Name of research institute or organization:

Max Planck Institute for Chemistry, Mainz

Title of project:

Composition analysis of ice particle residuals combining aerosol mass spectrometry and counterflow virtual impactor technique

Project leader and team:

Dr. Johannes Schneider, project leader
Dr. Thomas Klimach
Susan Schmidt

Project description:

The project INUIT (Ice NUclei research unIT) focuses on the investigation of heterogeneous ice formation in the troposphere. Besides modelling and laboratory activities, also field measurements are an integral part of INUIT. The main field campaign of the INUIT project (INUIT-JFJ) was conducted at the High Alpine Research Station Jungfraujoch during January and February 2013, in collaboration with several international partners in the frame of CLACE 2013. Previous data that were obtained from similar field campaigns (partly during earlier CLACE experiments at Jungfraujoch, but also on other mountain stations as Storm Peak or aircraft-based measurements) yielded results that have shown to be not unambiguous. The role of lead in ice nucleation was found to be important by some researchers, while the role of primary biological particles acting as ice nuclei was found to be very high in other measurements, but this was not found at Jungfraujoch. Also the role of black carbon that was observed to be enhanced in ice residuals is not yet understood.

Thus, the scientific objectives of the INUIT-JFJ field project of our group were: Operating two aerosol mass spectrometers (the compact time-of-flight aerosol mass spectrometer C-ToF-AMS and the single particle laser ablation instrument ALABAMA) at the Jungfraujoch station together with our partner groups in order to 1) analyze ice particle residuals from ambient mixed phase clouds sampled through an ice counterflow impactor inlet (Ice-CVI); 2) analyze ice nuclei that were activated by an ice nucleus chamber and selected by a CVI; 3) clarify the role of different particle types for ice nucleation under realistic atmospheric conditions; 4) characterize the background aerosol in the free troposphere.

The data analysis is still in progress, but the results so far [1] indicate that:

- The main part of the ice particle residuals were composed of organic material mixed with other chemical compounds. Additionally, we found particles which consisted of mineral components (approximately 23 %) (Figure 1).
- The background aerosol particles consisted mainly of pure organic components or organics mixed with ammonium, metals or mineral components. The aerosol mass concentration shows strong variations with certain events where sulfate and/or nitrate dominate the submicron aerosol mass (Figure 2).
- Back trajectory calculations show that during our measurements the air masses were dominated mainly by long-distance transport from North America over Great Britain and France. This may explain the lower abundance of mineral dust in the ice residuals compared to the previous studies.

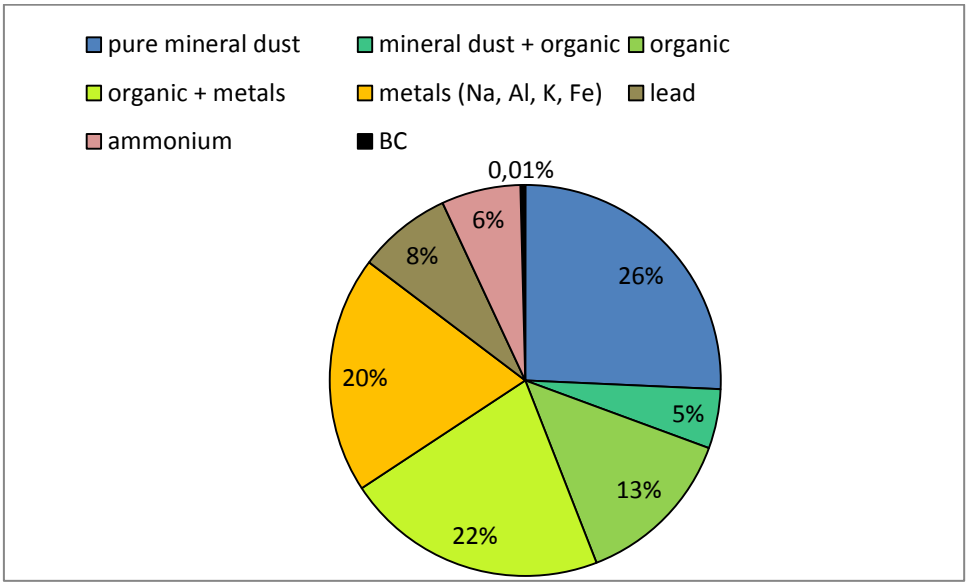

Figure 1. Relative abundance of particle types in ice residuals, measured with the single particle aerosol mass spectrometer ALABAMA using the ice counterflow virtual impactor Ice-CVI.

