Assessment of black carbon influences on air quality in a suburban area from eastern Europe during winter season

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Introduction

Atmospheric aerosols represent an important climate-forcing component of the Earth System and play a central role in Air Quality. Many studies focusing on the assessment of biomass burning (BB) aerosol were performed across Europe underlining the major impact of domestic heating on air pollution during winter (Favez, 2009; Fuller, 2014). On the other hand, the contribution of this source in Eastern Europe remains largely unknown and needs to be fed by intensive research focused on this issue. The influence of residential heating and traffic emissions on winter air pollution at a suburban environment from Romania was investigated during winter period 2017-2018 in the framework of ACTRIS-EMEP-COLOSSAL campaign. High time-resolved data on light-absorbing aerosols using a seven-wavelength Aethalometer (AE33 model), NOx, retrieved from Horiba Monitors, and filter-based (PM2.5) measurements of EC/OC and anhydride sugars (incl. levoglucosan) were combined to apportion black carbon (BC) (wood or fossil fuel) contribution.

Methods

The separation of BC resulted from wood burning from BC produced by traffic/fossil fuel was based on following equations:

$$b_{abs}(\lambda_{UV})_{wb} = \frac{1}{1-\left(\frac{\lambda_{UV}}{\lambda_{IR}}\right)^{-\alpha_{ff}} \cdot \left(\frac{\lambda_{UV}}{\lambda_{IR}}\right)^{\alpha_{wb}}} \cdot \left[b_{abs}(\lambda_{UV}) - \left(\frac{\lambda_{UV}}{\lambda_{IR}}\right)^{-\alpha_{ff}} \cdot b_{abs}(\lambda_{IR})\right]$$

$$b_{abs}(\lambda_{IR})_{wb} = \left(\frac{\lambda_{UV}}{\lambda_{IR}}\right)^{\alpha_{wb}} \cdot b_{abs}(\lambda_{UV})_{wb}$$

$$b_{abs}(\lambda_{UV})_{ff} = b_{abs}(\lambda_{UV}) - b_{abs}(\lambda_{UV})_{wb}$$

$$b_{abs}(\lambda_{IR})_{ff} = b_{abs}(\lambda_{IR}) - b_{abs}(\lambda_{IR})_{wb}$$

(Kalogridis et al., 2017)

where: $b_{abs}(\lambda_{UV})_{wb}$; $b_{abs}(\lambda_{IR})_{wb}$; $b_{abs}(\lambda_{UV})_{ff}$; $b_{abs}(\lambda_{IR})_{ff}$ are absorption coefficients at the UV and IR wavelengths associated with wood burning (wb) and fossil fuel combustion (ff)

To properly determine the Angström exponent pair (α_{ff} and α_{wb}) we used as tracers the levoglucosan time series averaged every 3 days, resulting a time series of 31 data points; and NOx time series averaged also at 24h.

Conclusions

A sensitivity test was performed for pairs of α_{FF} 0.8-1.2 and α_{wb} 1.7-2.5 and a step of 0.1 was used to determine all possible combinations. The approach used to find the best pairs of alpha (α_{ff} 1.02/ α_{wb} 1.88) was based on correlation factors analyses and standard deviation as threshold. The results shows a r^2 of 0.97 between levoglucosan and specific absorption coefficient of wood burning (fig. 1).

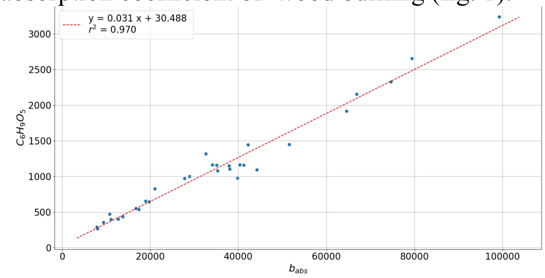

Figure 1.Corelation between levoglucosan and biomass burning absorption

The r^2 between NO_x and fossil fuel absorption coefficient shows a value of 0.79 (fig. 2), indicating a high correlation also.

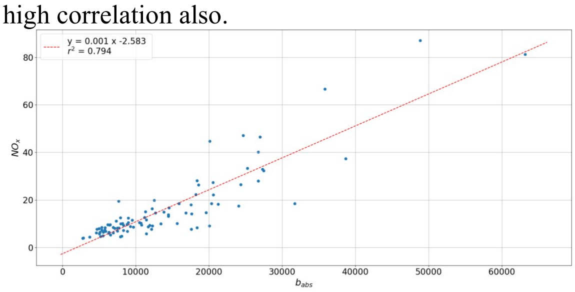

Figure 2. Correlation between NO_x and fossil fuel absorption

Based on this approach, in the factors separation, the BC resulted from residential heating represents the main contributor to the total equivalent BC.

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