Studies of carbonaceous particles at a traffic site @ Moscavide, Portugal

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Abstract

With the purpose of characterising ambient aerosols and their time evolution and to assess the contribution of the main emission sources and processes leading to aerosol formation in the atmosphere a campaign was conducted in the urban centre of Moscavide (North of Lisbon, Portugal). A traffic air quality monitoring station was located close to one-way street with a total length of 1.2 km. Particulate matter was sampled and on-line BC measurements (Aethalometer AE33) and total carbon (TC, measured by TCA08) were performed simultaneously. The sampled filters were analysed by gravimetry, by XRF, for the determination of element concentrations, and by thermo-optical analysis, for the measurement of organic and elemental carbon.

We present highly time resolved measurements, perform source apportionment and investigate local and regional pollution events. Separation of contributions to BC from different combustion sources is based on the dependence of absorption on the wavelength, while the measurement of TC allows the determination of equivalent OC, that is the difference between TC and EC (inferred from BC), at high time resolution. The combination of the data generated by the on-line equipments was combined with data from the chemical analysis of filters (OC/EC and elements), obtaining for the first time the parameters for the thermal protocol applied in the University of Aveiro. Additionally, data from chemical characterisation of particles is used to support the source apportionment.
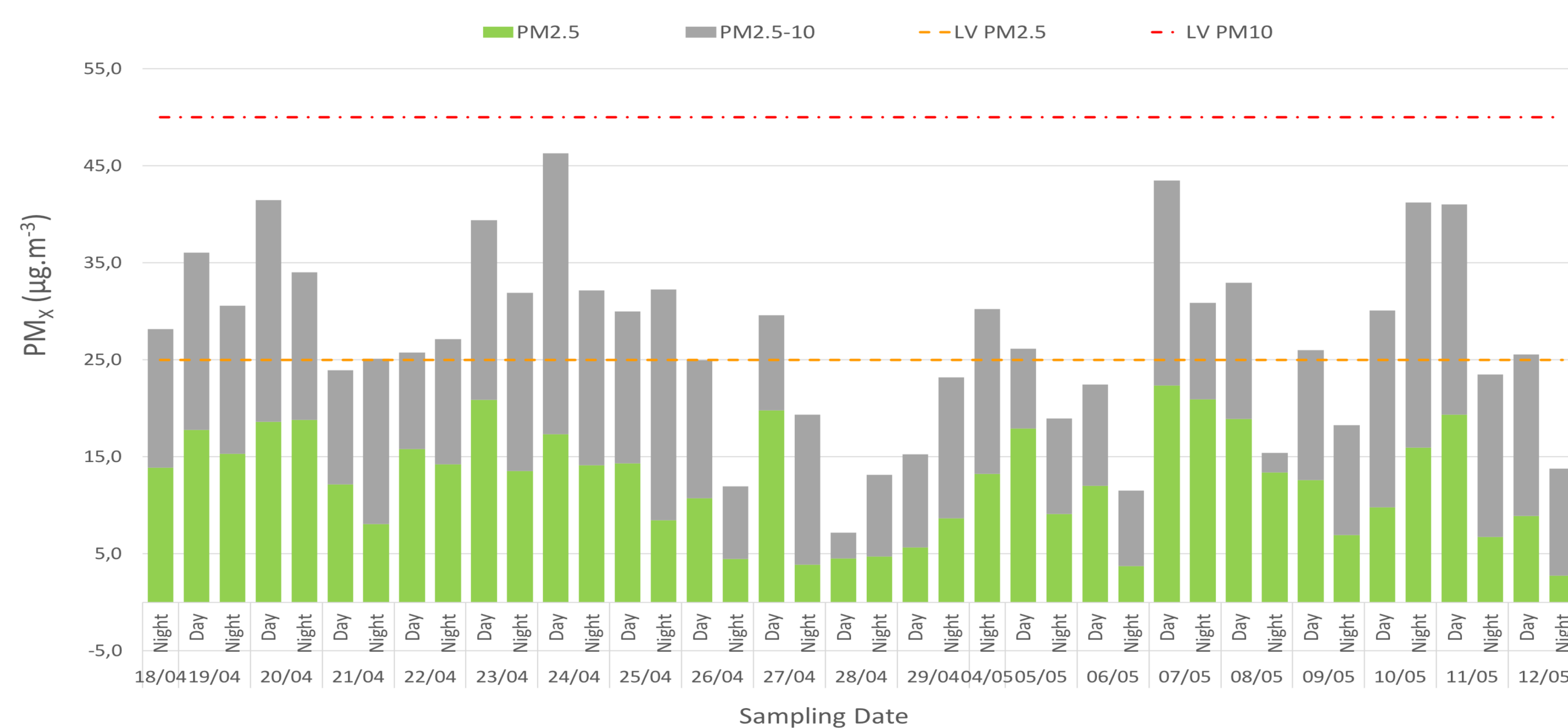
Introduction

Particulate matter (PM) is a complex mixture of extremely small particles and liquid droplets emitted by different sources and produced in the atmosphere. It is very spatially and temporally heterogeneous and many sources contribute to PM and their gaseous precursors. One of the most important fractions is carbonaceous matter, which includes a refractive primary component - black carbon (BC).

