Characterization of secondary inorganic aerosol and their precursor gases at a suburban site in Northern France

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Fine particulate matter with diameter smaller than 2.5 µm ($PM_{2.5}$) poses human health and environmental concerns. In Europe, its concentration in ambient air is regulated by the 2008/50/EC Directive, which sets a limit value of 25 µg/m^3 starting Jan. 1st 2015.

This limit is frequently exceeded in the French Nord-Pas de Calais region. Main reasons accounting for it are its location amidst an extensive road network, urban density, and the proximity to European capitals (London, Paris, Brussels) as well as significant industrial areas.

A large contributor to $PM_{2.5}$ is secondary inorganic aerosol (SIA), which may account for more than half of its mass in Europe. In particular, in North-Western Europe, ammonium nitrate may reach 27% of the $PM_{2.5}$ mass (Putaud et al. 2004). Despite such importance, there is a current lack of high-time resolution data on the chemical composition of $PM_{2.5}$ in northern France.

Consequently, improvement on the knowledge of SIA concentrations and their formation processes from precursor gases appears as a cornerstone in order to implement efficient policies to reduce the levels of $PM_{2.5}$ in the region and thus improve air quality.

In this context, a long-term field campaign aimed at characterizing secondary inorganic aerosol and their precursor gases at a suburban site in Douai, France, started in Feb. 2015.

Concentrations of 8 water-soluble inorganic ions (WSII) (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) have been determined every hour with a MARGA 1S (Monitor for AeRosols and GAses in ambient air) (ten Brink *et al* 2007). A 2-wavelength Aethalometer at 370 nm and 880 nm was used for the analysis of UV-absorbing aromatic compounds and near-infra-red absorbing compounds (black carbon), respectively, with a time resolution of 5 minutes. NO_x and SO_2 have been monitored every 15 minutes with a NOx 2000G monitor and AF22M SO_2 monitor, respectively. The $PM_{2.5}$ total mass has been measured by a Beta Attenuation Monitor (BAM-1020) every hour. Heavy metals have been sampled on Teflon filters on a daily basis using a PARTISOL 2300 air sampler. Meteorological parameters such as temperature, relative humidity, pressure, wind speed and direction and precipitation were also monitored on site.

The annual average mass contribution of WSII to $PM_{2.5}$ has been of 56.6 %. Monthly averages for all the WSII measured by the MARGA are shown in Figure 1, with NO_3^- being the predominant ion, followed by SO_4^{2-} and NH_4^+. The daily and seasonal variability for each inorganic ion and precursor gas will be presented. We will as well show the gas-particle equilibrium of the semi-volatile species, which in the case of ammonium nitrate has been compared with that calculated by the thermodynamical model ISORROPIA II (Fountoukis and Nenes 2007). Pollution roses used to derive local sources will also be discussed, as well as the ion balance and the oxidation ratios.

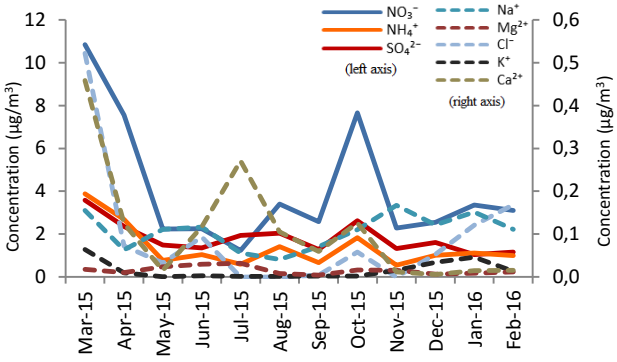

Figure 1. Monthly averages (March 2015 – February 2016) of water-soluble inorganic ions measured at a suburban site in Douai, France

This study is the first one in France to conduct such a measurement campaign with a MARGA, delivering a long-term hourly database on inorganic aerosols and their precursor gases. Hence, it has contributed to improve the knowledge of SIA, and has proven the valuable use of MARGA for air quality monitoring.

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