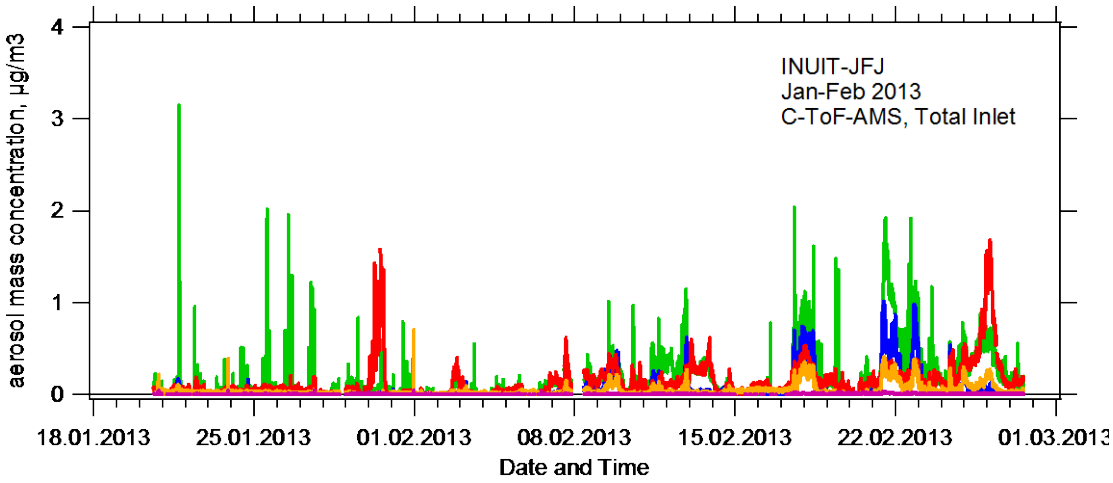

Figure 2. Total non-refractory aerosol mass concentrations (aerosol particles and ice residuals) measured using the compact time-of-flight aerosol mass spectrometer C-ToF-AMS.

Key words:

Ice nuclei, aerosol composition, aerosol-cloud interaction, aerosol mass spectrometry

Internet data bases:

http://www.ice-nuclei.de/the-inuit-project/

Collaborating partners/networks:

University Frankfurt, Germany; University Bielefeld, Germany; Karlsruhe Institute for 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:

Refereed journal articles and their internet access

Fröhlich, R., M.J. Cubison, J.G. Slowik, N. Bukowiecki, A.S.H. Prévôt, U. Baltensperger, J. Schneider, J.R. Kimmel, M. Gonin, U. Rohner, D.R. Worsnop and J.T. Jayne, The ToF-ACSM: a portable aerosol chemical speciation monitor with TOFMS detection, Atmos. Meas. Tech., **6**, 3225-3241, doi:10.5194/amt-6-3225-2013, 2013. http://www.atmos-meas-tech.net/6/3225/2013/amt-6-3225-2013.html

Conference papers

[1] Schmidt, S., J. Schneider, T. Klimach, S. Mertes, L. Schenk, U. Kästner, F. Stratmann, J. Curtius, P. Kupiszewski, E. Weingartner, E. Hammer, P. Vochezer, M. Schnaiter, and S. Borrmann, In-situ single particle composition analysis of ice residuals in mixed-phase clouds during INUIT-JFJ 2013, European Aerosol Conference, Prague, Czech Republic, Sept. 1-6, 2013.

Kupiszewski, P., E. Weingartner, R. Färber, M. Gysel, E. Hammer, C. Fuchs, U. Baltensperger, P. Vochezer, M. Schnaiter, C. Linke, E. Toprak, S. Mertes, J. Schneider, T. Klimach, S. Schmidt, CLACE 2013: Cloud microphysics and physico-chemical characterization of ice residuals in mixed-phase clouds, European Aerosol Conference, Prague, Czech Republic, Sept. 1-6, 2013.

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