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Paper/Poster-Abstract Form

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Extended Summary

Title: Measurement of black carbon content distribution during incense burning event

Introduction

Black carbon (BC) is of great concern due to its effects on Earth's radiation balance. Moreover, carbonaceous fraction of aerosol particles was also related to negative effect on human health (Soto *et al.*, 2008). The BC effects on human health depend on its ability to cross the respiratory system which is a function of the aerodynamic behavior of the particles carrying BC content. Thus, the BC content with respect the whole particle mass need to be deepened, that is to measure the BC content mass distribution as function of particle diameter. BC is a result of combustion sources, therefore, during the last years, a number of studies were conducted in urban areas where vehicles are expected to emit carbonaceous particles. However, high BC concentrations were also found in indoor microenvironments (cigarettes, cooking and other combustion phenomena).

In the present work a preliminary study of the BC content mass distribution during incense burning events was carried out. Incense was used in the experimental analysis since it allows to easily obtain lasting constant concentrations.

Experimental analysis

In the proposed experimental campaign freesia and citronella based incense sticks were used. The smoke produced by incense stick burning was channeled through a duct in a plenum where sampling points were supplied. Samplings of particles emitted by incense burning were performed in the plenum were lasting constant particle concentrations were assured.

BC content mass distributions were measured by connecting a BC monitor (the aethalometer AE51, Magee Scientific) to an Electrostatic Classifier (EC3080, TSI Inc.). The EC3080 is able to classify dimensionally monodisperse particles which are immediately flown to the AE51 that measures BC mass concentration through optical attenuation method. Diameter logarithmically equally spaced were used to built the BC distribution in the range 20-500 nm with a resolution of 8 channels per decade. 5 minute-samplings for every selected channel diameter were performed, thus the time spent to measure the complete BC distribution was about 1 hour. Therefore, constant particle concentration levels in the plenum need to be guaranteed. To this purpose, particle number concentrations were continuously monitored through a Condensation Particle Counter (CPC 3775, TSI Inc.). Finally, BC mass values of every channel were corrected by charging and selection efficiencies characteristics of the EC3080.

BC total mass concentrations were measured through the AE51 alone before and after the BC distribution measurement in order to evaluate the metrological compatibility between the two methods.

Particle mass distributions and total concentrations were also measured during freesia incense burning event by connecting the CPC 3775 to the EC3080 in a Scanning Mobility Particle Sizer (SMPS 3936, TSI Inc.) configuration to evaluate the BC content with respect the whole particle mass for the produced freesia incense smoke.

Results

Total particle number concentrations of $3.5\times10^6\pm0.5\times10^6$ part. cm^{-3} and $2.7\times10^6\pm0.4\times10^6$ part. cm^{-3} were measured during freesia and citronella incense burning events, respectively. Standard deviations lower than 15% indicate that steady-state concentrations of the aerosol in the plenum were obtained. Corresponding average BC total mass concentrations were measured equal to 39.8±2.8 μg m^{-3} and 34.5±5.2 μg m^{-3}, respectively.
In Figure 1, mass distributions of BC content due to freesia and citronella incense stick burning events are reported. Such BC distributions are log-normal with a mode value of about 200 nm and 300 nm for freesia and citronella incense, respectively. The BC total mass concentration evaluated by such measured distributions are equal to 40.0 e di 36.0 μg m^{-3} for freesia and citronella incense burning events, respectively: these values are metrologically compatible with the total BC concentrations obtained through the AE51 time-integrated measurements.

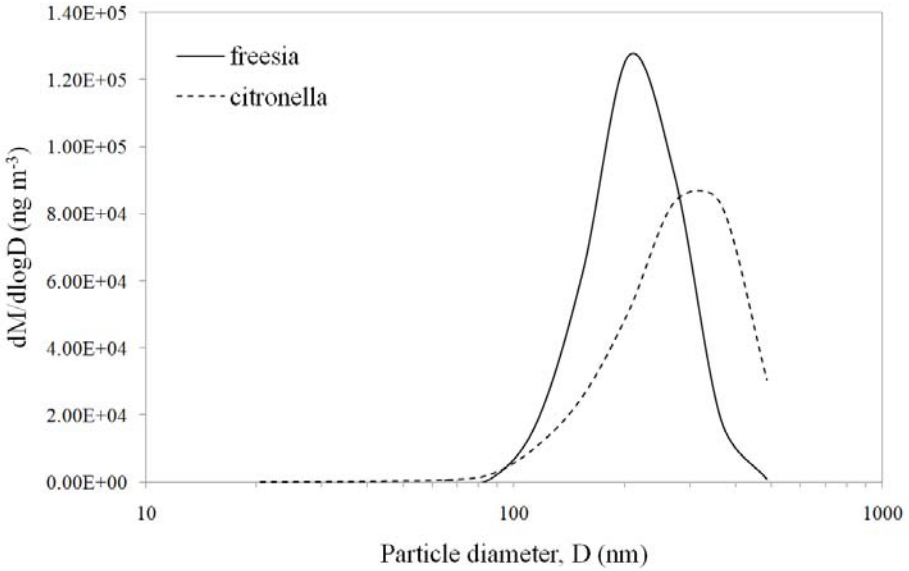

Figure 1 – Mass distributions of BC content due to freesia and citronella incense sticks burning.

