The contribution of wood burning and other sources to wintertime organic aerosol levels in two Greek cities

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Keywords: PM_1, organic aerosol, AMS, biomass burning, SOA, PMF analysis.
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Secondary organic aerosol (SOA) constitutes a major fraction, up to 90%, of ambient aerosol (Kanakidou et al., 2005) and is formed by a variety of gas-, particulate- and aqueous-phase processes. It has been traditionally assumed that most of the SOA is formed during daytime through reactions of volatile, intermediate volatility and semi-volatile organic compounds. While there are indications of nighttime formation and processing of SOA, the corresponding processes and their importance are in general not well understood. For example, Bougiatioti et al. (2014) provided evidence of nighttime chemical processing of biomass burning organic aerosol (BBOA) and its partial conversion to oxidized organic aerosol (OOA) in a day or so during summertime in the Eastern Mediterranean. The high BBOA emissions during wintertime in Greece during recent years provide an opportunity to study both the fresh BBOA properties but also its chemical aging in an environment that is still quite photochemically active during the day.

Local and regional air pollution sources were characterized in two major Greek cities (Athens and Patras) during two wintertime campaigns. In Patras, the measurements took place from February 26 to March 5, 2012, in the premises of the campus of the Technological Educational Institute (TEI). A more extensive campaign was conducted a year later in the center of Athens from January 10 till February 9, 2013, at the National Observatory premises. The instrumentation used in both campaigns included a High Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS), and other aerosol size distribution and concentration instruments (APS, SMPS, TEOM, MAAP) were also deployed. During the campaign in Athens, additional instrumentation was used, such as a Proton Transfer Reaction Mass Spectrometer (PTR-MS), a thermodenuder system, and gas-phase monitors (CO, CO_2, NO_x and O_3). Positive matrix factorization (PMF) analysis (Paatero and Tapper, 1994) of AMS measurements was used to investigate the origins and the possible sources of organic aerosol (OA).

In both cities, PM_1 consisted of mainly organics (60-75%), black carbon (5-20%) and inorganic salts (around 20%). More than half (50-60%) of the OA in both cities was due to biomass burning (BBOA), while the remaining organics originated from traffic (HOA) (12-17%), meat cooking (COA) (11-16%) and long-distance transport (OOA) (18-25%). In both cities, the contribution of residential wood burning was even higher (80-90%) during the nighttime peak concentration periods.

Further PMF analysis, suggested that the BBOA component probably consisted of two BBOA factors. The AMS mass spectrum of the first one (BBOA-I) showed a prominent contribution of characteristic BBOA mass fragments, such as *m/z* 60 ($C_2H_4O_2^+$) and 73 ($C_3H_5O_2^+$). The AMS spectrum of the second one (BBOA-II) was characterized by lower signal in *m/z*'s attributed to fresh OA, like *m/z* 43, 55 and 57, and a stronger peak at *m/z* 44, which is related to aged organic aerosol. Furthermore, *m/z* 60 was also lower, implying the reaction of levoglucosan. BBOA-I and BBOA-II displayed distinct diurnal variation and poor correlation to each other ($R^2 \approx 0.2$).

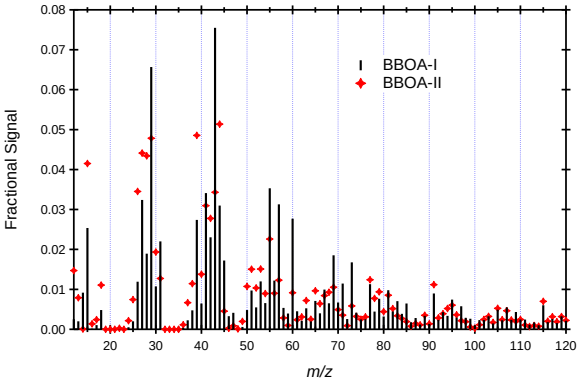

Figure 1: The spectra of the two BBOA factors in Patras.

This research was supported by the European Research Council Project ATMOPACS (Grant Agreement 267099), the ESF-NRSF ARISTEIA grant ROMANDE and the Greek/European Union operational program THALES.

Bougiatioti, A., Stavroulas, I., Kostenidou, E., Zarmpas, P., Theodosi, C., Kouvarakis, G., Canonaco, F., Prévôt, A. S. H., Nenes, A., Pandis, S. N., and Mihalopoulos, N. (2014). *Processing of biomass-burning aerosol in the eastern Mediterranean during summertime, Atmos. Chem. Phys.*, 14, 4793-4807.

Kanakidou, M., Seinfeld, J. H., Pandis, S. N., Barnes, I., Dentener, F. J., Facchini, M. C., Van Dingenen, R., Ervens, B., Nenes, a., Nielsen, C. J., Swietlicki, E., Putaud, J. P., Balkanski, Y., Fuzzi, S., Horth, J., Moortgat, G. K., Winterhalter, R., Myhre, C. E. L., Tsigaridis, K., Vignati, E., Stephanou, E. G., and Wilson, J. (2005). *Organic aerosol and global climate modeling: a review, Atmos. Chem. Phys.*, 5, 1053–1123.

Paatero, P. and Tapper, U. (1994). *Positive matrix factorization: A non- negative factor model with optimal utilization of error estimates of data values. Environmetrics*, 5, 111–126.