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

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Carbonaceous aerosol (CA) has an important impact on air quality, human health and climate change. Total Carbon (TC) is generally divided in organic carbon (OC) and elemental carbon (EC) (although a minor fraction of carbonate carbon (CC) may be present). This classification is based on their thermo-optical properties: while EC is strongly light absorbing, OC is generally transparent in the visible range except for some particular compounds. In fact, another fraction of light-absorbing organic carbon exists which is not black and is generally called brown carbon (BrC) (Andreae and Gelencsér, 2006).

We recently introduced a new method to apportion the absorption coefficient (b_{abs}) of carbonaceous atmospheric aerosols starting from multi-wavelength optical analysis (Massabò *et al.*, 2015). This analysis is performed by the MWAA, an instrument developed at the Physics Department of University of Genoa (Massabò *et al.*, 2013). The method is based on the information gathered at five different wavelengths ***(Figure 1)***, in a renewed and upgraded version of the approach usually referred to as Aethalometer model (Sandradewi et al., 2008). The resulting optical apportionment ***(Figure 2)*** provides the quantification of EC and, with some assumptions, also of OC coming from fossil fuels and wood burning.

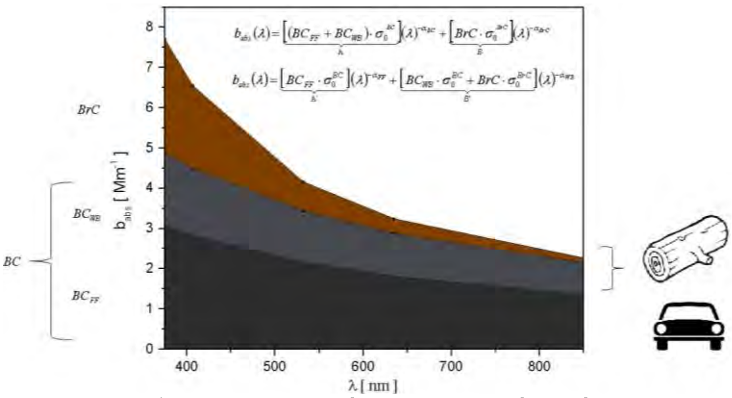

Figure 1*: Mean spectral apportionment at the rural site.*

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).

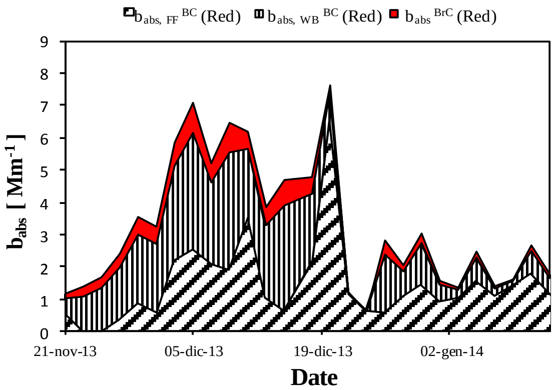

Figure 2: Optical apportionment @ λ = 635nm.

We present here the results of an apportionment study of carbonaceous aerosol sources performed in a rural area and in a coastal city, both located in the North-West of Italy. The optical apportionment also provides a direct measurement of the absorption Ångström exponent of BrC (α_{BrC}) which resulted to be $\alpha_{BrC} = 3.95 \pm 0.20$. Results obtained by the proposed approach are validated against independent measurements of levoglucosan and ^{14}C concentration. We also present a new possibility, based on the apportionment of the absorption coefficient of particle-loaded filters, for correcting the thermo-optical analysis of PM samples.

References:

Andreae, MO, and Gelencsér, A. (2006). *Atm. Chem. and Phys.*, 6, 3131-3148.
Chen et al., (2015*), Atmos. Meas. Tech.*, 8, 451-461.
Massabò et al., (2013), *Journal of Aerosol Science*, 60, 34-46.
Massabò et al., (2015), *Atmospheric Environment*, 108, 1-12.
Sandradewi et al., (2008), *Environ. Sci. Technol*., 42, 3316-3323.