MARGA: Chemical chraracterization and sources of inorganic gaseous and PM_{10} pollutants in Central Europe

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The analysis of inorganic ions originating from gases (HCl, HONO, HNO_3, SO_2, NH_3) and particles (Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) was performed at the TROPOS research station and EMEP/ACTRIS-site Melpitz situated 50 km in the northeast of Leipzig (Spindler et al. 2013). The sampling period was from 2010 until 2014. Highly-time resolved (1 h) quantifications of these compounds are possible with the Monitor for AeRosols and Gases in ambient Air (MARGA) (ten Brink et al. 2007). With a flow of 1 m^3 per hour the air passed through a Teflon coated PM_{10} inlet and entered a Wet Rotating Denuder (WRD) in which water-soluble gases diffuse in the absorbance liquid. After passing the WRD the particles were sampled in the Steam Jet Aerosol Collector (SJAC) (Khlystov et al. 1995). The collected liquid samples were analyzed by an ion chromatography system.

For validation of the MARGA the resulting concentrations were compared with other measurement techniques during the 5 year measurement period. Good agreements can be obtained for the comparison with PM_{10} filter measurements, Aerodyne High-Resolution Time-of-Flight Aerosol Mass Spectrometer (AMS) and Aerosol Chemical Speciation Monitor (ACSM). Comparisons with Batchdenuder indicated that there are artefacts for the measurement of HONO and HNO_3 with the MARGA. The concentrations of HONO were to high during daytime and HNO_3 was significantly underestimated by the MARGA.

The high-time resolution gives the opportunity to study the daily cycles of the species in the gas and particle phase. Parallel measurements of the meteorology in Melpitz help to interpret the resulting cycles. NH_3 concentrations, for instances, show a increase in the early morning which has two possilbe reasons. On the one hand, during sunrise the increasing temperature promote the evaporation of dew and particulate ammonium nitrate which release NH_3. On the other hand, the disappearing nocturnal boundary layer lead to vertical transport from higher air masses to lower ones. These higher air layers are often influenced by long range transport. For other gases also the photochemical formation during daytime plays an important role.
As Melpitz is a representing station for the atmospheric background concentrations in Central Europe, measured high concentrations are attributed either to a low mixing layer, to long range transport or local agricultural emissions. For studying the source areas for the long range transport we used meteorological parameters and HYSPLIT backward trajectories. The wind direction data give hints about the inflow direction due to the prevailing pressure systems. In Winter, high concentrations of SO_4^{2-} and NO_3^- are combined with easterly winds which transports the anthropogenic pollutants from Eastern Europe westward to Melpitz. This can be supported by the combination of the measured MARGA data with backward trajectories using the Concentration Weighted Trajectory (CWT) analysis (Seibert et al. 1994).