Name of research institute or organization:

Department of Physics, University of Helsinki

Title of project:

Investigation of free tropospheric nucleation

Part of this programme:

ACTRIS

Project leader and team:

Dr. Federico Bianchi, project leader
Dr. Erik Herrmann
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Project description:

This project consists of a field study at the Jungfraujoch with state-of-the-art instruments to elucidate the various processes and mechanisms governing new particle formation (NPF) in the free troposphere at a molecular level. From 2 years' extensive measurements with a neutral cluster air ion spectrometer (NAIS, from the University of Helsinki) we expect to gain an overview of the new particle formation events over quite a long-time period. So far we have done 4 months of measurements. With this instrument, we are able to detect aerosols below 5 nm (0.8 nm - 45 nm mobility diameter for ions and 3 - 45 nm for neutral particles).

We installed the NAIS at the Jungfraujoch East ridge in July 2016 with the help of the Paul Scherrer Institute (PSI) colleagues. This is a new location which became available only in the recent months. Since the installation the instrument is working properly and we were already able to detect several nucleation events.

Figure 1 shows the size distribution of positive and negative ions measured directly by the NAIS without any other additional charging. As mentioned already, in this mode, the instrument can measure down to 0.8 nanometers. This extremely good sensitivity is quite useful to detect nucleation from the earliest step where the first cluster is formed. In figure 2 we can see that there are some similarities between positive (bottom panel) and negative (top panel) ions but also differences. In both polarities the nucleation event is quite clear and it starts well before 12. Here, the nucleation is observed earlier than in the neutral case because the cut off of the instrument is lower.

All the polarities show clearly and in a similar way the nucleation event, however, there are also some differences, especially between positive and negative ions. For example, the red band around 1 nm visible in the positive ions is totally missing in the negative one. In the next upcoming weeks, we will further investigate this feature, however we are already quite confident that it is mainly due to some instrument artefact.

At the moment the measurements are working very well and in the next two years we hope to get more exciting results and hopefully we can couple the actual setup with extra instrumentation.

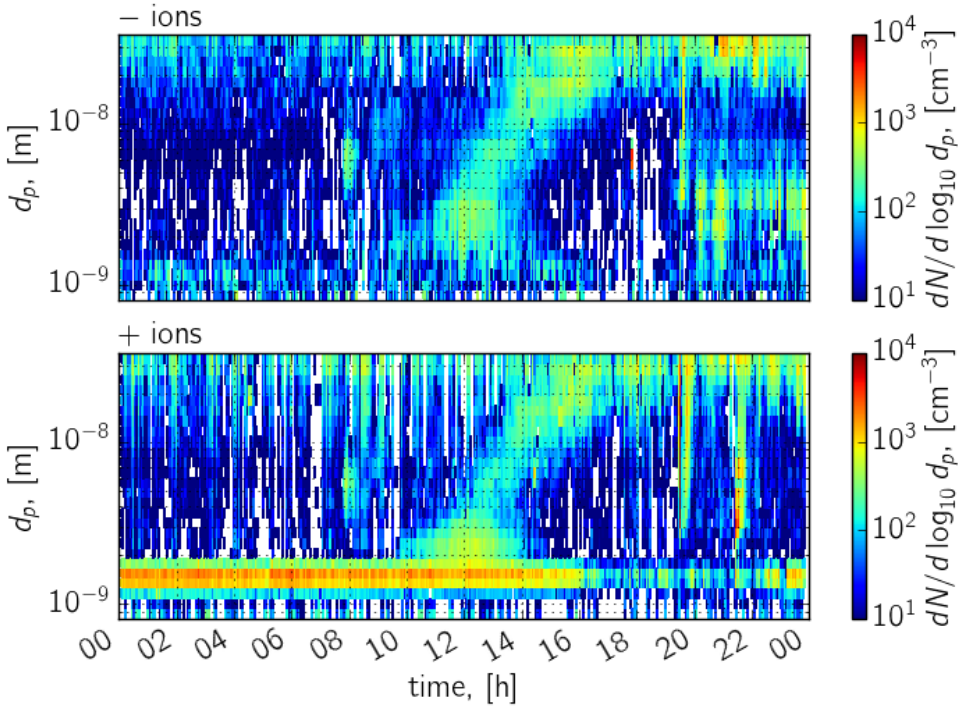

Figure 1. Ion size distribution measured by the NAIS. Negative ions displayed in the top panel and positive ions in the bottom one during a nucleation event recorded at the Jungfraujoch station.

