Name of research institute or organization:

Institute for Atmospheric and Environmental Sciences, Goethe-University, Frankfurt / M., Germany
[1]Institute for Applied Geosciences, Technical University of Darmstadt, Darmstadt, Germany

Title of project:

Ice Nucleating Particles (INP) at Jungfraujoch during CLACE 2017

Part of this programme:

ACTRIS, BACCHUS, INUIT

Project leader and team:

Prof. Dr. Joachim Curtius, Dr. Heinz Bingemer, Dr. Diana Rose, Prof. Dr. Martin Ebert[1]; project leaders
Daniel Weber, Rebecca Kohl, Fabian Frank, Phillip Brauner, Jennifer Wolf, Lisa Schneider

Project description:

a) Ice nucleus chamber FRIDGE:
The number concentrations of ice nucleating particles in the immersion mode (INP_I) and in the deposition/condensation modes (INP_{DC}) were measured during 25 January – 23 February 2017 at the High Altitude Research Station Jungfraujoch. Samples were collected daily and analyzed on site by the ice nucleus counter FRIDGE. INP_{DC}-samples were collected by electrostatic precipitation of particles onto Si-wafers, followed by activation, photography and counting of ice on the substrates in FRIDGE. INP_I-samples were collected by filtration of aerosol and analysis of aqueous filter extracts by the drop freezing method on the cold stage of FRIDGE.

The number concentrations of both INP_I and INP_{DC} during the campaign were very low, at the lower end of our recent measurements in Colorado and Cyprus. INP_{DC} (at -30°C and 101% RH) range between 0.01-1 $\#L^{-1}$ and INP_I between 0.1-1 $\#L^{-1}$. The abundance of INP_I exceeds INP_{DC} on average by a factor of 15. INI_I parallels INP_{DC} ($R = 0.53$, $N = 25$), suggesting that both modes are addressed by the same individual particles in air.

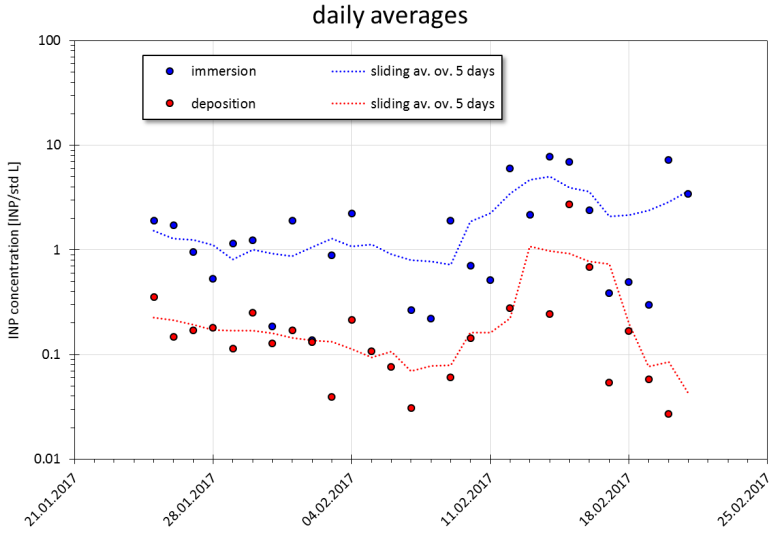

Figure 1. Daily means of INP_{DC} (red) and INP_I (blue) measured by FRIDGE at Jungfraujoch during CLACE 2017.

For chemical analysis of INP_{DC} the substrates were transferred to a scanning electron microscope (SEM, with EDX) at the Technical University of Darmstadt, together with the coordinates of the sites where ice nucleation on INP_{DC} had been observed previously on the wafer in FRIDGE. Individual particles present at these sites were analyzed by ESEM/EDX. The most abundant component of INP_{DC} were alumosilicates derived from soil and desert, followed by mixtures of alumosilicates and carbon, by carbon-rich particles, soot and carbonates (Figure 2).