BC is emitted during the incomplete combustion of fossil fuels, biofuels, and biomass burning and absorbs at all wavelengths of solar radiation. Together with methane and tropospheric ozone, BC is one of the most important contributor to current global warming after carbon dioxide. BC and co-pollutants are currently considered a major environmental cause of respiratory and cardiovascular diseases, with a global estimation of more than 7 million premature deaths annually from exposure to indoor and outdoor polluted air. Thus, it is of main importance to determine the chemical composition of submicron aerosol at high time resolution, providing the necessary information for accurate source apportionment.

Methodology

- **Study site:**
  - Avenue of Moscavide (Loures, Portugal) → urban-traffic background

Lisbon

- **Experimental set-up:**

Results and Discussion

- **No sampling periods showed PM_{10} or $PM_{2.5}$ values above the limit value**

- Highest mean PM_{10} and $PM_{2.5}$ concentration during the day period on weekdays (35.1 ± 7.2 µg.m^{-3} and 16.9 ± 4.1 µg.m^{-3}, respectively)
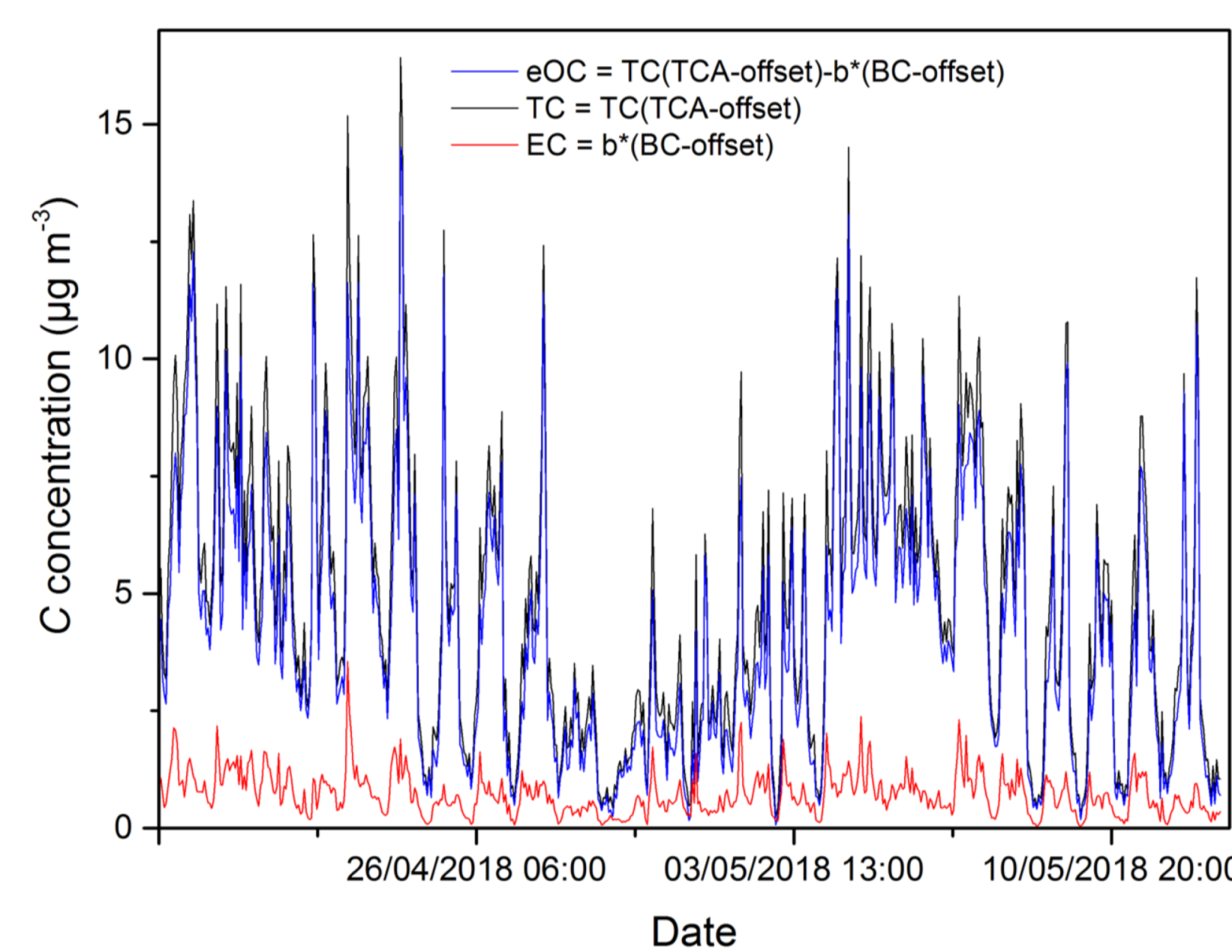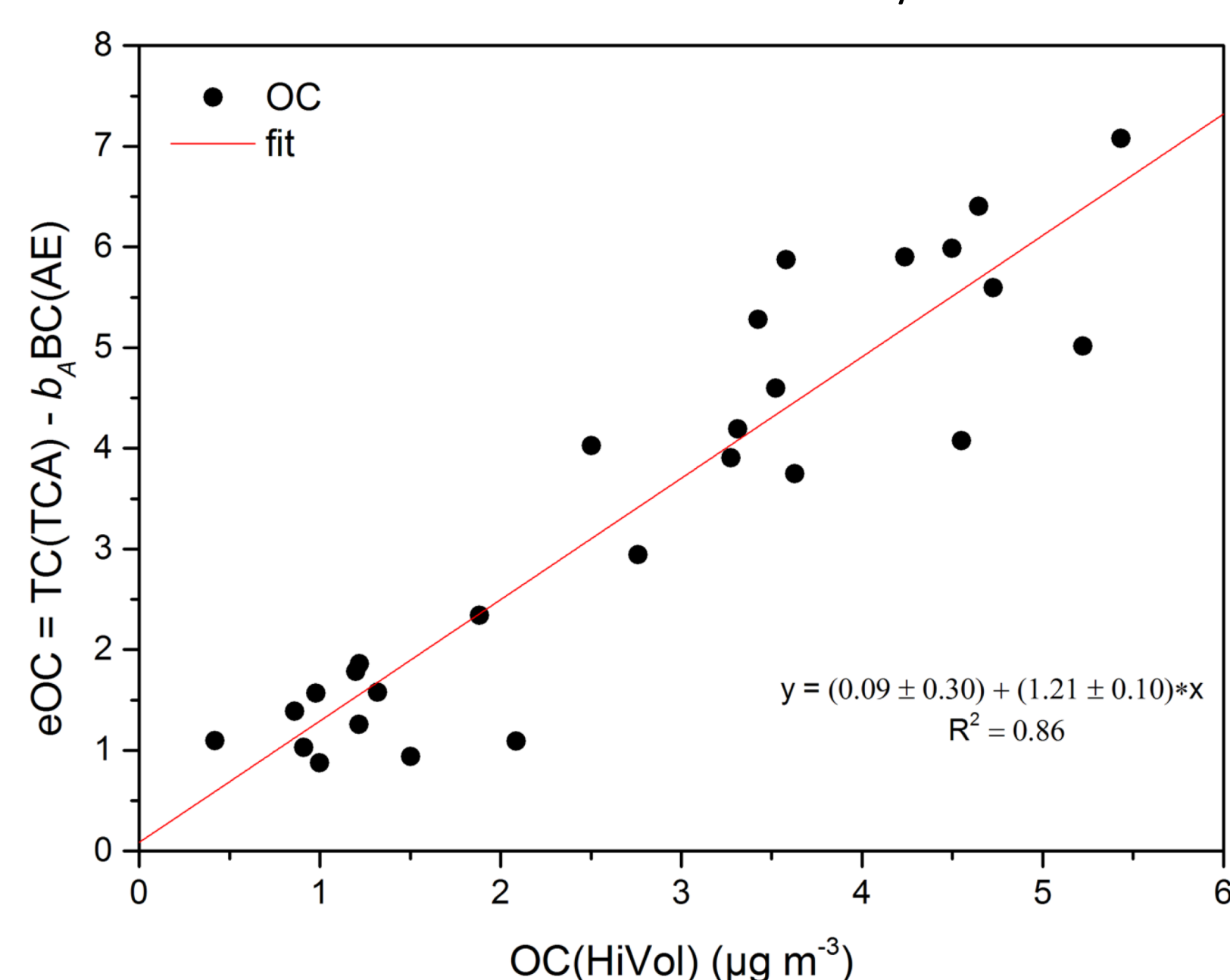
TC-BC method

