

Name of research institute or organization:

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**Particle Chemistry Department**  
**Institute for Atmospheric Physics, University of Mainz**  
**and Max Planck Institute for Chemistry, Mainz**

Title of project:

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Cloud and Aerosol Characterization Experiment 6 (CLACE 6)

Project leader and team:

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Dr. Joachim Curtius, project leader

Dr. Ernest Weingartner, Dr. Martin Gysel, Dr. Johannes Schneider, Dr. Michael Kamphus, Dr. Ulrich Pöschl, Dr. Ulrich Bundke, Dr. Martin Ebert, Dr. Daniel Cziczo, Dr. Richard Winterhalter, Dr. Stephan Mertes, Dr. Keith Bower, Dr. Michael Flynn, et al.

Project description:

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The properties of clouds in the atmosphere have a major influence on Earth's climate and on the hydrological cycle. Therefore, a detailed understanding of the microphysical and radiative properties of clouds is essential. Atmospheric aerosol particles interact with clouds and influence the cloud formation.

Ice nuclei are aerosol particles that lead to the formation of primary ice particles in the atmosphere by heterogeneous nucleation. These are of special interest for the formation of mixed phase clouds, i.e. clouds that exist at temperatures where supercooled water droplets as well as ice particles are present inside the clouds. These types of clouds are often present at the altitude of the Jungfraujoch research station and make this station a unique place for ground-based in situ studies of mixed-phase clouds.

The German Collaborative Research Center 641 "The Tropospheric Ice Phase" (SFB "TROPEIS"), funded by the German Research Foundation DFG, comprising 14 different scientific sub-projects, focuses on research concerning ice particles in the atmosphere. Therefore, a major fraction of the CLACE 6 experiments was conducted and funded within the framework of the SFB "TROPEIS", namely the contributions by the University of Frankfurt, the Technical University of Darmstadt, the University of Mainz and the Max-Planck-Institute for Chemistry in Mainz.

The CLACE 6 experiment was the sixth intensive field mission on the characterization of clouds and aerosol carried out at the High Alpine Research Station Jungfraujoch. The experiment took place from 4 February, 2007, to 24 March, 2007, with an intensive measurement period from 17 February to 14 March. Numerous cloud events were sampled during this time.

For the CLACE mission in 2007 about 40 individual scientists and technicians came up to the High Altitude Research Station Jungfraujoch to take part in the measurements directly. The Spinx lab and its outside platforms hosted more than 25 additional instruments, including:

- 3 different aerosol mass spectrometers,
- an ice nucleus counter (INC),
- two cloud condensation nucleus counter (CCNC),

- numerous condensation nucleus counters (CNC),
- optical aerosol counters (OPC),
- several soot monitors, including a new a single particle soot photometer
- scanning mobility particle sizers (SMPS),
- a forward scattering spectrometer probe (FSSP),
- a cloud particle imager (CPI),
- a wet nephelometer
- an EC/OC analyser
- a Hygroscopicity Tandem Differential Mobility Analyzer (HT-DMA)
- a particle volume monitor (PVM)
- an ice counterflow virtual impactor (Ice-CVI)
- several particle impactors for off-line analysis
- filter samplers for off-line analysis
- snow samplers
- ice and graupel samplers

Several of these instruments were entirely new developments and were tested for the first time in the field, for example, the ice nuclei counter from U Frankfurt. Three different inlet systems were used to sample the aerosol and the cloud elements. The photographs show a group of researchers involved in CLACE 6 on the platform of the Sphinx laboratory and an impression of the rough measurement conditions on the platform is given.



A first data workshop to present and discuss the data obtained during CLACE 6 will be carried out in Frankfurt from 6 to 7 March 2007. Data sets from the campaign have been supplied to a central the CLACE FTP-server.

To review the various scientific results of the measurements is beyond the scope of this report. Please consult the sub-project's individual reports for further details.

**Acknowledgement.** We thank the International Foundation HSFJG, the SFB 641 "Tropospheric Ice Phase" and the FP6 EU project EUSAR for comprehensive support.

Key words:

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ice nuclei, mixed phase clouds, ice phase, ice particle residuals, cloud-aerosol-interactions, aerosol composition, CLACE

Internet data bases:

An FTP-server for internal use by all CLACE participants has been established.

Collaborating partners/networks:

Institutions and investigators participating in CLACE 6:

Institut für Troposphärenforschung, Leipzig: Dr. Stephan Mertes, Prof. Jost Heintzenberg

Labor für Atmosphärenchemie, Paul-Scherrer-Institut, Villingen: Dr. Ernest Weingartner, Dr. Martin Gysel, Julie Cozic, Dr. Rahel Schmidhauser, Prof. Urs Baltensperger

Institut für Atmosphäre und Klima, Eidgenössische Technische Hochschule Zürich, Zürich: Dr. Daniel Cziczo, Livia Keller, Hanna Herich, Prof. Ulrike Lohmann

Institut für Mineralogie, Technische Universität Darmstadt, Darmstadt: Dr. Martin Ebert, Dr. Annette Worringer, Nathalie Benker, Prof. Stephan Weinbruch

