Urban background aerosol monitoring (Athens center) with emphasis on biomass burning processes during winter-time and implications on air quality

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Since the advent of economic recession in Greece in 2008, air quality improved significantly due to the limitation of anthropogenic activities, such as vehicles use and industrial production (Vrekoussis et al. 2013). However, since 2012-13 several smog events were encountered in the Great Athens Area (GAA) as a result of extensive wood burning use in domestic heating systems due to increased heating oil price. The turn into more traditional burning materials for heating purposes resulted in enhanced levels of atmospheric particulate and gaseous species, highlighting the importance and need for specialized pollution monitoring in Athens.

Here we present results from multi-year measurements (December 2013 to February 2016) conducted at the Thissio sampling site in the centre of Athens (National Observatory of Athens, 37.97 N, 23.72 E, 110 m). Three winter-time intensive campaigns, of approximately three months each, took place, whereas the rest of the period (March to November) was considered as background or biomass burning limited period. The study focuses on the investigation of the particulate pollution and the determination of the factors controlling their level and emissions throughout the year. Sources apportionment was performed and emphasis is given on the key role of biomass burning processes during winter and their impact on Athens' air quality.

The major PM measurement techniques are presented in Table 1. The composition of $PM_{2.5}$ quartz filter samples, concerning ions, carbonaceous compounds and biomass burning tracers was determined. Meteorological data and data of gaseous compounds (CO, NO_x) were also available. In addition, auxiliary on-line measurements were conducted during the winter campaigns, using a PILS-IC and ACSM for cations and organics, respectively.

Table 1. Overview of the main measurement techniques

Species	Technique
BC, BC_{ff}, BC_{wb}	7-λ Portable Aethalometer
BC	Multiangle Absorption Photometer
PM_{10}	Beta-attenuation monitor
$PM_{2.5}$, $PM_{2.5-10}$, PM_{10}	Quartz filter sampling & chemical analyses

A clear seasonal variability for PM, BC and EC (Figure 1) was observed with summer-time minima and enhanced levels during winter. Under favourable conditions smog events were frequently observed during the three winter time campaigns accompanied by PM_{10} 24 hour limit exceedances and increase in CO and BC concentration due to accumulation of chemicals within the usually night shallow mixing layer (200-400 m).

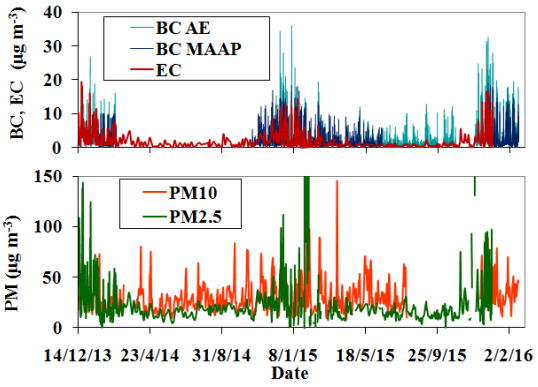

Figure 1. Temporal variability of $PM_{2.5}$, PM_{10}, BC and EC over the period December 2013 - February 2016.

Compounds related to wood burning, verified by multi-tracer correlations, exhibited significant night-time maxima. During the traffic rush hours enhancement of pollutants from fossil fuel combustion processes was also observed. An average contribution of BC up to 10% on PM_{10} mass concentration was estimated. Source apportionment measurements indicated that approximately 40% of the measured BC was due to biomass burning BC_{bb} and the remaining 60% was due to both traffic and oil combustion for heating (BC_{ff}).

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Vrekoussis M, Richter A, Hilboll Al, Burrows JP, Gerasopoulos E, Lelieveld J, Barrie L, Zerefos C. and Mihalopoulos N. (2013) *Geophys Res Lett* 40:458-463.