

In-situ single particle composition analysis of free tropospheric ice nuclei and ice residuals in mixed-phase clouds during INUIT-JFJ 2013

S. Schmidt¹, J. Schneider¹, T. Klimach¹, S. Mertes², L. Schenk², U. Kästner², F. Stratmann², U. Bundke³, B. Nillius³, F. Frank³, J. Curtius³ and S. Borrmann^{1,4}

¹Particle Chemistry Department, Max Planck Institute for Chemistry, 55128 Mainz, Germany

²Leibniz Institute for Tropospheric Research, 04318 Leipzig, Germany

³Institute for Atmospheric and Environmental Sciences, Goethe University, 60438 Frankfurt, Germany

⁴Institute for Atmospheric Physics, Johannes Gutenberg University, 55128 Mainz, Germany

Keywords: single particle analysis, ice nuclei, mass spectrometry

Presenting author email: susan.schmidt@mpic.de

During a field campaign at the High Alpine Research Station Jungfraujoch (JFJ, Swiss Alps, 3570 m a.s.l.) which was conducted in January/February 2013 in the framework of the research unit INUIT (Ice Nuclei research UNIT), we investigated the physico-chemical properties of ambient ice nuclei (IN) and ice particle residuals (IPR). By combining a pumped counterflow virtual impactor (PCVI) and online aerosol mass spectrometry, ice nuclei from ambient air, that were activated by an IN counter (FINCH) and pre-selected by the PCVI, were fed into an aerosol mass spectrometer and analyzed for their chemical composition, as well as for their microphysical properties. Additionally, ice crystals were sampled from ambient mixed-phase clouds by a unique Ice-CVI (Mertes et al., 2007) and their residues (IPR) were also analyzed in-situ by aerosol mass spectrometry.

Previous investigations conducted at the Jungfraujoch have shown that mineral dust particles dominate the ice particle residue number (Kamphus et al., 2010) but also black carbon was found to be enriched in these residual particles (Mertes et al., 2007; Cozic et al., 2008). The objective of the INUIT-JFJ 2013 campaign was to extend our understanding of ice formation beyond the previous findings with new instrumental techniques.

The chemical analysis of the IPR and IN was performed with the single particle mass spectrometer ALABAMA (Aircraft-based Laser Ablation Aerosol Mass Spectrometer) that covers a particle size range of 150 to 900 nm (Brands et al., 2011). Additionally, particle size was measured by an optical particle counter (OPC, Grimm 1.129) with a particle size range from 0.25 to 32 μm .

We acquired more than 600 mass spectra of IPR sampled by the Ice-CVI. The evaluation of the data will be done with the software package CRISP (Klimach et al., 2010). This program allows for the assignment of the mass spectra into different clusters that contain similar mass spectra. In this case the spectra will be sorted with the fuzzy c-means algorithm (Hinze et al. 1999).

The first preliminary analysis of the acquired IPR data shows that the most abundant particle type (17% of all mass spectra) has components of mineral dust like lithium (Li), sodium (Na), potassium (K), aluminum (Al), iron (Fe) but also organic compounds (Fig. 1). Another particle type (11% of all mass spectra) found in the IPR contains carbon fragments, organic compounds (OC), sodium, aluminum and potassium. These findings

partially agree with the results from previous researches. After completion of the campaign, a more detailed analysis of the data will give further insights into the chemical nature of ice nuclei and ice particle residuals.

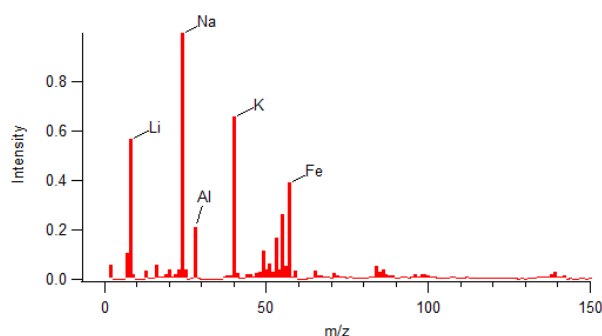


Fig. 1: Average mass spectrum of those mass spectra of ice residuals that were assigned to the largest cluster (17% of all spectra). The observed ions are characteristic for mineral dust.

This work was supported by the DFG projects 1525 (INUIT), SPP 1294 (HALO) and the Max Planck Society.

Mertes, S., Verheggen, B., Walter, S., Connolly, P., Ebert, M., Schneider, J., Bower, K. N., Cozic, J., Weinbruch, S., Baltensperger, U. and Weingartner, E. (2007) *Aerosol Sci. Technol.*, **41**, 848–864.

Kamphus, M., Ettner-Mahl, M., Klimach, T., Drewnick, F., Keller, L., Cziczo, D. J., Mertes, S., Borrmann, S. and Curtius, J. (2010) *Atmos. Chem. Phys.*, **10**, 8077–8095.

Cozic, J., Mertes, S., Verheggen, B., Cziczo, D. J., Gallavardin, S. J., Walter, S., Baltensperger, U. and Weingartner, E. (2008) *J. Geophys. Res.-Atmos.*, **113**, D15209.

Brands, M., Kamphus, M., Böttger, T., Schneider, J., Drewnick, F., Roth, A., Curtius, J., Voigt, C., Borbon, A., Beekmann, M., Bourdon, A., Perrin, T. and Borrmann, S. (2011) *Aerosol Sci. Technol.*, **45**, 46–64.

Klimach, T., Drewnick, F., and Borrmann, S. (2010), International Aerosol Conference, Helsinki

Hinze, K.-P., Greweling, M., Drews, F., Spengler, B. (1999) *J Am Soc Mass Spectrom.*, **10**, 648–660.