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

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Where:

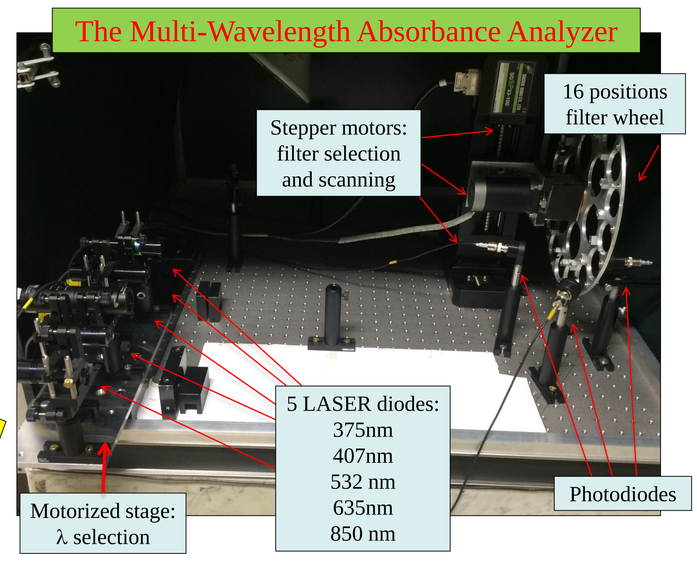
Sampling site: Propata, Ligurian Appennines, ~ 1000 m a.s.l.

Samples: ≈ 300 24h PM10 samples, collected on quartz fiber filters.

Instruments:

- Sunset EC/OC analyzer → Elemental, Organic and Total Carbon.
- HPLC – PAD → Levoglucosan.
- AMS → ^{14}C for quantification of Modern and Fossil Carbon.
- MWAA → Aerosol Absorption coefficient @ 5λ: 375, 407, 532, 635 and 850nm.

The Multi-Wavelength Absorbance Analyzer (MWAA) is a prototype instrument realized at the Physics Department of the University of Genoa.



D. Massabò et al., JAS:60:34-46, 2013

We developed an algorithm for the apportionment of the absorption coefficient (b_{abs}) of the atmospheric aerosols:

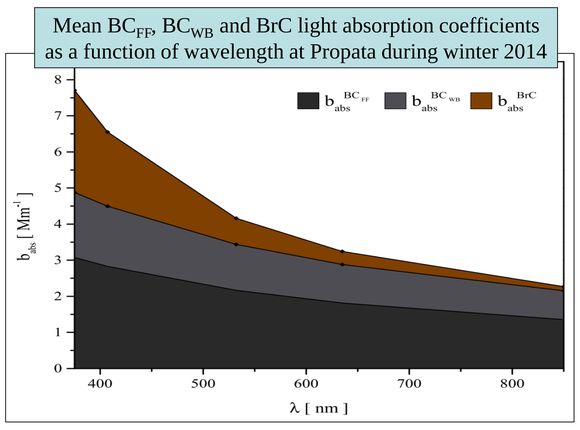
The *"MWAA model"* [D. Massabò et al., 2015] exploits two different decompositions of b_{abs}, based on:

SOURCES ⟷ **BC and BrC spectral dependences**

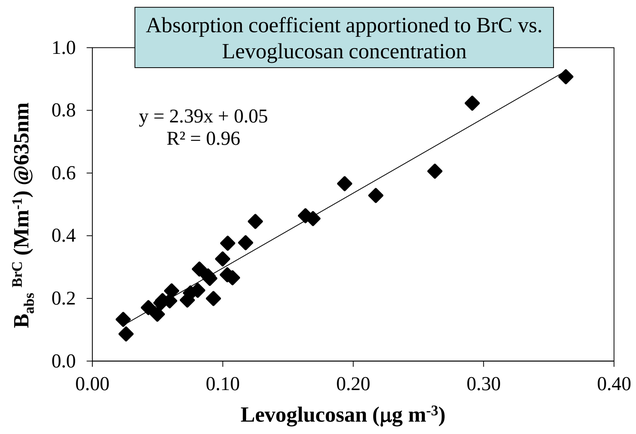
$$b_{abs}(\lambda) = b_{abs}^{FF}(\lambda) + b_{abs}^{WB}(\lambda)$$
$$b_{abs}(\lambda) = a\lambda^{-\alpha_{FF}} + b\lambda^{-\alpha_{WB}}$$

$$b_{abs}(\lambda) = b_{abs}^{BC}(\lambda) + b_{abs}^{BrC}(\lambda)$$
$$b_{abs}(\lambda) = a\lambda^{-\alpha_{BC}} + b\lambda^{-\alpha_{BrC}}$$

Mean BC_{FF}, BC_{WB} and BrC light absorption coefficients as a function of wavelength at Propata during winter 2014



