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Source apportionment of atmospheric particulate matter (PM) using a constrained US-EPA-PMF5.0 model at different urban environments in France

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Particulate matter (PM) is one of the most studied atmospheric pollutant in urban areas due to their adverse effects on human health (Pope et al., 2009). Intrinsic properties of PM (e.g. chemical composition and morphology) are directly linked to their origins. Therefore, a harmonized and comprehensive apportionment study of PM sources in urban environments is extremely required to connect source contributions with PM concentration levels and then develop effective PM abatement strategies.

Multivariate receptor models such as Positive Matrix Factorization (PMF) are very useful and have been used worldwide for PM source apportionment (Viana et al., 2008). PMF uses a weighted least-squares fit and quantitatively determines source fingerprints (factors) and their contributions to the total PM mass. However, in many cases, it could be tricky to separate two factors that co-vary due to similar seasonal variations, making unclear the physical sense of the extracted factors. To address such issues of source collinearities, additional specific constraints are incorporated into the model (i.e. constrained PMF) based on user's external knowledge allowing better apportionment results.

In this work and within the framework of the SOURCES project, a harmonized source apportionment approach has been implemented and applied for the determination of PM sources on a large number of sites (up to 20) of different typologies (e.g. urban background, industrial, traffic, rural and/or alpine sites) distributed all over France and previously investigated with annual or multiannual studies (2012-2016). A constrained PMF approach (using US-EPA PMF5.0 software) was applied to the comprehensive PM-offline chemical datasets (i.e. carbonaceous fraction, major ions, metals/trace elements, specific organic markers) in a harmonized way for all the investigated sites. Different types of specific chemical constraints from well-characterized sources were defined based on external knowledge and were imposed to some species in the PMF factor profiles. As an example, the contributions of the levoglucosan, a specific tracer of the biomass burning emissions, were pulled up maximally in the biomass burning factor profiles and were set to zero in all other resolved factors (e.g. vehicular emissions, biogenic emissions, etc,...). The different source categories contributing to ambient PM concentration levels were chemically characterized and quantified. Chemical profiles of the resolved common sources have been exploited and compared allowing us to get extra knowledge on the spatial variabilities of the source compositions.

The presentation will address the main points achieved with this program.

Pope, I. C., et al. (2009), New England Journal of Medicine, 360(4), 376-386.
Viana, M., et al. (2008), Journal of Aerosol Science, 39(10), 827-849.

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