Organic acids in bulk and size-resolved cloud water from HCCT-2010

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„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 philosophy as during FEBUKO 2001 and 2002 experiments (Herrmann, 2005)
- Joint project with partners from Germany (Leipzig, Mainz, Frankfurt), France (Lille, Lyon), Great Britain (Leeds), and the US (Fort-Collins, CO)

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

See also contributions #63, #196, #205, #280, #326, #344, #462, #554, #560, #607

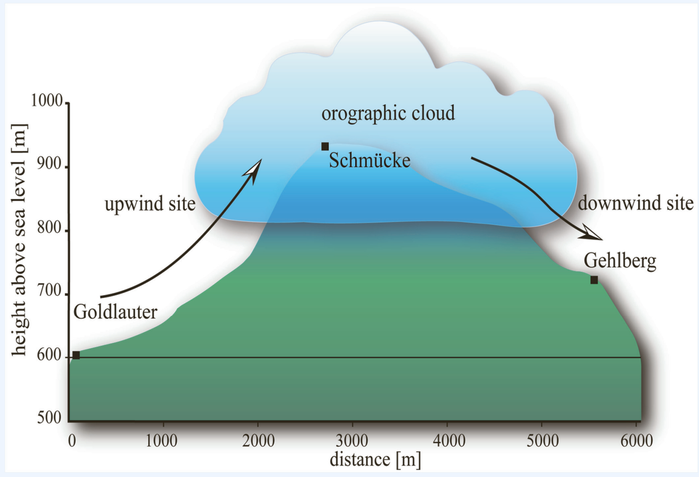

Figure 1: Scheme of the campaign area

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

Experimental

- 73 hours of cloud water sampling during “Full Cloud Events” (Table 1)
- Cloud water sampling by Caltech Active Strand Cloud Water Collectors (CASCC)
- Bulk sampler CASCC2 (Demoz et. al, 1996), 3-stage CASCC (Raja et al., 2008), and 5-stage CASCC (Moore et al., 2002)
- Particle Volume Monitor (PVM) for liquid water content (LWC) of clouds
- Forward Scattering Spectrometer Probe (FSSP) for droplet distributions
- Analysis of short-chain mono- and dicarboxylic acids by capillary electroporesis (CE) (Neusüß et al., 2000)
- Analysis of longer-chain acids by hollow-fibre liquid phase microextraction and CE-MS (van Pinxteren et al., 2012)

Bulk concentrations

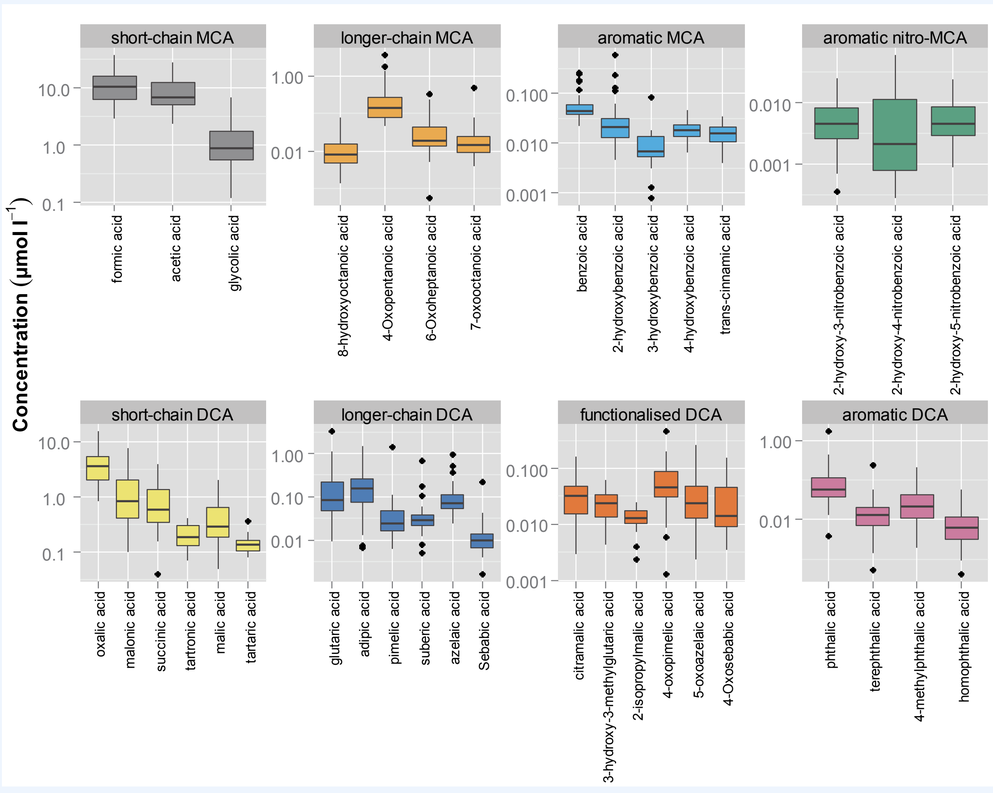

Figure 2: Bulk cloud water concentrations (µmol l-1) of all determined carboxylic acids

