Assessment of the changes in PM levels and air quality in Leipzig

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Air quality improvement is still a global as well as a European challenge. In order to reduce adverse health effects of air pollutants, actions have been taken to abate emissions from transport and industries, including technological developments and tightened regulations on local, national and EU-wide levels. Despite the progress made, many cities in Europe and Germany (including Leipzig) are still challenged to comply with legal limit values, especially for pollutants such as NO_x and particulate matter (PM). PM can have very diverse sources, including primary emissions and secondary formation from multiple precursor gases, which makes it more difficult to develop mitigation strategies. In order to better assess the air quality evolution, a detailed knowledge of PM sources and their impacts are needed.

Together with the Saxon State Office for Environment, Agriculture and Geology, TROPOS is engaged since 15 years to study the air quality and PM sources in Leipzig and surrounding areas. In 1999/2000 a PM source apportionment study took place based on size-resolved chemical composition of aerosol particles at several sites. In 2013 to 2015, similar but more comprehensive data were collected. A total of 42 size-resolved particle samples were taken during summer and winter season using a 5-stage Berner impactor. Sampling was performed in parallel at 4 sites (heavy traffic site, street-canyon kerbside, urban background, rural background). All samples were analysed for the major constituents inorganic ions (ion chromatography, IC), OC/EC (thermographic method) and water-soluble organic carbon (TOC analyser), as well as for trace metals (total X-ray fluorescence) and a variety of organic compounds including oxalate (IC), monosaccharides (IC), alkanes, PAHs and hopanes (GC-MS).

Using Positive Matrix Factorization (PMF) receptor modelling various source contributions were obtained including, Traffic, coal combustion, biomass combustion, photochemistry, secondary formation, cooking, fungal spores, urban dust, fresh sea/road salt, and aged sea salt. For the PM10 mass fraction, traffic made typically (20 – 40% at kerbside sites), secondary formation (30 – 60%), biomass combustion (10 – 15% in winter), and coal combustion (30 – 40% in winter with eastern air mass inflow) were the main quantified sources.
Contributions from biomass combustion derived up to 60% from local emissions at the residential site. In contrast, coal combustion was only present during eastern air mass inflow and showed very similar concentrations at all sites. About half of the PM10 mass was attributed to urban sources with highest reduction potentials of up to 80% for local (urban) mitigation measures in ultrafine and coarse particles. A comparison of size-resolved present-day concentrations with data from the year 2000 revealed that local increments of elemental carbon have decreased by about 50%, corroborating results from a former study on the positive effects of a low emission zone, implemented in Leipzig in 2011.