Hygroscopic properties and watersoluble fraction of atmospheric particles in the diameter range from 50 nm to 3.8 µm

Dr. B. Busch[1/2]
Prof. Dr. J. Heyder[2]
K. Kandler[1]
E. Karg[2]
Dr. L. Schütz[1]

[1]Institut für Physik der Atmosphäre, Universität Mainz, Becherweg 21, D-55099 Mainz, Germany

[2]Institut für Inhalationsbiologie, GSF Forschungszentrum, Ingolstädter Landstr. 1, D-85758 Oberschleißheim, Germany

Introduction

Measurements of the hygroscopic properties and of the water-soluble fraction of the atmospheric particles have been performed during several experiments in maritime and continental airmasses close to sea level. Objective of this study was to determine the chemical and physical properties in airmasses above the planetary boundary layer in the free troposphere as part of the Cloud and Aerosol Characterization Experiment (CLACE). Measurements were carried out at the JFJ research station from February 15th to March 31st, 2000.

Cloud microphysics is affected by the size dependent hygroscopic properties and the soluble fraction of aerosols. The activation of particles, the resulting cloud droplet spectra, and the probability of precipitation is modified.

Methods

HTDMA

The hygroscopic properties of particles with an initial dry size between 50 nm and 250 nm are measured with a Hygroscopic Tandem Differential Mobility Analyzer (HTDMA) shown in Fig. 1 (Busch and Wiedensohler, 1998). The HTDMA consist of one Differential Mobility Analyzers (DMA) followed by a humidifier and a drier and two parallel DMAs. With the first DMA a monodisperse fraction of the atmospheric aerosol is separated at ambient humidity. One part of this fraction is humidified up to 90 % relative humidity the other part is dried to nearly 0 %. The altered size distributions due to condensation and evaporation of water vapor is analyzed with combinations of DMAs and Condensation Particle Counters (CPC).

SoFA

The water-soluble fraction of aerosol particles is determined with the SoFA (Soluble Fraction of Large and Giant Aerosol Particles) method (Eichel et al., 1996) presented in Fig. 2: Atmospheric particles with seven specific sizes in the range from 0.35 to

3.4 µm are collected by Double Stage Impactors (DSI). The sampled aerosol particles are solved in pure water and the residual particle spectrum is determined by a Coulter Counter Multisizer (CCM) and a High Sensitivity Liquid In-Situ (HSLIS) Aerosol Spectrometer Probe. From the differences between the measured size distribution of the residual particles in the liquid phase and the original particle size the soluble volume of the particles can be calculated. In order to compare these measured soluble volume fractions with the calculated soluble volume fraction modes determined by the HTDMA, distinct classes of solubility are determined by a three-modal forced fit algorithm in the range of the SoFA system. The relative frequency of different solubilities is calculated from the absolute frequencies of the residual spectrum.

Results

During CLACE growth factors of atmospheric particles in the range of 50 nm to 250 nm were measured continuously at a relative humidity of 90 % with the HTDMA. Averages of the water-soluble fraction of the aerosol were determined with the SoFA method.

Hygroscopic properties: Atmospheric particles could be separated at 90 % relative humidity into two fractions with different hygroscopic behaviour.

In order to determine the water-soluble fractions all over the size range from 50 nm to 4 µm a hygroscopic growth model (Berg et al., 1998) was used to estimate this fraction for both modes in the HTDMA range. This model assumes that the particles consist of ammonium sulfate with an unsoluble core.

Allthough the raw data are analyzed by now it is not possible to present final results of the CLACE campaign regarding the hygroscopic properties of aerosol particles.

Acknowledgement

This work was supported by the BMBF under grant 07AF112.

References:

[1] O. H. Berg, E. Swietlicki, G. Frank, B. G. Martinsson, S.-I. Cederfelt, P. Laj, L. Ricci, A. Berner, U. Dusek, Z. Galambos, N. S. Mesfin, B. Yuskiewicz, A. Wiedensohler, F. Stratmann, D. Orsini, Comparison of Observed and Modeled Hygroscopic Behavior of atmospheric particles, Contr. Atmos. Phys., **71**, 47-64 (1998).