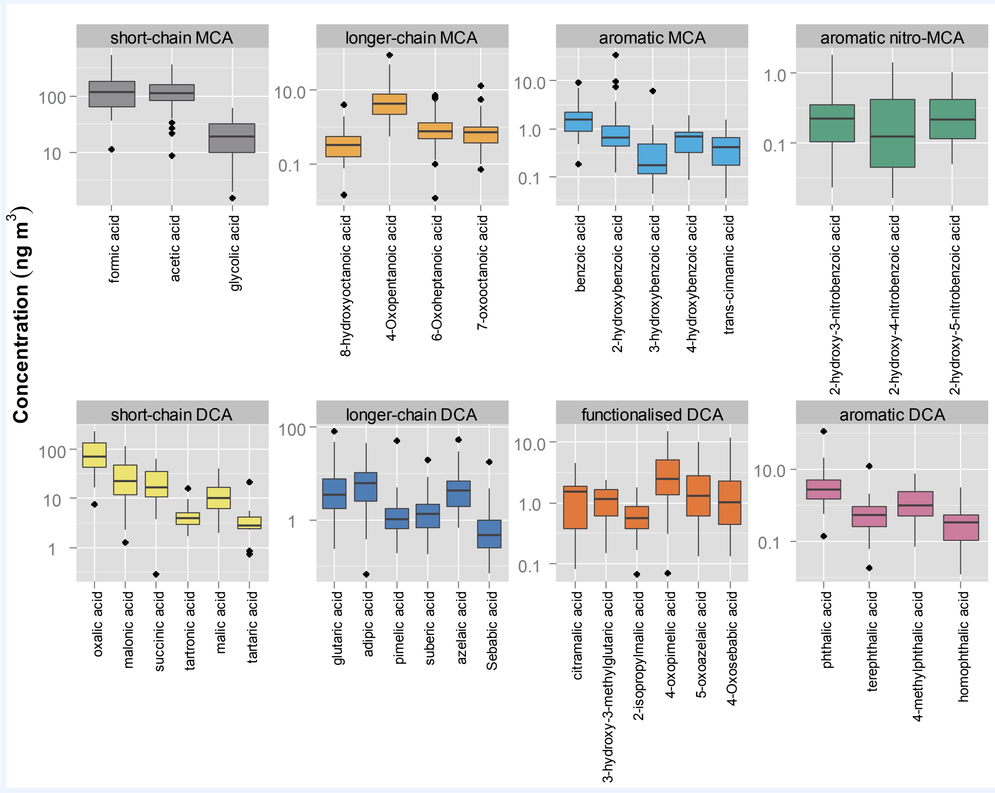

Figure 3: Bulk cloud water loadings (ng m-3) of all determined carboxylic acids

- Wide range of concentrations for different acids (~0.001-10 µmol l^{-1}) (Fig. 2)
- Short-chain (C1-C2) monocarboxylic acids (MCA) show-highest conc., followed by short-chain (C2-C4)-dicarboxylic acids (DCA)
- All further acids (except C5-C10 straight-chain DCA) determined for the first time from cloud water samples
- Cloud water loadings (CWL) in ng m^{-3} obtained from aqueous phase conc. and measured LWC (Fig. 3)
- → equivalent aerosol concentration
- Uptake of acids into cloud water either by dissolution from CCN (esp. DCAs) or scavenging from gas phase (esp. short-chain MCAs)
- Aromatic nitro-acids potentially important due to light absorbing properites (“brown carbon”)

