Black Carbon Concentration Trend in the South-Eastern Baltic Region

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Introduction

A comprehensive study of in-situ optical measurements at GAW and IMPROVE stations carried out by Collaud Coen et al. (2013) for the last 20-year time period revealed that the decreasing trends of scattering and/or absorbing aerosol signals prevail in the northern hemisphere. However, the increase in aerosol decadal trends of absorption coefficient by a few percent per year was also observed at several measurement stations, located on islands and classified either as mountain or as marine sites. The status of equivalent black carbon (eBC) in the South-Eastern Baltic Region starting from 2008 was analysed fragmentally in several scientific publications. In this study the trend of a long-term time series of eBC mass concentration from the Preila Environmental pollution research station (coastal/rural site) were analysed for the first time. The causes of the eBC long-term trend were discussed based on the analysis of possible local and regional sources and an overview of previous eBC studies for this region.

Methods

The online measurements of eBC were carried out by an aethalometer (model AE31, Magee Sci. Co.). Empirical filter loading correction algorithm was applied for eBC data (Virkkula *et al.*, 2007). A thorough statistical analysis of annual, seasonal and monthly eBC variations was conducted. The trend analysis was carried out using parametric: linear regression and the least square method (MLS) The time-series of the measured eBC mass concentration were analysed by decomposing them into a set of certain functions: a trend, periodic fluctuations, etc. Therefore, eBC concentration can be resolved by the sum of these components, as described in Eq. (1): $c(t) = A(t)\sin(f) + T(t) + \partial(t)$, where $A(t)\sin(f)$ is the time dependent annual amplitude with the repeating period of one year, $T(t)$ – the trend function, in general, and $\delta(t)$ – other components (e.g. noise), which were not considered in this study. The aethalometer model (Sandradewi *et al.*, 2008) was employed for distinguishing biomass burning and traffic sources.

Conclusions

The MLS has shown that the mean eBC concentration for the whole measurement period was 750 ng/m^3. A seasonal pattern was also observed with the highest eBC values (1170 ng/m^3) in winter gradually declining to the minimum concentration (380 ng/m^3) in summer. The annual 95th percentile of eBC has also increased by 65 ± 20 ng/m^3 per year, while the 5th percentile remained constant during the analysed period. This indicated that the variability of eBC during the study period had increased. A positive annual linear trend for the whole period was estimated to range from +1.97 % to +5.35 % per year. The MLS trend analysis revealed a second order trend, Eq. (2): $T_{eBC} = -12t^2 + 117t + 528$, where T_{eBC} is the mass concentration of eBC [ng/m^3] and t – time [years], with $t = t_0$ starting on the 1st of January, 2008. This trend reached maximum on 2013 January and was declining during the last years of the analysed period, or, according to the t-test, had any statistically significant trend (Fig. 1).

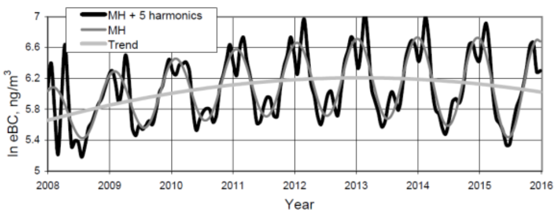

Figure 1. The eBC mass concentration variation calculated by the MLS method for the period of 2008-2015. Here black bold line - the eBC mass concentration variation: the main (annual) approximation component (grey slim line) combined with the five harmonics; bald gray line - second order trend.

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