Absorption coefficient apportioned to BrC vs. Levoglucosan concentration



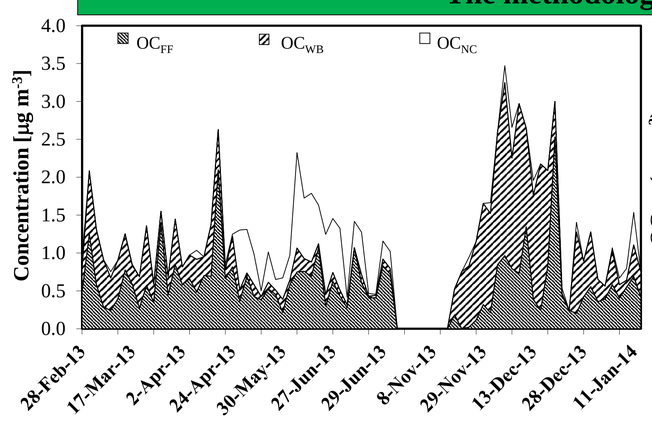
Processing the absorption coefficients measured at 5-λ, the ***"MWAA model"*** provides:

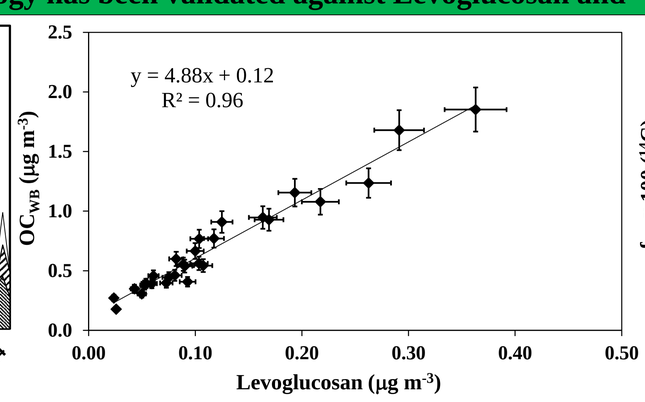
1) The AAE of BrC (α_{BrC}) → $<\alpha_{BrC}>$ = 3.8 0.2

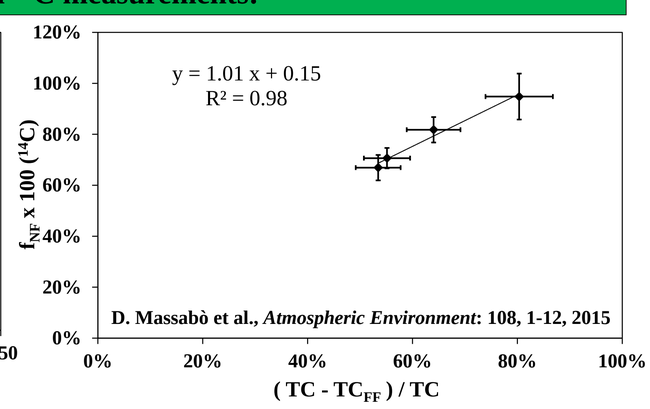
2) The relative contributions to the total absorption coefficient (b_{abs}) of BC_{FF}, BC_{WB} and BrC at every measured λ

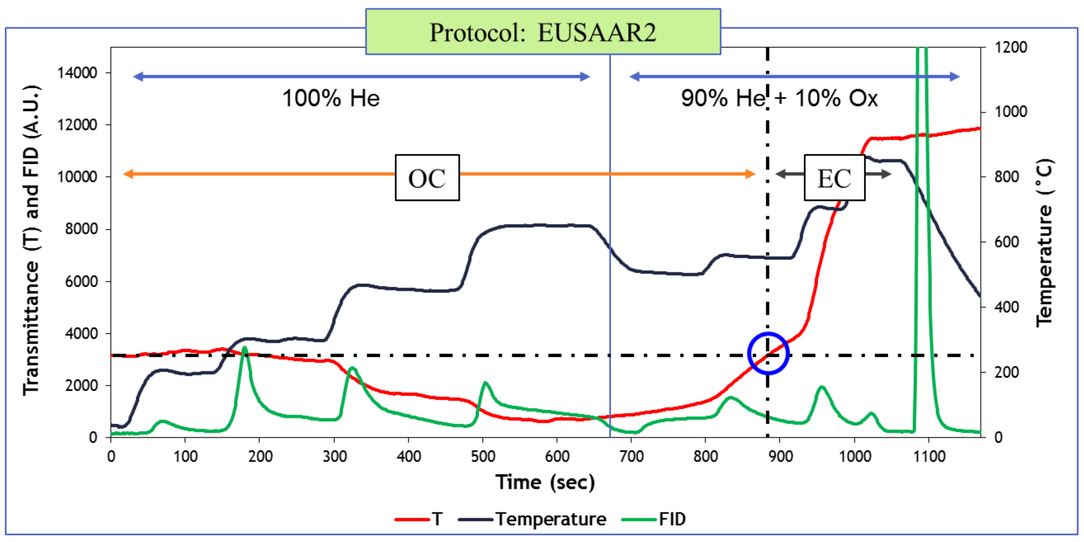
3) The apportionment of OC: from fossil fuels (OC_{FF}), wood burning (OC_{WB}) and originated by non combustion sources (OC_{NC})

