

Investigation of ambient submicron aerosol in the Barcelona metropolitan area using AMS mobile and stationary data

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DAURE campaign, Barcelona

Compared to other European regions, the metropolitan area of Barcelona sees relatively high particulate matter (PM) (Pérez, 2008) due to

- high anthropogenic emissions
- a dry and warm Mediterranean climate
- low dispersive conditions due to a unique topographical situation (see Figure 1).



Figure 1: Geographical and topographical situation of Barcelona, Spain

The 2009 DAURE Winter Campaign (23-February-2009 to 27-March-2009) focused on the characterization of sources of urban and rural fine and coarse aerosols in the Barcelona region, with particular attention to carbonaceous aerosols.

AMS mobile and stationary measurements



Figure 2: Urban background site

Two Aerodyne high-resolution time-of-flight aerosol mass spectrometers (AMS) (DeCarlo, 2006) were deployed together with additional instrumentation, one at the urban background site, one in a mobile van, allowing for on-road measurement measurements and investigations into the spatial variability of aerosol concentration and composition.

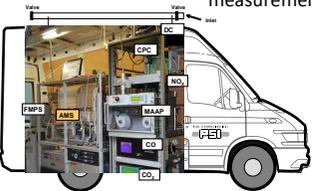


Figure 3: PSI mobile laboratory with CO₂, CO, and NO_x analyzer, Diffusion Charger, Condensation Particle Counter, Fast Mobility Particle Sizer, Multiangle Absorption Photometer and AMS

Results

1 Urban background site: PM₁ chemical composition (AMS and MAAP data)

Time series. The DAURE 2009 campaign covered two periods of anticyclonic conditions (high PM₁ concentrations) and one period with low concentrations (cyclonic condition), see Figure 4.

Organics: Source apportionment based on marker mass fragments. Organic aerosol (OA) makes up the biggest fraction of PM₁ (42%). Contributions to OA from traffic (hydrocarbon-like OA, HOA), biomass burning (BBOA) and secondary production (oxygenated OA, OOA), were estimated using the method described in Weimer, 2009.

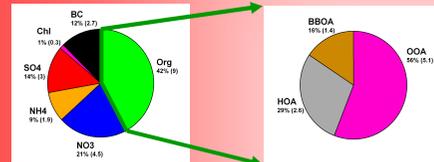


Figure 5: Rel. composition of PM₁ and rel. contributions of HOA, OOA, BBOA to OA, in % (μg m⁻³), avg. whole campaign

Diurnal patterns. Organics, BC, and NO₃ show the most distinct diurnal pattern, with peaks during morning and evening rush hours. The similar trends of HOA and Organics on the right panel in Figure 6 indicate a significant influence of traffic on the diurnal evolution of organics. The small peak at ~14:30 can be explained by the sea breeze coming in after noon and advecting higher pollutant concentrations from the city centre to the station.

2 Mobile measurements: Spatial distribution of source contributions

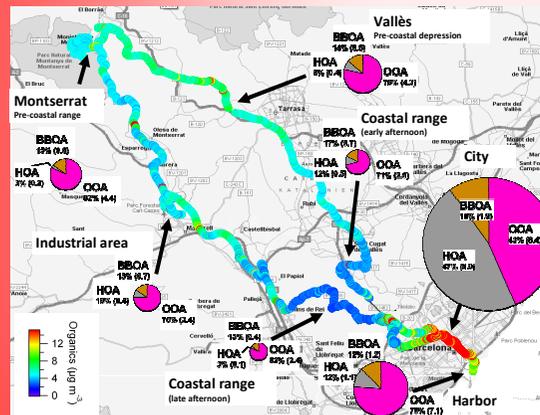


Figure 7: Afternoon drive outside Barcelona city. Route colored by organics. The size of pie charts is relative to total organic mass

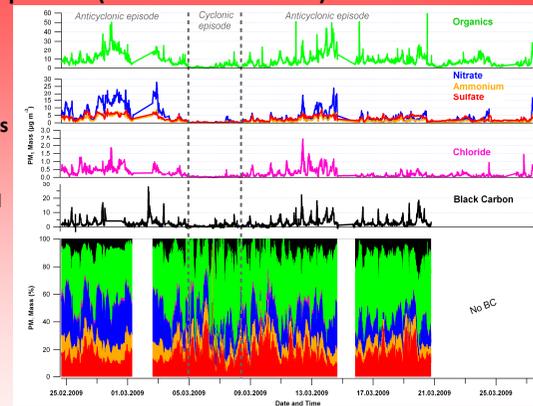


Figure 4: Time series of mass concentrations

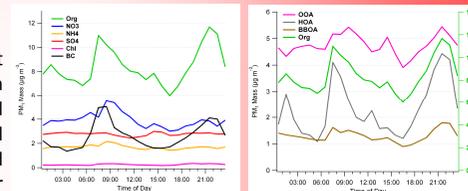


Figure 6: Diurnal patterns of PM₁ chemical species, avg. whole campaign

Summary & Conclusions

- Topography (enclosing coastal ranges), climate (Mediterranean), and high anthropogenic emissions (dense traffic, highly industrialized areas) lead to high PM levels in the city of Barcelona.
- Organic matter makes up the biggest fraction of PM₁.
- Diurnal patterns of PM₁ species are influenced by traffic and wind regime.
- The most important sources of submicron organic aerosol are secondary production from volatile organic precursor compounds, traffic, and biomass burning.
- Mobile measurements show the spatial variation of source contributions to primary organics: Traffic emissions are most important downtown Barcelona; biomass burning has a significant impact in the agricultural/industrial region of Vallès/Montserrat.

Outlook – let me get back to you

- Analysis of AMS high-resolution data
- Calculation of sources applying Positive Matrix Factorization (PMF) on mobile and stationary data (unit-mass and high resolution)
- Analysis of gas phase data
- Mobile measurements: Investigation of further aerosol sources (industry, harbor, downtown Barcelona) and their spatial and temporal evolution

References

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- DeCarlo, P., et al. (2006). *Anal. Chem.*, 78, 8281-8289
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