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Time-resolved analysis of urban air pollution

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Air pollution directly affects the quality of life, human and other being's health, climate, and mediately has an effect on the water and soil pollution. Because of its general environmental and health impact air pollution is continuously monitored worldwide in the bigger cities. In Budapest 12 monitoring station are operating that provide hourly concentration data for the main urban air pollutants namely: carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), particle mass under diameter of 10 μm (PM_{10}) and ozone (O_3).

Generally, air pollutions is characterised by the atmospheric concentrations of the pollutants. While the majority of the receptors (eg. human beings) are affected by the concentration, study of the total columnar mass of the pollutants has similar importance. Columnar mass (*CM*) can be defined as the pollution mass contained by an air column over $1m^2$ ground surface in the boundary layer. Mathematically it can be expressed from the next formulation of the concentration:

$$c(t)=CM(t)/MH(t), \qquad (1)$$

where $c(t)$, $CM(t)$ and $MH(t)$ are the time functions of the concentration, the columnar mass and the thickness of the boundary layer that will be referred as mixing height (MH) in the following. Consequently, the dimension of the columnar mass is $\mu g/m^2$.

Columnar mass characterizes the emission more direct than the concentration, namely its time dependence is devoid from the variation of the thickness of the boundary layer. Based on the time-resolved analysis of the columnar mass, information about the time profile of the emission, as well as chemical modifications occurred after the emission can be obtained. Since climate effect of specific pollutants depends on the numbers of particles or molecules being in the light path, which is related to the columnar mass; CM in addition is the fitting parameter for quantification of climate effect of air pollution.

Relation between the concentration and columnar mass is determined by the volume, within which pollutants are mixed that can be characterized by its vertical dimension, the so called mixing height (MH). In this work hourly averages of mixing height was calculated by AERMOD for a monthly period in June, 2007. Columnar mass was calculated for the pollutants listed above based on Eq.1. Mass fluxes of the pollutants that were calculated as the time derivative of CM are presented in the following figures.

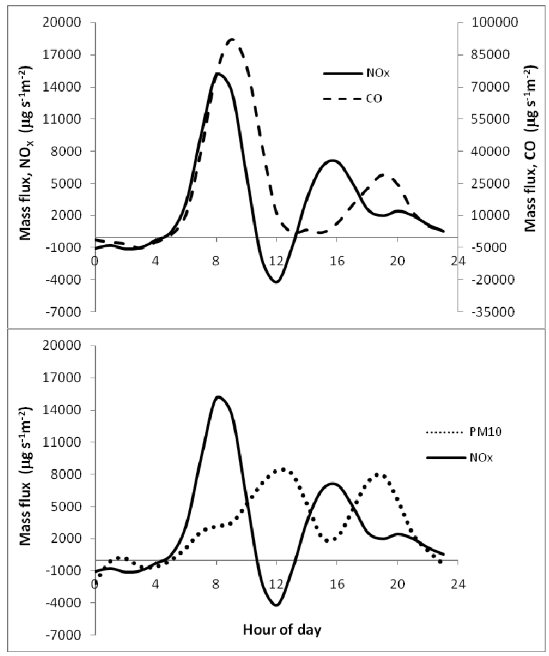

Figure 1. Average daily profiles of CO and NO_X mass fluxes (top panel) as well as NO_X and PM_{10} mass fluxes (bottom panel)

It can be seen from the figures that around 5:00, when the urban traffic starts, the mass flux is positive for all pollutants. The traffic's intensity, and as parallel the emission increase until 9:00, then start to decrease as it can be found from the curve of CO. Mass flux of NO_X reaches its maximum one hour before at 8:00 and has a minimum at 12:00 in the negative range. At the same time mass flux of PM_{10} has a maximum. In the following period NO_X and PM_{10} have complementary variation. This phenomenon can be interpreted by secondary aerosol production from nitrogen compounds as precursor agents. Comparing the local maximum of PM_{10} mass flux at 8:00 by the maxima at 12:00 and 19:00, it can be deducted that the secondary formation of the aerosol has higher contribution to the urban PM_{10} load than the primary emission.

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