The methodology has been validated against Levoglucosan and ^{14}C measurements:





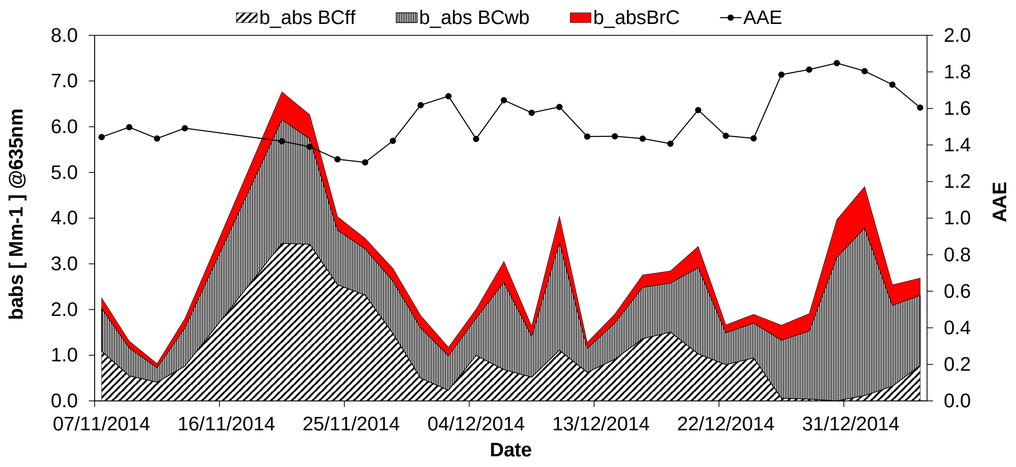




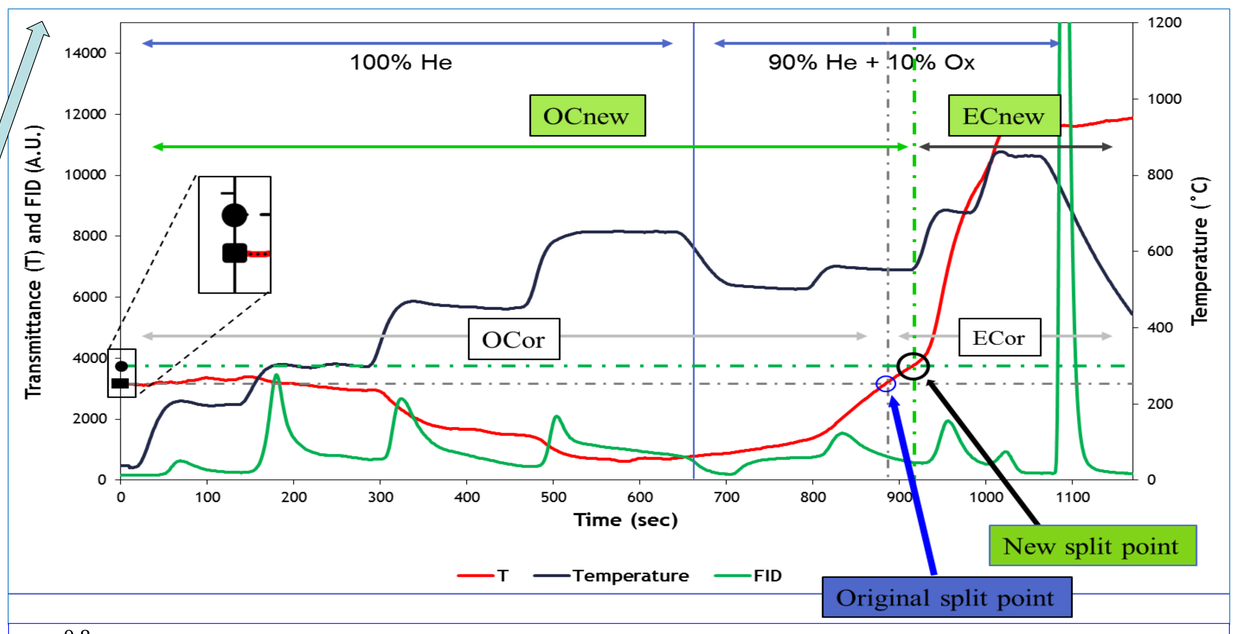
The **split point** is operationally set at the moment in which the laser signal is back to its starting value. EC/OC separation is based on the assumption that EC is the only light absorbing species present on the filter.

