Identification and characterization of black carbon aerosol sources in Lithuania

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Black carbon (BC) is the most ubiquitous aerosol component which absorbs visible light and affects climate through both direct and indirect mechanisms. The term BC refers to light absorbing carbon aerosols produced by incomplete combustion processes. Due to the molecular structure, which is characterized by valence electrons in π-orbitals, BC able to absorb visible light (380–880 nm). BC is a major component of "soot", a complex light-absorbing mixture that also contains organic carbon. Due to high sorption capacity and optical properties, BC originated from biomass burning (BB) is of great importance to the atmosphere processes. A carbonaceous aerosol component has been observed in fresh volcanic clouds from several volcanoes. The ash plume of the Grimsvötn eruption on 21 May 2011 offered an exceptional opportunity to characterize the volcanic aerosols.

The aim of this experimental study was to investigate BC aerosol source and particles size distributions and their dynamics in the marine environment.

Data set and methodology

The data from the monitoring site located at the EMEP Preila environmental pollution research station (55°55'N, 21°00'E, 5 m asl) in the coastal/marine environment were presented. This station is located on the Curonian Spit, which separates the Curonian Lagoon and the Baltic Sea, and thus can be characterized as a regionally representative background area.

A Magee Scientific Company AethalometerTM, Model AE31 Spectrum, manufactured by Aerosol d.o.o., Slovenia, was deployed at the site and provided real-time, continuous measurements of the BC mass concentration. The optical transmission of carbonaceous aerosol particles was measured sequentially at seven wavelengths λ (370, 450, 520, 590, 660, 880 and 950 nm). The concentration of BC corresponds to the 880 nm wavelength.

The aerosol size distribution was measured by using the Scanning Mobility Particle Sizer (SMPS) built by the Leibniz Institute for Tropospheric Research, Germany. The SMPS is composed of a differential mobility analyzer and CPC UF-02proto. This system had the following general specifications: size range 8 - 900 nm; scan time 5 min; resolution 71 size channels.

We analyzed the aerosol characteristics with respect to categorized air mass backward trajectories for the initial estimation of the BB potential source locations and quantitative contribution. Backward trajectories were produced using the Flextra model (NILU) and meteorological data provided from ECMWF (European Centre for Medium Range Weather Forcast).

Results

Discernible influence of the BB can be seen in Figure 1, where the exponents of the absorption coefficients $\alpha_{370-520}$ are depicted. This is a strong indication that the aerosol particles over the site containing the different amount of UV-absorbing material depend on the source. The Ångström exponent of the absorption coefficient for organic species depends on the wavelength. The dependence of α on the wavelength can be seen in Fig. 1.

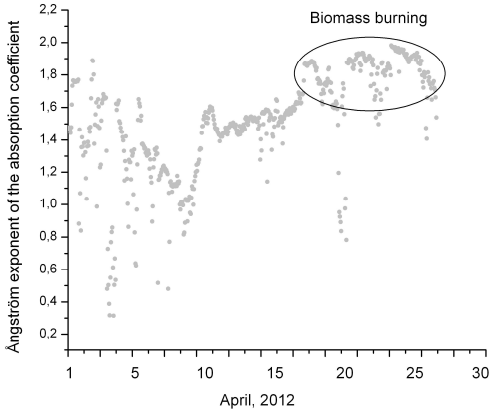

Figure 1. The spectral variation of instantaneous measurements of the Ångström exponent of the absorption coefficient for April 2012

The surface measurements and analysis of the Ångström exponent of the absorption coefficient done separately for shorter and longer wavelengths (i.e., α=370–520 nm and α=660–950 nm) showed that high levels of aerosol BC were related to the transport of air masses rich in BB products caused by active grass burning. During the events the highest mean values of the Ångström exponent of the absorption coefficient $\alpha_{370-520}$ and $\alpha_{590-950}$ nm were observed (2.4±0.1 and 1.5±0.1, respectively).

The observational data and analysis demonstrated that new secondary particle formation event could occur within the lower troposphere at a large distance from the eruptive activity.

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