Chemical characterization of PM_{10} and trace gas measurements with the online-system MARGA at the research station Melpitz in Germany

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1. Introduction

The sampling system MARGA (**M**onitor for **A**erosols & **Ga**ses in ambient Air), developed by Applikon Analytical, Netherlands [1], was connected to a PM_{10} inlet to quantify the inorganic components Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+} and 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. The measurements were carried out for 21 months (October 2009 - June 2011) at the research station of the Leibniz-Institut für Troposphärenforschung e. V. in Melpitz, Germany (12°56'E, 51°32'N, 86 m a.s.l.). A detailed description of the research station is given in Spindler et al., 2010 [2].
Sample collection inside the MARGA is realized via a combination of a wet rotating denuder and a steam-jet aerosol collector [3]. An online ion-chromatography system ensures a fast and reliable analysis of the samples.

2. Seasonal variation

Figures 1 and 2 show the measured gases and the main ions by the MARGA over the whole measuring period from October 2009 until June 2011.
The seasonal variation of the aerosol concentration is visible: Ammonia for example shows a very distinct seasonal trend: In the winter months the NH_3 concentration is very low and increases strongly in spring due to the beginning of agriculture activities and higher temperatures.
In the winter season the long-range transport of anthropogenic polluted air masses causes higher concentrations of NO_3^-, SO_4^{2-}, NH_4^+ and SO_2.
Ammonia and nitrate show the lowest concentrations in the summer months with high temperatures due to the evaporation of NH_3 and HNO_3 from the particle phase.

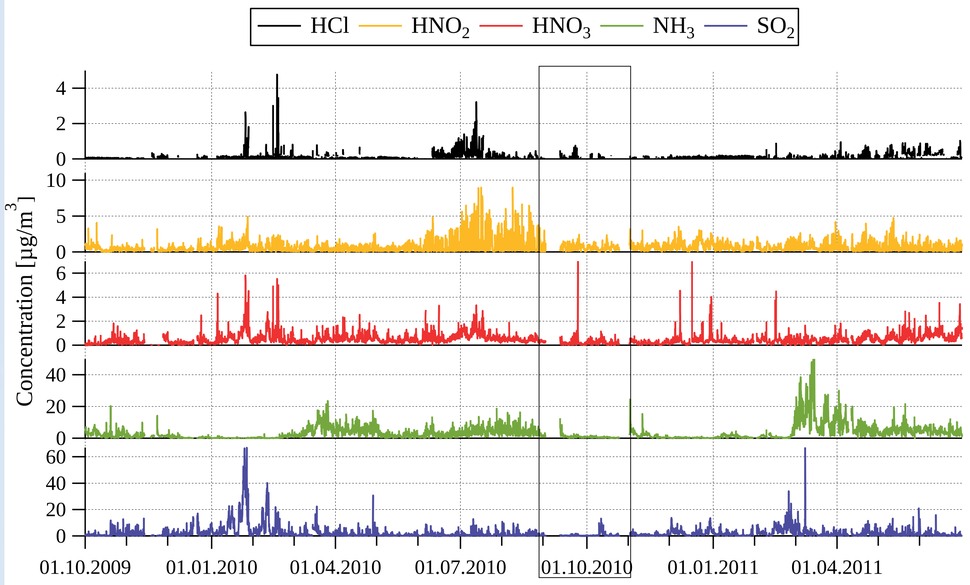

Fig. 1: Seasonal variation of the gases measured with the MARGA between October 2009 and June 2011. During Sept/Oct 2010 (framed box) the MARGA took part in a measuring campaign (HCCT) in Thuringia.

