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

A. Piazzalunga1, P. Fermo2, R. Vecchi3, G. Valli4, S. Comero1, V. Bernardoni3, O. Cazzulni4, A. Giudici4, G. Lanzani4
1Dept. of Environmental Sciences, University of Milano-Bicocca, Piazza della Scienza 1, 20126, Milan, Italy
2Dept. of Inorganic, Metalorganic and Analytical Chemistry, Università degli Studi di Milano, Via Venezian 21, 20133, Milan, Italy
3Dept. of Physics, Università degli Studi di Milano,Via Celoria 16, 20133, Milan, Italy
4ARPA Lombardia-Department of Milan, via Rostelli 3/1, 20124, Milan, Italy

andrea.piazzalunga@unimib.it

Introduction
The carbonaceous fraction (OC, organic carbon, ed EC, elemental carbon) represents one of the important 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 (Particulate 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.

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/ECp) is known. It is noteworthy that in the literature (OC/EC) 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 (in 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/ECp) 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. Average discrepancies between the two approaches for OCp have been calculated from Schmidl et al. (2008) data. (*) the emission ratio LG-C/OC and (OC/EC) wb were calculated from Schmidl C. et al., (2008) data. Using the losuglucon (LG) concentration, the following relations allow the estimate of OC:

\[
OC_{wb} = \frac{OC_{tot} \times LG-C}{11*(*)}
\]

(\*) the emission ratio LG-C/OC and (OC/EC)wb were calculated from Schmidl C. et al., (2008) data.

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, Bosiscoltanana-MN, Mantova, Alpe S.Colombo- 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.

Contributions due to traffic and wood burning
A different approach for the estimate of OC can be used if losuglucon (LG) data are available. In this work, it was applied to wintertime when primary OC (OCp) can be taken as the sum of OC due to wood burning (OCwb) and to traffic (OCtr). Using the losuglucon (LG) concentration, the following relations allow the estimate of OC:

\[
OC_{wb} = \frac{OC_{tot} \times LG-C}{11 (*)}
\]

(\*) the emission ratio LG-C/OC and (OC/EC)wb were calculated from Schmidl C. et al., (2008) data.

(*) (OC/EC)wb is the summer value obtained in this work for primary OC/EC ratio when only the traffic source is important.

OCwb = OCtr + OCwb values were compared (figure 3) with the OCp values calculated as

\[
OC_{tr} = EC_{tot} \times 1.6, \text{where 1.6 is the (OC/EC) ratio evaluated in this work for PM10}
\]

Average discrepancies between the two approaches for OCp quantification were 12% in Milan and 35% in Sondrio. It is worth noting that literature values for LGOC 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 Lombardy and 78% in Sondrio (an alpine town).

Acknowledgments
This work was funded by Lombardy Region through the ParFil project.

References
Vecchi R. et al., (2008b) Environmental Monitoring and Assessment 154: 283-300

Table 1

<table>
<thead>
<tr>
<th></th>
<th>PM 10</th>
<th>PM 2.5</th>
<th>PM 10</th>
<th>PM 2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>winter</td>
<td>summer</td>
<td>winter</td>
<td>summer</td>
</tr>
<tr>
<td>mean</td>
<td>6.8</td>
<td>1.8</td>
<td>4.1</td>
<td>0.6</td>
</tr>
<tr>
<td>st deviation</td>
<td>0.9</td>
<td>0.4</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>median</td>
<td>5.8</td>
<td>1.4</td>
<td>3.4</td>
<td>0.5</td>
</tr>
<tr>
<td>min</td>
<td>1.0</td>
<td>0.1</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>max</td>
<td>31.1</td>
<td>7.7</td>
<td>13.3</td>
<td>2.1</td>
</tr>
<tr>
<td>nr samples</td>
<td>268</td>
<td>350</td>
<td>132</td>
<td>158</td>
</tr>
</tbody>
</table>

Figure 2

Figure 3