The effect of Brown Carbon on thermal-optical analysis: a correction based on optical multi-wavelength analysis

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Carbonaceous aerosol (CA) plays an important role in environmental issues like air quality, human health and global climate change. It mainly consists of organic carbon (OC) and elemental carbon (EC) although a minor fraction of carbonate carbon could be also present. Thermal-optical methods are presently the most widespread approach to OC/EC speciation. Despite their popularity, there is still a disagreement among the results, especially for what concerns EC as different thermal protocols can be currently used. The main hypothesis at the basis of the technique is that on their different optical properties: while EC is strongly light absorbing, OC is generally transparent in the visible range. However, another fraction of light-absorbing carbon exists which is not black and it is generally called brown carbon (BrC) (Andreae and Gelencsér, 2006). We introduced a new way to apportion the absorption coefficient (b_{abs}) of carbonaceous atmospheric aerosols starting from a multi-wavelength optical analysis (Massabò et al., 2015). This analysis was performed thanks to the MWAA, an instrument developed at the Physics Department of University of Genoa (Massabò et al., 2013). The method uses the information gathered at five different wavelengths in a renewed and upgraded version of the approach usually referred to as Aethalometer model (Sandradewi et al., 2008). Moreover, with some assumptions, also the quantification of OC coming from fossil fuels and wood burning can be obtained.

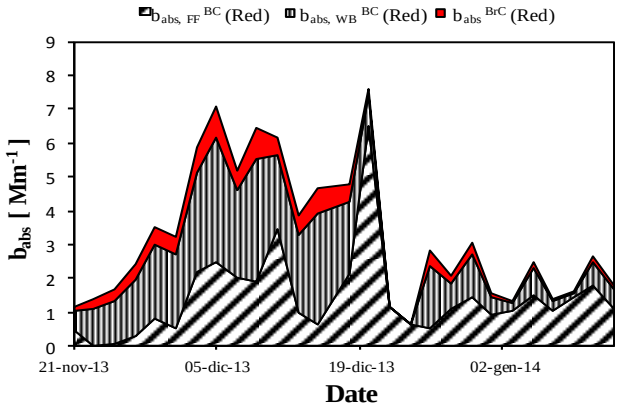

Figure 1: Optical apportionment @ λ = 635nm.

Thermal-optical methods are presently the most widespread approach to OC/EC speciation. Despite their popularity, there is still a disagreement among the results, especially for what concerns EC as different thermal protocols can be used. In fact, the pyrolysis occurring during the analysis can heavily affect OC/EC separation, depending on PM composition in addition to the used protocol. Furthermore, the presence in the sample of BrC can shift the split point since it is light absorbing also @ 635nm, the typical laser wavelength used in this technique (Chen et al., 2015). We have recently introduced a new possibility, based on the apportionment of the absorption coefficient of particle-loaded filters, for correcting the thermo-optical analysis of PM samples (Massabò et al, 2016).

We present here the results of an apportionment study of carbonaceous aerosol sources performed in an Alpine area, validated against independent measurements of levoglucosan. We also present developments of the thermo-optical analysis correction (Massabò et al., 2016) which lead to a better homogeneity between the results obtained with different thermal protocols.

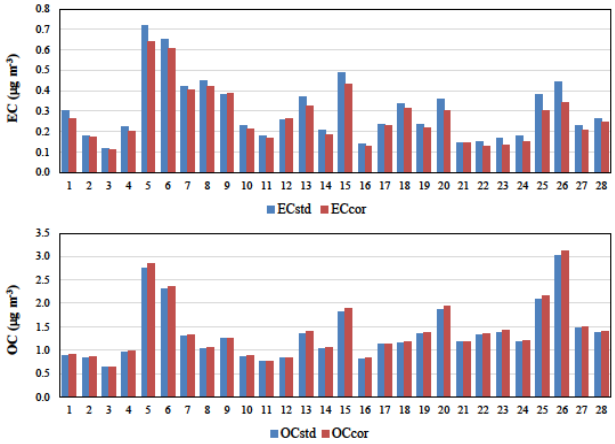

Figure 2: Histogram showing EC and OC values quantified without (std) and with (cor) the proposed correction.

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