Assessment of air quality improvements in Leipzig, Germany: Source apportionment of size-resolved aerosol particles in 2000 and today

Dominik van Pinxteren*[1], Khanneh Wadinga Fomba[1], Yoshiteru Iinuma[1], Konrad Müller[1], Gerald Spindler[1], Fabian Rasch[1], Alfred Wiedensohler[1], Wolfram Birmili[1], Gunter Löschau[2], Andrea Hausmann[2] and Hartmut Herrmann[1]

1) Leibniz-Institut für Troposphärenforschung (TROPOS), Permoserstr. 15, 04318 Leipzig, Germany
2) Saxon State Office for Environment, Agriculture and Geology, Pillnitzer Platz 3, 01326 Dresden

Air pollution has been of much concern to European societies since several decades. In order to reduce adverse health effects of air pollutants, much action has 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). While the main source of NO_x is high temperature combustion in motor engines, 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.
As a major prerequisite for efficient and sustainable air quality policies, a detailed knowledge of the sources of PM and their quantitative impact at a given site is needed. To this end, the Leibniz-Institute for Tropospheric Research (TROPOS) has been cooperating since 15 years with agencies (especially the Saxon State Office for Environment, Agriculture and Geology) to study 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.
A similar project has been repeated in 2013 – 2015 at the same sites in an even more comprehensive way. 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). In addition, number size distributions of submicron particles were determined continuously at the 4 sites by tandem differential mobility spectrometers (TDMPS), soot was measured by multi angle absorption photometers (MAAP) and trace gases were determined by standard gas monitors.
This comprehensive and multi-dimensional dataset is serving as the basis for detailed source apportionment using methods of different complexity (Lenschow approach, SOA estimation, macrotracer approaches, factor analysis approaches). Preliminary results are indicating significantly reduced levels of many particle constituents as compared to the years 1999/2000, a concentration gradient from rural background towards urban traffic sites and considerable impacts from wood burning and long-range transported pollution especially during winter.
More detailed data analysis is performed and expected to yield interesting insights into i) major and minor current sources of urban and regional PM and ii) a qualified assessment of changes in air quality by comparison with concentrations and results of the previous study.