Effect of the extensive use of fireplaces on carbonaceous particle concentration levels in Athens, Greece

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The main factors contributing to reported exceedances of the particulate matter (PM) air quality limit values, in Athens are the high urbanization of the city, mostly reflected by intense traffic, along with meteorological conditions that favour the accumulation of the emitted pollutants. During the last two years, the financial crisis has greatly affected every aspect of the country's economic and other activity, including significant changes in the emission strength of certain sources. Instead of diesel fuel oil, which was traditionally used for residential heating, massive use of fireplaces or wood stoves became a regularphenomenon across the city. The objective of the present work was to investigate the long term effect of this intense biomass burning activity on the concentrations of PM and in particular its carbonaceous constituents.

The results presented correspond to winter measurements (November – January) collected during 2010 – 2013 at Demokritos urban background station (GAW-DEM, 2007). 24-hr $PM_{2.5}$ concentrations were measured gravimetrically, while elemental (EC) and organic (OC) carbon concentrations were monitored on a 3-hr basis by Semi-Continuous OCEC Field Instrument (Sunset Laboratory Inc.).

During January 10 – February 10, 2013 an intensive campaign was conducted, targeted specifically on the effects of biomass burning. $PM_{2.5}$ and $PM_{2.5\text{-}10}$ concentrations were measured gravimetrically by means of a low volume custom-made two stage impactor. Two samples were collected daily starting at 8:00 am and 6:00 pm, in order to characterize separately the day-time and night-time periods. In addition, 6-hr PM_{10} samples were collected on quartz filters, to be analyzed for OC and EC (Lab OC-EC Aerosol Analyzer, Sunset Laboratory, Inc.).

Initial results clearly demonstrated an increase in $PM_{2.5}$ and organic carbon concentrations during the present and last winter, in comparison to 2010-11 (Figure 1). The largest difference corresponded to the contribution of OC to $PM_{2.5}$ mass, which has more than doubled during the last two winter seasons (mean OC-to-$PM_{2.5}$ concentration ratios for the three consecutive periods: 0.21, 0.55 and 0.47). This effect was more pronounced in 2011-12 when temperatures were generally lower than the following year. January 2013 was rather mild (mean value around 10°C), with frequent south winds and a number of Sahara dust transport events. On the other hand, the drop of temperature was followed by a sharp increase in OC levels, especially during the night, clearly indicating the use of fireplaces (Figure 2).

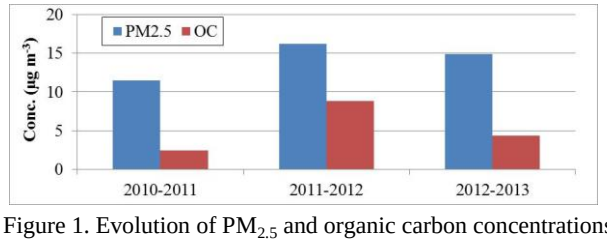

Figure 1. Evolution of $PM_{2.5}$ and organic carbon concentrations during wintertime of 2010 - 2013.

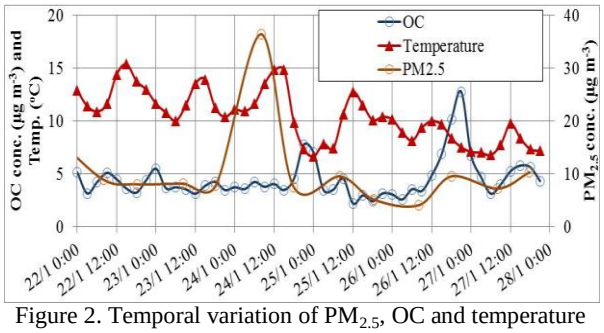

Figure 2. Temporal variation of $PM_{2.5}$, OC and temperature during 22 – 27/1/2013.

Elemental carbon concentrations were similar during 2010/11 and 2012/13(0.72 μg m^{-3} and 0.68 μg m^{-3} on average, respectively) and much higher during 2011/12 (2.53 μg m^{-3}). These results reflect changes in anthropogenic activities caused by the financial crisis of the two last years. In the previous years the main source of EC in the area was vehicular traffic. During winter of 2011/12 biomass burning emissions were added to traffic causing a great increase in concentration levels. During winter 2012/13 lower traffic densities were observed, while the change in source contributions is highlighted by the EC/OC concentrations ratio which has decreased from a value of 0.30 to 0.15, indicative of biomass burning aerosol (Schmidl et al., 2008).

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