Influence of cloud to the local aerosol chemical composition during the Hill Cap Cloud Thuringia 2010 (HCCT 2010) campaign

L. Poulain[1], Z.J. Wu[1], A. Tilgner[1], D. van Pinxteren[1], M. Müller[2], B. D'Anna[3], C. George[3], J. Schneider[4], S. Mertes[1], A. Wiedensohler[1] and H. Herrmann[1]

[1] Leibniz-Institut für Troposphärenforschung, Leipzig, Germany
[2] Deutsches Biomasseforschungszentrum, Leipzig, Germany
[3] Université Lyon 1, CNRS, UMR5256, IRCELYON, Institut de Recherches sur la Catalyse et l'Environnement de Lyon, Villeurbanne, France
[4] Max Planck Institute for Chemistry, Particle Chemistry Department, Mainz, Germany

Contact: *poulain@tropos.de*

INTRODUCTION

Impact of cloud on the local aerosol chemical composition was investigated during the Hill Cap Cloud Thuringia 2010 (HCCT 2010) field campaign which took place in autumn 2010 at the Mt. Schmücke in the Thuringia forest (Germany). Three sampling stations were equipped: one on the top of Mt. Schmücke, where clouds were samples, and two valley stations located upwind and downwind to the summit of the mountain (Fig. 1). A total of 4 Aerodyne ToF-AMSs were deployed during the campaign (one at each valley stations and 2 at the summit station (one connected downstream of a Cloud Virtual Impactor (CVI) for droplet residuals and one connected to an interstitial inlet measuring interstitial particles).

EXPERIMENTAL APPROACH

To investigate the impact of cloud chemistry to the aerosol chemical composition and size distribution, several specific meteorological criteria are requited (e.g. specific wind direction and wind speed, presence of cloud at the summit station but not at the two valley stations and an absence of precipitation). However, it is crucial to know if instruments provide similar results during non-cloud events prior to study cloud interaction. Therefore several periods with a connected air mass flow between the three stations but without any cloud at the summit station were investigated. Periods of the comparison between the AMS measurements performed at the two valley stations during dry overflow and cloud periods (Tab. 1) are presented.

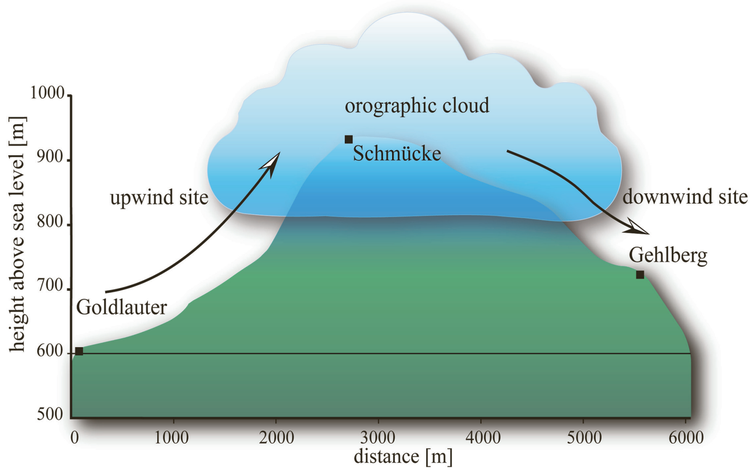

Fig. 1: Scheme of the HCCT-2010 sampling sites and the general philosophy of cloud passage experiment.

Rating	1	2	3	4	5	6	7	8	9	10
Cloud name	FCE 11.3	FCE 1.1	FCE 26.2	FCE 26.1	FCE 22.1	FCE 13.3	FCE 11.2	FCE 13.1	FCE 7.1	FCE 12.1
Starting time	02.10 14:30	14.09 11:00	24.10 09:15	24.10 01:30	19.10 21:30	06.10 12:15	01.10 22:30	05.10 19:15	24.09 23:45	05.10 11:00
Ending time	02.10 20:00	15.09 02:00	24.10 11:45	24.10 08:45	20.10 03:30	07.10 03:15	02.10 05:30	06.10 04:30	25.10 01:45	05.10 13:00

Table 1: Presentation of the 10 best cloud events (FCE). The color code refers to the color code used in Fig. 3.

