OC, EC, and SOA contribution to PM in Lombardy (Italy): results of three winter campaigns (2005-2007)

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Introduction

The carbonaceous fraction (OC, organic carbon, ed EC, elemental carbon) represents one of the major components of atmospheric aerosol. The new Air Quality Directive 2008/50/EC requires measurements of elemental and organic carbon at selected background sites in each Member State. Up to now, very scarce data have been available for Northern Italy, one of the most polluted areas in Europe. OC and EC quantification was carried out in the frame of ParFiL (Particolato Fine in Lombardia) project whose aim was to study air quality in Lombardy region. The study of the carbonaceous fraction allows to acquire information on sources contribution to PM and to enhance the knowledge of health effects and implication on climate changes.

Experimental

PM10 and PM2.5 sampling campaigns were carried out, during three years (2005-2007) at urban, background, rural, and remote sites (Milano, Sondrio, Varese, Brescia, Cantù-CO, Boscofontana-MN, Mantova, Alpe S.Colombano-SO, Lodi) representative for geographical differences of the Lombardy region. Every year about 80 samples in total were collected at each site (figure 1).
TOT (Thermal Optical Transmittance) method was used for OC/EC quantification using NIOSH protocol.

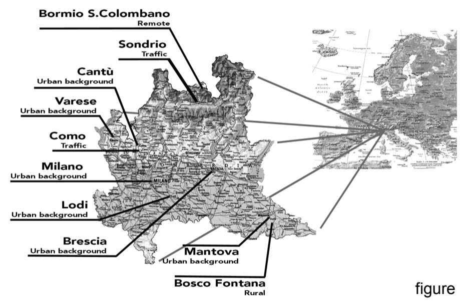

figure 1

SOA estimate

In this work the EC-tracer method has been applied to estimate SOA. Indeed, since primary OC and EC are mostly emitted by the same sources, EC can be used as a tracer of primary combustion-generated OC (Turpin and Huntzicker 1995), provided that the OC/EC primary ratio $(OC/EC)_p$ is known. It is noteworthy that in the literature $(OC/EC)_p$ emission ratios are still very different and uncertain.
Plotting the OC *vs.* EC concentration data taken from the urban sites dataset produced by the PARFIL project, an edge (the red dotted line in the graph) in the lowermost part of the plot can be observed. It represents the minimum value of the $(OC/EC)_p$ ratio for major combustion sources at urban sites (i.e. traffic and wood burning for domestic heating).
The existence of an intercept might suggest the contribution to primary OC due to non-combustion sources or sampling artefacts (Cabada et al. 2004).
OC sampling artefacts were estimated by Vecchi et al. (2009a) during winter (3,8 µg/m³) and summer (2,4 µg/m³) in Milan, and the OC concentration detected on field blanks was 1µg/m³.
These OC values (for artefacts and blanks) are comparable with the intercepts values, as in our case the contribution of non-combustion sources are considered negligible.
The (OC/EC)p ratio during summertime can be representative for the traffic source and it is in good agreement with literature data (Harkus M. (2008), Giugliano M. (2005))
During wintertime both wood burning for domestic heating and traffic contribute to OC and EC emission at the investigated urban sites (see also poster T057A01 and oral presentation T057A13) and the $(OC/EC)_p$ ratio represents the contribution due to both sources. The $(OC/EC)_p$ ratio evaluated in this work for PM10 (1,6 ± 0,1) is in good agreement with the one (1,58) obtained by Vecchi R. et al. (2009b) using a different approach.
Absolute values and percentages of primary OC in Lombardy are reported in table 1.

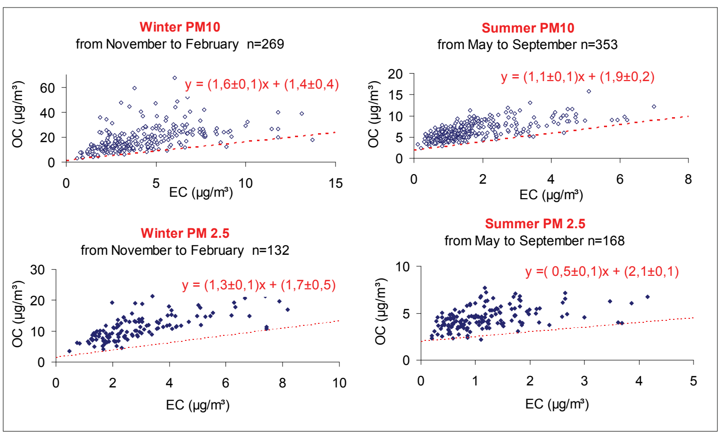

figure 2

	PM 10 winter µg/m³	PM 10 summer µg/m³	PM 2.5 winter µg/m³	PM 2.5 Summer µg/m³	PM 10 winter % OC_p	PM 10 Summer % OC_p	PM 2.5 winter % OC_p	PM 2.5 Summer % OC_p
mean	6,8	1,8	4,1	0,6	39%	27%	35%	13%
standard deviation	4,1	1,3	2,5	0,4	17%	14%	14%	7%
median	5,6	1,4	3,4	0,5	36%	23%	34%	12%
min	1,0	0,1	0,6	0,1	8%	2%	13%	3%
max	31,1	7,7	13,3	2,1	96%	80%	91%	47%
nr. samples	268	350	132	158	265	350	132	158

table 1

Contributions due to traffic and wood burning

A different approach for the estimate of OC_p can be used if levoglucosan (LG) data are available. In this work, it was applied to wintertime when primary OC (OC_p) can be taken as the sum of OC due to wood burning (OC_{wb}) and to traffic (OC_{tr}). Using the levoglucosan (LG) concentration, the following relations allow the estimate of OC_p:

$$OC_{wb} = LG\text{-}C \times 11 \quad (*)$$
$$EC_{wb} = OC_{WB} / 3 \quad (*)$$
$$EC_{tr} = EC - EC_{wb}$$
$$OC_{tr} = EC_{tr} \times 1{,}1 \quad (**)$$
$$OC_p = OC_{tr} + OC_{wb}$$

(*) the emission ratio LG-C/OC and $(OC/EC)_{wb}$ were calculated from Schmidl C. et al. (2008) data
(**) $(OC/EC)_{tr}$=1 is the summer value obtained in this work for primary OC/EC ratio when only the traffic source is important.

$OC_p = OC_{tr} + OC_{wb}$ data were compared (figure 3)with the OCp values calculated as $OC_p = EC \times 1{,}6$, where 1,6 is the $(OC/EC)_p$ ratio evaluated in this work for PM10

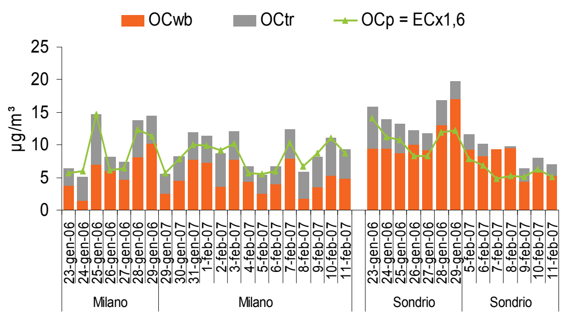

figure 3

Average discrepancies between the two approaches for OC_p quantification were 12% in Milan and 35% in Sondrio. It is worth noting that literature values for LG/OC and OC/EC emission factors show very large uncertainties (up to one order of magnitude). During the winter time wood burning source accounts on average for 57% of primary OC in Milan (the largest town in Lombardy) and 78% in Sondrio (an alpine town).

Acknowledgments
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