Chemical composition of bulk and size-resolved cloud water during the HCCT-2010 cloud experiment

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HCCT-2010

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INTRODUCTION and EXPERIMENTAL

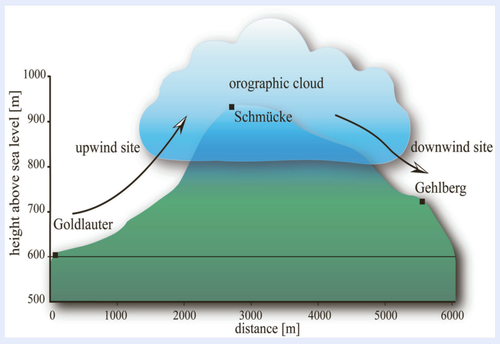

Figure 1: Scheme of the campaign area.

- Hill Cap Cloud Thuringia 2010 (HCCT-2010): Lagrangian-type cloud experiment on cloud chemistry and aerosol-cloud interaction at Mt. Schmücke, Thuringia, Germany (Fig.1)
- 8 "Full Cloud Events" with connected air flow and cloud water sampling (Table 1)
- Bulk cloud water sampler CASCC2 (Demoz et. al, 1996), 3-stage CASCC (Raja et al., 2008), and 5-stage CASCC (Moore et al., 2002), Fig.2
- Counterflow Virtual Impactor (CVI) for sampling of droplet residuals (Mertes et al., 2005) by Aerodyne aerosol mass spectrometer (AMS) downstream CVI
- Analysis of clod water samples by IC, CE, CE-MS, TOC, TXRF

Table 1: Full Cloud Events with cloud water sampling

FCE /Date (CEST)
FCE1.1 | 14-09 11:00 – 15-09 02:00
FCE7.1 | 24-9 23:45 – 25-09 01:45
FCE11.2 | 01-10 22:30 – 02-10 05:30
FCE11.3 | 02-10 14:30 – 20:00
FCE13.3 | 06.10 12:15 – 07-10 03:15
FCE22.1 | 19-10 21:30 – 20-10 03:30
FCE26.2 | 24-10 09:15 – 11:45
FCE26.1 | 24-10 1:30 – 8:45

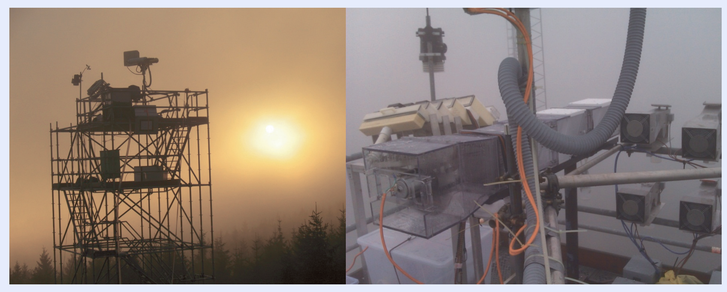

Figure 2: Pictures of the measurement tower and the cloud water collectors.

BULK CONCENTRATIONS

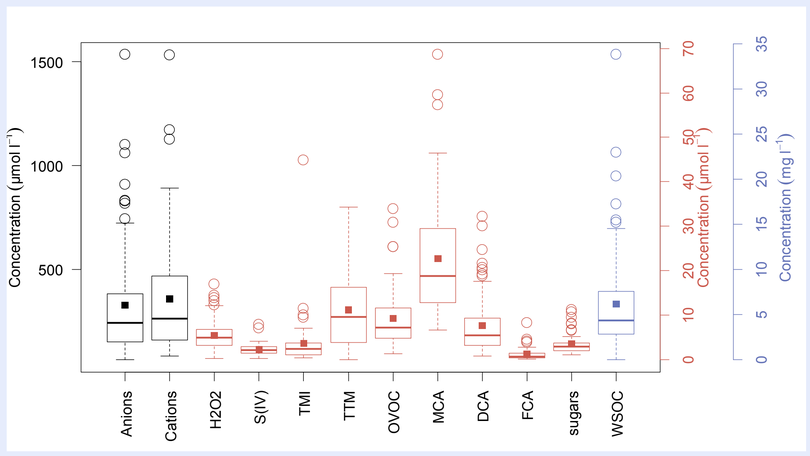

Figure 3: Boxplots of bulk cloud water concentrations of different compound classes analysed during HCCT-2010 *(TMI: trace metal ions, TTM: total trace metals, OVOC: oxygenated volatile organic compounds, MCA: monocarboxylic acids, DCA: dicarboxylic acids, FCA: functionalised lnoger-chain carboxylic acids, WSOC: water-soluble organic carbon)*

