Name of research institute or organization:

Max Planck Institute for Chemistry, Mainz

Title of project:

Online and offline characterization of cloud condensation nuclei and ice residuals

Project leader and team:

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Project description:

As part of the INUIT-JFJ/CLACE2013 field campaign, we performed (i) online measurements of cloud condensation nuclei (CCN), (ii) aerosol sampling for X-ray microspectroscopy and (iii) filter sampling for DNA analysis at the high alpine research station Jungfraujoch in January and February 2013. The focus of the campaign was the analysis of mixed-phase clouds, which consist of liquid water droplets and ice crystals. The analysis of atmospheric aerosol properties and involved microphysical processes is crucial for a sound understanding of cloud formation and development. Here we present our preliminary results on the concentration, chemical composition and morphology of cloud active particles.

(i) Size-resolved CCN measurements were conducted at a total aerosol inlet using a continuous-flow longitudinal thermal-gradient CCN counter (CCNC) manufactured by DMT (Roberts and Nenes, 2005). Combining the CCNC with a differential mobility analyzer (DMA) and a condensation particle counter (CPC), size resolved CCN spectra were obtained (Frank et al., 2006; Rose et al., 2008; Krüger et al., 2013) . The common method to record size-resolved CCN spectra is to measure different diameters at a fixed supersaturation. During this campaign, however, we tested a new approach, in which the selected particle diameter was kept constant and the supersaturation in the CCNC was varied quickly. With this method the problem of changing aerosol properties within one scan due to a size-dependent aerosol chemical composition could be eliminated. During this campaign this method was applied to atmospheric conditions for the first time. The measurements behaved well and the data analysis is still ongoing. Our results will provide the hygroscopicity/CCN activity of aerosol particles depending on their size.
In addition, the hygroscopicity of ice residual particles was analyzed by connecting the CCNC to an ice counterflow impactor inlet (Ice-CVI). Our first results show a clear difference in the hygroscopicity of ice residuals compared to that of total aerosol. The final data may give information about the different freezing processes in the observed cloud event.

(ii) Aerosol samples were collected with a single-stage impactor at the Ice-CVI inlet and at the total aerosol inlet. The samples have been analyzed using different micro-spectroscopic techniques: (i) scanning transmission X-ray microscopy with near-edge X-ray absorption fine structure (STXM-NEXAFS) analysis at synchrotron facilities and (ii) scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX). These techniques allow spatially resolved investigations of the chemical composition and mixing state of

individual aerosol particles (Moffet et al., 2010; Pöhlker et al., 2012). Preliminary results from typical ice residuals are shown in Fig. 1, which indicates complex internally mixed particles. A characteristic organic coating has been found for most particles, which further contain inorganic constituents such as mineral dust and different salts.

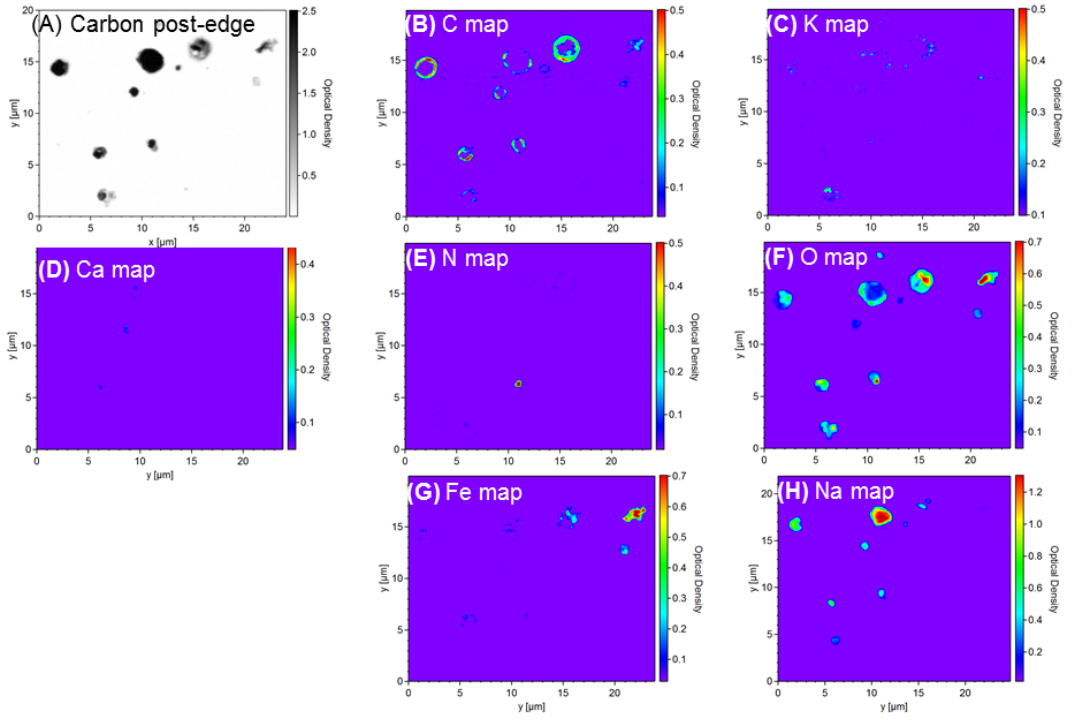

Figure 1. STXM elemental maps of representative region on Ice-CVI sample.

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Key words:

Ice nuclei, aerosol composition, aerosol-cloud interaction, cloud condensation nuclei, STXM

Collaborating partners/networks:

University Frankfurt, Germany; University Bielefeld, Germany; Karlsruhe Institute of Technology (KIT), Germany; Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, Germany; Technical University Darmstadt, Germany; Paul Scherrer Institute (PSI), Switzerland; ETH Zurich, Switzerland; University of Manchester, UK

Scientific publications and public outreach 2013:

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Krüger, M. L., S. Mertes, T. Klimach, Y. Cheng, H. Su, J. Schneider, M.O. Andreae, U. Pöschl and D. Rose, Assessment of cloud supersaturation by aerosol particle and cloud condensation nuclei (CCN) measurements, Atmos. Meas. Tech. Discuss., **6**, 10021-10056, doi: 10.5194/amtd-6-10021-2013, 2013.
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Rose, D., S.S. Gunthe, Z. Jurányi, M. Gysel, G.P. Frank, J. Schneider, J. Curtius and U. Pöschl, Size-resolved and integral measurements of cloud condensation nuclei (CCN) at the high-alpine site Jungfraujoch, Atmos. Chem. Phys. Discuss., **13**, 32575-32624, doi: 10.5194/acpd-13-32575-2013, 2013.
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