Chemical characterization and source investigations of PM_{10} in Central Europe with the MARGA

B. Stieger[1], G. Spindler[1], K. Müller[1], L. Poulain[1], A. Grüner[1], M. Wallasch[2] and H. Herrmann[1]

[1]Chemistry Department, Leibniz-Institute for Tropospheric Research, Leipzig, Saxony, 04318, Germany
[2]Federal Environment Agency, Dessau-Roßlau, Saxony-Anhalt, 06844, Germany
Keywords: meteorological influences, variations in time, instrument comparison, source analysis.
Presenting author email: stieger@tropos.de

The Monitor for Aerosols and Gases in ambient Air (MARGA) is used for the high-time resolved (1 h) quantification of inorganic ions in the particle phase (PM_{10}) (Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) and the corresponding trace gases (HCl, HONO, HNO_3, SO_2, NH_3) (ten Brink et al., 2007). The air flow of 1 m^3 per hour passes a Teflon coated PM_{10} inlet and enters a Wet Rotating Denuder (WRD) in which the water-soluble gases diffuse in water as the absorbance liquid. Particles were collected after passing the WRD with a Steam-Jet Aerosol Collector (SJAC). In a supersaturated environment the particles grow up to droplets. The liquid solutions of the WRD and SJAC are analysed by an ion chromatography system.

From 2010 until 2014 sampling took place at the TROPOS research station and EMEP/ACTRIS-site Melpitz located 50 km in the northeast of Leipzig. It is a representing station for measuring the atmospheric background concentrations in Central Europe. This site is mainly influenced by two main wind direction sectors. Marine air masses coming from west originates above the Atlantic Ocean and overflow a large part of West Europe. Easterly winds transports continental dry air to the Melpitz site (Spindler et al., 2013). Meteorological parameters were quantified continuously in this time.

In this five years several comparisons with other aerosol measurement techniques could be made. Good correlation with PM_{10} filter measurements can be observed. For the main ions in the particle phase Cl^-, NO_3^-, SO_4^{2-} and NH_4^+ coefficients of determination of 0.862, 0.877, 0.906 and 0.869 were achieved, respectively. Also comparisons with an Aerodyne High-Resolution Time-of-Flight Aerosol Mass Spectrometer and Aerosol Chemical Speciation Monitor are in good agreement.

Beside the investigation of seasonal and weekly variations of the considered ions the MARGA system gives the opportunity to study the diurnal variations due to the high-time resolved measurements. To find possible sources of the measured ions in the regional and long-range scale we use meteorological parameters as well as HYSPLIT 96h backward trajectories. For ions with known regional sources like NH_4^+ the meteorology support the understanding of phase distribution between the gas and particle phase, which is both measured by the MARGA. NH_4^+ shows a strong decreasing concentration trend with increasing temperature with the result of higher NH_3 concentrations especially in the temperature interval of 0° until 10°C. This can be explained by evaporation processes. For long-range transport the pressure can give hints about the air mass origin. Especially in winter the SO_4^{2-} concentrations are elevated when high pressure was measured. Because of the anticyclonic rotation of the Sibirian high pressure system in winter, SO_4^{2-} is transported to Melpitz from easterly directions. The reason of the high concentration are anthropogenic emissions as for example individual heating with coal. This can also clearly be observed by wind direction data and can graphically be shown by the combination of the measured data with backward trajectories (Fig. 1) using the Concentration Weighted Trajectory (CWT) analysis (Liu et al., 2013). The Figure was created with the R package "openair" (Carslaw and Ropkins, 2012).

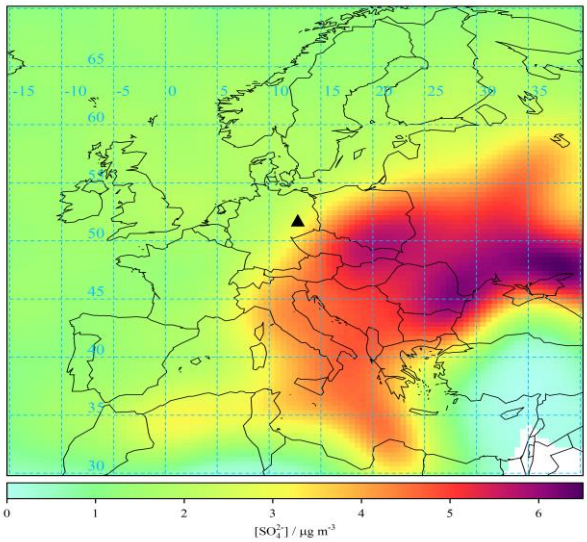

Figure 1. "Openair" contour plot of the air mass origin of SO_4^{2-} based on MARGA measurements in Melpitz (▲) from 2010 until 2014.

This work was financially supported by the Federal Environment Agency in Germany under grant 351 01 093 and 351 01 070.

Carslaw, D.C. and Ropkins, K. (2012) *Environ. Modell. Softw.* **27-28**, 52-61.

Liu, N., Yu, Y., He, J.J., Zhao, S.P. (2013) *Atmos. Pollut. Res.* **4** (3), 306-314.

Spindler, G., Grüner, A., Müller, K., Schlimper, S., Herrmann, H. (2013) *J. Atmos. Chem.* **70** (2), 165-195.

ten Brink, H., Otjes, R., Jongejan, P., Slanina, S. (2007) *Atmos. Environ.* **41**, 2768-2779.