Quantitative analysis of long-term source contributions to the organic aerosol in Europe

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The anthropogenic influence on particulate matter with aerodynamic diameters smaller than 10 μm (PM_{10}) is proven to be significant, e.g. by the strong presence of weekend effects (Bigi and Ghermandi, 2014) and the importance of wood-burning emissions, especially in winter (Zotter *et al*, 2014). Due to the high contribution of the organic aerosol (OA) to PM (Jimenez *et al*, 2009) and its influence on health (Cassée *et al*, 2009) and climate, the determination of the chemical composition and the sources of this fraction is crucial to understand particulate air pollution. OA can be either directly emitted (primary OA, POA) or formed by oxidation processes of gaseous precursors (secondary OA, SOA). For these reasons, examining sources and their contributions in different regions and over long time periods is required for designing effective mitigation strategies.

Aerosol mass spectrometer (AMS, Aerodyne Research, Inc.) measurements and subsequent application of positive matrix factorization (PMF, Paatero 1994) offers a direct quantification of the contribution of primary emissions such as biomass burning (BBOA), traffic emissions (hydrocarbon-like OA, HOA), and cooking (COA). SOA is typically differentiated in terms of volatility and /or degree of oxygenation (semi-volatile: SV-OOA and low-volatile: LV-OOA) (e.g. Lanz *et al* 2007). However, the systematic deployment of the AMS on a dense network for long term measurements to determine regional and seasonal differences is hindered by the instrument cost and intensive maintenance. Recently, long-term information on the chemical composition of OA for source apportionment became available with the aerosol chemical speciation monitor (ACSM) and offline AMS analysis. Both provide mass spectral data proven valuable for source apportionment (Crippa et al, 2014; Daellenbach *et al*, 2015).

Here, we present offline AMS measurements of PM_{10} at 9 stations in Switzerland with different exposure characteristics for the entire year of 2013 (819 samples). Data are analysed with the multilinear engine ME-2 (Paatero 1999), and obtained estimates of source contributions are combined with back-trajectory analysis for the determination of source regions. Besides the primary emissions of traffic, cooking and biomass-burning, we show that we can identify different types of SOA from different origins (Fig., 1). We can clearly observe the production of SOA in summer (SOOA), following the increase in biogenic emissions with temperature. Also a long-range transported SOA, prominent in winter (WOOA), could be extracted. This factor correlating with anthropogenic secondary inorganic species is most notably perceived when the site is affected by air masses from continental Europe. These offline AMS results are also compared to results from laser-desorption/ionization mass spectrometry analyses (Samburova *et al*, 2005) for further insights in the chemical nature of the aerosol. We will present this first thorough assessment of the local and regional sources affecting the air quality during winter and summer at the different sites.
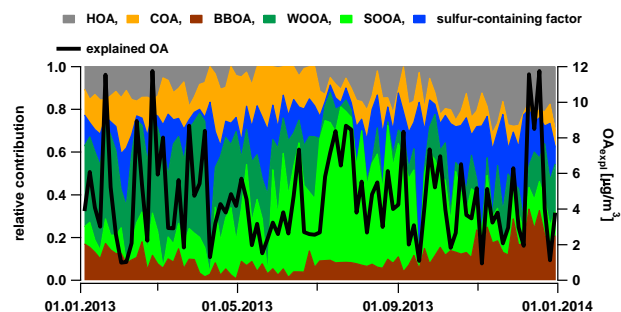

Figure 1: relative contributions of sources to OA in Zurich (2013).

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