Source apportionment of submicron organic aerosols at an urban background site by positive matrix factorization (PMF) applied to aerosol mass spectra

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Keywords: aerosol mass spectrometry, aerosol modelling, SOA, PM1, source apportionment.

Submicron ambient aerosol was characterized in summer 2005 at an urban background site in Zürich (Switzerland) during a three-week measurement campaign. Highly time-resolved samples of non-refractory aerosol components were analyzed with an Aerodyne quadrupole aerosol mass spectrometer (Q-AMS).

The quantification of different types of organic aerosols (OA) such as primary organic aerosols (POA) and secondary organic aerosols (SOA), or more classes if possible, was identified as an important research activity (Fuzzi et al., 2006) as it is a necessary first step in the development of mitigation strategies.

Positive matrix factorization (PMF; Paatero, 1997) was used for the first time for aerosol mass spectra to identify the main components of the total organic aerosol and their sources. The PMF retrieved factors were compared to measured reference mass spectra from literature and were correlated with tracer species of the aerosol and gas phase measurements from collocated instruments.

Six factors were found to explain virtually all variance in the data and could be assigned either to sources or aerosol components such as oxygenated organic aerosol (OOA). Our analysis suggests that at the measurement site only a small (<10%) fraction of organic PM1 originates from freshly emitted fossil fuel combustion. Other primary sources identified to be of similar or even higher importance are charbroiling (10–15%) and wood burning (~10%).

The fraction of all identified primary sources is considered as primary organic aerosol (POA). This interpretation is supported by calculated ratios of the modelled POA and measured primary pollutants such as elemental carbon (EC), NOx, and CO, which are in good agreement to literature values.

A high fraction (60–69%) of the measured organic aerosol mass is OOA which is interpreted mostly as secondary organic aerosol (SOA). The oxygenated organic aerosol could be separated into a highly aged fraction, OOA I, (40–50%) with low volatility and a mass spectrum similar to fulvic acid (a model compound that describes the chemical functionality of aged, oxygenated aerosol), and a more volatile and probably less processed fraction, OOA II (on average 20%).
