Organic and elemental carbon in the surroundings of a cement complex in southeastern Spain

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Keywords: carbonaceous aerosols, PM2.5, PM10, OC-to-EC ratio.
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Carbonaceous species are major components of atmospheric particulate matter (PM) and directly affect human health and the environment. The carbonaceous fraction of PM consists of elemental carbon (EC) and organic carbon (OC), which includes thousands of organic compounds. In this work, we present OC and EC concentrations in both PM2.5 and PM10 daily samples collected at a suburban location close to a cement complex in southeastern Spain. The samples were gathered every four days from September 2005 to August 2006. Details of the sampling campaign and the characteristics of the sampling site are given in Galindo *et al* (2011). OC and EC concentrations were obtained at INFN of Florence with a Sunset Laboratory Thermal-Optical Carbon Aerosol analyser using the NIOSH protocol.

Annual average concentrations of PM and carbonaceous species during the study period are presented in Table 1. OC concentrations were obtained by subtracting the carbon carbonate (CC) - calculated from the anion deficit (Galindo *et al*, 2011) - from the organic carbon content obtained from the thermal-optical analysis.

Table 1. Annual mean concentrations (µg/m^3) of PM, OC and EC in PM2.5 and PM10.

Fraction	PM	OC	EC
PM2.5	18.0±7.6	2.3±1.2	1.0±0.5
PM10	40.5±17.5	2.6±1.4	1.1±0.6

Annual mean OC and EC concentrations were generally lower than those measured at urban stations in the Mediterranean basin and Europe, but higher than those found at rural locations (Pio *et al*, 2011). OC was the main constituent of total carbon (TC = EC + OC), both in PM2.5 and PM10, contributing approximately 70%. This percentage is very similar to that obtained by Viana *et al* (2006) in Barcelona.

As expected, the contribution of TC to the average PM2.5 mass concentration was significant (20±9%) and only sulphate accounted for a higher proportion of the PM2.5 mass (26±9%). In PM10, TC contributed only 10±4% to the annual mean concentration.

Figure 1 shows monthly variations of OC and EC concentrations and the OC/EC ratio for PM2.5. Similar results were found for the PM10 fraction. OC levels were maxima in winter and minima during spring and summer, with a winter/summer ratio of 1.5 for PM2.5 and 1.8 for PM10. This seasonal pattern was caused by the lower atmospheric dispersion conditions and the shift of the gas-particle equilibrium to particulate phase during winter. EC concentrations showed limited monthly variations probably because of the relatively constant flow of traffic in the area surrounding the sampling site.

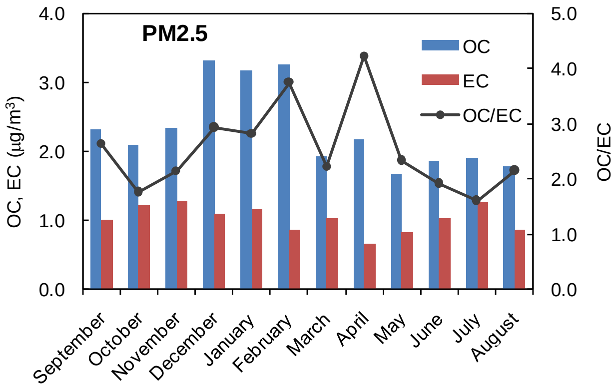

Figure 1. Monthly OC and EC concentrations and OC/EC ratio.

Annual average OC/EC ratios were 2.5±1.3 and 2.5±1.6 for PM2.5 and PM10, respectively. These values fell within the range reported for other European urban and industrial locations (Pio *et al*, 2011), although a different seasonal variation was observed. At our sampling site, the lowest OC/EC ratios were obtained in summer (Figure 1), suggesting a high contribution of semi-volatile organic compounds in comparison with non-volatile organics. This assumption was supported by the significant negative correlation obtained between monthly average OC concentrations and temperature in both PM2.5 and PM10 ($r > 0.78$).

This work was partially supported by the Spanish Ministry of Science and Innovation under the CGL2009-08036 (PASSE) and CGL2012-39623-C02-2 (PRISMA) projects.

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