AIRUSE LIFE+: Natural contributions to urban PM in Southern Europe and strategies to minimise human exposure

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The AIRUSE-LIFE+ project aims at identifying the major sources of airborne particulate matter (PM) in urban areas of Southern Europe (SE) in order to assist towards the development of effective control measures, adapted to the specific climatic, environmental and emission conditions of the area. Air quality in Southern Europe has been known to be significantly affected by natural sources. This work focuses on two prominent natural sources of particulate matter, the long range transport of Saharan dust and sea spray. Contribution of these sources to PM_{10} and $PM_{2.5}$ concentrations for five SE cities is assessed and relevant mitigation strategies are proposed for the protection of public health.

PM_{10} and $PM_{2.5}$ measurements and detailed chemical characterisation have been conducted from January 2013 to February 2014 at three urban background sites (Barcelona, Florence and Milano, BCN-UB, FI-UB, MIL-UB), a sub-urban background site (Athens, ATH-SUB) and a traffic site (Porto, POR-TR). The contribution of natural sources was determined through the chemical speciation data, as well as source apportionment modelling (USA-EPA PMF5). Additional tools used included meteorological data, air mass back trajectory analysis and forecast models for Saharan dust long range transport, in order to confirm the areas of origin of naturally emitted aerosol.

Sea salt was identified as a separate source at all cities by source apportionment modelling, either in fresh and/or aged form, depending on the geography of each site. Aged sea salt chemical profile contained NO_3^- and was depleted in Cl, due to the interaction of NaCl with anthropogenic HNO_3, leading to the formation of gaseous HCl and particulate $NaNO_3$. Sea salt was also calculated through the chemical speciation data using typical sea water composition ratios for Mg/Na, K/Na, Ca/Na and SO_4^{2-}/Na. The largest sea salt contribution was found at Porto on the Atlantic coast (13% contribution to PM_{10}), followed by the Mediterranean coastal sites (6% for Barcelona and 7% for Athens), while the inland Italian cities presented the lowest contributions (3% for Florence). As expected, sea salt was found mainly in the coarse mode (Figure 1).

Saharan dust was identified as a separate source by PMF only for FI-UB data. The obtained chemical profile presented a composition very similar to earth crust. For the remaining sites, Saharan dust contribution was separated from the local dust contribution by considering Saharan dust long-range transport forecasts and applying the methodology for net dust calculation (Escudero et al., 2007). Contribution of African dust was larger in the Eastern Mediterranean (Figure 1). African dust outbreaks contributed to PM_{10} concentration on an annual basis by 14% at ATH-SUB, 4% at FI-UB and around 1% at the remaining sites. These contributions were reduced to <1% for days exceeding the PM_{10} daily limit value, except for ATH-SUB were African dust outbreaks contributed by 52% to PM_{10} levels (38 μg m^{-3}) and caused the majority of daily exceedances.

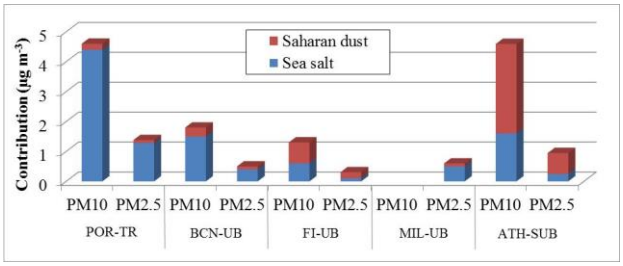

Figure 1.Contribution of sea salt and Saharan dust to PM_{10} and $PM_{2.5}$ concentration at each city.

The results demonstrated that natural sources' contribution to PM_{10} concentration levels is not negligible and may lead to exceedances of the EU daily limit value. Mitigation measures can only be focused on minimizing the effects of this type of pollution, since the sources themselves cannot be controlled. Control strategies should relate to (i) measures to reduce the potential of dust particles deposited, on the streets and other surfaces, to resuspend and (ii) measures to protect human health, through emergency action plans for the days when extreme dust events are forecasted.

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Escudero, M., Querol, X., Pey, J., Alastuey, A., Pérez, N., et al. (2007) *Atmos. Environ.* **41**, 5516–5524.