The microphysical and optical properties of small ice crystals

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The importance of small ice crystals with sizes smaller than 50µm to the microphysical and optical properties of cirrus clouds are currently controversially discussed (McFarquhar *et al.*, 2007). This is because some *in situ* cloud probes seem to clearly overestimate the number concentrations of small ice particles due to particle shattering on their protruding shrouds or inlets. On the other hand, if these small ice crystals are real they can have a substantial impact on the radiative properties of the clouds (Mitchell *et al.*, 2008).

In order to unravel the microphysical nature of small ice particles, we started to run dedicated ice cloud characterisation experiments at the aerosol and cloud chamber AIDA of Forschungszentrum Karlsruhe. Ice particles are nucleated homogeneously and heterogeneously on different aerosols by expansion cooling experiments in the -28C to -80C temperature range. The emerging and disappearing ice clouds are probed routinely by FTIR extinction spectroscopy, laser light scattering and depolarisation measurements, and single particle optical counting and sizing (Wagner *et al.*, 2009). For a series of AIDA experiments the light scattering and depolarisation measurements were analysed in the context of size and shape parameters retrieved from FTIR extinction spectroscopy using theoretical T-matrix computations for compact ice cylinders. Although the measured trends in the size dependence of the depolarisation properties could be reproduced by the simplified ice particle model, remaining discrepancies are likely caused by the missing details of the ice crystal morphologies. That's why we employed a set of additional *in situ* cloud particle probes, like the Cloud Aerosol and Precipitation Spectrometer CAPS, the Small Ice Detectors SID-2H and SID-3, and the Video Ice Particle Sampler VIPS in the recent AIDA ice cloud characterisation campaign HALO02.

Figure 1 gives an example of a HALO02 expansion cooling experiment started at an initial temperature of -68C. The generated cloud was composed of two size-separated ice particle modes corresponding to homogeneous and heterogeneous ice nucleation. The two ice nucleation modes have distinct backscattering linear depolarisation properties with higher depolarisation ratios for the homogenously nucleated small ice particle mode.

Such experiments offer the possibility to investigate the link of the bulk optical and ice mass properties of the cloud to the microphysical details of the constituent ice particles. Moreover, *in situ* cloud probes can be compared under defined laboratory conditions and without any particle shattering artefacts for clouds composed entirely of small ice particles.

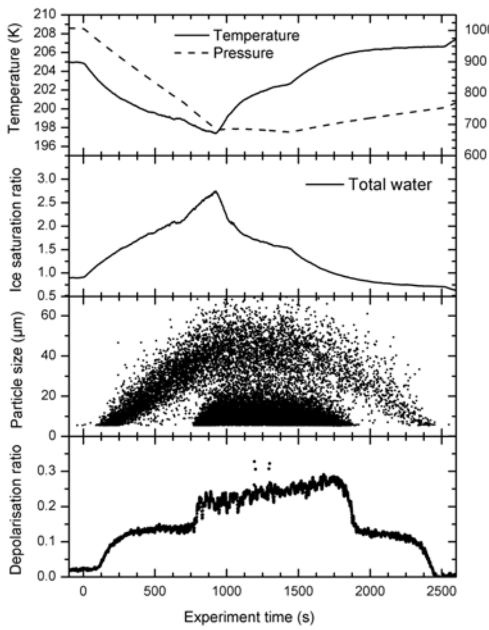

Figure 1.AIDA ice cloud experiment with subsequent heterogeneous and homogeneous ice nucleation events. Note that the given optical particle size overestimates the ice particle geometry.

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