Cloud chemistry during HCCT-2010: Water soluble organic carbon

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HCCT-2010

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INTRODUCTION

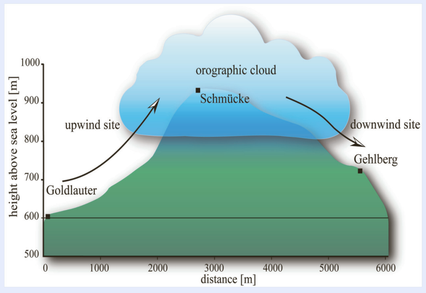

Figure 1: Scheme of the campaign area.

- Hill Cap Cloud Thuringia 2010 (HCCT-2010): Ground-based cloud experiment on cloud chemistry and aerosol-cloud interaction
- Conducted in September and October 2010 at the Schmücke mountain, Thuringia, Germany
- Similar campaign setup as during FEBUKO 2001 and 2002 experiments (Herrmann, 2005)
- Lagrangian-type approach with three sampling sites (Fig. 1):
  - Upwind site for incoming aerosol (cloud condensation nuclei (CCN) and gas phase)
  - In-cloud site for cloud water and interstitial aerosol characterisation
  - Downwind site for residual particles and gas phase after cloud dissipation
- Joint project with partners from Germany (Leipzig, Mainz, Frankfurt), France (Lille, Lyon), Great Britain (Leeds), and the US (Fort Collins, CO)

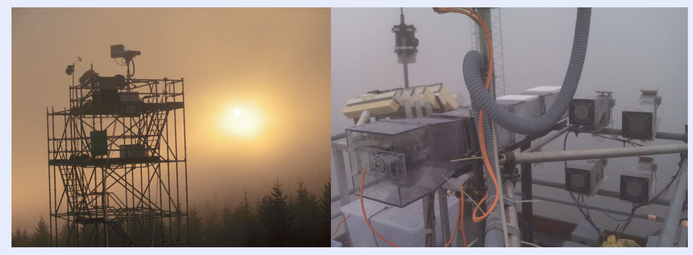

Figure 2: Pictures of the measurement tower and the cloud water collectors.

EXPERIMENTAL

- 73 hours of cloud water sampling during “Full Cloud Events” (Table 1)
- Cloud water sampling by Caltech Active Strand Cloud Water Collectors (CASCC) on a tower 20m above ground
- Bulk cloud water sampler CASCC2 (Demoz et. al, 1996), 3-stage CASCC (Raja et al., 2008), and 5-stage CASCC (Moore et al., 2002)
- Counterflow Virtual Impactor (CVI) for sampling of droplet residuals (Mertes et al., 2005)
- Aerodyne aerosol mass spectrometer (AMS) downstream CVI for chemical characterisation of droplet residuals
- Particle Volume Monitor (PVM) for liquid water content (LWC) of clouds
- Forward Scattering Spectrometer Probe (FSSP) for droplet distributions
- Analysis of water soluble organic carbon (WSOC) by Shimadzu TOC-analyzer after filtration of cloud water samples

Table 1: Full Cloud Events with cloud water sampling

Rating	FCE /Date
1	**FCE11.3** | 02-10, 14:30– 20:00
2	**FCE1.1** | 14-09., 11.00 – 15-09, 2.00
3	**FCE26.2** | 24-10, 9.15 – 11.45
4	**FCE26.1** | 24-10, 1:30 – 8:45
5	**FCE22.1** | 19-10, 21.30 – 20-10, 3.30
6	**FCE13.3** | 06.10, 12.15 – 07-10, 3.15
7	**FCE11.2** | 01-10, 22:30 – 2-10, 5:30
8	**FCE13.1** | 05-10, 19:15 – 06-10, 4:30
9	**FCE7.1** | 24-9, 23:45 – 25-09, 1:45
10	**FCE12.1** | 05-10, 11:00 – 13:00
11	**FCE13.2** | 06-10, 5:15 – 6:15
12	**FCE20.1** | 15-10, 23:00 – 23:45

