The Contribution of Local and Regional Sources to Particulate Matter in European Megacities

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The ongoing urbanization over the past decade has led to an increasing number of Megacities around the world, now hosting more than half of the world's population These large urban centers are substantial sources of anthropogenic pollutants having adverse effects on human health, visibility and ecosystems. In order to improve air quality in those urban areas we need to quantify the fraction of the pollution originating from local and regional sources and to determine the response of the system to emission controls. Three-dimensional chemical transport models (CTMs) are well suited to help address these source receptor questions since they model all the necessary processes that impact air pollution concentrations and transport in the domain.

In this study we applied PMCAMx (Fountoukis et al., 2011) a three dimensional CTM over Europe to study the influence that emissions in large European urban areas (e.g. Paris, London, Po Valley) might have on the concentration of the major $PM_{2.5}$ components during a summer and a winter period. We combined PMCAMx with the Particulate Source Apportionment Technology (PSAT) (Wagstrom et al., 2011) which directly computes the contribution of different emission areas or source types. The contributions of local, medium, and long range transport and different source categories (e.g., transport, fires, etc.) were quantified.

Local emission sources are predicted to have a significant effect on primary pollutant levels, like Elemental Carbon (EC) while secondary pollutants concentrations are dominated by sources outside major urban areas like Paris. The impact of local sources is high for EC (up to 60%) for both periods. Sulphur dioxide-sources located more than 500 km away from Paris account for 70% of the concentration of $PM_{2.5}$ sulphate in Paris during summer and almost 50% during the simulated winter period. SOA mid-range sources (from 100 km up to 500 km away from Paris) play the most important role in Paris SOA-concentrations with their summer contribution being around 70% and their winter around 60%.

The PSAT results were compared with those of an "annihilation" scenario zeroing out all anthropogenic emissions over an urban area. The results of these simulations suggest that the two methods, despite the non-linearity of the corresponding processes for secondary aerosol formation, are in good agreement with each other (Figure 2). PSAT is a lot more computationally efficient.

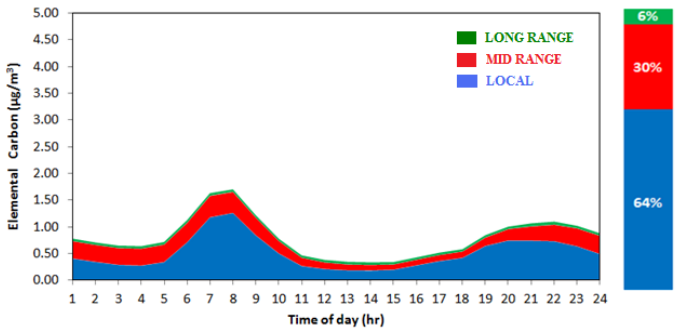

Figure 1. Hourly variation of Elemental Carbon and the contributions from each source for the center of the Paris during summer.

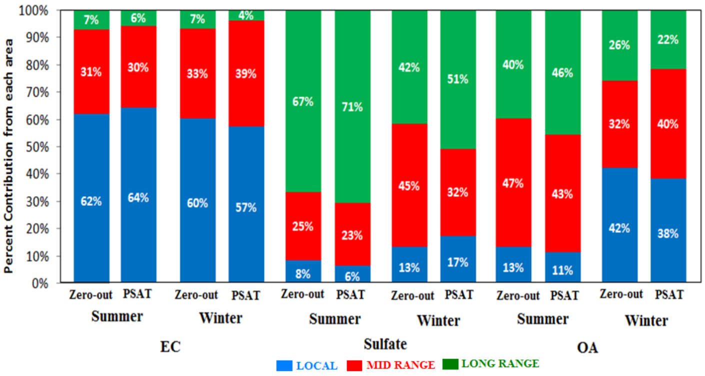

Figure 2. Contribution from each area for EC , sulphate and OA for the two methods for both periods.

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