Temporal variation of urban atmospheric aerosol during smog episodes in Debrecen, Hungary

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One of the leading environmental problems is the atmospheric particle matter (APM) in densely populated urban. High pollution levels regularly occur in most cities all around the world. Debrecen, the second largest city in Hungary and the regional centre of the Northern Great Plain region is no exception. There are several days every year when the particle matter concentration level exceeds the alarm threshold value (100 μg/m^3 for PM_{10} in 24- hours average). It is called "smog" by the authorities when the increased pollution level remains over the limit value for days.

The aim of this work was to study the variation of elemental components and sources of PM_{10}, $PM_{2.5}$ and $PM_{2.5\text{-}10}$ as well as their dependence on meteorological conditions during two smog episodes occurred in November 2011.

Aerosol samples were collected with two-stage PIXE International sequential streaker to study the hourly evolution of atmospheric aerosol concentration. Furthermore, 9-stage cascade impactors were also applied to get information about the size distribution of the elemental components.

Particle Induced X-ray Emission (PIXE) at IBA Laboratory (MTA Atomki) was employed to determine the elemental composition ($Z \geq 13$). Concentrations of black carbon were evaluated by smoke stain reflectometer. Weather prediction model (WRF) was applied to determine the planetary boundary layer (PBL) height values. Source apportionment was carried out on obtained data using the positive matrix factorisation (PMF) method.

The result of the elemental mass size distributions indicates that the elements can be classified into three groups. The first group comprising of minerals is with a dominant peak at the 8-16 μm range. The second group composed of K, Cl, S and Zn. One prevalent peak can be found in the droplet mode (0.5-1 μm) and another lower peak at 4-8 μm. High temperature processes such as combustion processes, particularly woody biomass burning release these elements. The third group contains Br and Pb. The low concentration of these elements seems to be considerable in droplet mode (0.5-1 μm) too, implying that these particles (comprising Br, Pb) used to have a major common source in gasoline.

The time pattern of the aerosol elemental components and PM sources exhibited strong dependence on the planetary boundary layer thickness.

The concentration of some elements (K, Cl, BC) showed inverse tendency compared to PBL in the fine fraction in the first week (2-8 November 2011). This result is represented in Figure 1.

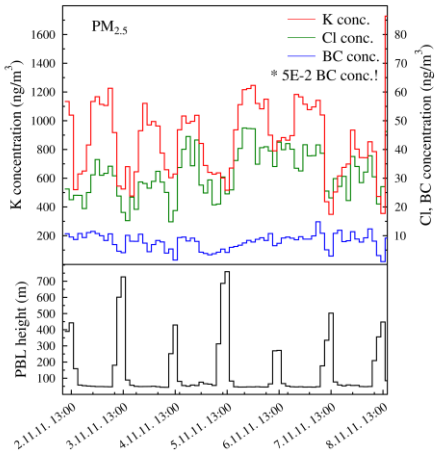

Figure 1. Temporal variation of the concentrations of the elements (K, Cl, BC) and the planetary boundary layer from the 2nd till 8th of November

Traffic derived elements (Fe, Cu, Zn, Pb) and elements from combustion processes (K, Cl, BC) showed also negative correlations with the PBL in the second week (15-21 November 2011).

PMF modelling determined four factors in both size fractions. The sources were identified as soil, biomass burning, traffic and oil combustion in case of fine fraction. Soil with soil improvement agent, two biomass burning, and road dust were recognised in $PM_{2.5\text{-}10}$. Due to above mentioned reasons, biomass burning as domestic heating was the main contributor to formation of smog and the meteorological condition was responsible for the accumulation of combustion aerosols during nights when the planetary boundary layer was the lowest.

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