Moreover, whole particles mass distribution was measured through the SMPS 3936 when freesia incense sticks were burnt. In Figure 2 the mass distribution of BC content and the total particle mass distribution (incense smoke density of 1.1 g cm^{-3} as reported in Ji *et al.*, 2010) emitted during incense burning event are reported. Incense aerosol particle distribution is clearly higher than the BC content distribution, in fact, the total BC mass concentration was measured to be only 0.4% (40.0 μg m^{-3}) of the total incense aerosol particle mass concentration.

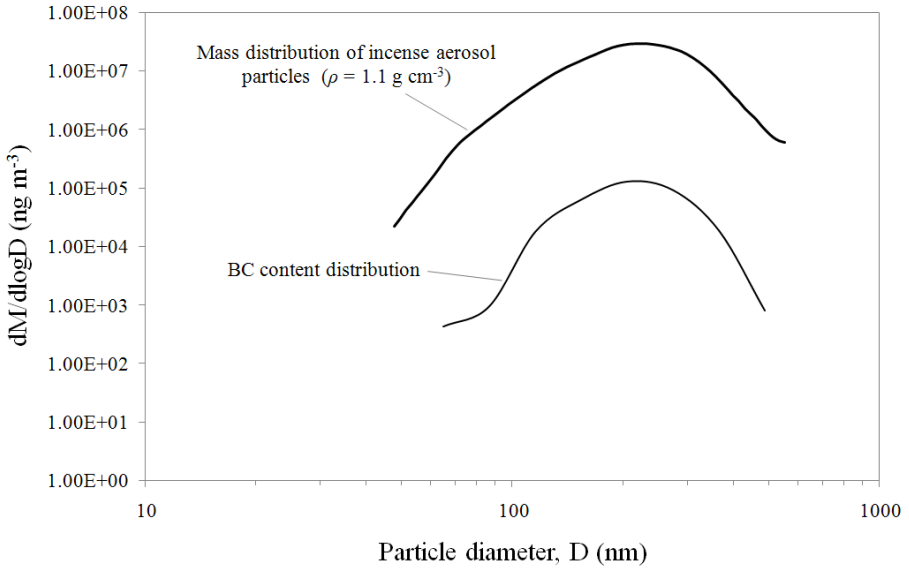

Figure 2 – Comparison between mass distribution of particle and BC content during freesia incense burning event.

References

Ji, X., Le Bihan, O., Ramalho, O., Mandin, C., D'Anna, B., Martinon, L., Nicolas, M., Bard, D., Pairon, J.-C., 2010. Characterization of particles emitted by incense burning in an experimental house, Indoor Air 20, 147–158.

Soto, K.F., Garza, K.M., Shi, Y., Murr, L.E., 2008. Direct contact cytotoxicity assays for filter-collected, carbonaceous (soot)nanoparticulate material and observations of lung cell response. Atmospheric Environment 42, 1970-1982.

Short CV: Luca Stabile earned the master degree in Mechanical Engineering at the University of Cassino, Italy, in 2006 and the Ph.D. degree in Civil Engineering from the same institution in 2011 with a dissertation on the aerosol measurement in several microenvironments. Currently he is assistant professor at the University of Cassino and his main research topic is the aerosol particle characterization. He is author of several papers published on national and international journals and presented to national and international congresses.

Measurement of black carbon content distribution during incense burning event

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Introduction

Black carbon (BC) is of great concern due to its effects on Earth's radiation balance. Moreover, carbonaceous fraction of aerosol particles was also related to negative effect on human health. The BC effects on human health depend on its ability to cross the respiratory system which is a function of the aerodynamic behavior of the particles carrying BC content.

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However, high BC concentrations were also found in indoor microenvironments (cigarettes, cooking and other combustion phenomena).

