Ambient Black Carbon measurements by Laser-Induced Incandescence

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Introduction

Black carbon (BC) is an ubiquitous component of particulate matter produced from combustion processes. Toxicological, controlled human exposure, and epidemiological studies show a causal relationship between health effects and short and long-term exposure to fine particulate matter. In addition, BC is a short lived climate species and it affects climate through direct and indirect effects. A measurement campaign has been carried out during the winter time (February –March 2016) in urban (Milano) and rural (Motta Visconti) areas. The aim of this campaign is to go deep insight into the nanoparticles optical properties by coupling on-line optical diagnostics and off-line UV-visible spectrometer measurements. In this work BC measurements performed with laser-induced incandescence will be compared with multi-angle absorption photometer (MAAP) data. The comparison of LII and two-wavelength aethalometer measurements allows the discrimination of the contribution of brown carbon BrC on absorption and to evaluate the mass absorption cross section (MAC).

Measurement Campaign

BC measurements with:

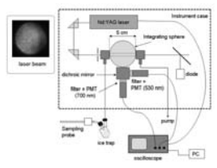
✓Laser-Induced Incandescence measurements (SIILIS instrument) – resolution = 1min

✓Multi-angle absorption photometer (MAAP) - λ = 670 nm (6.6 m^2/g) – resolution = 1h

✓Two-wavelength Aethalometer (Magee Scientific) – resolution = 1 min

- ✓ λ = 370 nm (39.5 m^2/g)
- ✓ λ = 880 nm (16.6 m^2/g)

SILIIS: Sphere-integrated LII Spectroscopy

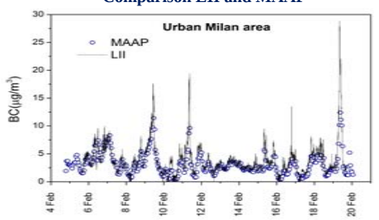


detection range : 20 ng/m^3 – 20 g/m^3

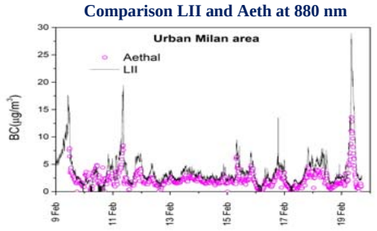
Results

Urban area

Comparison LII and MAAP

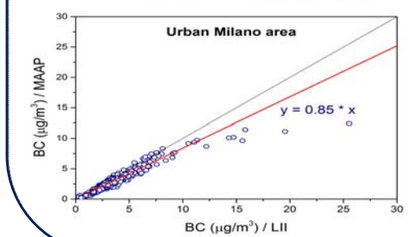


Comparison LII and Aeth at 880 nm

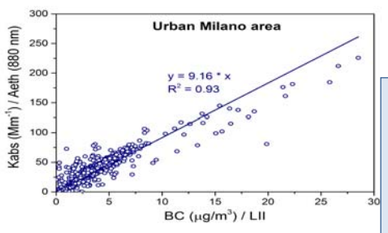


✓Aethalometer raw data are corrected for the loading effects according to Virkkula et al. 2007

Corelation between LII and MAAP

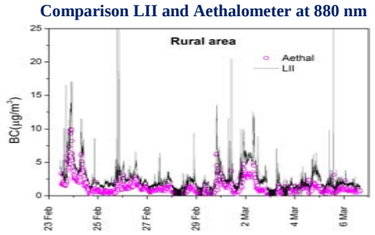


Corelation between LII and Aeth at 880 nm

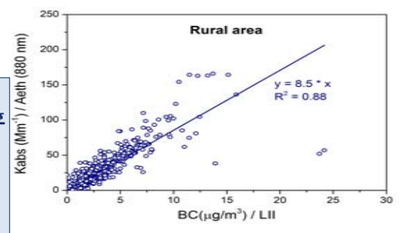


Rural area

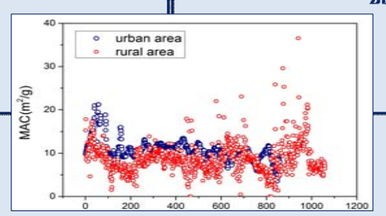
Comparison LII and Aethalometer at 880 nm



Corelation between LII and Aeth at 880 nm

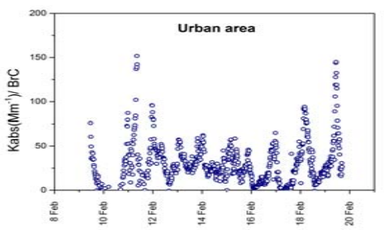


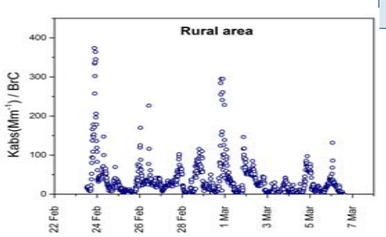
Mass absorption cross section: $MAC = \frac{K_{abs}}{BC}$



Brown Carbon contribution

✓ K_{abs} (BrC) = K_{abs}(370nm) – [K_{abs}(880nm) * 880nm/370nm]





Conclusions

✓Good correlation between LII and MAAP

✓LII vs K_{abs} @880nm allows the evaluation of the mass absorption cross section (MAC).

✓The MAC values obtained in the rural and urban areas can be considered very similar, as also underlined in the spread values of the slopes (K_{abs} vs LII).

✓Assuming a dependence of the BC absorption coefficient on λ^{-1}, the comparison of the absorption at the two wavelengths allows the evaluation of the contribution of BrC in the two areas under analysis.

✓The K_{abs} values of BrC detected in the rural area are slightly higher than the corresponding values measured in the urban area.

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