Insights on BC determination on quartz-fibre and PTFE filters: results of two field experiments in Milan (Italy)

R. Vecchi,[1] G. Valli[1], V. Bernardoni[1], C. Paganelli[1], and A. Piazzalunga[2,3]

[1]Department of Physics, Università degli Studi di Milano, Milan, 20133, Italy
[3]Department of Inorganic, Metallorganic and Analytical Chemistry, Università degli Studi di Milano, Milan, 20133, Italy
[3]Department of Environmental Sciences, University of Milan – Bicocca, 20126, Milan, Italy
Keywords: polar photometer, MAAP, mass absorption coefficient, denuder, TOT
Presenting author email: roberta.vecchi@unimi.it

Many measurement methods have been developed for Black Carbon (BC) measurements based on light absorption and a lot of inter-comparisons among different methods have been conducted so far. Nevertheless, at the state of the art, a reference methodology and a clear definition of black carbon does not exist (Bond and Bergstrom, 2006).

In this presentation, we will show results obtained with a home-made polar photometer suitably set up to measure light-absorption by BC particles collected on quartz-fibre and Teflon filters. Parallel measurements by a Multi Angle Absorption Photometer (MAAP) were also performed. Thermal optical transmittance analysis was carried on quartz fibre filters to obtain $\sigma_{abs,BC}$ values by different thermal protocols.

Two field experiments were carried out in Milan in 2009/2010 and in 2011 performing sampling campaign during winter and summer periods in each experiment.

The first campaign was mainly devoted to the validation of our experimental set-up, which was demonstrated to give b_{abs} values (in Mm^{-1}) fully comparable to those obtained by a MAAP when using quartz fibre filters to collect atmospheric particles ($b_{abs,\ polar\ ph.} = 0.96\ b_{abs,\ MAAP}$ R^2=0.96). On the contrary, b_{abs} values (in Mm^{-1}) determined with the same set-up and radiative transfer scheme resulted significantly lower (about a factor 2) when collecting the aerosol on PTFE filters and – even if at a less extent – the same behaviour was detected on quartz fibre filters where the water soluble component was removed by washing the filter.

The second experiment was planned to investigate the potential role of volatile organic compounds on the differences observed on quartz fibre and PTFE filters. In this case, the sampler collecting on the quartz-fibre filter was equipped with an activated carbon monolith denuder to remove organic gases from the incoming air stream. Results obtained by our polar photometer showed a fairly good agreement between the absorption coefficients measured on quartz fibre and PTFE filters ($b_{abs,\ PTFE} = 0.90\ b_{abs,\ quartz\ denuded}$ R^2=0.97).

According to our results, the use of a denuder on optical systems collecting particle on quartz/glass fibre filters would give a more accurate b_{abs} value and, therefore, a better BC estimate.

In methods based on light-absorption measurements a crucial parameter is the BC mass absorption coefficient ($\sigma_{abs,BC}$ in $m^2\ g^{-1}$) defined as the ratio of aerosol absorption coefficient (m^{-1}) to the BC mass concentration ($\mu g\ m^{-3}$). Depending on the size distribution and refractive index, $\sigma_{abs,BC}$ can range between 2 and 25 $m^2\ g^{-1}$ (Bond and Bergstrom, 2006) and the absorption properties due to the internally mixed BC particles can be enhanced as compared to those in the externally mixed BC particles (Naoe et al. 2009). In particular, a problem arises when converting aerosol absorption properties to BC concentration as generally mass absorption coefficients are derived from the TOT/TOR analysis of EC, which is not standardised yet. During the field experiments carried out in Milan we determined the BC mass absorption coefficients using three different thermal protocols (NIOSH, EUSAAR_2, IMPROVE-like) on untreated quartz fibre filters and water washed fibre filters (first experiment) and the NIOSH protocol was used on denuded quartz fibre filters collected during the second experiment.

Results show that there is a very large variability in the $\sigma_{abs,BC}$ as reported in table 1.

Table 1. Comparison between BC mass absorption coefficients ($\sigma_{abs,BC}$ in $m^2\ g^{-1}$) obtained with the TOT method and different thermal protocols

	NIOSH	EUSAAR_2	IMPROVE-like
Untreated	16.0	10.7	10.1
Water washed	8.7	6.9	6.3
Denuded	9.6		

These results clearly show that the BC concentration given by optical systems using conversion coefficients based on EC values will always be affected by a certain degree of inaccuracy. Methods to overcome this problem are therefore mandatory as this practise is widely used by the scientific community using optical systems.

Bond, T.C. and Bergstrom, R.W. (2006) *Aerosol Sci. Technol.* **40**, 27-67.

Naoe, H., Hasegawa, S., Heintzenberger, J., Okada, K., Uchiyama, A., Zaizen, Y., Kobayashi, E., Yamazaki, A. (2009). *Atmos. Environ.*, **43**, 1296-1301