SAMPLER INTERCOMPARISONS

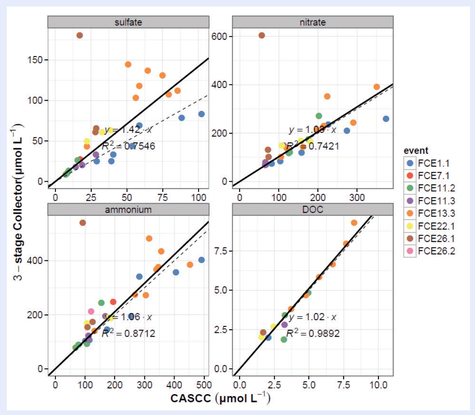

Figure 4: Comparison of volume-weighted cloud water concentrations from 3-stage collectur with bulk concentrations for main constituents

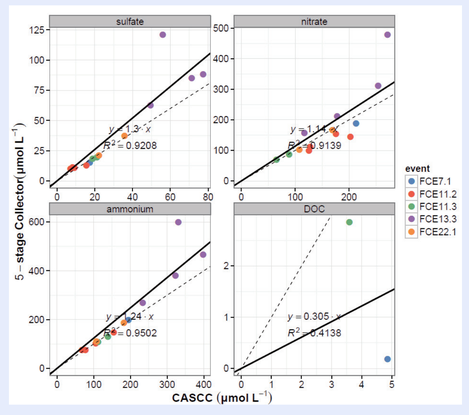

Figure 5: Comparison of volume-weighted cloud water concentrations from 5-stage collectur with bulk concentrations for main constituents

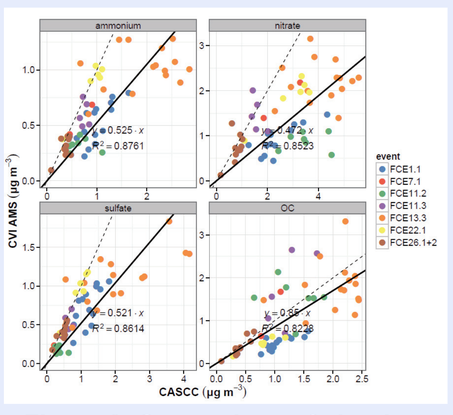

Figure 6: Comparison of cloud water loadings (equivalent air concentrations) from droplet residuals (CVI-AMS) and bulk cloud water sampler. AMS organic mass divided by 2.5 to simulate OC

SIZE-RESOLVED CONCENTRATIONS

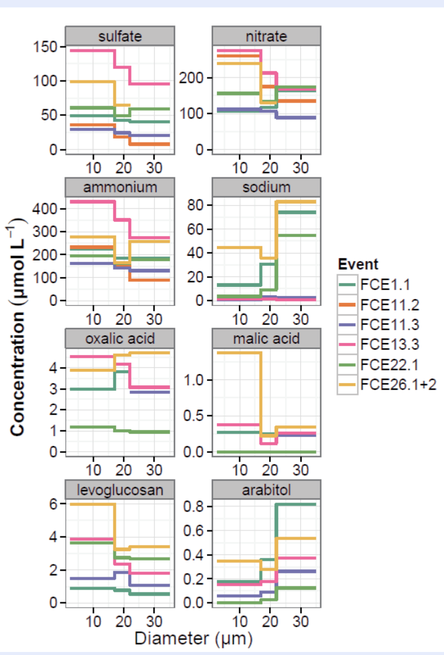

Figure 7: Eventwise volume-weighted mean size districtutions of cloud water concentratinos from 3-stage collector for selected compounds. Diameter indicates nominal cut-off sizes of collector stages.

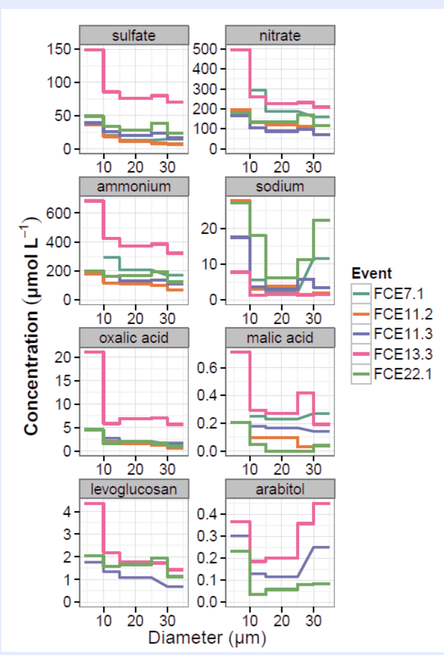

Figure 8: Eventwise volume-weighted mean size districtutions of cloud water concentratinos from 5-stage collector for selected compounds. Diameter indicates nominal cut-off sizes of collector stages.

