Performance evaluation of black carbon portable instruments with a laboratory experimental set-up under a controlled environment.

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RESUME

Le « carbone suie » (BC) est un composant majeur de la suie produite lors de la combustion de combustibles fossiles, principalement des moteurs à combustion (en particulier le diesel), de la combustion résidentielle du bois et du charbon et de la combustion des déchets agricoles. Le BC joue un rôle important en tant que forceur climatique de courte durée (Bond et al., 2013).

L'aethalomètre est la méthode la plus utilisée pour mesurer les concentrations de « carbone suie » dans l'atmosphère. Cette méthode recueille l'air dans l'atmosphère à travers un filtre et la diminution de la transmission de la lumière à travers la zone d'échantillonnage est mesurée. Des instruments portables dédiés à une telle mesure sont disponibles dans le commerce. Un besoin d'évaluation de leur performance est donc identifié. Dans cette étude, nous présentons les résultats d'une intercomparaison entre un instrument de référence et des instruments portables réalisée à l'aide d'un montage expérimental dans un environnement contrôlé en termes de température, d'humidité relative, de concentrations d'aérosols et de distributions de taille.

ABSTRACT

Black carbon (BC) is a major component of the soot produced during combustion of fossil fuels, principally from combustion engines (especially diesel), from residential burning of wood and coal and from field burning of agricultural wastes. BC plays a significant role as a short-lived climate forcer (Bond *et al.*, 2013).

Aethalometers are the most used method for measuring black carbon concentrations in the atmosphere. This method collects air in the atmosphere through a filter and the decrease of light transmission through the sampling area is measured. Portable instruments dedicated to such measurement are commercially available. A need for their performance evaluation is therefore identified. In this study, we present the results of an intercomparison between reference and portable instruments performed using an experimental set-up under a controlled environment in terms of temperature, relative humidity, aerosol concentrations and size distributions.

KEYWORDS: Black carbon, portable instrument, controlled environment, metrological evaluation.

1. EXPERIMENTAL SET-UP

Five portable instruments AE51 (TSI), three MA200 and one MA300 (AethLabs) devices were evaluated against a reference method. The portable instrument was placed inside an exposure chamber where the temperature (T) and relative humidity (RH) were controlled in real time. Experimental set-up is presented in the Figure 1. Soot particles were produced using a miniature inverted soot generator (MISG, *Argonaut scientific*). The soot aerosol goes through a catalytic stripper (CS010, *Catalytic instruments GmBh*) to remove all organic compounds before their injection into the exposure chamber.

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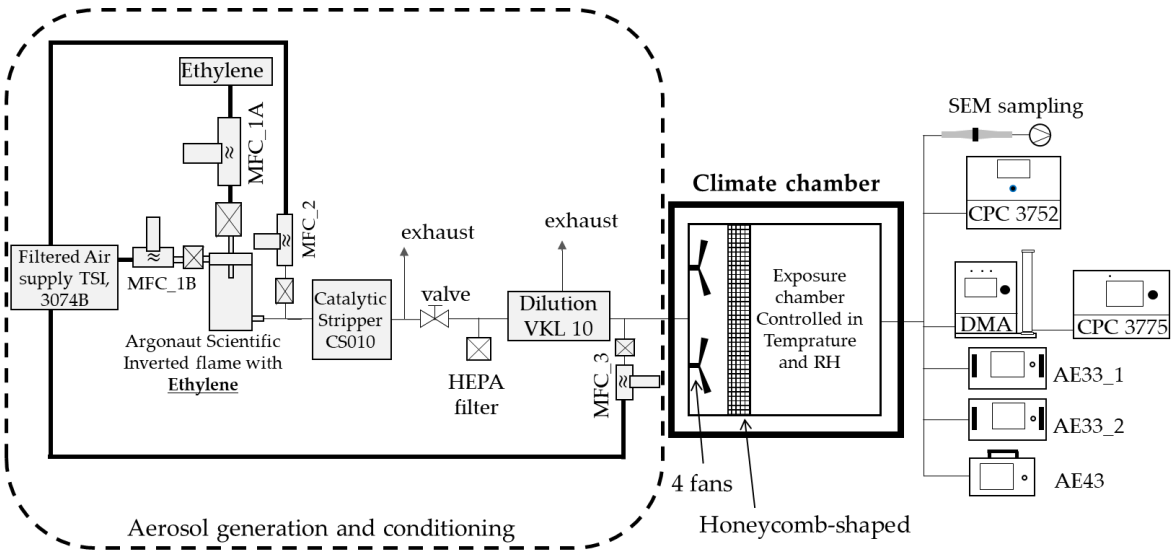

Figure 1. Scheme of the experimental set-up.

