PM2.5 and PM1 from urban, rural and a remote site in North of Italy: different contributing sources and biological effects

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Keywords: fine particulate matter, chemical composition, CMB model, cytotoxicity.

PM samples were collected in three locations of the North of Italy: Milan (MI), a big urban site, Oasi Le Bine (OB), a rural site, and Alpe San Colombano (ASC) as an high altitude remote site on Alps. Fine PMs (PM1 and PM2.5) were sampled daily over two year (2007/2009). Daily filters were pooled together to obtain representative samples for spring, summer, autumn and winter, and than analysed for chemical composition and biological effects.

Chemical analysis were performed to determine: organic carbon and elemental carbon, levoglucosan, inorganic ions (NO_3^-, $SO_4^=$, NH_4^+, Cl^-, Na^+, K^+, Ca^{++}, Mg^{++}), elements (Si, Fe, Al, Zn, Cu, V, Mn, Pb, Ni, Cr, Mo, As, Cd), C2-C5 mono and dicarboxylic acids, C20-C32 n-alkanes and PAHs.

Results from PM chemical composition were used for a source apportionment study by chemical mass balance (CMB 8.2, EPA). CMB computations indicate that the secondary aerosol components, ammonium nitrate and ammonium sulphate are the main source for sites in the plane, MI and OB (29 % to up 49.% of fine PM mass in all season). Traffic is a primary PM source with higher values in MI, where it is estimated up to 26-30% of PM1 and PM2.5. Wood burning contribute to 27-30% of winter fine PM in the plane.

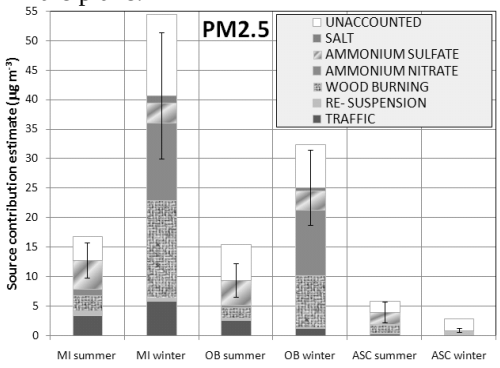

Figure 1. PM2.5 source contribution estimate (µg m^{-3}), and standard error, for the three receptor sites (MI, OB e ASC) in summer and winter.

A tendency for the CMB to underestimate PM levels is observed, meanly 30% of fine PM unaccounted. It indicates that a significant source has not been considered in the study (e.g. secondary organics). In ASC the unaccounted PM2.5 and PM1 concentrations were up 69% in winter, when the high altitude remote site of ASC is in the free troposphere.

Biological effects of fine PM have been investigated by *in vitro* tests on the human lung carcinoma epithelial cell line A549 (Gualtieri et al., 2010). Results for cell viability reduction (1-MTT), LDH and DNA damage were over the control (unexposed cells) for all PM samples (cell exposure = 6 µg cm^{-2}). Cells exposed to PM samples from OB showed very similar biological effects compared to PM samples from MI both in summer and winter (Figure 2), except for the high DNA damage (2.25) in MI during winter. Some biological effects were surprisingly high in ASC during winter (e.g. LDH = 2.16), and PM samples had a high mass contribution of elements (11-13% of PM mass).

Bivariate and multivariate analysis have been applied to study the relationship between biological responses and PM chemical composition and sources. Results confirm as secondary products of summer photochemical reactivity (e.g. $S0_4^=$ and carboxylic acids) might have a role in inducing cell viability reduction in summer (Perrone et al.., 2010).

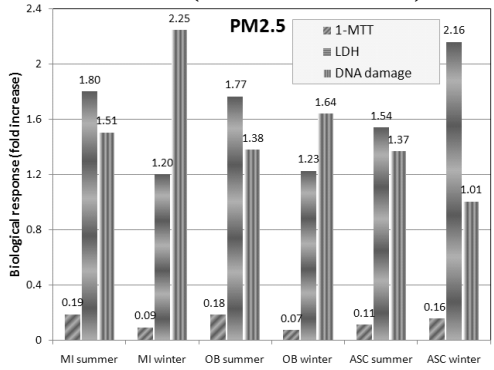

Figure 2. Biological responses (concentration = 6 µg cm^{-2}) for PM2.5 samples in summer and winter

This work was supported by Lombardy Region (VESPA project) and by ASI (QUITSAT project).

Gualtieri, M., et al. (2010). *Toxicol. Lett.*, doi:10.1016/j.toxlet.2009.03.003

Perrone, M.G., et al. (2010). *Chemosphere 78, pp. 1368-1377*