Characterization of Cloud Interstitial Aerosol Particles

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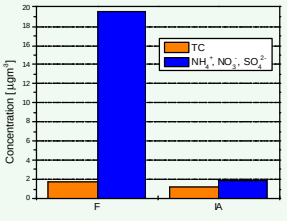
INTRODUCTION

The chemical composition of mountain forest cloud (= fog) water has been extensively studied in Central Europe. The acidity of fog water has decreased over the past 15 yerars as a result of SO_2 and NO_x emission control. However, high concentrations of toxic substances (e.g., heavy metals), are still found. The deposition of such pollutants, and nutrients, plays an important role in biogeochemical cycles of the montain forest ecosystems.

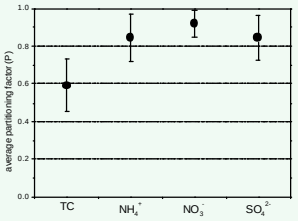
The scope of this project was to sample cloud interstitial aerosol (**IA**), i.e. non-activated particles that are significantly smaller than the fog droplet, and to analyze its role as reservoir for ions, and organic and inorganic carbon. The a priori assumption was that ions should be present predominately in the fog water (**F**) phase, while carbon dominates in the interstitial aerosol.

RESULTS (i)

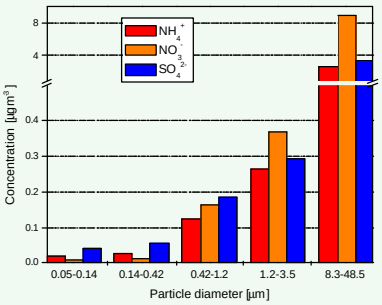


This figure describes the partitioning of total carbon and main ions between fog droplets (**F**) and interstitial aerosol (**IA**).

The ratio of TC to inorganic ions is the main discriminator between the two phases.



This figure demonstrates the partitioning factors $P = C_F / (C_F + C_{IA})$ for TC and individual ions. While TC is present in both phases to about equal amounts, the ions are predominately in the fog water phase.



A more detailes analysis of the concentratrions of ions in the size spectrum of IA (impactor samples) and fog water shows that:

- the concentrations of ions increase with increasing particle size,
- nitrate dominates at particle sizes > 1.2 µm ∅
- a chemical separation seems to be apparent at 0.42 µm ∅ particles, dividing the spectrum into non-activated and activated aerosol particles.

CONCLUSIONS

Fog is a "natural separator" that separates hygroscopic from hydrophobic particle material. In our field experiment, ions (NH_4^+, SO_4^{2-}, and NO_3^-) were well separated (90 % in fog water, 10 % in IA). However, the total carbon was present in both phases to about equal amounts.

Chemical analysis seems to indicate activated aerosol particles in the foggy air masses at sizes larger than 0.42 µm ∅.

However, there seem to be problems with size - resolved sample collection of interstitial particles. Possibly, large particles can penetrate the impactor to "forbidden" collection stages.

More detailed studies are needed

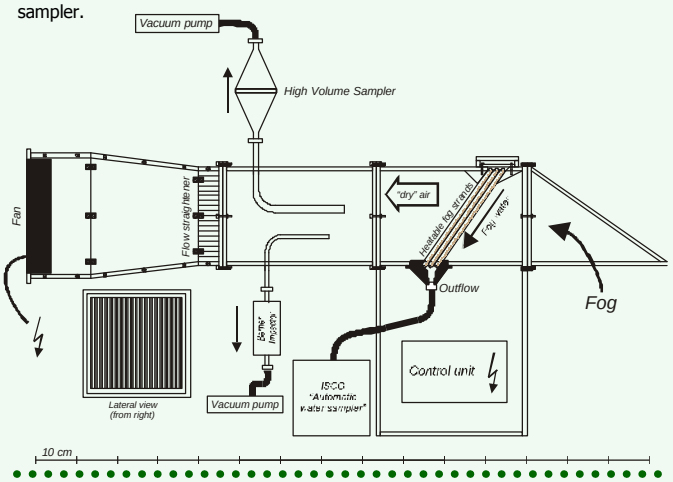
- to further analyze the problems with the Berner impactor,
- to analyze the composition of single aerosol particles in order to see effects of external mixture on the deliquescence of aerosol particles.

SITE and METHODS

Samples were collected at the "Waldstein" ecosystem research site in the "Fichtelgebirge" mountain range in Central Europe, at 50°08'32"N, 11°52'04"E, 775 m a.s.l.

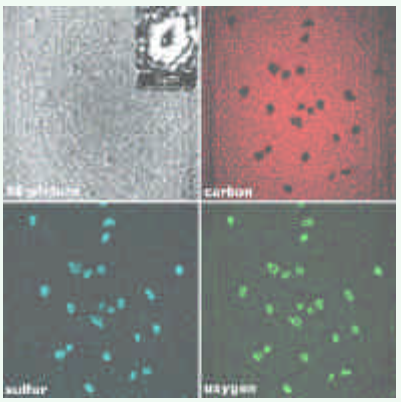
Between 19 Oct 2001 and 03 Dec 2001, we collected a total of 57 fog water samples, using the Bayreuth Heatable Active Strand Cloud Water Collector (BCC, 50 % cut off size: 8.1 µm ∅). During 22 of these sampling intervals, interstitial aerosol was collected from the downstream air flow, by using an isokinetic and isoaxial sample manifold. Two separate subsamplers were employed:

A 6 - stage Berner impactor, and a high volume filter sampler.



RESULTS (ii)

This figure shows a scanning electron microscopy picture (SEM, upper left panel) and energy dispersive X-ray micro analysis (EDX) mappings of stage 1 of a Berner impactor sample (0.05 µm ≤ ∅ ≤ 0.14 µm), collected on 26 Noc 2001. The four graph sizes are 210 µm × 210 µm.



Large amounts of carbon are present on this sample (upper right panel).

However, a number of large particles (about 5 µm ∅, see scaled-up insert in the upper left panel) are present. These particles definitely should not be present on this impactor stage, but should have been separated at least 3 stages earlier than detected here. This phenomenon was found on each single analyzed impactor sample from our campaign.

These large particles contain large amounts of oxygen and sulfur (lower panels) and indicate the presence of sulfate (SO_4^{2-}).

Strictly speaking these particles "contaminate" the measured size distribution, as collected with the berner impactor.

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