Organic compounds in fine particulate matter across the Veneto region, Italy: Spatial-temporal variations and meteorological influences

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The Scientific community has paid much attention to both carbonaceous fraction and particulate polycyclic aromatic hydrocarbons (PAHs) because of their great influences on the global radiation budget (Seinfeld and Pandis, 1998) and carcinogenic and mutagenic effects (WHO, 2000; IARC, 2010), respectively. However, no published works are so far available describing the chemical speciation of carbonaceous particulate matter for extended period of time at Veneto, and long-term $PM_{2.5}$-bound PAHs data at regional scale are incomplete.

A year-long sampling campaign (2012-2013) was conducted at 6 major cities located in 6 Provinces of the Veneto region to observe the spatial and seasonal variations of organic compounds [elemental carbon (EC), organic carbon (OC), and PAHs] at a regional scale and to determine the factors affecting their variations. Sixty samples per province were collected for analysis in every alternate month (April, June, August, October, December and February): 10 samples per sampling site in 10 consecutive days of the months selected. EC and OC were analyzed using the NIOSH (National Institute of Occupational Safety and Health) 5040 thermal/optical transmittance method, whereas for PAHs, the samples were ultrasonically extracted with acetonitrile and measured by High Performance Liquid Chromatography.

$PM_{2.5}$ concentration fluctuated from 3.0 μg m^{-3} to 82.6 μg m^{-3} with a value (mean±standard deviation) of 24±17 μg m^{-3}. Concentrations were predominantly higher in the colder months than in the warmer ones. OC concentration ranged from 0.98 to 22.34 μg m^{-3}, while the mean value was 5.48 μg m^{-3}, contributing for 79% of the total carbon. EC concentrations fluctuated from 0.19 to 11.90 μg m^{-3} with a mean value of 1.31 μg m^{-3} (19% of the total carbon). The monthly OC concentration gradually increased from April to December. EC did not vary in accordance with OC, but the highest values were recorded in winter, as well. Although there were concentration differences among the provinces, these were not statistically significant as confirmed by Kruskal-Wallis one-way analysis of variance test. The OC/EC ratios ranged from 0.71 to 15.38 with a mean value of 4.54, which is higher than the values observed in most of the other European cities. The secondary organic carbon (SOC) was calculated from the EC tracer method and the SOC contribution to TOC was higher during winter as compared to summer.

Concerning PAHs, the total concentration of 8 particulate PAHs ranged from 0.2 to 70.4 ng m^{-3} with a mean value of 11.5 ng m^{-3}. The average BaP concentration was 2.0 ng m^{-3} (17.4% of the total PAHs) which is two-times higher than the limit set by the European Union. The PAH concentrations across the region follow the same pattern with maxima during winter months and minima in the summer period. Health risk, evaluated as the lifetime lung cancer risk (LCR), showed a potential carcinogenic risk from the airborne BaP_{TEQ} which is six fold higher in winter than in summer.

In this study, OC, EC and PAHs showed an inverse relationship with temperature, solar radiation, and wind speed. Statistically significant meteorological factors controlling organic and elemental carbon were investigated by fitting linear models using a robust procedure based on weighted likelihood. Temperature and wind velocity turned out to be statistically significant, with a multiple R^2 value of 0.79. The results of this study concluded that organic compounds are significant contributors to $PM_{2.5}$ mass (averagely 32% of $PM_{2.5}$). The main factors for the increased organic compound concentrations in winter are biomass burning for household heating and cooking, followed by volatile organic compounds absorption on particle, due to lower atmospheric temperature and stability.

IARC-International Agency for Research on Cancer (2000) *Some non-heterocyclic polycyclic aromatic hydrocarbons and some related exposures*, vol. 43-53.

Seinfeld, J.H., Pandis, S.N. (1998) In*: Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, Wiley.

WHO (World Health Organization)., 2000. *Air quality guidelines for Europe*. 2nd ed. Copenhagen: WHO Regional Publications; European Series No. 91.