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CHARACTERIZATION OF EQUIVALENT BLACK CARBON (EBC) AT A REGIONAL BACKGROUND SITE IN CENTRAL EUROPE: VARIABILITY AND SOURCE IDENTIFICATION

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INTRODUCTION

Black carbon (BC) is recognized to play an important role on adverse public health and in the Earth's climate system (Bond et al., 2013). It is the most efficient light-absorbing aerosol species in the visible spectrum emitted as primary pollutant from a variety of combustion related sources. Although measurements of Equivalent Black Carbon (EBC) with multiple wavelength aethalometer have been used to provide insights regarding the influence of fossil fuel (traffic emissions) and wood smoke in ambient air (Sandradewi et al., 2008; Vaishya et al 2017), scarce studies have been reported in Eastern Central Europe using real-time EBC measurements.

This study focuses on the seasonal, diurnal and weekly trends of EBC at a regional background site in Central Europe during a 5-year measurement. Our aim is to identify the potential sources of EBC, especially the influence from fossil fuel and biomass burning.

EXPERIMENTAL SETUP

The EBC in PM_{10} is monitored from September 2012 to December 2017 at the rural background NAOK (National Atmospheric Observatory Košetice, 49°35' N, 15°05' E), central Czech Republic. Ground based measurements were performed with at 5 min time resolution using a 7-wavelength aethalometer (AE31, Magee Scientific). The EBC data have been corrected for loading effect (Virkulla et al, 2007).

Delta-C variable (Delta-C = EBC370 nm – EBC880 nm), a proxy for biomass burning (Wang et al. 2011) and Ångström absorption exponent (α-value) were calculated for source identification (Sandradewi et al., 2008; Vaishya et al 2017).

RESULTS AND CONCLUSIONS

The wavelength dependence of light absorption by collected aerosols has been investigated to identify the potential sources of EBC at the rural site. Figure 1 shows a clear seasonal trend of EBC concentrations with higher values during the colder months (winter: EBC_{370nm} = 1.53 ±1.25 μg/m³, EBC_{880nm} = 1.00 ±0.87 μg/m³) and lower values during warmer months (summer: EBC_{370nm} = 0.45 ±0.26 μg/m3, EBC_{880nm} = 0.44 ±0.29 μg/m³).

In winter wood burning is the important sources of BC consitent with the higher Delta-C and α-value measured during this season compare to summer when fossil fuel combustion is the main source of EBC. This result is also in agreement with preliminary comparison with Levoglucosan (tracer of wood smoke), which show that there is higher correlation between Levoglucosan and Delta-C (r = 0.86) and α-value (r = 0.69) observed in winter.

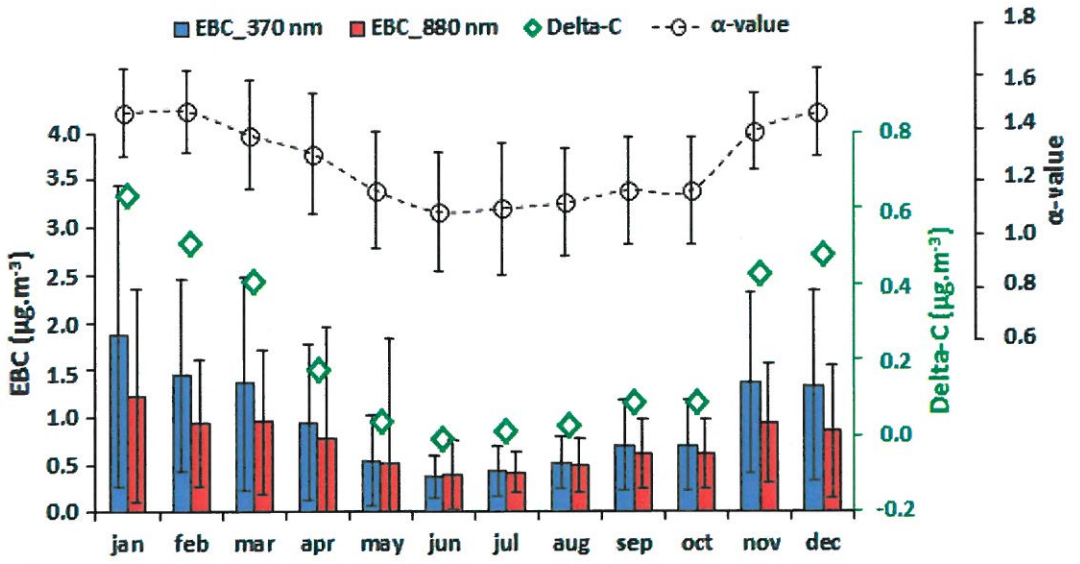

Fig.1: Monthly and seasonal variation of EBC, Delta-C and α-value at the NAOK.