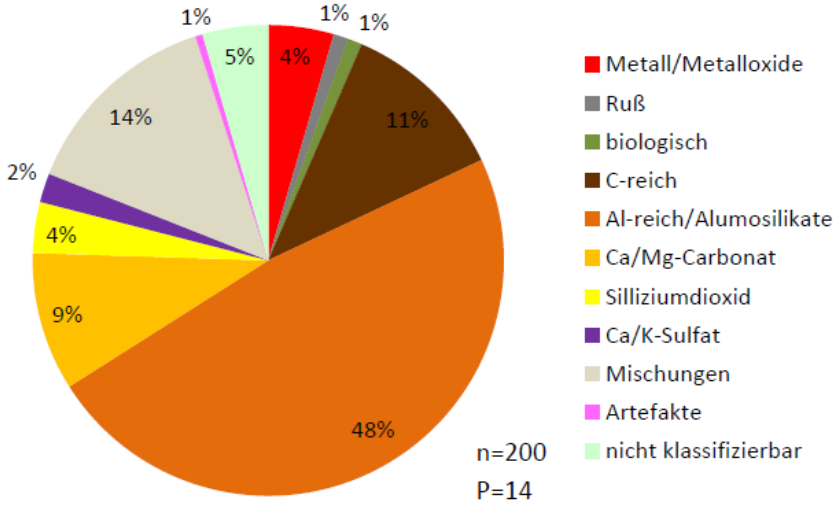

Figure 2. Average chemical composition of INP_{DC} analyzed by SEM (with EDX) in 200 individual INP_{DC} from 14 samples of FRIDGE.

b) Ice nucleus chamber FINCH:
During CLACE 2017 the continuous flow mixing chamber FINCH was operated in the Sphinx Laboratory. Air was sampled from two different inlets: (1) A total inlet (operated by the Paul Scherrer Institute) to sample interstitial plus activated aerosol and (2) a total inlet with a Portable Ambient Particle Concentrator (PAPC, operated by the University of Toronto) to sample a concentrated flow of interstitial plus active aerosol. The FINCH chamber was kept at -25°C for most of the campaign. The saturation ratio RH_w varied between 1.0 and 1.22. Approximately once per hour background noise was recorded by sampling zero air. This was done only for the first eight days. The mean INP concentration measured by FINCH is shown in Figure 3. Between 31 January and 9 February technical issues obstructed FINCH and no INP concentration is available. A detailed analysis of data is ongoing.

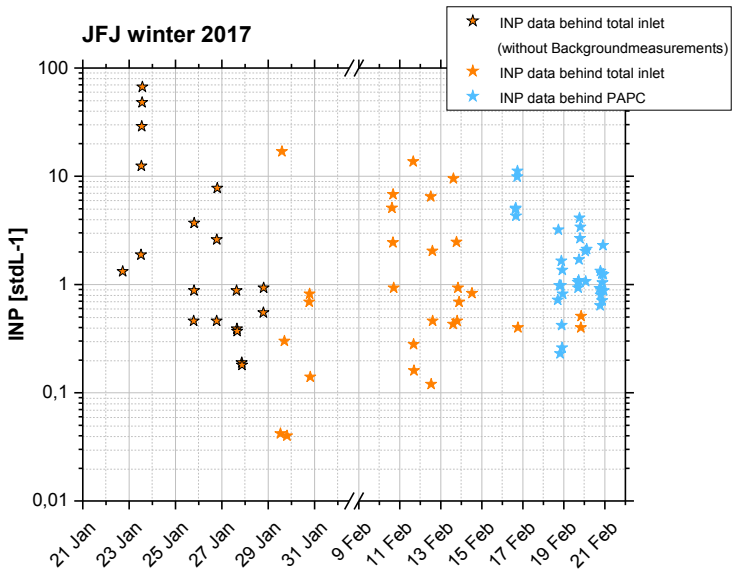

Figure 3. Mean INP number concentration measured by FINCH during CLACE 2017.

Key words:

Ice nucleating particles, FRIDGE, FINCH

Internet data bases:

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

Collaborating partners/networks:

BACCHUS, ACTRIS, INUIT

Scientific publications and public outreach 2017:

Refereed journal articles and their internet access

Schrod, J. et al., Ice nucleating particles over the Eastern Mediterranean measured by unmanned aircraft systems, Atmos. Chem. Phys., **17**, 4817–4835, doi:10.5194/acp-17-4817-2017, 2017.
http:// www.atmos-chem-phys.net/17/4817/2017/

Theses

Schneider, L., Optimierung der Kopplung des Eisnukleus-Messverfahrens FRIDGE an die elektronemmikroskopischen Einzelpartikelanalyse im ESEM, Master Thesis, Goethe-University, Frankfurt/M., 2017.

Frank, F., Charakterisierung des Eiskeimzählers FINCH, PhD Thesis, Goethe-University, Frankfurt/M., 2017.

Wolf, J., Atmosphärische Eiskeimkonzentration auf dem Jungfraukoch während der INUIT/CLACE-Kampagne 2017, B.Sc. Thesis, Goethe-University, Frankfurt/M., 2017.

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