Number particle size distributions within the exposure chamber were measured using a Scanning Mobility Particle Sizer (TSI, SMPS). Particulate mass concentrations were measured using a TEOM microbalance and total number concentrations with a Condensation Particle Counter (TSI, CPC 3752). Finally, black carbon concentrations were determined with two aethalometers (AE33, *Magee scientific*) and one portable black carbon monitor (AE43, *Magee scientific*) was used as reference method.

2. RESULTS

Figure 2 shows linearity correlation of portable instruments in comparison with the AE33 reference instrument for $T = 19.91°C \pm 0.04°C$ and $RH = 10.2 \pm 0.3\%$.

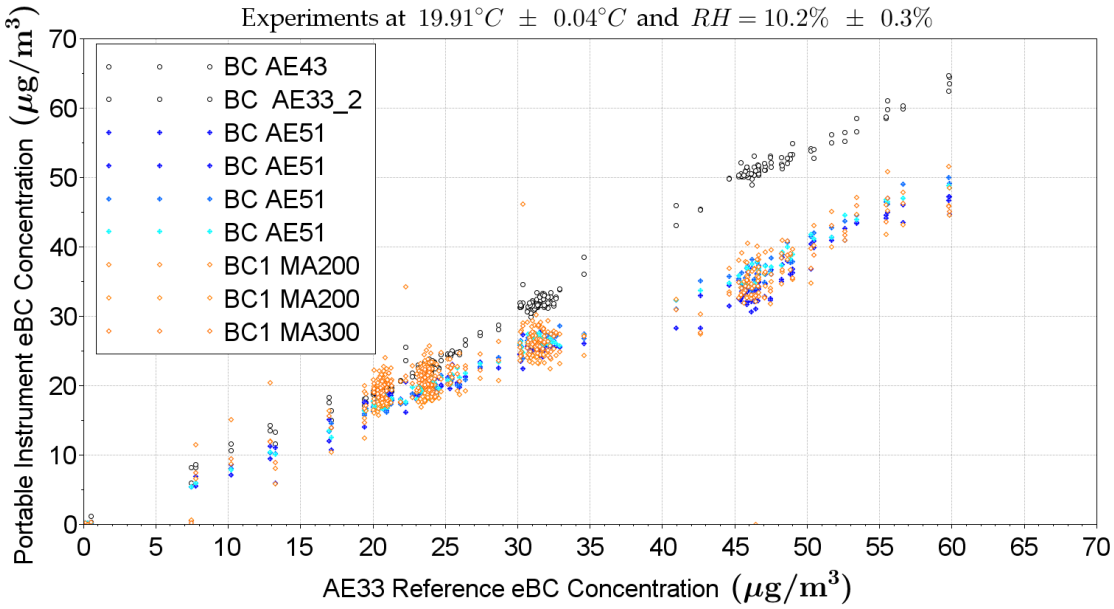

Figure 2. Linearity correlation between portable instrument and reference method

The slope of the linear regressions (measured values of the portable instruments versus the values of the AE33 reference) varied between 0.40 and 0.57 for AE51. R^2 value (square of the Pearson correlation coefficient) was in the range between 0.91 and 0.98 for AE51. There is however a necessity to correct all datas with an harmonized approach for all devices (taking into account loading effect). The impact of temperature and relative humidity from corrected datas will be shown during the presentation.

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Bond, T.C. *et al.* (2013) 'Bounding the role of black carbon in the climate system: A scientific assessment', *Journal of geophysical research: Atmospheres*, 118(11), pp. 5380–5552.