Contribution of combustion sources to Black Carbon in Milan (Italy)

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Black carbon (BC) is an ubiquitous component of particulate matter produced from combustion processes. Toxicological, controlled human exposure, and epidemiological studies show a causal relationship between health effects and short and long-term exposure to fine particulate matter. A limited number of epidemiological studies reports a correlation between BC exposure and health outcome (Janssen et al., 2011). The World Health Organization concluded that BC is a valuable indicator of particulate matter health thread as it likely acts as a carrier of toxic species that trigger the health response (REVIHAAP report, 2013). In addition, BC is a short lived climate species and it affects climate through direct and indirect effects (IPPC report, 2013). The quantification of BC sources in urban environment is mandatory for the implementation of effective policy measures. Existing BC emission inventories are still characterized by uncertainty, especially related to the contribution of wood combustion for residential heating.

In February 2014, BC was measured on-line at high time resolution with a home-made instrument based on Laser Induced Incandescence (LII) technique (Migliorini et al., 2013) during four days. Measurements were performed at an urban background site in Milan, where nitrogen oxides, ozone, sulfur dioxide, BTX, are continuously detected. Black carbon was also measured by multi-angle absorption photometer (MAAP), which is widely used for this kind of analysis. Being BC collected on a filter and optically measured, the optical properties of particles and the particle/filter interaction strongly affect the concentration. LII measurements are based on laser absorption by the particle. However, the use of high laser energy density ensures to derive BC concentration independently from the optical properties of the particles under analysis. During the experiment, non-refractory chemical components of submicron aerosol particles (sulfate, nitrate, ammonium, chloride, and organics) were measured with a High Resolution – Time of flight – Aerosol Mass Spectrometer (HR-TOF-AMS).

Multilinear Engine (ME2) algorithm (Paatero, 1999; Canonaco et al., 2013) was applied to quantify the amount of primary organic aerosol, i.e. biomass burning organic aerosol (BBOA), hydrocarbon like organic aerosol (HOA, mainly traffic), and cooking organic aerosol (COA).

Time trends of BC measured by LII instrument and by MAAP are reported in figure 1. The highest concentrations were observed during morning and evening hours in correspondence with traffic rush hours. Similar daily trends were also observed for the HOA and NO_x, indicating that traffic was the main common source of these species. The concentration of BC associated to traffic and residential heating were estimated using a linear combination model and using as input the measured OA factors.

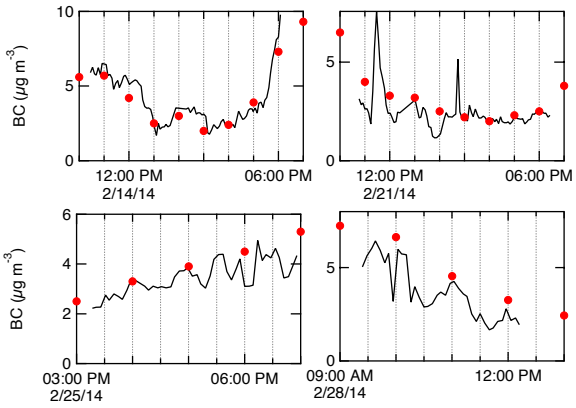

Figure 1. BC concentration measured by the LII instrument (black line) and by a MAAP (red circles).

The results, especially concerning the ratios of BC to tracers of combustion processes, will be discussed in regards of regional emission inventories.

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