Name of research institute or organization:

Institut für Atmosphäre und Umwelt, Universität Frankfurt

Title of project:

FINCH (Fast Ice Nucleus CHamber counter) Measurements of Ice Nucleus concentration as function of Temperature and Supersaturation during CLACE 6

Project leader and team:

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Project description:

FINCH principle of operation

The Fast Ice Nuclei Counter FINCH (Bundke, 2006a) was developed jointly by the Institute for Atmosphere and Environment Frankfurt and the Institute for Atmospheric Physics in Mainz (Figure.1). In FINCH, a 5-10 lpm sample air flow is introduced into the supersaturation zone at the upper end of the annular processing chamber (Figure 1). Here, supersaturation (with respect to water or ice) is produced by the mixing of particle-free warm, humidified air and cold dry air. Temperature and supersaturation are actively controlled using PID (Proportional Integral Derivative) algorithms with measurements of temperature and frost point as process variables. IN and CCN are activated and grow to macroscopic ice crystals or supercooled water droplets of 5 to 10 µm size as the sample travels along the annular processing chamber of about 1 m length. With a new developed optical detector it is possible to distinguish between supercooled droplets and ice particles, in order to obtain the number concentrations of CCN and IN. FINCH is called a fast IN-counter because of its high sample flow rate of 5-10 l/min. Considering a number concentration of 10 IN/l, a measuring period of 1 up to 2 minutes will be sufficient to obtain good statistics.

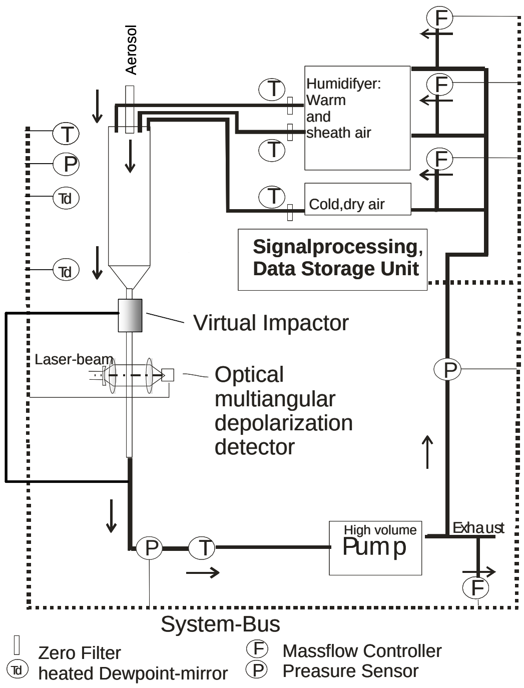
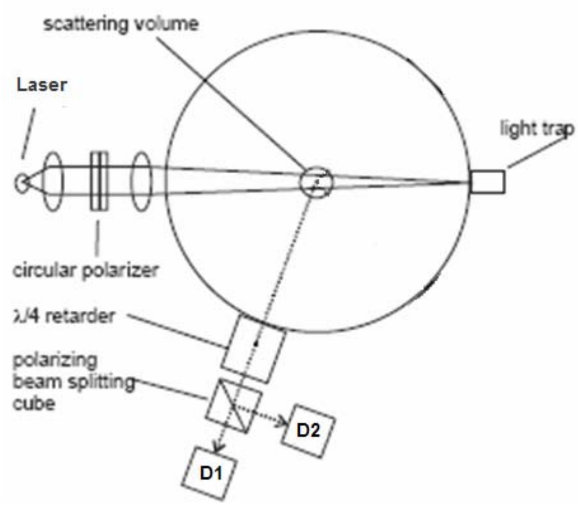


Figure 1. Schematic flow diagram of the FINCH counter

FINCH: Detection of ice nuclei and droplets

Cloud-active aerosols grow to supercooled droplets or ice crystals of 5-10 µm size while they travel through the processing chamber. For the detection and discrimination of super-cooled droplets and ice-crystals we have developed a new optical detector, shown in Fig.2a.



