Name of research institute or organization:

Technische Universität Darmstadt, Institut für Angewandte Geowissenschaften, Umweltmineralogie

Title of project:

Single particle analysis of ice nuclei and interstitial particles of mixed-phase clouds from the CLACE 5 campaign

Project leader and team:

Prof. S. Weinbruch, project leader
Dr. Annette Worringen, Dr. Martin Ebert, Dr. Nathalie Benker, Dr. Frank Zimmermann

Project description:

During the CLACE 5 campaign in February/March 2006 at the high alpine research station Jungfraujoch the aerosol-cloud interaction processes in mixed-phase clouds were studied.

The main focus of the single particle analysis approach is to identify the ice forming fraction and to characterize the remaining interstitial particle fraction of the total aerosol in mixed-phase clouds. For particle sampling we have used two self consturcted 2-stage impactors (cut off diameters 0.7 µm and 0.06 µm for CVI and 0.9 µm and 0.06 µm for Interstitial) behind different inlet systems. The interstitial aerosol was sampled behind an interstitial inlet operated with a PM2 cyclone impactor. An ICE-CVI (Counterflow Virtual Impactor) inlet, which was designed and operated by the Institute for Tropospheric Research in Leipzig (Mertes et al., 2005), has been used to sample resiudal particles of small ice nuclei (IN).

The size, morphology, elemental composition and mixing state of some hundred particles of selected IN- and intersitial-samples was analysed by environmental scanning electron microscopy (ESEM) combined with energy dipsersive X-ray analysis (EDX).

First results for the CLACE 5 campaign at the Jungfraujoch station will be presented for the period 24.02.-01.03.06 as example. The relative particle goup abundances [%] for the different samples of this period are given in Table 1.

Table 1: Particle group abundance [%] for different IN- and Interstitial (Int)-samples for one period during CLACE 5.

	IN	Int	Int	Int
Cut off diameter	0.7 µm	0.9 µm	0.9 µm	0.06 µm
Air mass origin	Central / East Europe and Atlantic	Central / East Europe	Atlantic	Atlantic
Particle group	Relative abundace [%]			
Pb-containing particles	9	1	0	0
(Aged) Sea Salt (sulfates)	24	4	62	17
Internally mixed particles, droplets	15	35	0	3
C_{dom} (organic)	14	11	6	20
soot	0	0	0	3
Silicates	6	10	3	0
Silicates with coating	13	23	9	10
Ca_{dom} (sulfates, carbonates)	6	6	3	0
Al_2O_3	0	3	2	0
Unstable particles (nitrates, sulfates)	0	3	14	46
Other	13	4	1	1

The most obvious difference between IN- and interstitial-samples is the occurense of Pb-containing particles in the IN-samples. These particles are predominantly internally mixed with (aged) sea salt, C_{dom}-particles or silicates (see for example Figure 1). Our observation of lead-containing particles in the IN-fraction is in agreement with findings of our co-workers. As a possible source for the lead-component in these particles aircraft emissions are assumed because lead is still added as additive to avitation gasoline. The potential behaviour of Pb-containing particles as ice nuclei is discussed by Szymer and Zawadzki [1997].

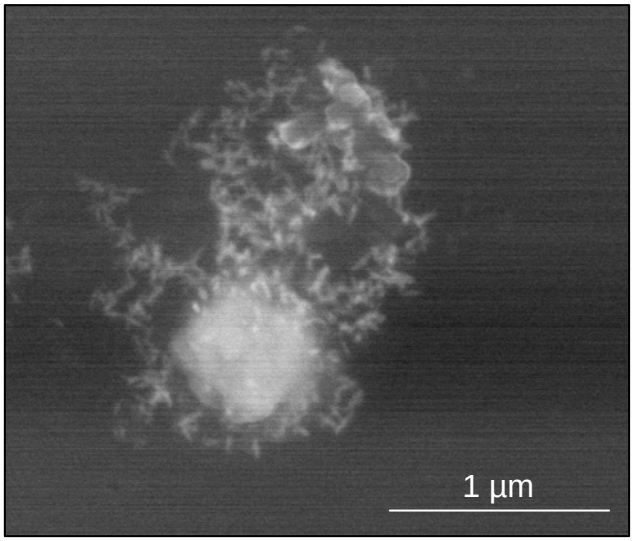

Figure 1: Secondary electron image of a C_{dom}/silicate mixed particle with Pb-rich hot spots (marked by arrows).

The chemical composition and size distribution pattern of the interstitial-samples show the same trends as it was observed during the CLACE 3 campaign. The maximum of the size distribution was found for particles smaller 500 nm. The dominant particle groups in the interstitial-samples are carbon-dominated particles, sulphates, and/or mixtures of sulphates with nitrates, carbon-domiated particles or silictes. Examples for sulfate droplets and internally mixed soot/sulfate/nitrate particles are shown in Figure 2. Differences between the aerosol composition of the interstitial-samples can be related to their air mass history. The samples, which came from the Atlantic show more (aged) sea salt particles, sulphates and nitrates than the sample from Central/Eastern Europe. This sample shows mainly internally mixed particles, aged particles (silicates with coating). Soot and fly ash particles were also found to be assoziated with polluted air masses.

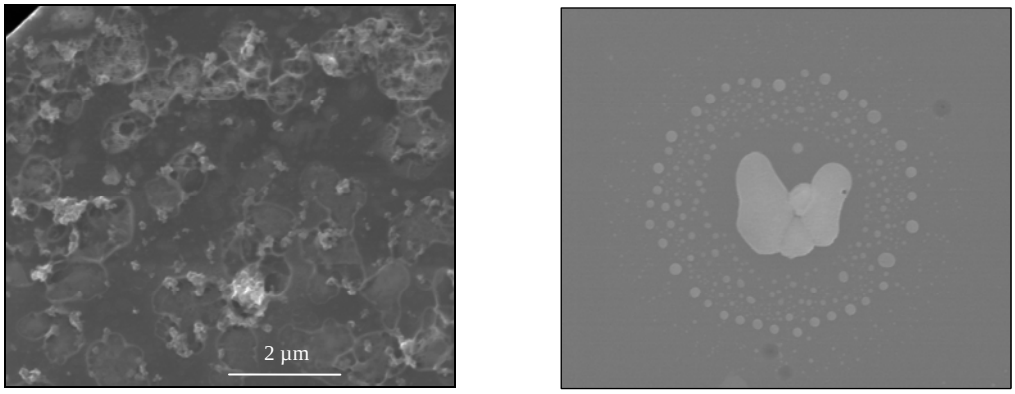

Figure 2: Secondary electron images of interstitial particles: (left) sulfate droplet with halo; (right) decomposing sulfate particles under electron bombardement – making visible the remaining soot inclusions.

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Key words:

Ice nuclei, ESEM, individual particle analysis, chemical composition

Collaborating partners/networks:

Institut für Troposphären Forschung, Leipzig, Germany
Institut für Physik der Atmosphäre, Johannes Gutenberg-University und Max-Planck Institut für Chemie, Mainz, Germany
Institute for Atmospheric and Climate Science, ETH Zurich, Switzerland

Scientific publications and public outreach 2006:

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