DRY OVERFLOW CONDITIONS

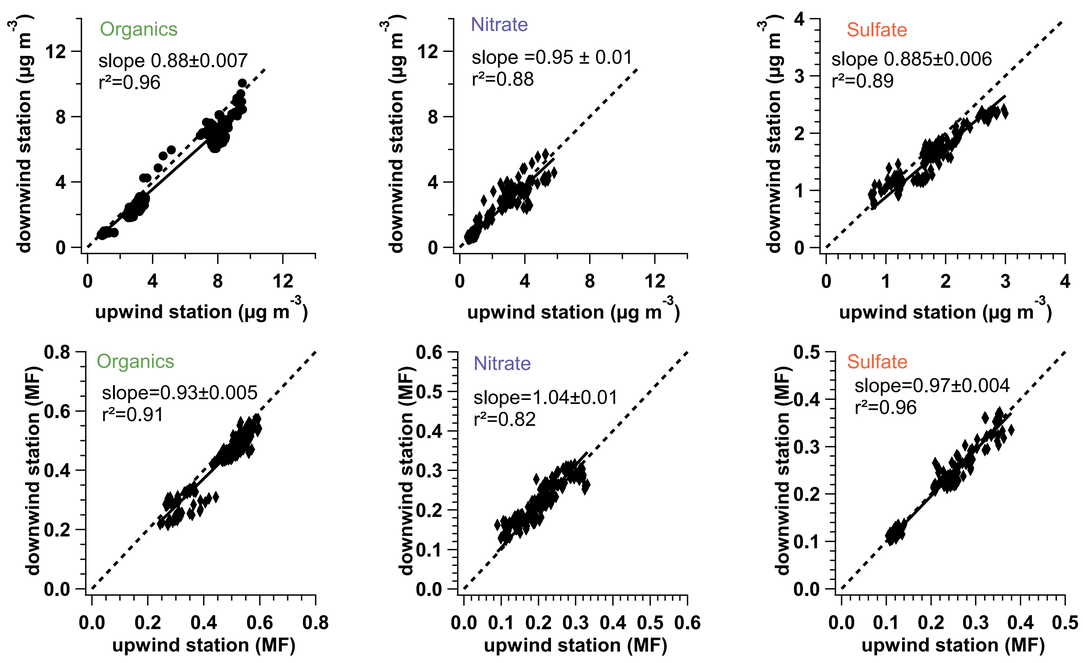

Fig. 3: Mass concentration (upper panel) and mass fraction (lower panel) of organics, nitrate and sulfate measured downwind and upwind of the mountain during dry-overflow (NCE)

Dry overflow between the 3 sampling stations was estimated based on the local meteorological conditions and concentration of relatively inert gas compounds like ozone. A total of 5 different periods was selected during the campaign.
A pretty good agreement between the valley stations was obtained during the selected dry-overflow periods. A similar agreement was also obtained for the comparison between valleys and summit measurements. These results allow a direct comparison of the AMS results during similar overflow between the 3 stations and presence of cloud at the summit station.

CLOUD EFFECT

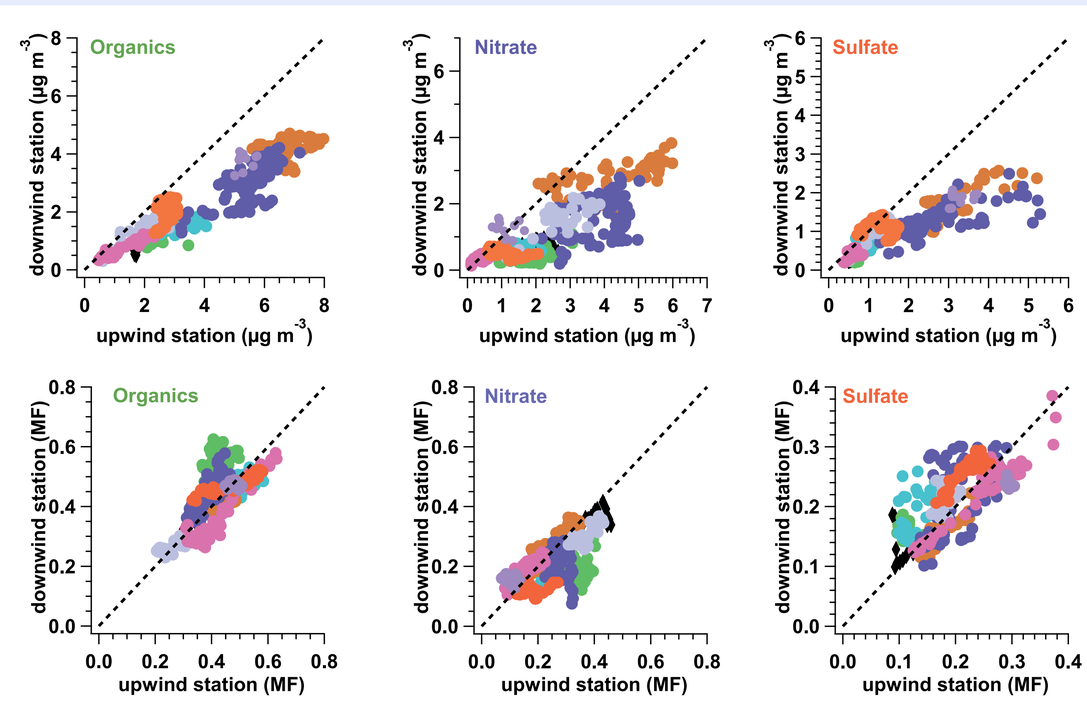

Fig.3: comparison of the mass concentration and mass fraction during the different cloud events (FCE)

Despite differences between FCE, a tendency can be observed. During cloud events, mass concentration at downwind station were systematically lower than the one measured at upwind station corresponding to wet deposition processes. However regarding the mass fraction of the different chemical compounds some differences can be observed with a general tendency to a tiny decrease of the nitrate mass fraction and a small increase of organics and sulfate mass fraction after crossing the cloud.