NUCLEATION SCAVENGING

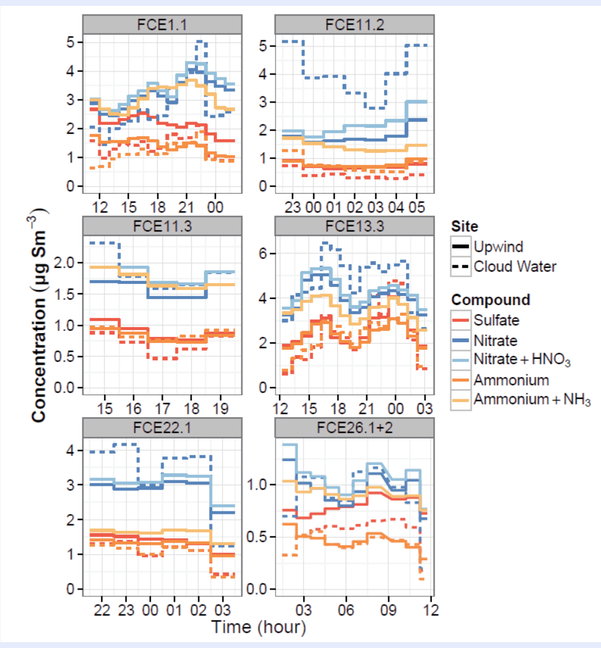

Figure 9: Time-resolved upwind site concentrations (from MARGA) compared to cloud water loadings. All data normalised to standard temperature and pressure (273 K, 1013 mbar).

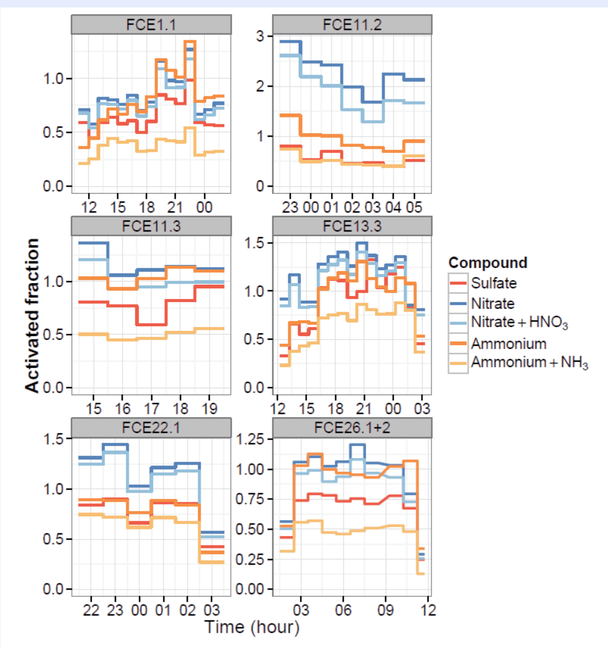

Figure 10: Time-resolved activated fraction of upwind site aerosol constituents. Note that for nitrate and ammonium the sum of particulate and gaseous species is given for comparison.

RESULTS SUMMARY

- Highest cloud water concentrations for inorganic ions, followed by mono- and dicarboxylic acids, trace metals, and organic carbonyl compounds (Fig. 3)
- Comparison between size-resolved and bulk collector concentrations reasonably good (Figs. 4-5)
- Comparison between droplet residue concentrations measured by AMS and bulk cloud water loadings shows significant deviations for some events. Reasons might be the PM1 cut-off of the AMS as well as sampling uncertainties and artifacts (Fig.6).
- Size-resolved concentration profiles show highest cloud water concentrations in smallest droplets for most compounds. Exceptions are compounds with pronounced aerosol coarse modes (e.g sodium from sea salt, arabitol from fungal spores), which sometimes show enhanced concentrations in large droplets as well (Figs. 7+8).
- Comparison of cloud water loadings with upwind site aerosol concentrations for main ions shows that about 50-100% of upwind site concentrations are recovered in the cloud (by nucleation scavenging). Activated fractions differs somewhat between compounds and events. Reasons can be different CCN size distributions and different cloud microphysical conditions.

REFERENCES AND FUNDING

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