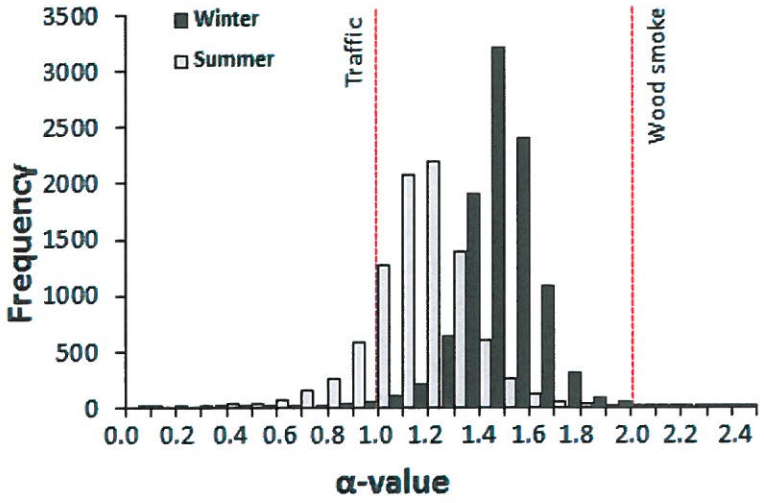

Fig.2: Distribution of mean α-value for 2012-2017.

The distribution of α-value during the long-term measurement is depicted in Figure 2. The measured α-value (1.1 ±0.2) in summer is consistent with reported value for traffic emissions (Sandradewi et al., 2008). In winter, increased emissions from wood burning lead to a higher α-value (1.5 ±0.2), see also Figure 1.

Diurnal cycles of EBC (Fig. 3) is more pronounced in winter than in summer with a morning rush hour peak, afternoon/evening maximum and lower concentrations observed at noon when the mixing height reaches a peak (i.e. higher dispersion of pollutants). In winter, the diurnal cycle shows an increasing EBC concentration in the evening time with a corresponding maximum Delta-C values that could be attributed to the increased wood burning.

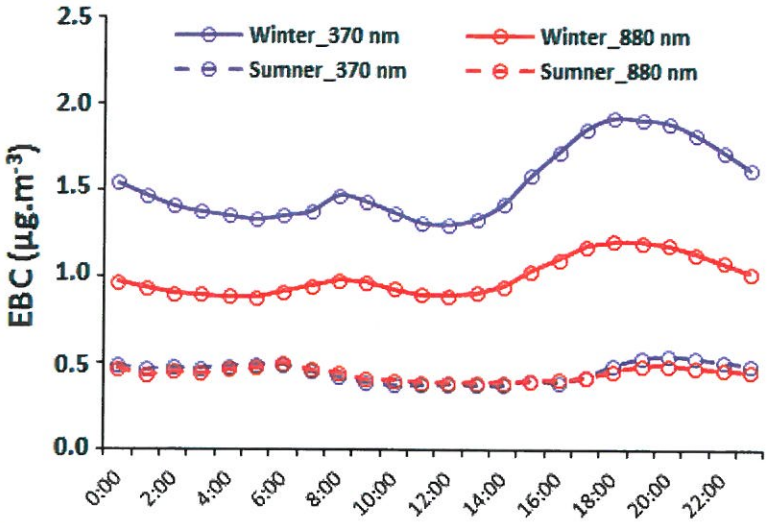

Fig.3: Diurnal cycles of EBC (in µg/m^3) during winter and summer.

In winter, lower concentrations of EBC are observed on Sunday compared to the rest of the week due to reduced emissions from human activity during weekends. During this season when worsening of atmospheric dilution exists, concentrations still high on Saturday that could be related to transport and accumulation of pollutants emitted from the previous working days. $EBC_{370nm} > EBC_{880nm}$ is observed during summer on Friday afternoons and the weekends which could be connected to the influence of wood smoke from barbeques.

Furthermore, the influence of fossil fuel and biomass burning will be investigated in detail by comparing EBC/Delta-C/α-value and other parallel measurements of atmospheric pollutants (CO/NO_x) at NAOK.

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