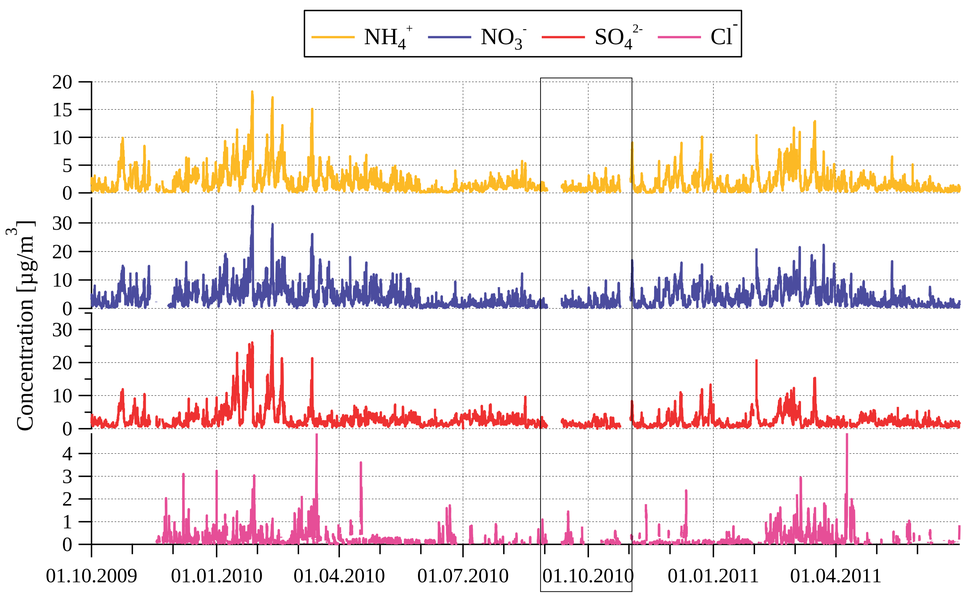

Fig. 2: Seasonal variation of the mainions measured with the MARGA between October 2009 and June 2011. During Sept/Oct 2010 (framed box) the MARGA took part in a measuring campaign (HCCT) in Thuringia.

3. Diurnal variation

Figure 3 shows as an example the diurnal variation of NH_3 and SO_2 in dependence of the air mass origin between October 2009 and March 2010 (air mass origin was determined with 96h backward trajectories of the NOAA-Hysplit model [4], details in Spindler et al., 2010 [2]). Ammonia shows higher concentrations in air masses of western origin. The higher temperatures during these periods enhance the NH_3 emission.
During eastern air flow high concentrations of SO_2 are detected in Melpitz due to the transport of anthropogenic polluted continental air masses.

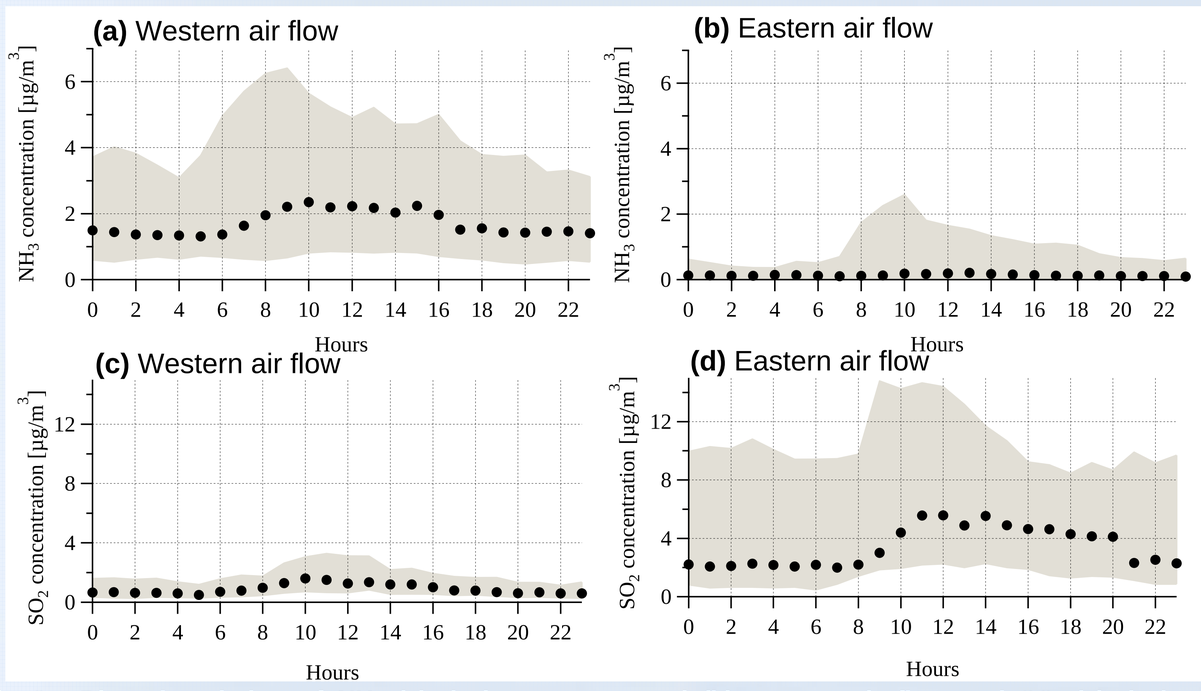

Fig. 3: Diurnal variation of NH_3 (a) during western and (b) eastern air flow and SO_2 (c) during western and (d) eastern air flow between October 2009 and March 2010. Symbols and grey shadings show medians and interquartile ranges, respectively.