Institut für Atmosphäre und Umwelt, Johann-Wolfgang-Goethe-Universität, Frankfurt: Dr. Ulrich Bundke, Dr. Thomas Wetter, Björn Nillius, Prof. Ulrich Schmidt

Institut für Physik der Atmosphäre, Johannes-Gutenberg-Universität, Mainz: Dr. Joachim Curtius, Dr. Michael Kamphus, Prof. Stephan Borrmann

Institut für Geowissenschaften, Johannes-Gutenberg-Universität, Mainz: Markus Maria Miedaner, Prof. Michael Kersten

Max-Planck-Institut für Chemie, Mainz: Dr. Johannes Schneider, Saskia Walter, Dr. Ulrich Pöschl, Diana Rose, Sachin Cunthe, Dr. Richard Winterhalter, Dr. Geert Moortgat, Prof. Meinrat Andreae, Prof. Jos Lelieveld, Prof. Stephan Borrmann

School of Earth Atmospheric and Environmental Sciences, University of Manchester: Dr. Michael Flynn, Dr. Keith Bower, Admir Targino, Prof. Tom Choularton

Scientific publications and public outreach 2007:

**Refereed journal articles**

Please consult the sub-project's individual reports for details.

**Conference Contributions**

Joachim Curtius chaired a special session on “the tropospheric ice phase” at the EGU General Assembly at Vienna in April 2007. Numerous talks and posters on CLACE results and measurements at the HFSJG were presented at this occasion:

EGU2007-A-01192

Zimmermann, F.; Ebert, M.; Worringer, A.; Schuetz, L.; Weinbruch, S.

Environmental scanning electron microscopy (ESEM) as a new technique to determine the ice nucleation capability of individual atmospheric aerosol particles

EGU2007-A-02600

Winterhalter, R.; Williams, J.; Fries, E.; Sieg, K.; Moortgat, G.K.

Concentrations of dicarboxylic acids in freshly precipitated snow samples at the high altitude research station Jungfrauojoch during CLACE 5

EGU2007-A-02720

Cziczo, D. J.; Gallavardin, S.; Herich, H.; Keller, L.; Lohmann, U.  
The Chemical Composition of Ice Nuclei in Mixed Phase Clouds

EGU2007-A-05268

Baltensperger, U.; CLACE Team  
Aerosol Partitioning in Mixed-Phase Clouds

EGU2007-A-06109

Kamphus, M.; Ettner-Mahl, M.; Drewnick, F.; Curtius, J.; Mertes, S.; Borrmann, S.  
Chemical analysis of ambient aerosol particles and ice nuclei in mixed phase clouds  
by single particle laser ablation mass spectrometry

EGU2007-A-06566

Raupach, S.M.F.; Curtius, J.; Vössing, H.J.; Borrmann, S.  
Groundbased digital in situ holography of large atmospheric particles in mixed phase  
clouds at the alpine site Jungfraujoch

EGU2007-A-07134

Schneider, J.; Walter, S.; Curtius, J.; Drewnick, F.; Borrmann, S.; Mertes, S.;  
Weingartner, E.; Gysel, M.; Cozic, J.  
In-situ analysis of free tropospheric aerosol and small ice crystal residuals using a  
high resolution aerosol mass spectrometer (HR-ToF-AMS) at Jungfraujoch during  
CLACE 5

EGU2007-A-07251

Sieg, K.; Fries, E.; Püttmann, W.; Jaeschke, W.; Winterhalter, R.; Williams, J.  
Occurrence of VOC in snow and ice in spring at Jungfraujoch (46.6°N, 8.0°E) in  
2005 and 2006 during CLACE 4 and 5

EGU2007-A-08430

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

EGU2007-A-08631

Crawford, I.; Gallagher, M.W.; Bower, K.; Choularton, T.W.; Connolly, P.; Flynn, M.;  
Verheggen, B.; Weingartner, E.; Mertes, S.  
Observations of phase transitions in mixed phase cloud during CLACE

EGU2007-A-08681

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

EGU2007-A-09627

Rose, D.; Frank, G.P.; Dusek, U.; Gysel, M.; Weingartner, E.; Walter, S.; Curtius, J.;  
Pöschl, U.  
Cloud condensation nuclei (CCN) concentrations and efficiencies on Jungfraujoch  
during the CLACE-5 campaign

EGU2007-A-11488

Miedaner, M.M.; Huthwelker, T.; Enzmann, F.; Kersten, M.; Ammann, M.;  
Stampanoni, M.  
On the kinetics of trapping air bubbles and salt precipitates during freezing of diluted  
salt solution droplets

Please consult the individual group reports for further details.

**Other**

Together with Prof. Flückiger from the HFSJG, a one day visit at the Jungfrauoch of Dr. Stefan Echinger, Michael Truchseß, and Simone Bischoff, as leading officers from the Max Planck Society, as well as Prof. M.O. Andreae, director of the Max Planck Institute for Chemistry, and Mr. Kunzmann, head of the administration of the MPI-Chemistry was organized in March 2007.

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<http://www.mpch-mainz.mpg.de/%7Eeschneid/CLACE6/index.ht>  
<http://www.sfb641.uni-frankfurt.de/index.html>