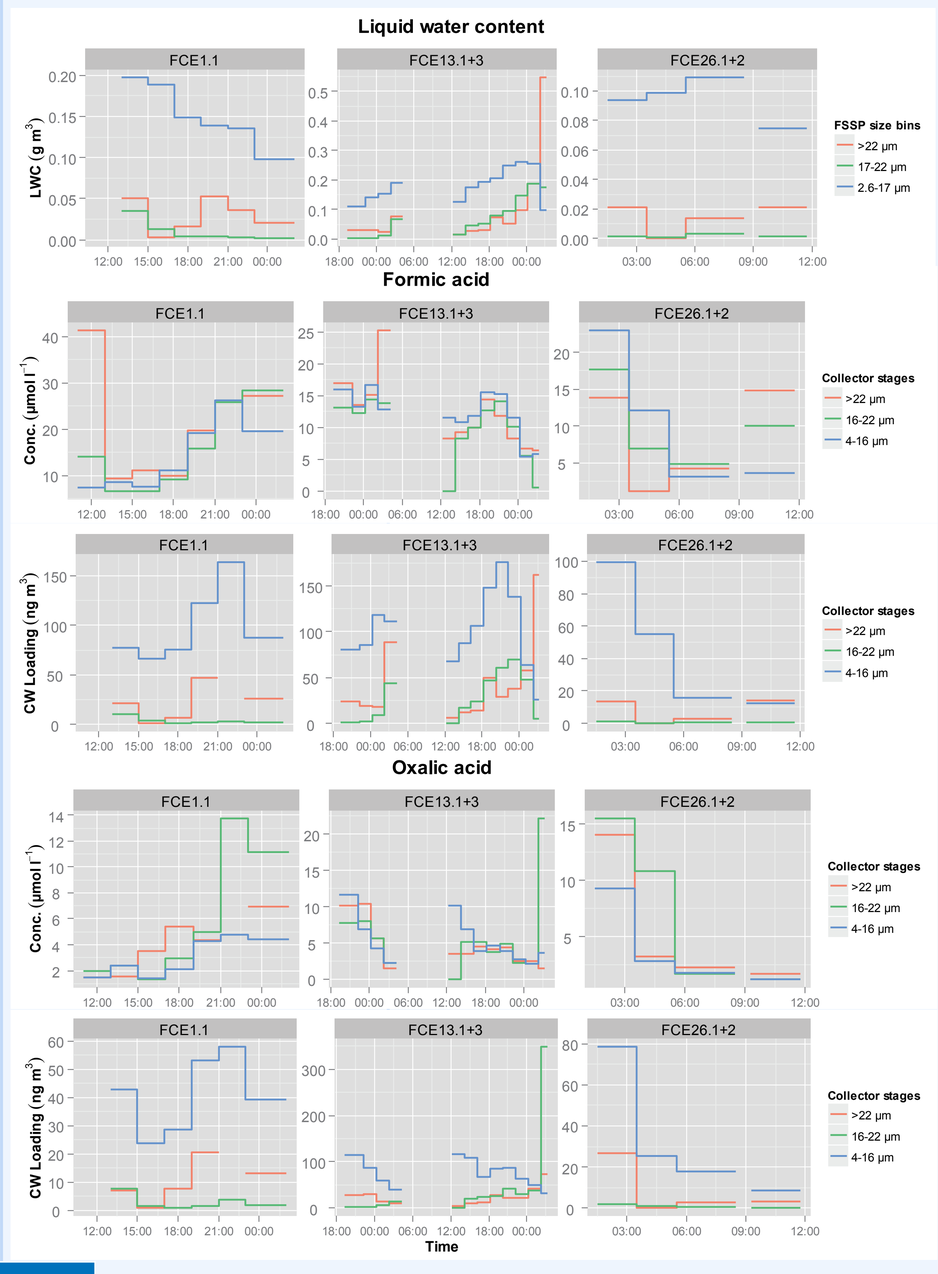

Figure 4: Results from 3-stage CASCC: LWC within collector size classes and concentrations and CWLs for formic and oxalic acid

Size-resolved concentrations

- LWC usually highest in droplets of 9–17 µm (Fig. 4)
- Aqueous phase concentrations of formic and oxalic-acid often similar among different collector stages (droplet size classes) (Figures 4 and 5)
- Notable exception: Very high aqueous phase conc. (up to 120 µmol l^{-1} for formic and 40 µmol l^{-1} for oxalic acid) in very small cloud droplets (4–10 µm from 5-stage CASCC)
- → low water content of small droplets
- Different time profiles of formic and oxalic acid
- → different sources and uptake mechanisms

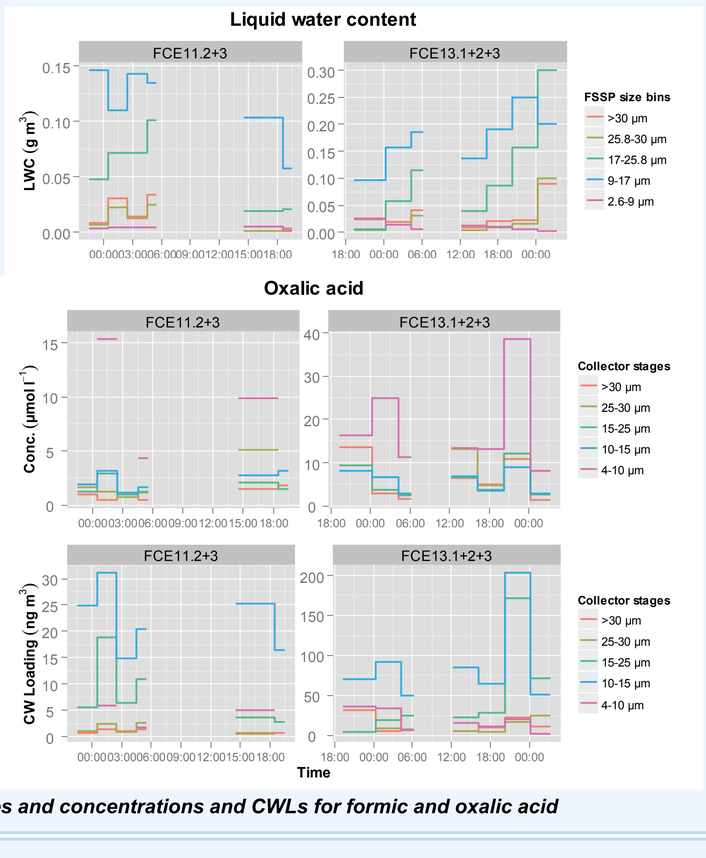

Figure 5: Results from 5-stage CASCC: LWC within collector size classes and concentrations and CWLs for formic and oxalic acid

References and Funding

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