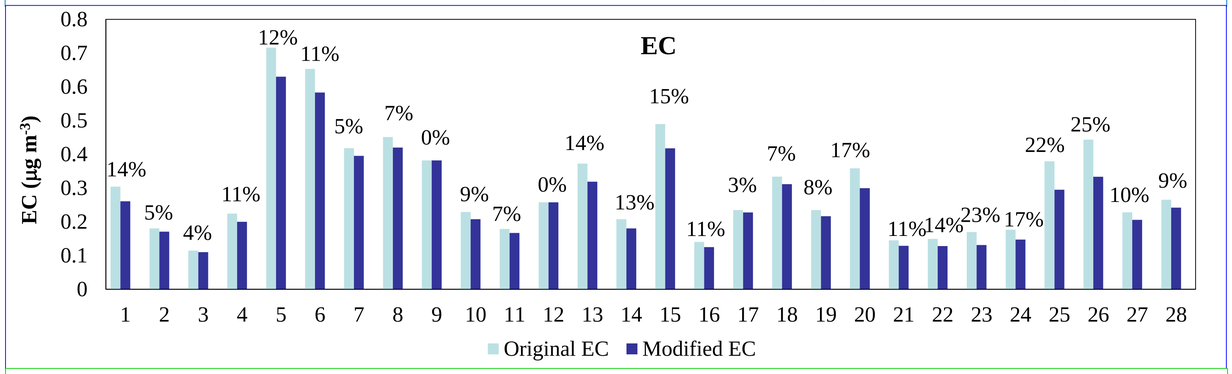
This is no more true if BrC is present on the filter!

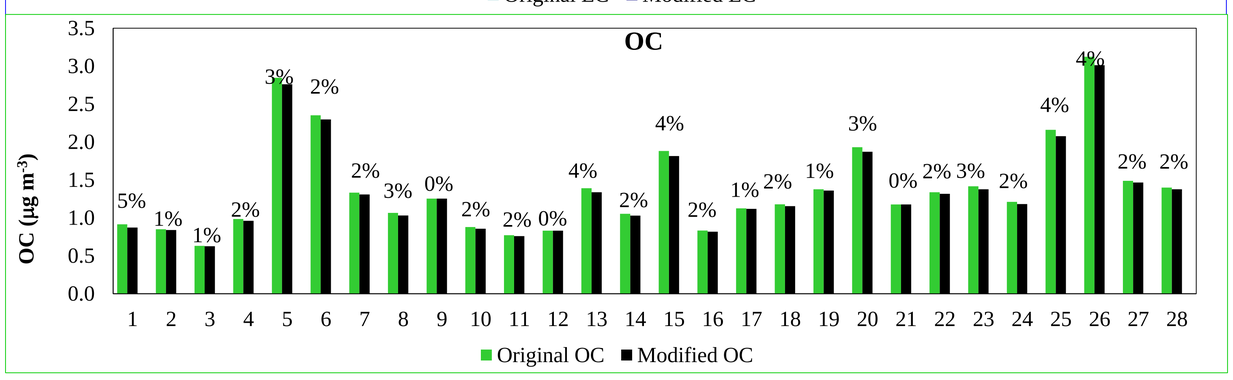
But we know the fraction absorbed by BrC @ 635nm (MWAA model)



We can implement the information obtained by the optical apportionment in order to correct the starting value of the laser. Basically we subtracted the attenuation value of the BrC to the total attenuation.







Bibliography

Massabò D, Bernardoni V, Bove MC, Brunengo A, Cuccia E, Piazzalunga A, Prati P, Valli G, Vecchi R. (2013). **A Multi-wavelength optical set-up for the characterization of carbonaceous particulate matter**, *Journal of Aerosol Science*, 60, 34-46.

Massabò, D, Caponi, L, Bernardoni, V, Bove, MC, Brotto, P, Calzolai, G, Cassola, F, Chiari, M, Fedi, ME, Fermo, P, Giannoni, M, Lucarelli, F, Nava, S, Piazzalunga, A, Valli, G, Vecchi, R, Prati, P, (2015). **Multi-wavelength optical determination of black and brown carbon in atmospheric aerosols**, *Atmospheric Environment*, 108, 1-12.

Massabò D, Caponi L, Bove, MC, Prati P, (2016). **Brown Carbon and thermal-optical analysis: A correction based on optical multi-wavelength apportionment of atmospheric aerosols**, *Atmospheric Environment*, 125, 119-125.