AIRUSE-LIFE+: Contribution of biomass burning to ambient PM2.5 in 5 Southern European cities.

V. Gianelle[1], C. Colombi[1], E. Cuccia[1], U. Dal Santo[1], C.A. Alves[2], C. Pio[2], D. Custódio[2], F. Lucarelli[3], G. Calzolai[3], S. Nava[3], K. Eleftheriadis[4], L. Diapouli[4], F. Amato[5], A. Karanasiou[5] and X. Querol[5]

[1]Regional Centre for Air Quality Monitoring, ARPA Lombardia, Via Juvara 22, 20122 Milan, Italy
[2]Centre for Environmental & Marine Studies, Dep. of Environment, Univ. of Aveiro, 3810-193 Aveiro, Portugal
[3]Dep. of Physics and Astronomy, Università di Firenze and INFN-Firenze, Sesto Fiorentino, 50019, Italy,
[4]Environmental Radioactivity Laboratory, N.C.S.R. Demokritos Univ., 15341 Ag. Paraskevi, Attiki, Greece
[5]Institute of Environmental Assessment and Water Research, Spanish Research Council, 08034 Barcelona, Spain
Keywords: PM, source apportionment, biomass burning, levoglucosan, Southern Europe, OC/EC.
Presenting author email: v.gianelle@arpalombardia.it

The AIRUSE-LIFE+ project aims at characterising similarities and heterogeneities in PM sources and contributions in urban areas from Southern EU. This work is focused on comparing the biomass burning contribution as results of the source apportionment of PM2.5 conducted at 3 urban background sites (Barcelona, BCN; Florence, FI; Milano, MLN) a sub-urban background site (Athens, ATH) and a traffic site (Porto, POR). On each dataset USA-EPA PMF5 was applied following the same protocol. PMF identified biomass burning (BB) as a source only at four of the five cities, with the exception of BCN. The impact of BB is especially high in the winter months, due to the generalised use of wood for residential heating (Gonçalves et al., 2012). The contribution of BB to PM in POR was also high in September. Several wildfires were registered in the Porto district in this particularly hot and dry month. In MLN the specific stagnant and reduced boundary layer depths induced by the typical meteorology of the Po Valley also enhance BB contributions during winter months. Due to the short period of wood burning for residential heating the annual average relative contribution of this source is very low in ATH.

Levoglucosan is the main tracer of biomass burning source. Although levoglucosan has been detected in some samples from BCN, biomass burning could not be assigned as a significant contributor to PM for this city. Levoglucosan represents 4-8% of PM mass emitted by biomass burning; OC and EC are the major components in the BB profile (12-65% and 4-14%, respectively). In spite of these quite large ranges (which can be due to the rotational ambiguity of PMF), the OC/EC ratio can be used as a more robust diagnostic of BB composition. The OC/EC ratio in BB aerosols varies from 2.6 (ATH), 2.9 (POR), 4.6 (MLN) to 6.1 (FI) which may be explained by a higher proportion of secondary organic aerosols in MLN and FI. Also potassium traces BB aerosols, representing 2-4% of the mass. Other components can be observed, such as Cl, S, and more sporadically Zn, Pb, NH_4^+ and NO_3^-.

BB contributions reproduce quite well the gradients found for levoglucosan among the AIRUSE cities. An annual mean of 1.4 μg/m^3 (11%) is estimated in ATH, 3.0 μg/m^3 (21%) in FI, 4.4 μg/m^3 (17%) in POR, up to 5.3 μg/m^3 (18% of PM2.5) in MLN. Therefore, this reveals quite contrasting impact of BB emissions across the Mediterranean depending on the type of fuel and combustion device used in each region for residential heating. Differently from other cities, Barcelona is well equipped with natural gas for residential heating; Florence is also well equipped with natural gas but the neighborhoods on the hill are often provided with chimneys. Even in Milan the use of natural gas for heating is very extensive, however, also due to the current economic crisis, many citizens are equipped with small pellet stoves. In ATH the BB source is also associated to tracers of waste combustion, such as As, Cd, Sb and Pb, with explained variance ranging between 12% and 72% as citizens of Athens have turned to alternative heating fuels, such as wood due to the economic crisis and the increased prices of diesel oil, which was the most common way of residential heating in Greece. In many cases, treated wood or even combustible wastes are now used as fuel.

Another factor identified by PMF was secondary nitrate (SNI). Although in urban environments nitrate mainly arises from NOx from traffic, a substantial fraction can also derive from biomass burning emissions. Therefore for each city, the corresponding share of NOx due to biomass burning can be applied also to SNI. Based on this approach, percentages of 16 and 13 were adopted in POR and MLN, respectively, to account for SNI from biomass burning. In FI, on the basis of the emission inventory, about 10% of NOx emissions are due to domestic heating, with only a part attributable to stoves and chimneys (2%). Thus, the total contribution from BB in FI can be appraised as the sum BB + 0.02*SNI, which results 2.9 μg/m^3 in PM2.5 (21%). In POR, the total contribution from BB was estimated to be 4.7 μg/m^3 (18% of PM2.5). In MLN, the total contribution from BB represented 6.4 μg/m^3 in PM2.5 (21%).

This work was funded by the European Commission thought the AIRUSE (LIFE11 ENV/ES/000584) project.

Gonçalves C., Alves C., Evtyugina M., Mirante F., Pio C., Caseiro A., Schmidl C., Bauer H., Carvalho F., 2010. *Characterisation of PM10 emissions from wood stove combustion of common woods grown in Portugal.* Atmospheric Environment 44, 4474-4480.