Source apportionment of $PM_{2.5}$ concentrations: comparison of source-oriented and receptor-oriented techniques

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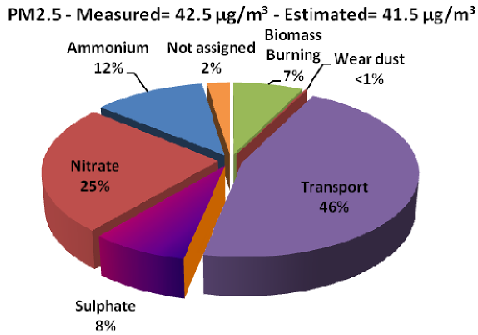
Airborne particulate matter is a complex mixture of both primary and secondary compounds, produced by several kinds of anthropogenic and natural sources, as well as by various chemical and physical processes in the atmosphere. Thus, the development of effective air quality policies requires a thorough knowledge of the role played by the different emission sources. Broadly speaking, both source-oriented and receptor-oriented approach can be applied for source apportionment (SA), to estimate these different contributions.

This work compares the SA results produced by two implementations of these approaches for $PM_{2.5}$ in the Po valley (Northern Italy), selected as case study due to its very critical conditions, with frequent exceedances of the air quality standards. Receptor modelling analysis has been performed using the Chemical Mass Balance model version 8.2 (U.S. E.P.A., 2004), fed with local source profiles (Colombi et al. 2010). $PM_{2.5}$ composition data were derived from a multi-year field campaign covering 2003-2007 (PARFIL Project). Source oriented analysis has been performed by means of the CAMx chemistry transport model, that implements PSAT (Yarwood et al., 2004), a powerful source apportionment algorithm. CAMx model was implemented for the calendar year 2005 over a 5 km resolution domain covering the whole Po valley. A set of 28 source categories was tracked including: road transport sector split according to the fuel, residential heating, energy production and agriculture. CMB source profiles were used as $PM_{2.5}$ emission speciation profiles by CAMx.

SA results from CMB and CAMx model at different receptors located at both urban and rural sites are presented and issues related to the comparison methodology are discussed. As an example, Figure 1 shows the results obtained for an urban receptor site in Milan for the winter season. $PM_{2.5}$ mass concentrations reconstructed by CMB was very close to the observed one, while CAMX partially underestimated it (-15%) CAMx results showed contributions to the $PM_{2.5}$ winter mean of 27% from road transport, 12% from biomass domestic heating, 52% from secondary sources; corresponding CMB results were 46% for road transport, 7% for biomass heating, 44% for secondary sources.

General conclusions stemming from the comparison of SA results at the different sites were:

- CAMx tends to underestimate the $PM_{2.5}$ observed mass concentration more than CMB; such discrepancy seems mainly related to a missing primary $PM_{2.5}$ fraction than to the accuracy in the modelling of the secondary fraction.
- Both models showed a better agreement in winter than in summer, suggesting that on low concentration conditions SA results are less reliable than on polluted situations.



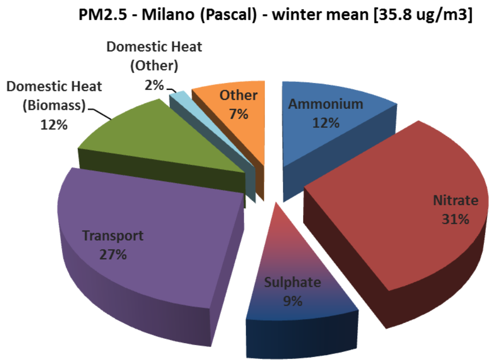


Figure 1. Comparison of PM2.5 source apportionment results at Milan receptor obtained by CMB (top) and CAMx/PSAT (bottom) for the winter season.

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