4. Comparison with other instruments

The MARGA shows good agreement with common instruments, e.g. with a SO_2-monitor (UV-fluorescence, figure 4) .
The comparison between the MARGA and PM_{10} filter measurements of nitrate indicates a negative artefact in the filter measurements in July 2010 (figure 5b) due to the volatility of NH_4NO_3. During July 2010 with the high mean temperature of 22°C the corresponding trace gas of nitrate (HNO_3) evaporates from the particle phase collected on the filter. In the winter months this artefacts is not present (figure 5a) due to the low temperatures.

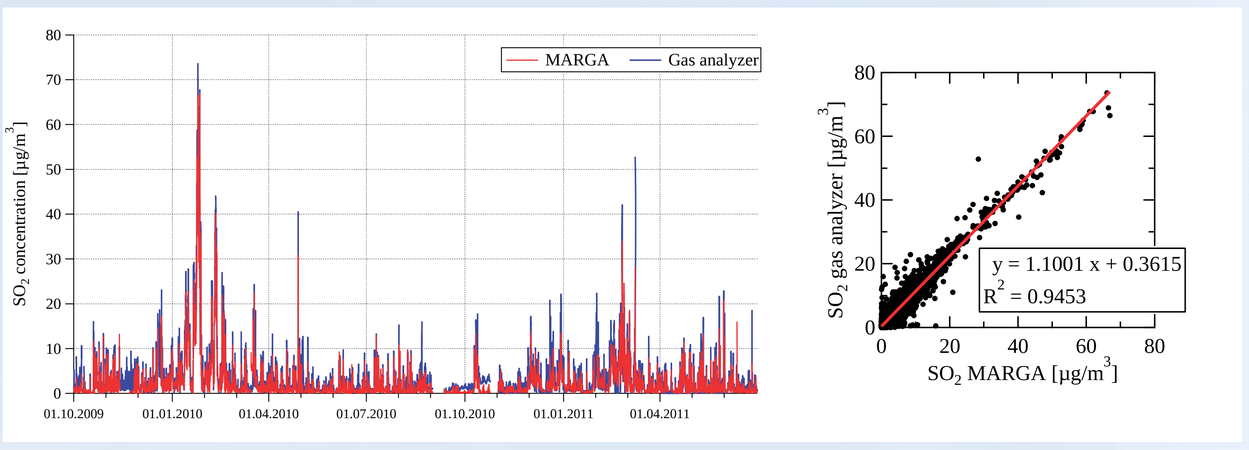

Fig. 4: SO_2 concentration comparison between the MARGA (red) and a gas-monitor (UV-Fluorescence, blue).

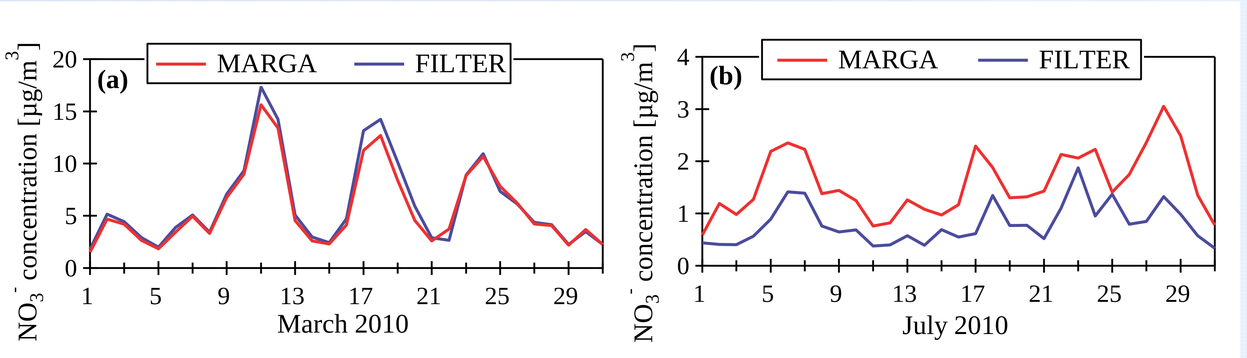

Fig. 5: NO_3^- concentration comparison between MARGA and a High-Volume Filter (quartz-fibre Filter, DIGITEL DHA-80) in a) winter (March 2010) and b) in summer (July 2010).

5. Summary

The MARGA was operated in Melpitz, Germany for 21 month. A data yield of over 90% was achieved for the main ions and gases since the launch of the MARGA in October 2009. The results have shown that the MARGA is a suitable instrument to characterise aerosols in a high time resolution.

6. References

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7. Acknowledgements

Financial support from the Umwelltbundesamt in Germany (grant no. 351 01 070) is gratefully acknowledged. We would also like to thank our technical staff: A. Dietze, S. Fuchs, A. Grüner, S. Haferkorn, R. Rabe, and A. Thomas.