Phenomenology and source apportionment of submicron aerosol particles in a Mediterranean harbour

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Marseille is the second largest city of France and the largest harbour of the Mediterranean Sea. It is a challenging environment for air quality, combining active photochemistry with high ozone concentrations and multiple anthropogenic sources including industrial activities (steel plant, refineries, and various petrochemical industries) and shipping (El Haddad et al. 2011). In order to document, on the long-term, the physico-chemical properties of fine particles, their sources and their evolution from day to multiyear period scales, we implemented an aerosol supersite in an urban background environment: Marseille-Longchamp (MRS-LCP).

In addition to air quality regulatory indicators ($PM_{2.5}$, PM_{10}, NO_x, O_3, SO_2), we installed a ToF-ACSM (Time of Flight -Aerosol Chemical Speciation Monitor) for the analysis of the non-refractory fraction of submicron particles (OA, nitrate, amonium, sulfate) an Aethalometer (AE33) for the analysis of black and brown carbon (BC, BrC), an online metals analyser (Xact) and a SMPS (Scanning Mobility Particle Sizer) for the study of the aerosol size distribution (10-1000 nm).

A real-time dataset collected between February 2017 and August 2018 is presented here. ToF-ACSM OA mass spectra were analyzed by means of Positive Matrix Factorization (PMF) using the multilinear engine (ME-2) approach (Canonaco et al. 2013). This dataset was also used to test a new time-dependent source profiles evaluation to capture the variability of the sources over the year. It was achieved by performing PMF on a rolling window, allowing the algorithm to best adapt to the current data and the capture of seasonal variations for the factor profiles. PMF runs were then analyzed according to a user-defined scheme of criteria. Such approach provides very valuable improvement for long time series dataset.

This analysis revealed very contrasted seasonal OA sources contributions and pointed out the overwhelming importance of local air masses circulation. Biomass Burning Organic Aerosol (BBOA) is the dominant aerosol source during winter (Bozetti et al., 2017), associated with lower boundary layer heights. This source is also mainly advected from inland by nocturnal breezes. In such conditions, the total PM concentration can increase by up a factor of 5 in less than 15 min. During summer the OA mass concentration is dominated by secondary organic aerosol or more precisely oxygenated organic aerosols (OOA) but the most interesting feature regards the submicron particles number concentration and their size distribution. Very intense plumes (Ntot>100 000 cm^{-3}) of ultrafine particles (Dp<100nm) associated with SO_2, metals and direct sulfate emission are observed systematically when sea breezes bring back over the city air masses impacted by industrial and shipping emissions.

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