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Sources of ambient submicron aerosol in the Barcelona metropolitan area: Applying PMF on AMS mobile and stationary data

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High anthropogenic emissions, low dispersive conditions due to a unique geographical situation, and a dry and warm Mediterranean climate lead to relatively high particulate matter (PM) levels in the metropolitan area of Barcelona (Spain), an urban center in the Western Mediterranean Basin with ∼5 000 000 inhabitants (Pérez et al., 2008).
The 2009 Winter Campaign DAURE (Determination of the sources of atmospheric Aerosols in Urban and Rural Environments in the western Mediterranean, 23-February-2009 to 27-March-2009) focused on the characterization of the sources of fine and coarse aerosols in the Barcelona region, with particular attention to carbonaceous aerosols. Within the framework of DAURE, two Aerodyne high-resolution time-of-flight aerosol mass spectrometers (AMS) (DeCarlo et al., 2006) were deployed simultaneously; one at an urban background site, the other in the PSI mobile van. The fixed site AMS recorded the chemical composition of submicron non-refractory PM with 2.5 minute resolution, while the mobile van was used for on-road measurements and investigations into the spatial variability of aerosol concentration and composition, with a special focus on the processing of primary emissions from the city center when being dispersed with the plume. Additional parameters measured at both the urban background site and on-road include particulate black carbon and number concentration as well as trace gases.
Positive Matrix Factorization (PMF) was applied to the organic fraction (unit mass and high resolution data) of submicron PM as measured by the two AMS in order to investigate components and sources of organic aerosol. Results show that secondary organic aerosol makes up the biggest organic fraction at the urban background site (up to 53% of total organics on average, with 2/3 belonging to the low-volatile and 1/3 to the semi-volatile fraction). Significant contributions from primary traffic sources (up to 28%), biomass burning (up to 13%) and a local primary organic aerosol, most likely cooking emissions (up to 18%) were also found, depending on meteorological conditions. Thermal convection, boundary layer height and the sea breeze/mountain wind system do not only influence the daily pattern of PM compounds, but also the evolution of the city' s plume. Data from mobile measurements show that the further away from the city centre, the more important the contributions from secondary species and the bigger the elemental O/C ratio, a measure for the degree of oxidation of the organic fraction and thus of aging of the air masses. Local concentration peaks in different areas outside the city center can be attributed to primary emissions from traffic, biomass and waste burning, industry or ships.

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