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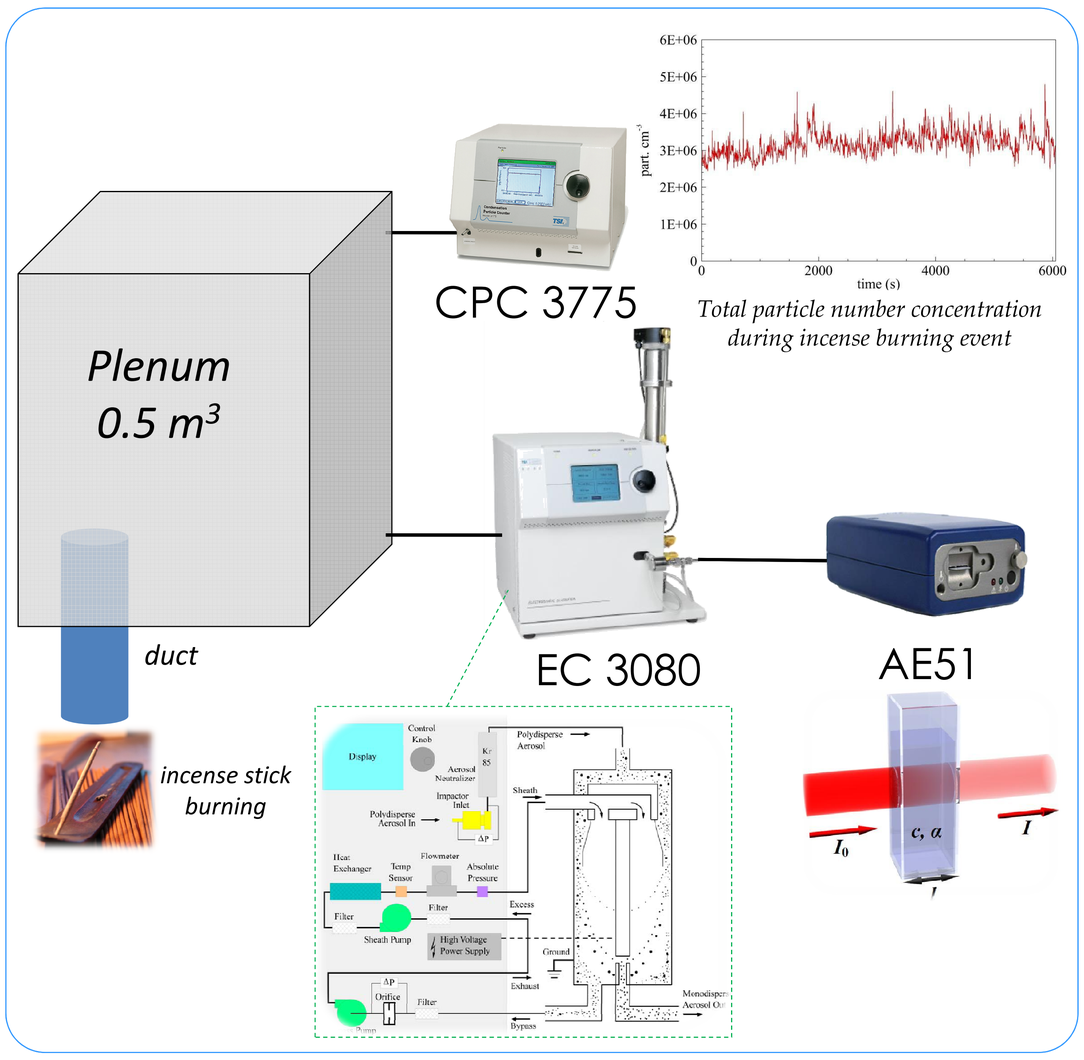

Total particle number concentration during incense burning event

Experimental analysis

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Results and discussions

- Total particle number concentrations of $3.5\times10^{6}\pm0.5\times10^{6}$ part. cm^{-3} and $2.7\times10^{6}\pm0.4\times10^{6}$ part. cm^{-3} were measured during freesia and citronella incense burning events, respectively. Standard deviations lower than 15% indicate that steady-state concentrations of the aerosol in the plenum were obtained.
- Corresponding average BC total mass concentrations were measured equal to 39.8±2.8 µg m^{-3} and 34.5±5.2 µg m^{-3}, respectively.
- In Figure 1, mass distributions of BC content due to freesia and citronella incense stick burning events are reported. Such BC distributions are log-normal with a mode value of about 200 nm and 300 nm for freesia and citronella incense, respectively. The BC total mass concentration evaluated by such measured distributions are equal to 40.0 e di 36.0 µg m^{-3} for freesia and citronella incense burning events, respectively: these values are metrologically compatible with the total BC concentrations obtained through the AE51 time-integrated measurements.