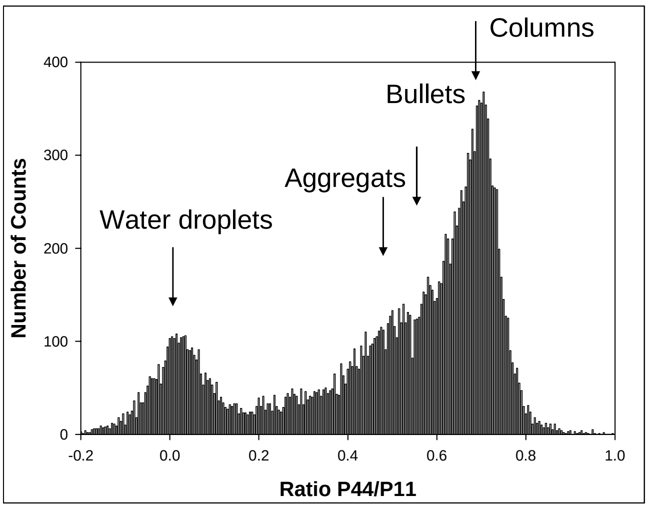


FIGURE 2 Schematic diagram of the optical sensor for detection and discrimination of super-cooled droplets and ice-crystals (a) left. The right graph (b) shows the Histogram (frequency of occurrence) of single particle detection as function of the ratio P44/P11 of scattered light from single particles. P11 and P44 are elements of the scattering matrix.

P44/P11 is a measure of the different depolarization of scattered light by ice crystals and by droplets, as described by Hu et al. (2003)

First Measurements during CLACE 6

The capabilities of FINCH were first exhibited during the CLACE 6 experiment. As an example Figure 3 shows the number-concentration of IN as one minute average values during a cloud event. Boundary layer air reached Jungfraujoch station at 10:20, when CN increased (See Figure 3b). Figure 3a shows that the IN concentration rose up to 4 IN/l until at 10:50 a cloud reached the station. Theconcentration of IN then fell rapidly, whereas CN remained at a constant level. The reasons for this may be either that IN were incorporated into hydrometeors, which were not sampled by the inlet, or that the residuals of those hydrometeors that were sampled and evaporated in the inlet could not be reactivated at the operating temperature and supersaturation of FINCH. The temperature and supersaturation were kept constant at -17 °C and 20% with respect to ice, to be comparable with ambient conditions.