[2] B. Busch, A. Wiedensohler, Hygroscopicity of atmospheric particles during the ACE-2 experiment on the research vessel Prof. Vodjanitsky, J. Aerosol Sci., **29**, 271-272 (1998).

[3] C. Eichel, M. Krämer, L. Schütz, and S. Wurzler, The water-soluble fraction of atmospheric aerosol particles and its influence on the cloud microphysics, J. Geophys. Res., **101**, D23, 29499-29510 (1996).

[4] M. Krämer, Alteration of atmospheric particle solubility by cloud processing, J. Aerosol Sci., **29**, Suppl. 1, S3-S4 (1998).

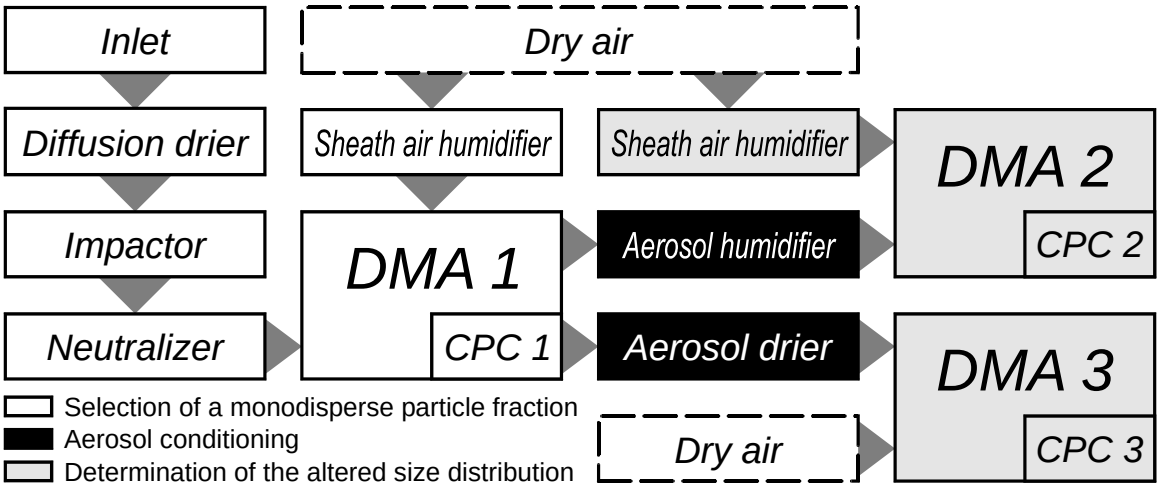

Fig. 1: HTDMA scheme

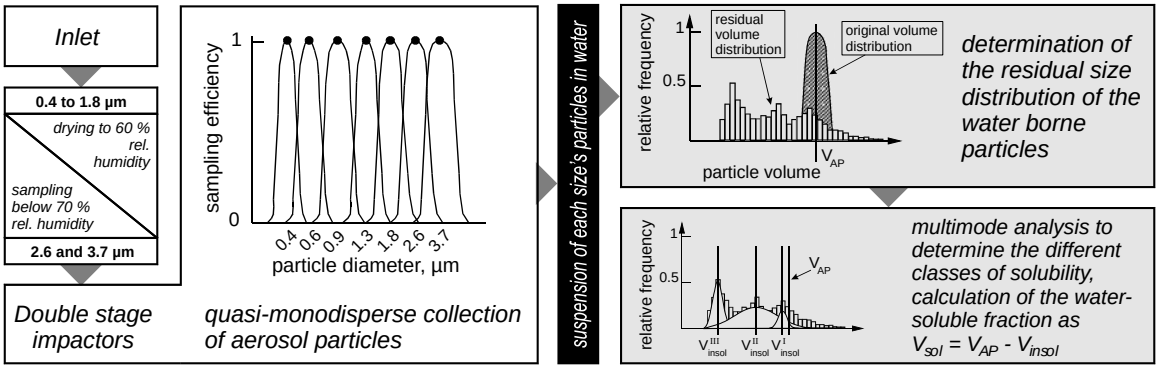

Fig. 2: SoFA scheme