Particle characterisation before and after a cloud passage

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INTRODUCTION

This contribution presents results of particle characterisation of main components during FEBUKO orographic cloud passage experiments (Field investigations of budgets and conversions of particle phase organics in tropospheric cloud processes) in autumn 2001 and 2002 in the Thüringer Wald (Germany). Three events (called I, II, and III) out of a total of fourteen were chosen as the best events considering all meteorological conditions (connected flow conditions). Size-segregated particle phase data obtained from physical (dry size distribution) and chemical (particle mass, main ions, OCEC) measurements are presented for the sites before (upwind site, U) and after (downwind site, D) the cloud passage.

EXPERIMENTAL

Particle sampling was performed at the U site in the village Goldlauter (605 m asl, 10°45’20’’E, 50°38’25’’N) and the D site in Gehlberg (732 m asl, 10°46’32’’E, 50°40’21’’N). For the size-segregated particle sampling two BERNER impactors (BI, cut offs: stage 1: 0.05-0.14, stage 2: 0.14-0.42, stage 3: 0.42-1.2, stage 4: 1.2-3.5, stage 5: 3.5-10 µm) operated in parallel (flow volume: 75 l min^{-1}) which were conditioned at 60% RH to minimise bounce-off effects.
The number size distribution of particles was measured by a Tandem Differential Mobility Particle Sizer (T-DMPS) for the particles in size range between 3-900 nm. In the T-DMPS, particles were dried and classified at relative humidity below 10%.
The particles collected by BI were chemically analysed by ion chromatography (Metrohm) and capillary electrophoresis (TSP) for the main ionic components. OCEC was determined by a two step thermographic method. Quality control was achieved through successful participation in international ring analysis initiatives. Analytical uncertainties were determined in different concentration ranges. The repeatability (95% confidence level was found to be about 15% for ion components and 20% for OC for stage 1 and 5 as well as about 5 and 10% for stages 2 to 4, respectively.

RESULTS

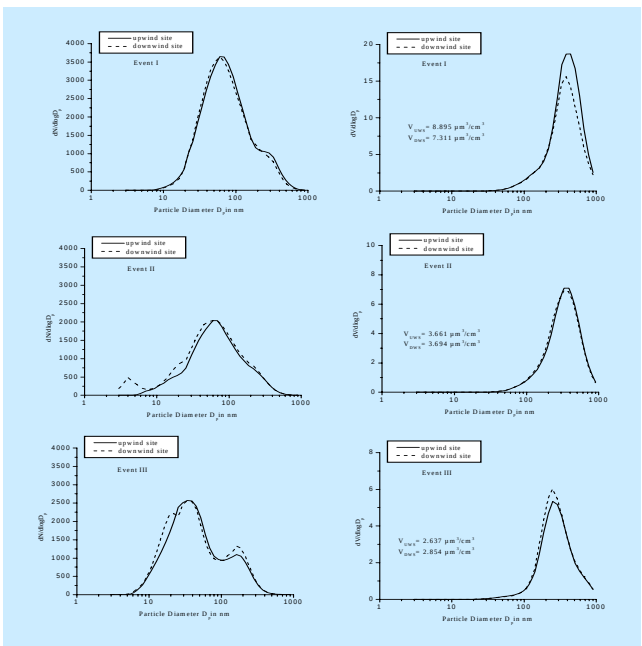

Fig. 1: Number and volume size distribution for events I, II, and III at U and D sites. Note that the scales are different.

Figure 1 represents the mean number and volume size distributions (NSD, VSD) at U and D sites for the three events.
During E I, the average NSD at the D site decreased in accumulation mode compared to the U site. Therefore, the VSD at the D site shows a significant decrease by about 15% in the accumulation mode range hinting to deposition of droplets and particles during transport to the D site.
The average NSD at the D site during event II shows some deviations at the smaller particle sizes – below 10 nm: within the uncertainty range of the Poisson statistic, around 20 nm: poor overlap of the both mobility size spectrometer (also in event III). The VSD is almost identical indicating no significant increase in aerosol mass.
During event III clear indications of an increase in aerosol volume due to cloud processsing are visible from the NSDsand VSDs. The accumulation mode NSDs and VSDs are clearly lifted to higher concentrations.

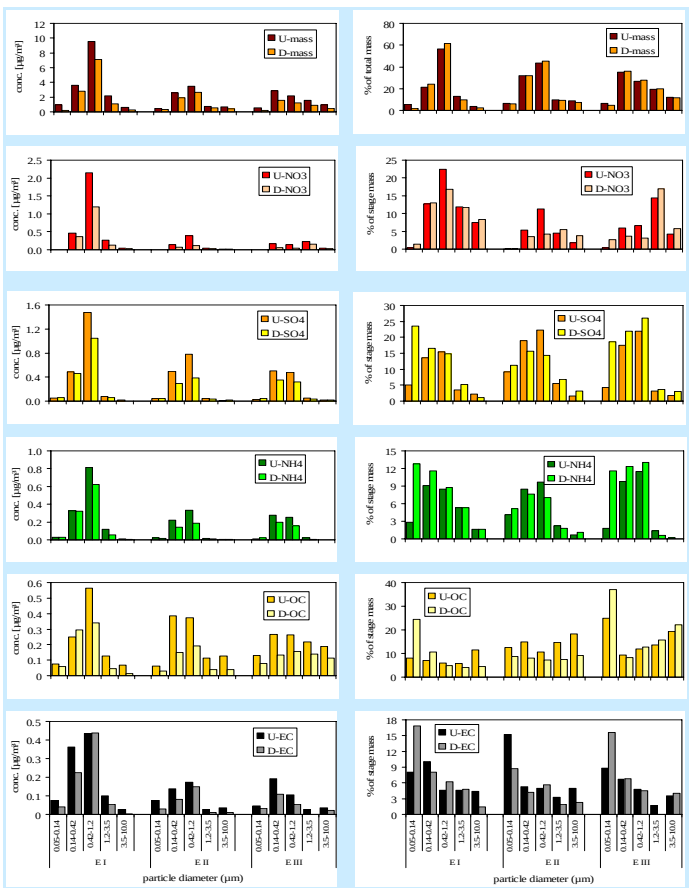

Fig. 2: Size-segregated mass, nitrate, sulphate, ammonium, OC, and EC concentration and fractions of total (for mass) and stage mass concentration for events I, II, and III at upwind and downwind sites

In order to find changes in the chemical particulate composition caused by cloud processing the different size ranges were compared between the U and D sites. To avoid the physical loss processes from U to D site the fraction of mass at respective impactor stage was also considered (Figure 2). The comparison shows that the mass concentration of particles for all size classes is always smaller at the D site than the U site (in total about 30-40%) caused by physical sink processes. Considering the fraction of stage mass to the total mass concentration no significant difference between U and D sites except for the smallest particles of E I and E III were found.
Concentration increases occur only in the smallest particle range (0.05-0.14 µm) for sulphate of about 20% (E I) and 70% (E III), ammonium about 17% (E I) and 150% (E III) as well as for OC in the 0.14-0.42 µm range about 20% (E I). Considering the fraction of stage mass the same components were increased and some others, too. The increase of the EC fraction in the smallest particle size range in E I and E III hints at a more local contamination. In several cases concistency between experimental and modelled results could be found (see Tilgner et al. Atmospheric Environment 39 (23-24), 4389-4401).

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