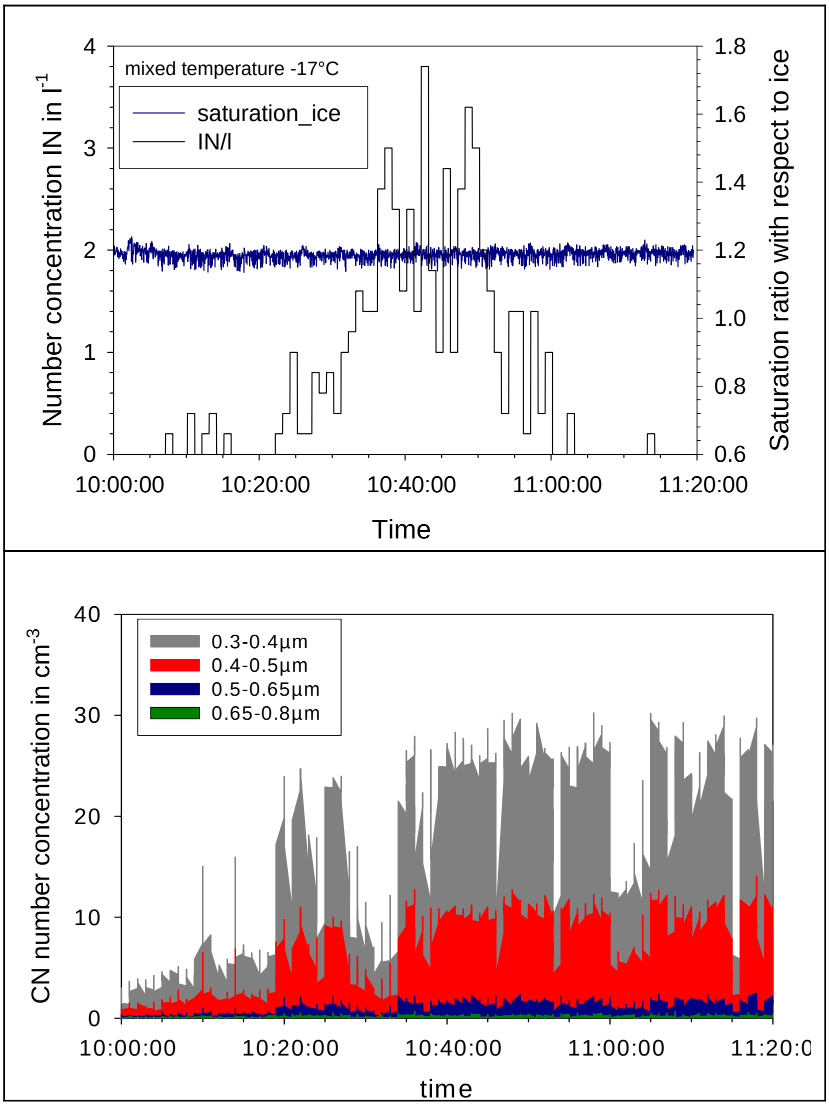


FIGURE 3 IN and CN measurements at Jungfraujoch station during an event of cloud formation. The upper graph shows the IN number concentration measured by FINCH at -17°C and 1.2 saturation ratio with respect to ice. Part (b) shows the CN number concentration measured for different size classes using a Grimm Optical Particle Counter (OPC) operated by the MPI Chemie Mainz by J.Schneider.

We have in total 40 hours of data measured at the total inlet. Futhermore we have IN and CCN data from one cloud event during which the air was sampled downstream of the Ice CVI (Counter flow Virtual Impactor) inlet (Meters et al. this issue). At this inlet position only the residuals of small ice crystals are sampled.During this cloud event FINCH measured ten times more CCN than IN. indicating that secondary ice production was effective in relativley fresh formed ice clouds.

Acknowledgements
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References

U. Bundke, H. Bingemer, T. Wetter, B. Nillius, R. Jaenicke, The FINCH (Frankfurt Ice Nuclei Chamber) Counter - new developments and first measurements. 7th International Aerosol Conference September 10-15, 2006 St. Paul, MN, USA, p.1350

Hu, Y.X., Yang, P., Lin, B., Gibson, G., Hostetler, C.et al.:,2003. Discriminating between spherical and non-spherical scatterers with lidar using circular polarization: A theoretical study, *Journal of Quantitative Spectroscopy & Radiative Transfer*, 79–80, 757–764

Key words:

Ice Nuclei, Cloud physics, CLACE

Internet data bases:

http://www.geo.uni-frankfurt.de/iau/PhysAtm/index.html

Collaborating partners/networks:

The CLACE community

Scientific publications and public outreach 2007:

Refereed journal articles

U. Bundke, H. Bingemer, B. Nillius, R. Jaenicke, T. Wetter, The Fast Ice Nucleus Chamber counter FINCH, J. Atm. Res. Submitted Sep 2007.

Book sections

U.Bundke, H.Bingemer, B. Nillius, R. Jaenicke, T. Wetter, The FINCH (Fast Ice Nucleus Chamber counter), in Colin D.O.´Dowd, Paul Wagner (eds.), *Nucleation and Atmospheric Aerosols*, Springer, 440-444, 2007.

Conference papers

Klein, H.; Bingemer, H. G.; Bundke, U.; Wetter, T.Measurements of atmospheric ice nuclei using a vacuum diffusion chamber and CCD detection, EGU2007-A-08430

Nillius, B.; Bingemer, H.; Bundke, U.; Jaenicke, R.; Wetter, T., First Measurement Results of the Fast Ice Nucleus Counter FINCH, EGU2007-A-08681

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