it with a total column length of 150 cm. The upper 2/3 of the instrument operates as a so-called nucleation and growth section in the way described above. For operation with a relative humidity below 100%, direct ice formation on the dry aerosols can be studied. Above liquid water saturation, ice nucleation can be induced via immersion freezing process, in which liquid water first condenses on the dry aerosol surface and freezes afterwards.

Exemplarily, we show the velocity profile inside INKA in the upper panel of figure 1 for wall temperatures of 249.4 K (inner wall, left margin of x-axis) and 264.4 K (outer wall, right margin of x-axis) and a total flow of 12.5 l/min. The location of a 10% sample mass flow is delimited by dashed lines. Due to buoyant circulation, the velocity profile is not centred in the gap and the aerosol lamina is displaced towards the cold wall. The exact location of the aerosol inside the chamber has to be calculated for each individual setting in wall temperatures, flow and total pressure. In our example, the aerosol residence time in the nucleation and growth section is about 12 s and the corresponding ice supersaturation is 1.24. Since the relative humidity is above 100%, this setting allows the ice activation via immersion and deposition nucleation mode and the subsequent growth of the crystals to detectable size.

The temperature of the outer walls of the lower 1/3 section of INKA can be controlled separately. We currently match the inner and outer wall temperatures in this section to grow the built ice crystals at the expense of any present droplets. The grown crystals are detected by an optical particle counter at the chamber outlet.

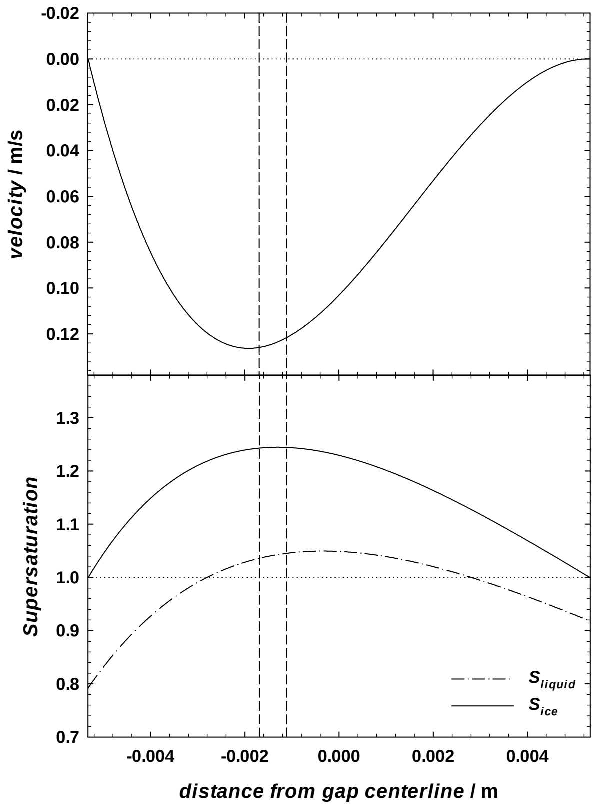

Figure 1. Velocity (upper graph) and supersaturation profile (lower graph) inside INKA (wall temperatures of 249.35 K and 264.35 K, total flow of 12.5 l/min).

INKA's performance was tested in the ice nuclei counter inter-comparison campaign at the AIDA facility, Karlsruhe, in March 2015, which was organized as part of the Fifth International Ice Nucleation Workshop series. We will show first data and discuss our findings.

Rogers, D. C. (1988) *Atm. Res.* **22**, 149-181.

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