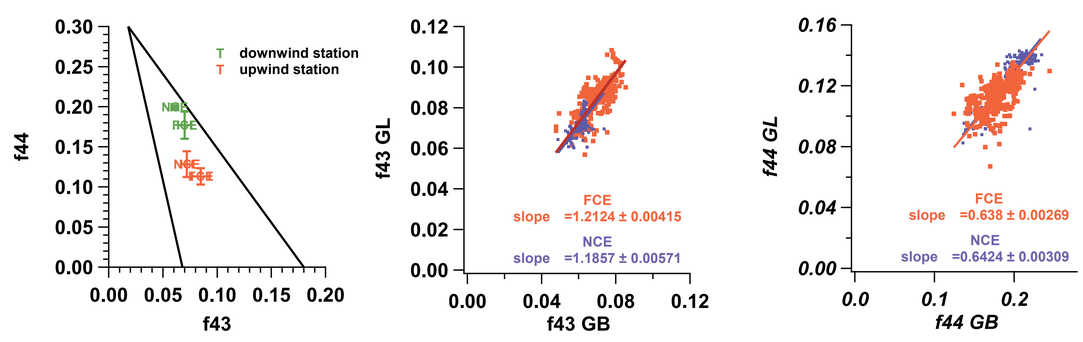

Fig. 4: Change in organic contribution of m/z 44 and 43 during dry overflow and cloud events

Change in organic oxidation state was investigated by comparing contribution of fragment 44 and 43 to total organic during NCE and FCE as well as their ratio between the two stations. Instrumental factor (C-ToF / HR-ToF) can explain the difference between the two stations observed in the triangle plot of Ng et al. (ACP, 2010) (Fig 4. left). However, it should be a constant factor since no tuning of the mass spectrum was performed during the campaign. Fraction of m/z44 to total organic (f44) seems to be quite constant for FCE and NCE while a small increase of f43 can be observed.

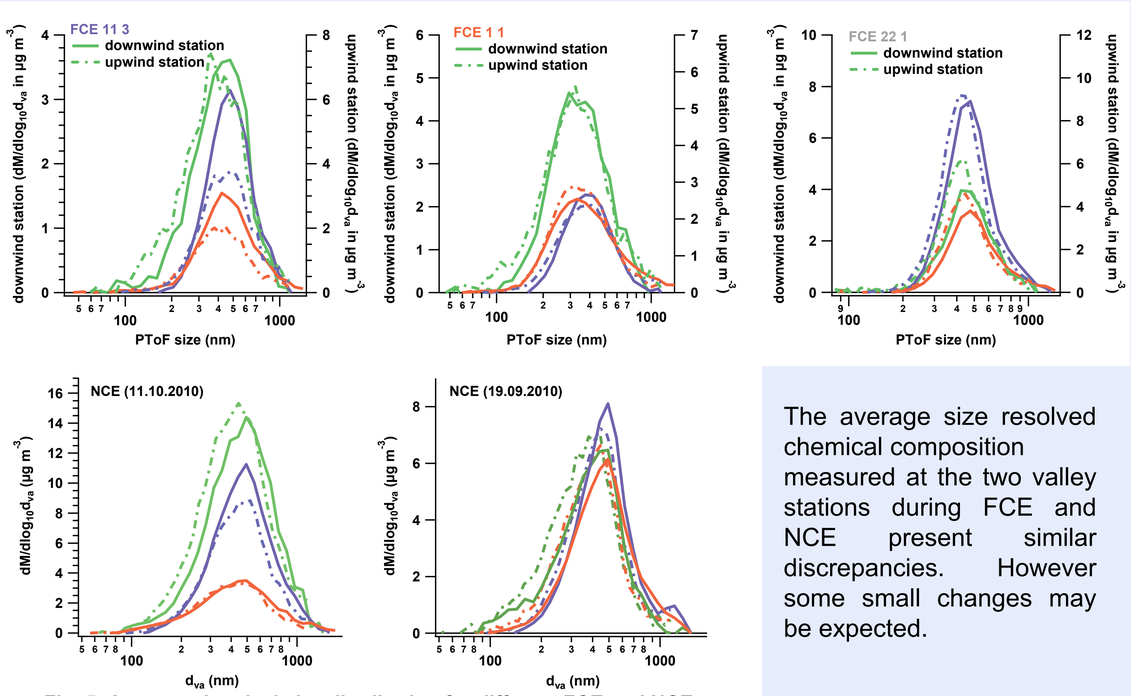

Fig. 5: Average chemical size distribution for different FCE and NCE.

The average size resolved chemical composition measured at the two valley stations during FCE and NCE present similar discrepancies. However some small changes may be expected.

CONCLUSION

Based on the different FCE observations made during the HCCT-2010 campaign, clouds chemistry may induced a small decrease on nitrate mass fraction while organics and sulfate slightly increase. Minor changes on the organic oxidation state based on f44 and f43 were also observed.