

Comprehensive Investigations on the Ice Nucleation Efficiency of Natural Soil Dust Samples

K. Höhler¹, I. Steinke¹, D. Cziczo², A. Danielczok³, F. Frank³, S. Garimella², O. Möhler¹, M. Raddatz⁴, M. Schnaiter¹, O. Stetzer⁵, and E. Toprak¹ (alphabetically ordered after I.S.)

¹Institute for Meteorology and Climate Research, Karlsruhe Institute of Technology (KIT), Germany

²Dept. of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, USA

³Institute for Atmospheric and Environmental Sciences, Goethe-University Frankfurt, Germany

⁴Leibniz Institute for Tropospheric Research, Leipzig, Germany

⁵Institute for Atmospheric and Climate Science, ETH Zürich, Switzerland

Keywords: nucleation, ice, cloud, soil

Presenting author email: Kristina.Hoehler@KIT.edu

Soil dust is a complex mixture of different minerals and organic material. Aerosols of this material are fed into the atmosphere by a variety of processes, such as e. g. tillage activities. Their role in climate processes is not yet completely understood and especially the ability to induce heterogeneous ice nucleation might be an important factor for their influence on earth's radiative budget.

For the investigation of aerosol ice nucleation ability, a broad range of instruments is currently being used, each constrained by its specific design. Also, especially for inartificial samples, discrepancies in findings by different methods might be due to sample variances and / or differences in aerosol preparation from the bulk sample.

To benefit from a comprehensive investigation of identical aerosol, a range of ice nucleation instruments participated in the campaign IN-19, which was held at the AIDA (Aerosol Interaction and Dynamics in the Atmosphere) facility in July 2012. Here, we used the AIDA cloud simulation chamber (Steinke *et al.* (2011)), the ice nucleation static diffusion chamber FRIDGE (Bingemer *et al.* (2012)), the continuous flow diffusion chambers PINC (Chou *et al.* (2011)) and SPIN (MIT), and the ice nucleation chamber FINCH (Bundke *et al.* (2008)) to learn about the heterogeneous nucleation behaviour of selected soil samples.

By combination of these methods, we have been able to investigate the same aerosol over a broad range of temperatures and humidities. Also, by sampling aerosol from a separate Aerosol Preparation Chamber (APC) using a Maxi-Differential Mobility Analyzer (Maxi-DMA) (Raddatz *et al.* (2013)), size selective measurements have been realized.

We here present findings made for soil sampled in northern Germany and in Argentina. Those samples have been selected due to their comparably high content of biological material. The bacterial activity of the aerosol in the AIDA chamber has been characterized with the WIBS instrument (Toprak and Schnaiter (2013)) prior to the cloud expansion experiment. We find that compared to desert dust aerosol, which shows significantly lower bacterial activity than the samples under investigation, enhanced ice nucleation ability in the immersion mode is observed.

In first comparisons, the data measured by the various instruments complement each other nicely. E.g.

FRIDGE results correlate with AIDA measurements with respect to the minimum temperature required for efficient deposition mode nucleation, as is shown in Figure 1.

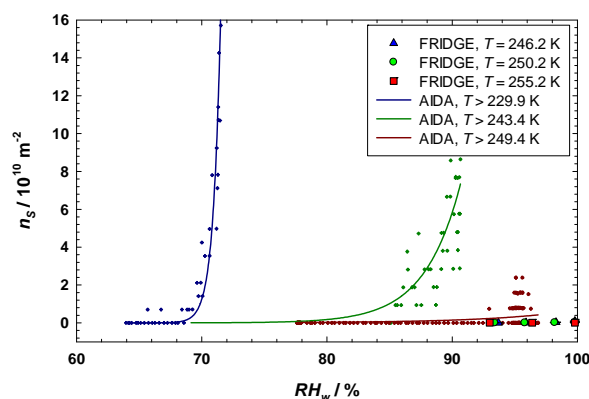


Figure 1. Ice active surface site densities n_s (number of ice crystals per surface area) measured with AIDA and FRIDGE at relative humidities RH_w below water saturation

We currently further compile the information gathered with the various instruments to achieve a complete picture on the heterogeneous ice nucleation ability of the soil dust samples under investigation. We will discuss the benefits and shortcomings of the individual instruments to complete our understanding and will further analyse the role of biological content in the nucleation behaviour.

This work was supported by the DFG HALO SPP 1294 (contract number MOEH 668/1-2) and by EUROCHAMP2 (Transnational Access Activity E2-2012-05-14-0075.)

Chou, C. et al. (2011), *Atmos. Chem. Phys.* **11**, 4725-4738.

Bingemer, H. et al. (2012) *Atmos. Chem. Phys.* **12**, 857-867.

Bundke, U. et al. (2008) *Atmos. Res.* **90**, 180-186.

Raddatz, M. et al. (2013), *AIP Conf. Proc.*, in press.

Steinke, I. et al. (2011) *Atmos. Chem. Phys.* **11**, 12945-12958.

Toprak, E. and Schnaiter, M. (2013) *Atmos. Chem. Phys.* **13**, 225-243.