# Evaluation of $PM_{10}$ and trace gas measurements with the MARGA during the HCCT 2010 campaign

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## INTRODUCTION

During the Hill Cap Cloud Thuringia (HCCT) field campaign in September and October 2010 at Mt. Schmücke (Germany) the online system MARGA (**M**onitor for **A**erosols & **Ga**ses in ambient Air [1,2]) was deployed at the upwind valley station in Goldlauter.
The instrument was developed by Metrohm Applikon, Netherlands and uses a combination of a wet-rotating denuder and a steam-jet-aerosol-collector to capture gases and particles in ambient air.
During the HCCT campaign the MARGA was connected to a $PM_{10}$ inlet-system to measure the concentrations of the inorganic components $Cl^-$, $NO_3^-$, $SO_4^{2-}$, $Na^+$, $NH_4^+$, $K^+$, $Mg^{2+}$, $Ca^{2+}$ in the particle phase and the corresponding trace gases HCl, $HNO_2$, $SO_2$, $HNO_3$ and $NH_3$ in a time resolution of one hour

## OVERVIEW

Table1 gives a summary of the measured particle and gas concentrations during HCCT in September and October 2010. Figures 1 and 2 show the time series of the main ions in the particle phase and the corresponding trace gases.

- Overall low gas phase concentrations, only in the mid of October high concentrations of $SO_2$ were observed due to the long range transport of continental air masses.
- Slightly higher particle concentrations in October
- Periods with high $Cl^-$ concentrations indicate the influence of maritime air masses, but most of the time the chloride concentration was below the detection limit of the MARGA

Table 1: Summary of the aerosol concentrations during HCCT.

| | Mean [µg/m³] | Stdev [µg/m³] | N | | Mean [µg/m³] | Stdev [µg/m³] | N |
|---|---|---|---|---|---|---|---|
| **HCl** | 0.13 | 0.14 | 164 | **$SO_4^{2-}$** | 1.38 | 0.8 | 1003 |
| **$HNO_2$** | 0.64 | 0.39 | 999 | **$Na^+$** | 0.12 | 0.16 | 922 |
| **$SO_2$** | 0.67 | 1.34 | 1002 | **$NH_4^+$** | 1.12 | 3.27 | 1001 |
| **$HNO_3$** | 0.23 | 0.62 | 989 | **$K^+$** | 0.1 | 0.04 | 888 |
| **$NH_3$** | 0.81 | 0.84 | 1000 | **$Mg^{2+}$** | 0.14 | 0.15 | 981 |
| **$Cl^-$** | 0.19 | 0.21 | 402 | **$Ca^{2+}$** | 0.59 | 0.36 | 992 |
| **$NO_3^-$** | 1.94 | 2.08 | 1003 | | | | |