Key words:

Nucleation, ions, spectrometers, free troposphere

Collaborating partners/networks:

Paul Scherrer Institute

Scientific publications and public outreach 2016:

Refereed journal articles and their internet access

Bianchi, F., J. Tröstl, H. Junninen, C. Frege, S. Henne, C.R. Hoyle, U. Molteni, E. Herrmann, A. Adamov, N. Bukowiecki, X. Chen, J. Duplissy, M. Gysel, M. Hutterli, J. Kangasluoma, J. Kontkanen, A. Kürten, H.E. Manninen, S. Münch, O. Peräkylä, T. Petäjä, L. Rondo, C. Williamson, E. Weingartner, J. Curtius, D.R. Worsnop, M. Kulmala, J. Dommen, and U. Baltensperger, New particle formation in the free troposphere: a question of chemistry and timing, Science, 352, 1109-1112, doi: 10.1126/science.aad5456, 2016. http://science.sciencemag.org/content/early/2016/05/24/science.aad5456

Frege, C., F. Bianchi, U. Molteni, J. Tröstl, H. Junninen, S. Henne, M. Sipilä, E. Herrmann, M.J. Rossi, M. Kulmala, C.R. Hoyle, U. Baltensperger, and J. Dommen, Chemical characterization of atmospheric ions at the High Altitude Research Station Jungfraujoch (Switzerland), Atmos. Chem. Phys. Discuss., doi: 10.5194/acp-2016-709, 2016. http://www.atmos-chem-phys-discuss.net/acp-2016-709/

Tröstl, J., E. Herrmann, C. Frege, F. Bianchi, U. Molteni, N. Bukowiecki, C.R. Hoyle, M. Steinbacher, E. Weingartner, J. Dommen, M. Gysel, and U. Baltensperger, Contribution of new particle formation to the total aerosol concentration at the high-altitude site Jungfraujoch (3580masl, Switzerland), Journal of Geophysical Research-Atmospheres, **121**, 19, 11692-11711, doi: 10.1002/2015JD024637, 2016. http://onlinelibrary.wiley.com/doi/10.1002/2015JD024637/epdf

Conference papers

Bianchi, F., H. Junninen, J. Kontkanen, A. Marinoni, P. Bonasoni, K. Sellegri, P. Laj, J. Dommen, D.R Worsnop, M. Kulmala, U. Baltensperger, Nucleation at high altitude: from the Alps to the Everest Base Camp, Air ions, clusters and atmospheric aerosols workshop, Hyytiälä, Finland, August 23-25, 2016.

Bianchi, F., H. Junninen, J. Kontkanen, A. Marinoni, P. Bonasoni, K. Sellegri, P. Laj, J. Dommen, D.R Worsnop, M. Kulmala, U. Baltensperger, Nucleation at high altitude: from the Alps to the Everest Base Camp, 22nd European Aerosol Conference EAC, Tours, France, September 04-09, 2016.

Bianchi, F., H. Junninen, J. Kontkanen, A. Marinoni, P. Bonasoni, K. Sellegri, P. Laj, J. Dommen, D.R Worsnop, M. Kulmala, U. Baltensperger, Nucleation at high altitude: from the Alps to the Everest Base Camp, Finnish Center of Excellence FCOE, Hyytiälä, Finland, October 12-14, 2016.

Magazine and Newspapers articles

"Cloud-seeding surprise could improve climate prediction", Nature, May 25, 2016.

"Earth's climate may not warm as quickly as expected, suggest new cloud studies", Science, May 25, 2016.

"Cloud-seeding surprise could improve climate prediction", Scientific America, May 25, 2016.

"Clouds can form without particles", Earth, October, 2016.

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