Identification of main sources of $PM_{2.5}$ during winter at a suburban site in Douai, Northern France

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The French Nord-Pas de Calais region is known to present high concentrations of atmospheric pollutants. Among them fine particulate matter ($PM_{2.5}$) is responsible for exceedances which occur mainly during cold periods and are often linked with increases of secondary inorganic aerosol (SIA) concentrations in the fine fraction, as has been described in more detail in a companion abstract.

In North-Western Europe, specifically, semi-volatile ammonium nitrate may reach up to 27% of the $PM_{2.5}$ mass, with a higher contribution in winter when condensation processes are favored by cold temperatures (Putaud *et al.,* 2004).

SIA is not only formed at the local scale, but it can also be transported over long distances. Therefore, efforts should be aimed at better understanding the contributing sources during winter in order to implement efficient policies to reduce the levels of $PM_{2.5}$ and hence improve air quality.

A long-term field campaign (>1 year, starting Feb. 2015) has been carried out at a suburban site in Douai, France, with a MARGA 1S (Monitor for AeRosols and GAses in ambient air) (ten Brink *et al.,* 2007) to measure the concentrations of 8 water-soluble inorganic ions (NO_3^-, SO_4^{2-}, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-) and 5 precursor gases (NH_3, SO_2, HONO, HNO_3 and HCl) with a 1-hour time resolution. A 2-wavelength (370 and 880 nm) Aethalometer was used for the analysis of UV-absorbing aromatic compounds and black carbon, respectively, with a time resolution of 5 minutes. The $PM_{2.5}$ total mass has been measured by a Beta Attenuation Monitor (BAM-1020) every hour. NO_x have been monitored every 15 minutes with a NOx 2000G monitor. Meteorological parameters (T, RH, P, wind speed and direction, precipitation) were also monitored on site.

Additional instruments have been set up during an intensive campaign from January to March 2016. In particular, complementary information on the chemical composition and size-distribution of non-refractory PM_1 aerosol, including NO_3^-, SO_4^{2-}, NH_4^+, Cl^- and organics is obtained by a HR-ToF-AMS (High resolution-Time of flight-Aerosol Mass Spectrometer) operated at a 5-min time step (DeCarlo *et al.,* 2006). A SMPS (Scanning Mobility Particle Sizer) determines the particle size distribution from 11.1-1083.3 nm with a time resolution of 5 minutes.

First, time profiles of the particulate species obtained both with the MARGA (in the $PM_{2.5}$ size fraction) and with the HR-ToF-AMS (in PM_1) have been compared, in order to assess the comparability of the datasets and the performance of both instruments.

Then, source apportionment has been applied using SoFi (Source Finder) ME-2 (Multilinear Engine) (Canonaco *et al.,* 2013) on both data sets and further investigation is ongoing on a combined database, in order to account for the different pollution sources and their contributions. This has been complemented with the analysis of pollution roses and air mass back-trajectories to distinguish between local and long-distance sources.

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