Enhanced approaches to characterise Organic Aerosol in the Po Valley area (Italy)

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In Europe particulate matter is responsible for more than 300.000 deaths each year, particularly in pollution hot spots, like the Po Valley (Northern Italy), where organic aerosol (OA) is one of the dominant components of fine particles.

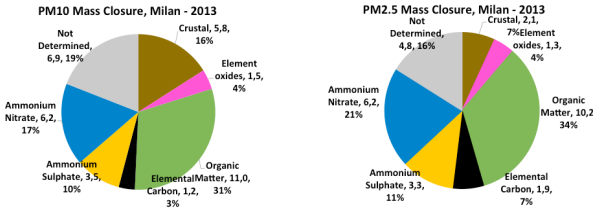

Figure 1. PM_{10} and $PM_{2.5}$ mass closure in Milan ($\mu g/m^3$) for 2013. OA accounts for more than 30% of $PM_{2.5}$.

Although the sources of primary organic aerosol are relatively well constrained, the secondary organic aerosol (SOA) is significantly underestimated by air quality models, due to the poorly understood formation and evolution of SOA in the atmosphere. Recent modelling studies (Pirovano et al., 2015) confirm the clear lack in reproducing the OA fraction also in the Po valley, particularly during the winter season.

The Volatility Basis Set (2D-VBS) model (Donahue et al., 2011) is one the most recent and comprehensive approaches to describe the fate of SOA in the atmosphere. Unfortunately, the implementation of the VBS approach in a full 3D chemistry transport model (CTM) is strongly limited by its computational burden.

The aim of this work is to evaluate the sensitivity of the CAMx model performance with respect to the choice of the SOA mechanism comparing the traditional Odum 2-product model (SOAP, Strader et al., 1999) with the recent VBS1.5 algorithm (Koo et al., 2014). VBS1.5 is a simplified version of the 2D-VBS module, hence more suitable for 3D model applications. CAMx model was implemented over a 5 km resolution domain covering the whole Po valley.

A one-month winter period of 2013 has been selected, based on the availability of carbonaceous aerosol observations in different areas of the basin. OA was characterized at the urban background site of Bologna with a High Resolution -Time of Flight - Aerosol Mass Spectrometer (HR-TOF-AMS). Results of positive matrix factorization (PMF) analysis are reported in Figure 2.

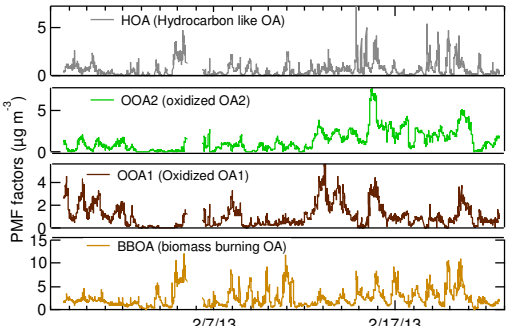

Figure 2. Time series of HOA, BBOA, OOA1 and OOA2 concentrations.

Furthermore, in Lombardy PM measurements in Air Quality Network provide daily chemical speciation dataset in several sites, including: elements (XRF), inorganic ions (IC), carbon compounds (TOT/TOR), PAHs (GC-MS) and different sugars (IC with amperometric detector).

CAMx modelling results have been compared to observed data both in terms of PM bulk mass and chemical composition, with particular reference to the carbonaceous fraction, firstly expressed as total organic aerosol. Then a specific evaluation of the primary and secondary/processed components has been performed. Finally a sensitivity analysis of the CAMx results with respect to the original SOAP algorithm has been performed and discussed.

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