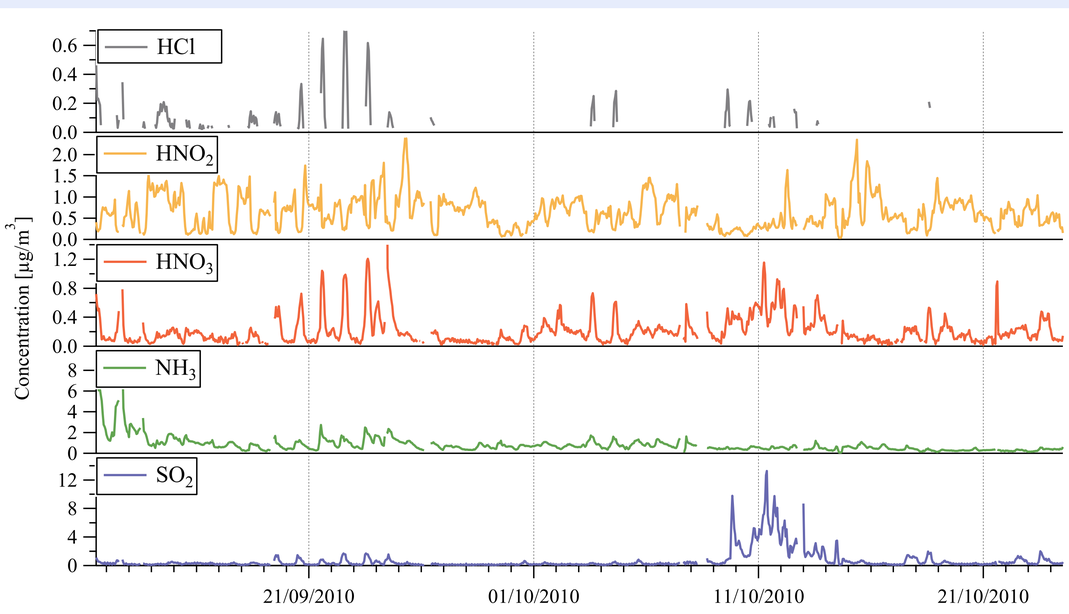


**Fig. 1: Gas concentrations during HCCT 2010 measured with the MARGA.**

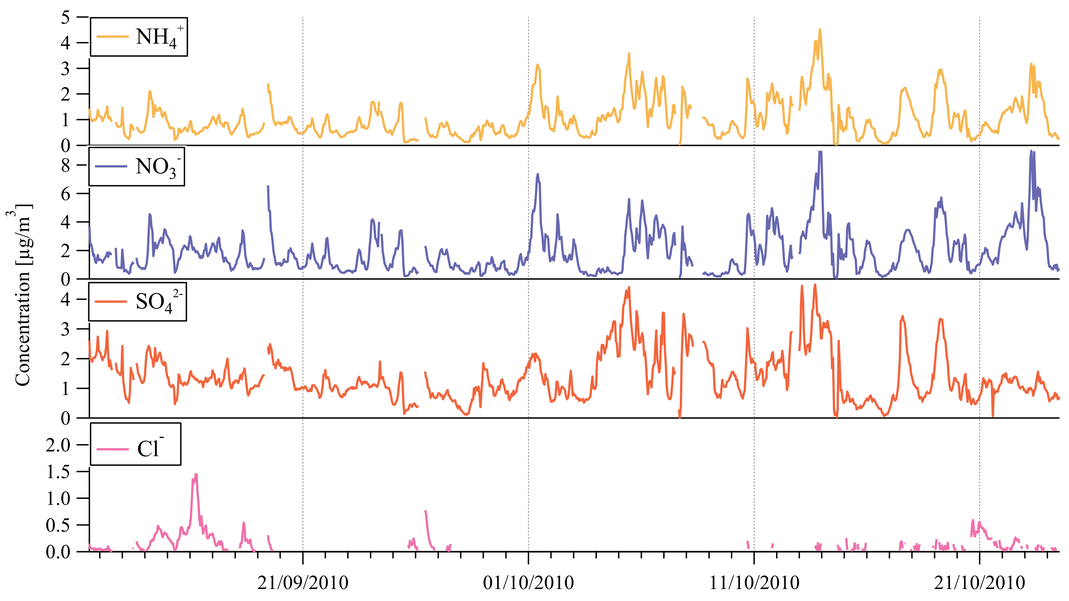


**Fig. 2: Concentrations of inorganic ions during HCCT measured with the MARGA.**

## SUMMARY

A MARGA was used to quantify the water-soluble inorganic ions in the particle phase and the corresponding trace gases during the HCCT campaign in autumn 2010. A data yield of over 90% was achieved for the main ions and gases.
The comparison of the MARGA with a HR-ToF-AMS shows a good agreement for nitrate, ammonium and sulfate. Only in the first week of the campaign a significant difference in the nitrate concentrations was visible.

## COMPARISON WITH AN AMS

The MARGA measurements were compared with a HR-ToF-AMS (High Resolution – Time of Flight - Aerosol Mass Spectrometer, Aerodyne, USA [3]) during the HCCT campaign:

- Despite the different size cutting of the two instruments (MARGA: $PM_{10}$, AMS: $PM_1$) a good agreement was found for $NO_3^-$, $NH_4^+$ and $SO_4^{2-}$ (figure 3) -> $NO_3^-$, $NH_4^+$ and $SO_4^{2-}$ mainly present in the submicron fraction of particles.
- Exception: In the first week of the campaign MARGA detects more $NO_3^-$ than AMS -> high $NO_3^-$ concentrations in the particle coarse mode due to the influence of maritime air masses

