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Urban aerosol in Oporto, Portugal: Chemical characterization of PM10 and PM2.5

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Several urban and industrial areas in Southern Europe are not capable of meeting the implemented EU standards for particulate matter. Efficient air quality management is required in order to ensure that the legal limits are not exceeded and that the consequences of poor air quality are controlled and minimized.
Many aspects of the direct and indirect effects of suspended particulate matter on climate and public health are not well understood. The temporal variation of the chemical composition is still demanded, since it enables to adopt off-set strategies and to better estimate the magnitude of anthropogenic forcing on climate.

This study aims to provide detailed information on concentrations and chemical composition of aerosol from Oporto city, an urban center in Southern Europe. This city is located near the coast line in the North of Portugal, being the country's second largest urban area. Moreover, Oporto city economic prospects depend heavily on a diversified industrial park, which contribute to air quality degradation. Another strong source of air pollution is traffic.

The main objectives of this study are: 1) to characterize the chemical composition of PM10 and PM2.5 by setting up an orchestra of aerosol sampling devices in a strategic place in Oporto; 2) to identify the sources of particles exploring parameters such as organic and inorganic markers (e.g. sugars as tracers for biomass burning; metals and elemental carbon for industrial and vehicular emissions); 3) to evaluate long range transport of pollutants using back trajectory analysis.

Here we present data obtained between January 2013 and January 2014 in a heavy traffic roadside sampling site located in the city center. Different PM10 and PM2.5 samplers were operated simultaneously in order to collect enough mass on different filter matrixes and to fulfill the requirements of analytical methodologies. More than 100 aerosol samples were collected and then analysed for their mass concentration and chemical composition of water soluble ions, carbon species (carbonates, organic carbon, elemental carbon and sugars) and metals.

High concentrations, up to more than 80 μg.m-3 for PM2.5 and up to 90 μg.m-3 for PM10, during summer, were associated with wildfires. Peak concentrations of biomass burning tracers, such as potassium ion (1.2 μgm-3) and levoglucosan (1 μgm-3), were registered in this period as well as high organic carbon/elemental carbon ratios. High PM10 concentrations, of about 70 μg.m-3, were also recorded in winter under dry weather conditions. A significant increase of levoglucosan concentrations, reaching 3.5 μg.m-3, were observed during this season. This phenomenon was associated with emissions from residential biomass burning for heating purposes. Moreover, it is possible to highlight the increase of formic and oxalic acid concentrations (up to 250 ng.m-3 and 600 ng.m-3, respectively) during dry days, indicating aerosol aging in the urban atmosphere before they were blown away. It was possible also to express the contribution of sea salt in Porto aerosol.
Analyses of organic and elemental carbon, as well as elements, allowed drawing a picture on sources of air pollution, either of regional/local origin (industry, traffic, biomass burning) or resulting from long range transport. In what concerns anthropogenic pollutants, it is important to emphasize the high concentrations of elemental carbon, Zn, Cu, Pb, Ba, Sn, Mn, V, Zr, Cr, and Sb. Zn, generally pointed out as a tracer of brake and tire wear, was found to be the most abundant metal in PM2.5 and PM10 samples.

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