BULK WSOC VS. CVI-AMS ORGANICS

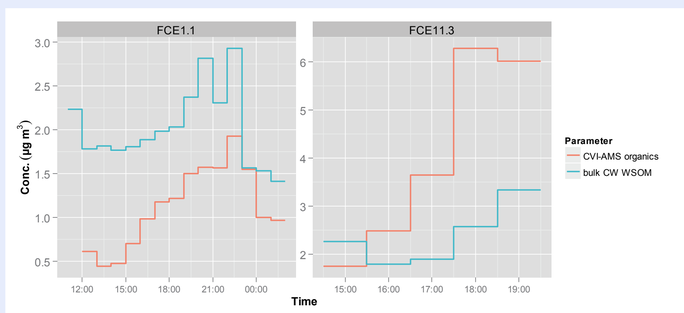

*Figure 3: Organic mass concentration from CVI residuals measured by AMS compared to water soluble organic matter (WSOM=2*WSOC) from bulk cloud water samples.*

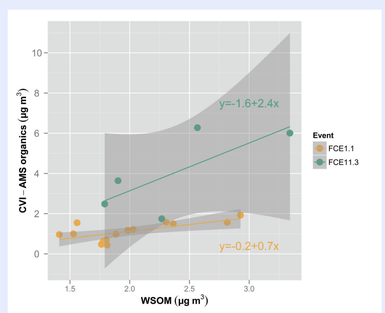

Figure 4: Scatterplot of data in Fig. 3 .

BULK CLOUD WATER WSOC

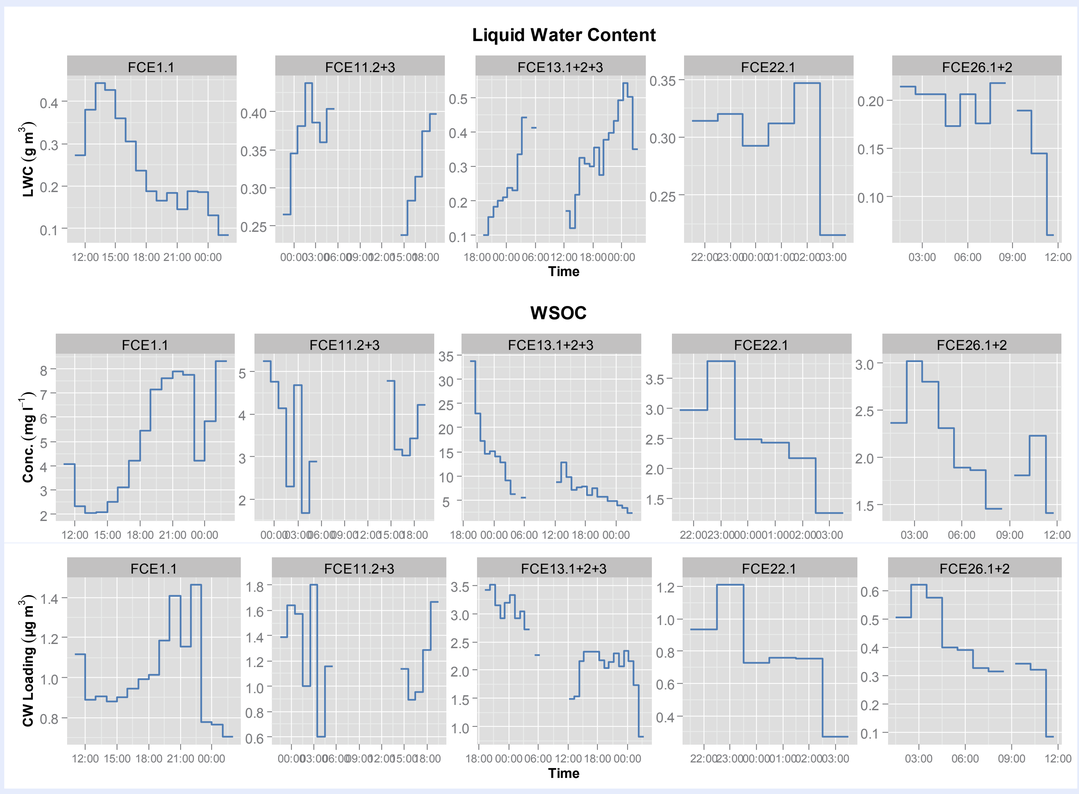

Figure 5: LWC measured by the PVM (top), bulk WSOC cloud water concentrations (middle) and WSOC cloud water loadings (CWL, bottom, obtained from aqueous phase conc. and LWC).

