Chemical mass balance modelling for the source estimation of high PM2.5 concentrations in Milan, Northern Italy

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Northern Italy is one of the most industrialized and populated regions in Western Europe and is characterized by high levels of fine particulate matter (PM2.5). Harmful health effects have been associated with exposure to PM2.5 and to associated toxic compounds.In Europe, the recent Air Quality Directive (2008/30/CE) establishes an annually averaged PM2.5 concentration of 25 μg m^{-3}, which will be the legal limit value from 2015 onwards. With the aim of designing effective PM2.5 reduction strategies, information on the strength of impacting sources is required.

In order to study PM2.5 mass concentrations and chemical compositions in Northern Italy, we conducted measurement campaigns at an urban site in Milan (MI) and a rural site in Oasi Le Bine (OB), over a three-year period (2006-2009) (Perrone et al., 2012).

Chemical mass balance modelling (CMB) was applied to PM chemical composition data in order to quantify the major PM2.5 sources during different seasons. 13 fitting species (EC, levoglucosan , C29 and C31 *n*-alkanes, five PAHs and four elements), comprised of compounds known to be good molecular markers, were used in CMB modelling with the aim of assessing contributions from five primary sources: traffic (TR), biomass burning (BB), natural gas combustion (NGC), plant debris (PD) and road dust (RD). A critical issue for CMB modelling is the availability of source profiles that represent the aggregate emissions from a given source at the considered receptor site. In the present study we used profiles representative of the region in question, where such were available (TR, BB and PD), and various composite profiles derived by literature data. The sensitivity of the CMB model to the selection of different profiles (TR and BB) was assessed .

From CMB calculations the contributions of primary sources to OC was estimated for seasonally averaged PM2.5 samples, and the PM mass from each source was reconstructed by applying a specific OM-to-OC conversion factor to each source and adding other primary components (e.g. EC; primary sulphate, nitrate and ammonium; major elements and their oxides) (El Haddad et al., 2011).

In MI, TR was found to be the strongest primary source (17-24%) for PM2.5 in all seasons, together with secondary inorganic and organic aerosol (21-54%) (Fig.1).In fall (F) and winter (W), BB was a major contributing primary source to PM2.5 concentrations at the MI urban site as well at the OB rural site, with a source contribution estimation (SCE) ranging from 8 to

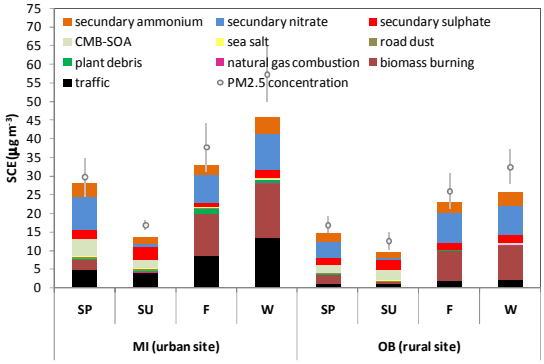

Figure 1. Source contribution estimation (SCE) to averaged seasonal PM2.5 concentrations in MI and OB.

15 μg m^{-3} at the MI urban site as well at the OB rural site. While TR is mainly a local source, and it has a stronger impact nearer the source, BB is a widespread source with a substantial regional contribution.

BB was also a contributing source to the high PAHs concentrations measured in the PM2.5 samples in the cold season. In figure 2 the ratio-ratio plot compares PAHs/EC ratios in the ambient air with those of sources. Winter data mainly cluster between a 50/50 and a 25/75 mix of BB and TR sources, thus suggesting a relative contribution of 25-50% for BB source to PAHs (BghiP and IcdP) ambient concentrations at the MI site.

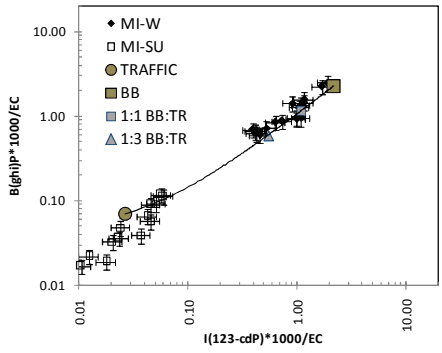

Figure 2. Ratio-ratio plot using PAHs and EC. Ambient data for MI site (W=winter; SU=summer) and source profiles for TR and BB.

El Haddad I, et al. (2011) *Atmos Chem Phys* **11**, 2039-2058

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