Organic and elemental carbon associated to PM_{10} and $PM_{2.5}$ in the urban atmosphere - Estimation of secondary organic carbon

C. Samara[1], D. Voutsa[1], A. Kouras[1], K. Eleftheriadis[2], Th. Maggos[2], D. Saraga[2], M. Petrakakis[3]

[1]Aristotle University of Thessaloniki, Department of Chemistry, Environmental Pollution Control Laboratory, University Campus, 54124 Thessaloniki, Greece
[2]National Centre of Scientific Research "Demokritos", Institute of Nuclear Technology and Radiation Protection, Environmental Research Laboratory, 15310 Ag. Paraskevi, Attiki, Greece
[3]Environmental Department, Municipality of Thessaloniki, Paparigopoulou 7, Thessaloniki 54630, Greece

Keywords: Carbonaceous particles; elemental carbon; organic carbon, PM10/PM2.5
Presenting author email: csamara@chem.auth.gr

Organic carbon (OC) and elemental carbon (EC) constitute major components of atmospheric particles with sum contribution in European urban areas reaching up to 25-40% and 30-50% of total PM_{10} and $PM_{2.5}$ masses, respectively (Putaud et al., 2004). Thessaloniki, Greece (40°62´E, 22°95´N) is a densely populated city suffering from high concentrations of airborne particulate matter. Previous studies indicated that organic matter constituted a significant fraction of the PM_{10} mass (23% and 18% at an urban-traffic and an urban-industrial site, respectively), while EC had a lower contribution at both sites (6.3% and 3.6 %, respectively) (Terzi et al., 2010).

The aim of the present study was to further investigate OC and EC in the urban atmosphere. For this purpose, PM_{10} and $PM_{2.5}$ fractions were collected from an urban-traffic (UT) and an urban-background (UB) site of Thessaloniki, usually exhibiting the max and min levels of air pollutants. At both sites, PM_{10} and $PM_{2.5}$ samples were concurrently collected during the warm and the cold months of the year (July-Sept 2011 and Febr-April 2012). Sampling was carried out according to EN12341 and EN14907 using Low Volume Samplers operating at constant flow rate 2.3 m^3/h. PM_{10} and $PM_{2.5}$ fractions were collected on Φ 47 mm high purity quartz filters prefired at 500 ^oC for 4 hours. Each sampling had a 24-h duration starting at 00:00. OC and EC were determined by the Thermal Optical Transmission method in a Sunset Laboratory OCEC Analyzer.

Summary statistics for OC and EC associated with $PM_{2.5}$ and PM_{10} are shown in Table 1. UB exhibited significantly lower concentrations than UT for both carbonaceous species with EC_{10} levels being towards the lowest among reported values for traffic impacted urban European sites (Grivas et al., 2012) and $OC_{2.5}$ levels within the range of reported values for urban background sites in Europe (Viana et al., 2006; Reche et al., 2012).

Table 1. Mean±SD for concentrations of PM_{10}, $PM_{2.5}$ and associated OC and EC ($\mu g/m^3$)

	OC_{10}	EC_{10}	$OC_{2.5}$	$EC_{2.5}$
UT (N=57)	11±4.6	6.4±2.1	9.0±4.8	5.4±1.7
UB (N=54)	6.6±4.6	0.9±0.6	5.7±4.4	0.7±0.4

Average contributions of OC and EC to total PM_{10} mass were 21% and 14% at UT *vs.* 19% and 2.7% at UB, respectively. The corresponding contributions of OC and EC to total $PM_{2.5}$ mass were 27% and 19% at UT *vs.* 23% and 3% at UB. It was found that 89% and 81% of EC associated to PM_{10} is distributed in the fine particle fraction at UT and UB, respectively, while the corresponding percentages for OC were and 88% and 86%, respectively. The mean OC/EC ratio at UT was 1.9±1.1 in PM_{10} and 1.9±1.4 in $PM_{2.5}$, whereas a clear prevalence of OC over EC was found at UB with mean OC/EC ratios 7.5±2.8 in PM_{10} and 8.1±2.6 in $PM_{2.5}$

EC_{10} and $EC_{2.5}$ levels at UT permanently exceeded the corresponding values at UB revealing that locally generated road traffic emissions are superimposed upon the urban EC background. UT also exceeded UB concerning OC_{10} and PM_{10}, however, a negative increment appeared for $PM_{2.5}$ and $OC_{2.5}$ during February possibly indicative of local emissions from residential wood burning.

Secondary organic carbon (OC_{sec}) was estimated by the EC tracer method (Turpin and Huntzicker, 1995; Pio et al., 2011). As seen in Table 2, the OC_{sec} contributions to OC at UB were higher than at UT averaging 59% and 43% in PM_{10}, and 61% and 46% in $PM_{2.5}$ in the cold and the warm period, respectively. The higher concentrations of OC_{sec} in winter than in summer might be suggestive of long-range transport and temperature influence, as well as to miscellaneous OC in winter, including secondary aerosols from traffic plus primary and secondary aerosols from stationary combustion.

Table 2. Secondary organic carbon (OC_{sec}) concentrations at the urban-traffic (UT) and urban background (UB) sites

		Warm season		Cold season	
		OC_{sec} ($\mu g\ m^{-3}$)	OC_{sec}/OC (%)	OC_{sec} ($\mu g\ m^{-3}$)	OC_{sec}/OC (%)
UT	PM_{10}	3.4±2.6	35±19	7.3±4.5	50±23
	$PM_{2.5}$	2.7±2.4	39±22	7.1±5.1	54±25
UB	PM_{10}	1.9±1.1	43±19	5.0±3.7	55±17
	$PM_{2.5}$	1.6±1.2	46±17	3.5±3.2	40±16

References

Grivas, G. et al. (2012). *Sci. Total Environ.*, **414**, 535-45.
Pio, C.A. et al. (2011). *Atmos. Environ.*,**45**, 6121-32.
Putaud, J.-P. et al. (2004). *Atmos. Environ.*, **38**, 2579-2595.
Reche, C. et al. (2012). *Sci. Total Environ.*, **427-428**:175-190.
Terzi, E. et al. (2010). *Atmos. Environ.*, **44**, 2231-2239.
Turpin, B.J., Huntzicker, J.J. (1995). *Atmos. Environ.* **29**, 3527-3544.
Viana, M. et al. (2006). *Atmos. Environ.*, **40**, 2180-2193.

Aknowledgements
This work was supported by the European Community (LIFE + Environment Policy and Governance).