An integrated source apportionment study: Positive Matrix Factorization vs. the Chemical Transport Model CAMx

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The contribution of particular emission sources to PM levels can be highlighted by two different tools: Receptor Models and Chemical Transport Models, both widely adopted even if rarely with a synergic approach. Actually, a satisfying methodology to compare the results and even the categorizations of the two approaches is still missing and highly desirable. In the framework of the MED APICE project (http://www.apice-project.eu/), the Department of Physics (DIFI) of the University of Genoa was involved in the evaluation of the impact of harbor activities on the urban air quality and the definition of strategies to reduce air pollution in port cities. This gave the opportunity to use both Source Apportionment approaches to integrate their potentialities. Receptor Models allow to obtain the evaluation of atmospheric pollutants apportionment from different sources, based on ambient data at monitoring sites whereas Chemical Transports Models (CTMs) extend the assessment on the formation of secondary aerosols on the whole studied territory with a certain resolution too.

For this purpose, a PM2.5 sampling campaign was carried out collecting daily PM2.5 samples for a six month period (May- October 2011) in the urban area of Genoa in three sites (two immediately outside the harbour area and one inland in the northern area of the city) selected considering the direction of prevailing winds. Subsequent compositional analyses produced a large database for a Receptor Model analysis. Positive Matrix Factorization, PMF (Paatero et al, 1994), was used to identify and characterize the major PM2.5 sources. Particular attention was given to the evidence of emissions from heavy fuel oil combustion by ships, known to be an important source of secondary sulphate aerosol.

Also, a meteorological and air quality modelling system has been implemented at DIFI, based on the mesoscale NWP model WRF (Skamarock, 2008) and the Eulerian CTM CAMx (ENVIRON, 2010). Through subsequent nesting, meteorological and pollutant concentration fields are obtained up to resolutions of order of 1 km. During the campaign, a large amount of data has been collected and analysed while simulations have been ran over the whole monitoring period.

Source apportionment for PM2.5 was evaluated by CAMx in the same period of the monitoring campaign through the specific Particulate Source Apportionment Technology (PSAT) tool. PSAT uses reactive tracers to apportion primary and secondary PM and gaseous precursors to secondary PM among different source categories and source regions.

Source apportionment outcomes allowed a comparison with the results obtained by Receptor Models. Table 1 shows the average contribution of the resolved sources to PM2.5 levels in the monitoring sites.

Table 1. Comparison between average sources apportionment obtained by PMF and CAMx.

PM2.5 Sources	PMF	CAMx - PSAT
Maritime/harbour	(13 ± 5) % coastal (9 ± 3) % inland	9% coastal 5% inland
Energy production and Industry	(30 ± 10) %	20%
Road transport	(40 ± 15) %	45%
Residential/tertiary	Not identified	5 %
Others (sea salt, dust, etc.)	(15 ± 5) %	20%

The PM2.5 source apportionment analysis by PMF and CTMs produced a quite comparable picture. In particular, focusing on the mail goal of the APICE project, i.e. the impact of maritime activities on air quality, the two approaches were in fair agreement both near the harbour sites and inland. The evaluation of the uncertainties of the CAMx apportionment is presently in progress and it will be discussed during the Conference.

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