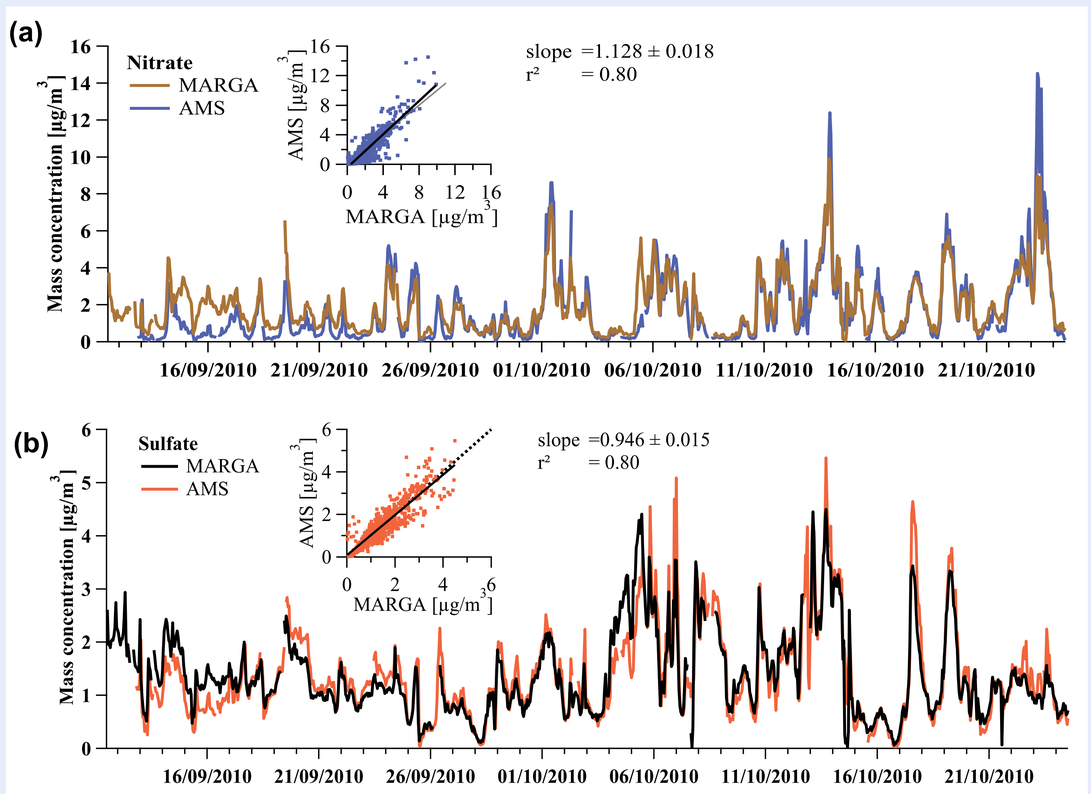


**Fig. 3: Comparison between MARGA and HR-ToF-AMS measurements during HCCT 2010.**
**(a) Comparison of the nitrate concentration.**
**(b) Comparison of the sulfate concentration.**

## DIURNAL VARIATIONS

Figure 4 shows the diurnal variation of selected gases and particles as box plots averaged over the whole HCCT campaign.

- Maximum concentration for $NH_3$ and $SO_2$ is observed in the early afternoon, minimum concentration during the night.
- $SO_4^{2-}$ shows no diurnal variation.
- $NO_3^-$ shows a weak diurnal variation with highest concentration in the morning and lowest concentration in the afternoon

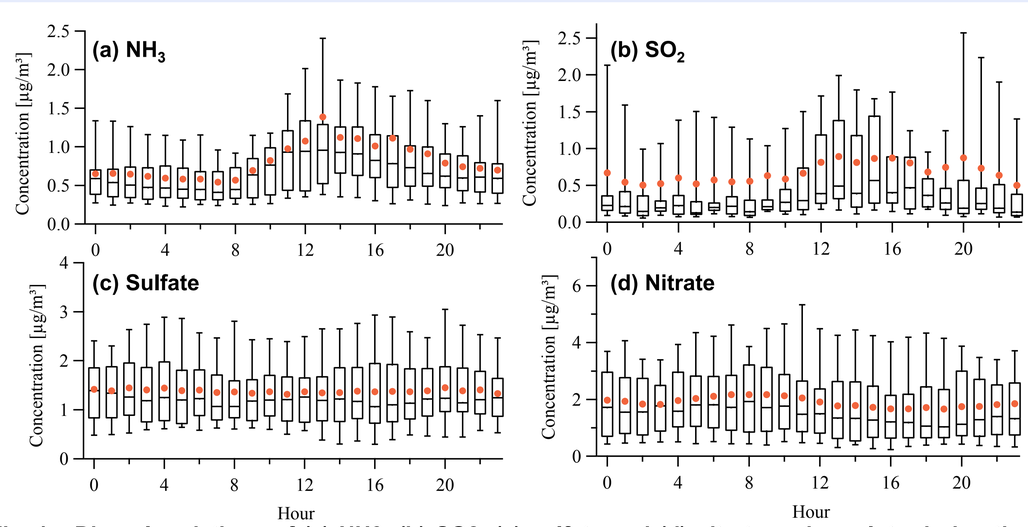


**Fig. 4: Diurnal variations of (a) NH3, (b) SO2, (c) sulfate and (d) nitrate as box plots during the HCCT campaign. The red dots represent the median concentration of the measured aerosols.**

## References

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[2] Makkonen, U., A. Virkkula, Mäntykenttä, J., Hakola, H., Keronen, P., Vakkari, V., Aalto, P. P. (2012). Semi-continuous gas and inorganic aerosol measurements at a Finnish urban site: comparisons with filters, nitrogen in aerosol and gas phases, and aerosol acidity. *Atmos. Chem. Phys. Discuss.* **12**(2): 4755-4796.
[3] Poulain, L., Spindler, G., Birmili, W., Plass-Dülmer, C., Wiedensohler, A., Herrmann, H. (2011). Seasonal and diurnal variations of particulate nitrate and organic matter at the IfT research station Melpitz. *Atmos. Chem. Phys.* **11**(24): 12579-12599.