This method combines two different highly time resolved measurements to determine organic carbon (OC) fraction with **high time resolution**:
- Optical measurement of BC with Aethalometer AE-33
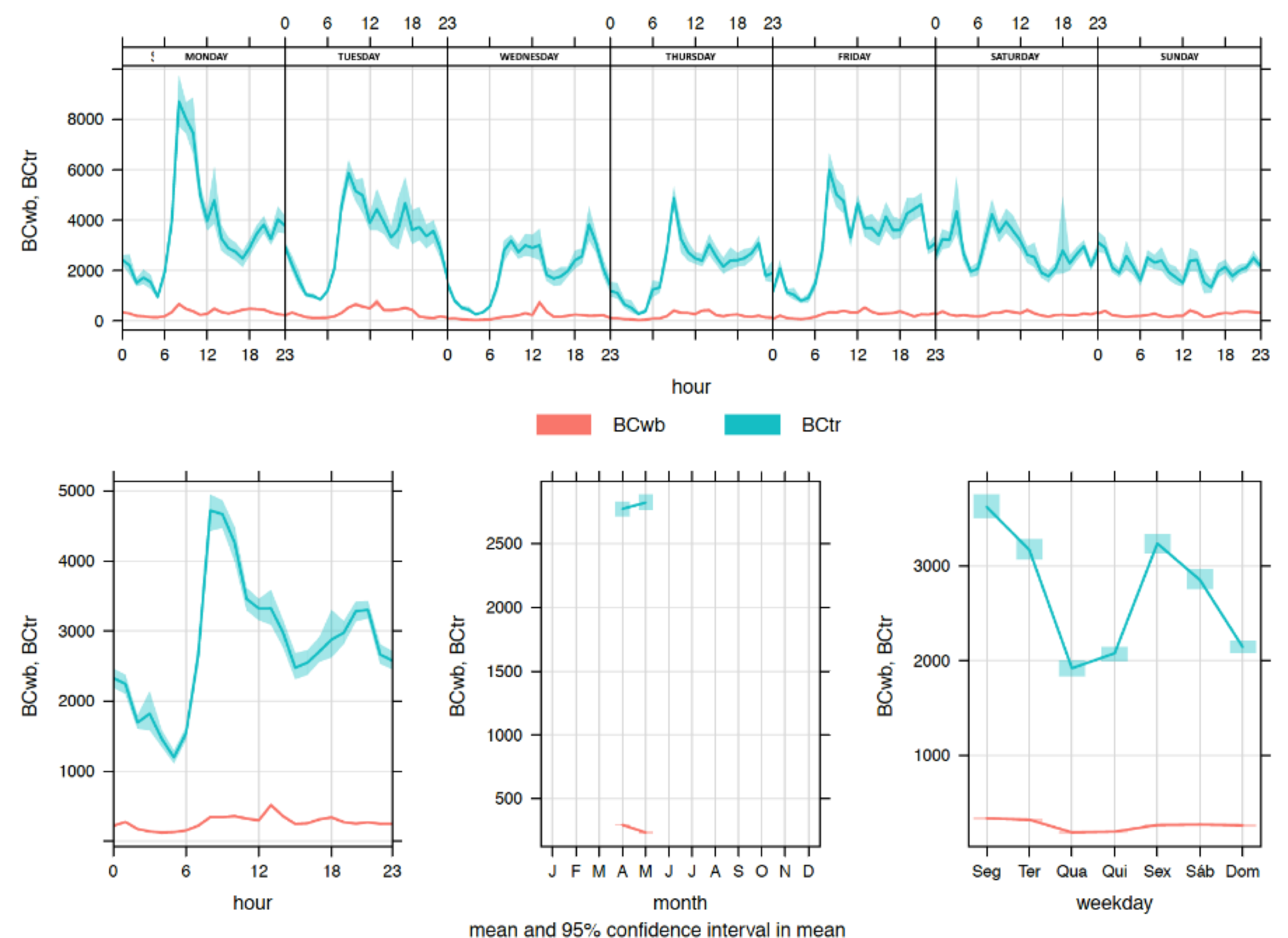- Thermal measurement of TC with newly developed TCA-08

$$OC = TC - b_A \cdot BC$$

- $b_A \cdot BC$ is equivalent to elemental carbon (EC), and the determined proportionality parameter b_A is region/site specific but also depends to a large extent on a thermal protocol used to determine the EC fraction with the conventional OC/EC method.

$y = (0.09 \pm 0.30) + (1.21 \pm 0.10)*x$
$R^2 = 0.86$

Aethalometer model

- BC source apportionment – dominated by traffic while wood burning contribution was negligible as expected (T_{aver} 30℃);
- Absorption Ångström exponent (AAE) values chosen were of 1.0 for traffic (α_{TR}) and 2.0 for wood burning (α_{WB}).