

Determination of vertical distribution of air pollution over Budapest by aircraft based measurements

B. Alföldy¹, V. Groma¹, E. Börcsök¹, A. Nagy², A. Czitrovsky², S. Török¹

¹KFKI Atomic Energy Research Institute, Konkoly-Th. M. u. 29-33., 1121, Budapest, Hungary

²Research Institute for Solid State Physics and Optics, Konkoly-Th. M. u. 29-33., 1121, Budapest, Hungary

Keywords: air pollution, mixing layer, Saharan dust, size distribution, trajectory.

Budapest (Bp) is the capital of Hungary, at the same time the largest city of the country. The air pollution of the city is principally determined by traffic related emissions however, contribution of industrial sources as well as pollution transport cannot be neglected.

Aircraft based measurement is an effective way to observe horizontal as well as vertical distribution of air pollution. Investigation of pollutant's vertical profile can provide additional information on the origin of the pollutants that helps the evaluation of urban air quality.

The aims of this work were (i) to study the homogeneity of the pollution in the mixing layer over the city; or (ii) find hot spots that can be associated to any specific emission source on the ground; (iii) to analyse the vertical profile of size fractioned aerosol concentration over downtown and suburban areas, in the mixing as well as the residual layer.

With this object fifteen flights were performed over Budapest and the surrounding area in June and September 2008, and January 2009. Aerosol count concentration and size distribution was measured by a Grimm 1.108 aerosol spectrometer. Black carbon concentration was measured by a Magee Scientific aethalometer. In addition, O₃ and CO concentrations were measured by Horiba gas monitors. The air pressure, temperature and relative humidity was registered by a compact meteorological sensor, while the geographical position was controlled and logged by GPS.

In the first figure concentration time series of two aerosol size fractions with particle diameter of 250nm and 700nm are presented together with the graph of the flying altitude on September 11, 2008. It is seen that until 15:30, while the flying altitude was varying around 400m AMSL the concentration of the two particle size fraction was correlated. After 15:30 the flying altitude increased. At 1400m AMSL, when the aircraft left the mixing layer the concentration of 250nm particles suddenly decreased, while concentration of 700nm particles increased. There was a significant drop in the O₃ concentration as well. These experimental facts together with the analysis of backward trajectories of air masses denote that Sahara originated air mass was sampled over the mixing layer.

Figure 2 shows results of air mass backward trajectory calculation by HYSPLIT model. It is seen

that air masses sampled under 1200m came from over the Atlantic Ocean, while air mass sampled at 1400m passed over the west part of Sahara before it reached European area. The air mass here picked up desert sand and transported into Europe.

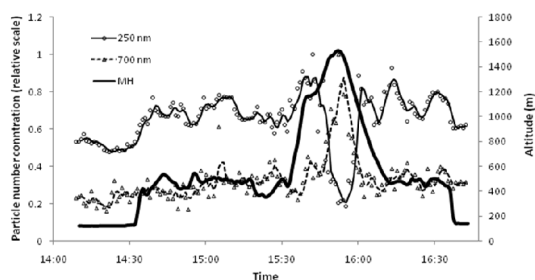


Figure 1. Count aerosol concentration of particles having 250 and 700nm diameter and flying altitude.

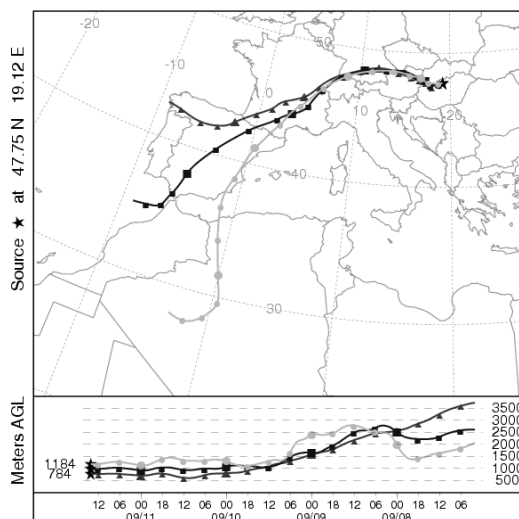


Figure 2. Backward trajectories of air masses sampled at 1000, 1200, 1400m AMSL over Bp.

It must be noted that over the mixing layer the calculated PM₁₀ concentration was low (around 7µg/m³) comparing to the urban pollution concentration. The Saharan dust pass was able to be identified alone over the mixing layer, where the background concentration is negligible. The results reveal the importance of transported pollution in the forming of urban background. Especially naturally generated aerosols can have significant contribution to the PM level in Europe that is not limited to intensive episodes only like Saharan dust events.