Real time chemical characterization of fine particulate matter in a Spanish regional background site

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Ambient aerosols have adverse effects on human health, and affect climate, ecosystems, crops, and regional visibility. Fine particulate matter (PM_1, particles with an aerodynamic diameter <1 µm) contains substantial fractions of carbonaceous aerosols and inorganic compounds. Carbonaceous aerosols comprise organic compounds, collectively referred to as organic aerosol (OA), elemental carbon (EC), and carbonates (from mineral dust), although the latter is negligible in submicron aerosol. It is necessary to know the sources of submicron aerosols to design strategies aimed at mitigating their effects. Known sources of carbonaceous aerosols are biomass, biofuel, and waste burning, residential heating, cooking, fossil-fuel combustion (including road traffic emissions), and biogenic emissions.

A forested regional background site located in northeast Spain, 50 km away from Barcelona, was chosen for the present study: Montseny (MSY, 41°46'46"N 02°21'29"E, 720 m a.s.l.). MSY is part of the Aerosols, Clouds, and Trace gases Research InfraStructure (ACTRIS) Network (http://www.actris.net). The Western Mediterranean Basin presents unique atmospheric dynamics regulated by complex climatic and orographic effects which control the concentration, composition and transport of PM. In general, in summertime, local circulation dominates the atmospheric dynamics, favouring the regional accumulation of pollutants and the stratification of polluted air masses. In winter, the inflow of clean Atlantic air masses favours the reduction of pollution levels. However, under anticyclonic conditions, pollution from the coast and valleys is accumulated due to thermal inversions persisting for a few days, and local upslope breezes can bring polluted air masses from the valley towards rural mountainous areas (Pérez et al., 2008).

An Aerosol Chemical Speciation Monitor (ACSM, Aerodyne Research Inc.) was deployed at MSY in June 2012 and sampling is planned to continue for a whole year, according to the ACTRIS schedule, in which a high number of European regional sites will deploy an ACSM for this time period. The ACSM measures non-refractory submicron aerosol distinguishing OA, nitrate, sulphate, ammonium and chloride (Ng et al., 2011). The ACSM was set to measure with a time resolution of approximately 30 min. Mass calibration of the ACSM was carried out regularly by determining the instrument response factor to a known ammonium nitrate calibration aerosol. Moreover, the sulphate response factor was calculated using a known ammonium sulphate calibration aerosol right after an ammonium nitrate calibration, and hence knowing the ammonium response factor. Positive Matrix Factorization (PMF), and complementarily Multilinear Engine (ME2), of the organic mass spectral data matrix will be carried out, providing information on different sources or types of the OA, such as hydrocarbon-like OA (HOA, a surrogate of road traffic emissions), biomass burning OA (BBOA), and oxygenated OA (OOA, a surrogate for secondary OA). A preliminary analysis of the dataset already showed the possibility to identify such sources, and also to distinguish between two separate OOA with different degrees of oxidation.

Additional measurements (complementary to the ACSM dataset) are: a) real time black carbon concentrations, measured by a Multi Angle Absorption Photometer (MAAP) with a PM_{10} inlet, b) 24h PM_1 samples collected on quartz fibre filters using high volume samplers with a PM_1 impactor inlet, c) real time PM_1 concentrations, measured by an optical laser spectrometer (GRIMM 1107) and corrected with the factors obtained by comparison with 'in situ' simultaneous gravimetric measurements. The 24h PM_1 samples are analyzed offline for organic matter, nitrate, sulphate, ammonium and chloride, among other components, which will be compared to the ACSM dataset.

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