SIZE-RESOLVED WSOC

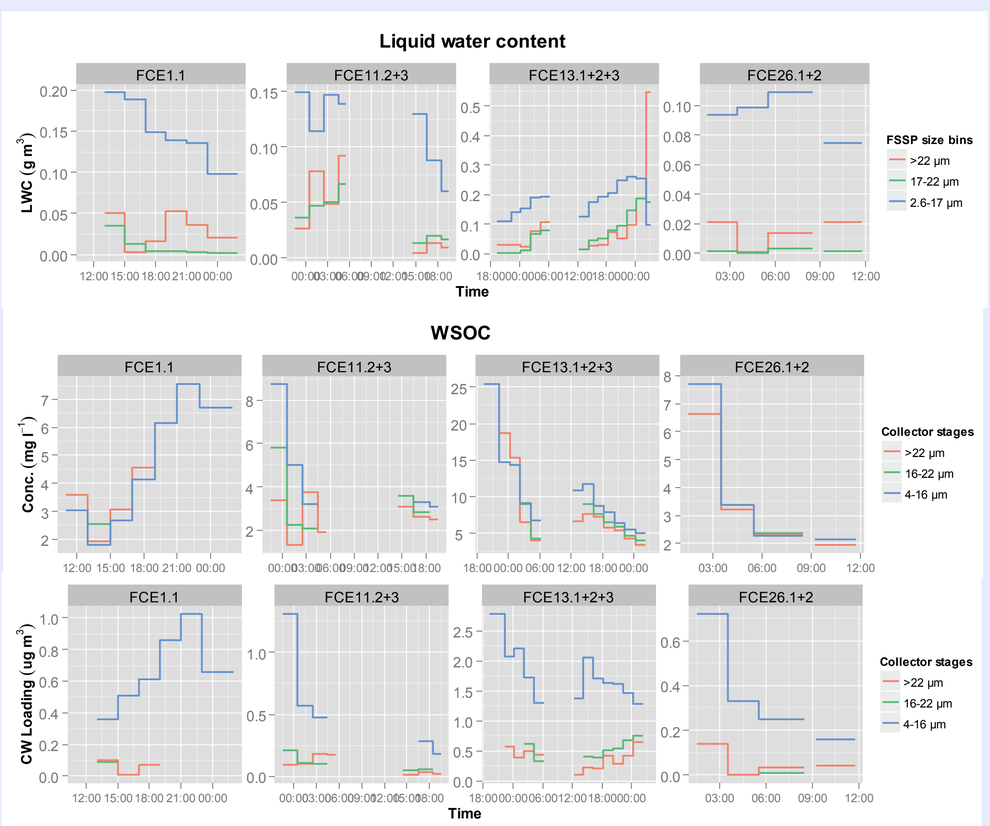

Figure 6: LWC measured by the FSSP (top), size-resolved WSOC cloud water concentrations (middle) and size-resolved WSOC cloud water loadings (bottom).

INTERCOMPARISON

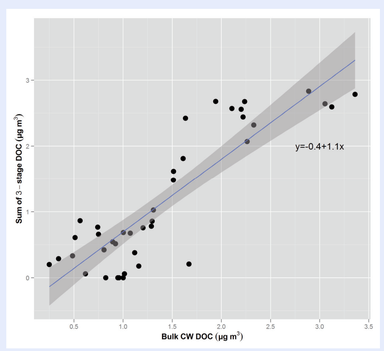

Figure 7: Bulk WSOC CWL compared to sum of size-resolved CWL.

CONCLUSIONS

- Comparison of bulk WSOM vs. CVI-AMS organic mass (Figs. 3+4) reveal substantial differences between two of the top events:
  - In FCE1.1 cloud water WSOM is higher than CVI AMS organics → volatile OM which is released from droplets during evaporation in CVI?
  - In FCE11.3 cloud water WSOM is much lower than CVI-AMS organics → Particulate OM which is not included in WSOM?
- Hourly bulk WSOC concentrations (Fig. 5) show time profiles which are related to
  - (i) variable LWC over time (dilution and enrichment), and
  - (ii) variable CCN and/or gas phase WSOC concentrations
- Size-resolved WSOC data (Fig. 6) usually show similar aqueous phase concentrations in 3 stages of collector
- In contrast, size-resolved CWLs show pronounced differences : CWL highest in smaller cloud droplets (4 – 16 µm) due to highest LWC in this size range
- Comparing bulk WSOC CWLs with sum of 3-stage collector data (Fig. 7) reveals good agreement between samplers. Scatter is likely related to
  - (i) broad DP50 cut-offs of the 3-stage CASCC, and
  - (ii) relatively large uncertainties of LWC determination from broad size bins of FSSP

REFERENCES AND FUNDING

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