BC/EC assessment on real samples by optical/thermal methods with and without WSOC removal and using different protocols

Piazzalunga[1], Andrea[1], Abate[2], Chiara[2], Bernardoni[3], Vera[3], Bianchi[2], Federico[2], Fermo[2], Paola[2], Paganelli[3], Chiara[3], Valli[3], Gianluigi[3], and Vecchi[3], Roberta[3]

[1]*Department of Environmental and Territorial Sciences, Università degli Studi di Milano-Bicocca, Piazza della Scienza 1, 20126, Milano*
[2]*Department of Inorganic, Metallorganic and Analytical Chemistry, Università degli Studi di Milano, Via Venezian 21, 20133, Milano*
[3]*Department of Physics, Università degli Studi di Milano e INFN- Milano, Via Celoria 16, 20133 Milano*

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Elemental Carbon (EC), also called Black Carbon (BC) when it is measured by optical techniques, is the most refractory fraction of carbon and it is the main light-absorbing component in atmospheric aerosol, with strong effects on radiation balance and visibility.

No reference method for EC/BC is defined yet, so the definition of this fraction is method-dependent. As regards thermal measurements, different choices in heating ramp and combustion atmosphere affect the results. Moreover, it is recognised [Yu et al., 2002] that WSOC may enhance the charring process during OC thermal evolution, strongly affecting the EC quantification.

The possible pyrolysis of the organic carbon component (OC) to form pyrolysed EC during the heating process, enhanced by the presence of water-soluble organic compounds (WSOC) in the sample and by inert atmosphere, can further complicate EC identification. As regards optical measurements carried out on aerosol deposited on filter, they can be complicated by the co-existence of BC, scattering aerosol components, and filter matrix (i.e. multiple scattering effects).

The aim of this work is an intercomparison between different optical/thermal measurements protocols carried out on real samples as-is and after WSOC removal.

28 couples of parallel aerosol samplings on quartz fibre filters were carried out in Milan (Italy) during January-February 2010. One of the two collected series was analysed as-is (NW) and one was analysed after WSOC removal (WW). The technique for WSOC removal was previously optimised to ensure high WSOC removal efficiency, good uniformity of filter deposits after the washing procedure, and no EC/BC losses.

Optical measurements on both washed and non-washed filters were carried out using a polar photometer set-up at the Physics Department of the University of Milan. After optical analysis, different thermal measurements were carried out on 1 cm^2 punches. The thermal methods used were Thermal-Optical Transmittance method (Sunset instrument) with three different protocols: NIOSH (Birch & Cary, 1996), EUSAAR_2 (Cavalli et al., 2010), IMPROVE (Chow et al., 1993); moreover, thermo-gravimetric method as described in Fermo et al. (2006), and thermal separation as described in Cachier (1989) were also tested.

In the presentation, results of the intercomparison between different thermal protocols and optical results will be shown.

As expected, good agreement in TC measurements was found, assuring quantification comparability between different thermal instruments. As regards thermal-optical protocols, the application of the same protocol to NW and WW filters showed a strong reduction in pyrolytic carbon formation (about -65%) and a better agreement between EC measured by different protocols was found after WSOC removal (e.g. from about 35% for NW filters to <20% for WW filters for NIOSH versus EUSAAR_2 protocols). Moreover, significant differences between EC measurements on NW and WW filters were identified for NIOSH protocol (23%), while for EUSAAR protocol EC values were in fair agreement, so pyrolytic carbon influence on EC quantification is much lower for EUSAAR_2 protocol.

Also split points positions were analysed, obtaining more insights on OC/EC separation.

Results of the comparison between the absorption coefficient measured by the optical method and the best EC estimation from thermal analyses allowed obtaining a value for the BC absorption cross section which was compared to literature values.

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