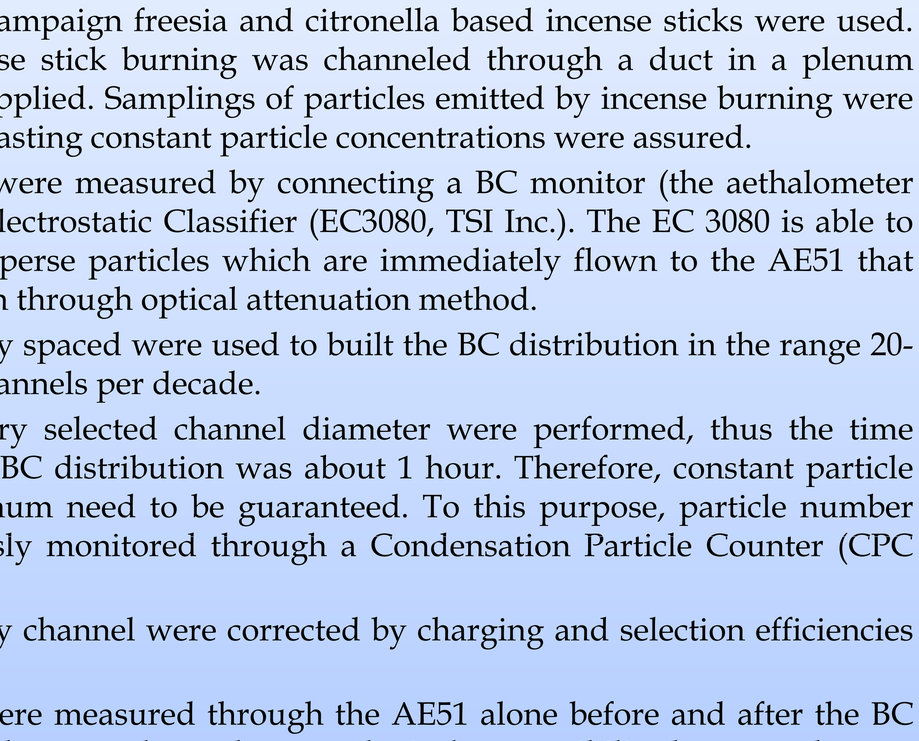

Figure 1 - Mass distributions of BC content due to freesia and citronella incense sticks burning.

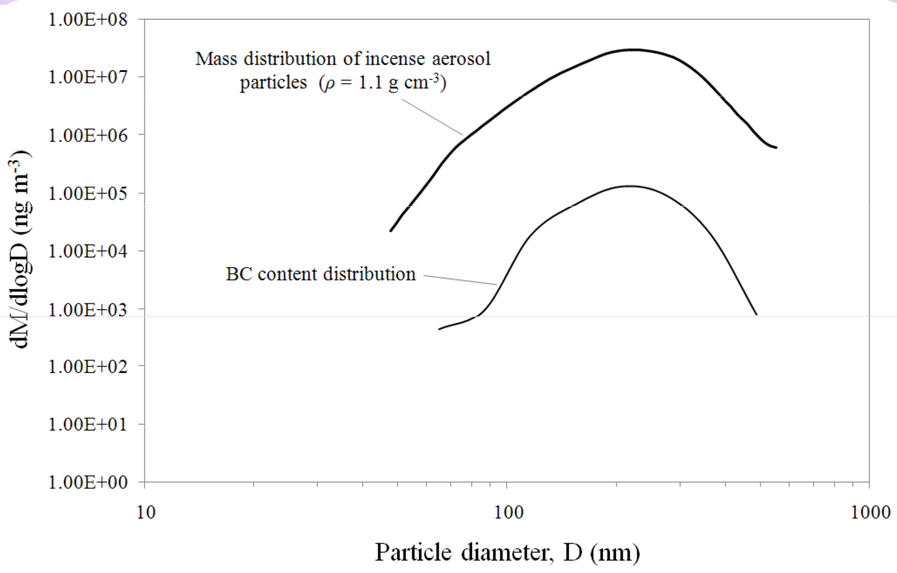

Figure 2 - Comparison between mass distribution of particle and BC content during freesia-based incense burning event.

Moreover, whole particles mass distribution was measured through the SMPS 3936 when freesia incense sticks were burnt.

- In Figure 2 the mass distribution of BC content and the total particle mass distribution (incense smoke density of 1.1 g cm^{-3} as reported in Ji *et al.*, 2010*) emitted during freesia-based incense burning event are reported.
- Incense aerosol particle distribution is clearly higher than the BC content distribution, in fact, the total BC mass concentration was measured to be only 0.4% (40.0 µg m^{-3}) of the total incense aerosol particle mass concentration.

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