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Aerosol particles in a metropolitan underground railway station

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The metropolitan underground railway in Budapest is one of the oldest underground transport systems. Mass concentration, its temporal variation, elemental composition of the aerosol particles, their residence time, and sources in the metro were examined in one of its central stations (Astoria) by in situ aerosol measurements and sample collections.

The temporal variation of the PM10 mass concentration (MC), horizontal wind speed and wind direction were determined with time resolutions of 30 and 4 s by a tapered element oscillating microbalance and wind monitor, and aerosol samples were collected by a stacked filter unit in the PM10–2.0 and PM2.0 size fractions on the platform. The samples were analyzed by gravimetry for the particulate mass, particle-induced X-ray emission spectrometry for elements, and light reflectometry for black carbon.

The diurnal variation of the PM10 mass concentration exhibited two peaks, one at about 7:00, the other at about 17:00. The mean PM10 mass concentration and standard deviation for the working hours were (155 ± 55) μg/m^3. Iron, Mn, Ni, Cu, and Cr exhibited concentrations that were larger than outside by factors between 5 and 20, and these elements were substantially enriched with respect to both the average crustal rock composition and outside average aerosol composition, while black carbon showed a smaller concentration inside than outside. Iron made up for 40 and 46% of the PM10–2.0 and PM2.0 masses, respectively, and 72% of the PM10 mass was associated with the PM10–2.0 size fraction. Mechanical wear and friction of the electric cables and collectors, rails, and wheels, and resuspension were identified as the primary sources, which is consistent with the high time resolution MC measurement (see Fig. 1). The composition of the aerosol in the metro station is quite different from the average outside downtown aerosol above. Table 1 demonstrates that all underground railways presented uniformly exhibit significantly larger concentrations than the daily ambient (outside) EU PM10 limit, and than that for the outside areas just above. Possible health implications for the passengers and workers in the metro will also be discussed.

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Table 1. Ranges and averages of particulate mass concentration in the coarse and fine size fractions for different underground railways.

City	Range (μg/m^3)	Mean (μg/m^3)
Prague	–	103
Berlin	–	147
Budapest	85–234	180
Rome	71–877	407
Stockholm	212–722	469
London	500–1120	795
Cairo	794–1096	938

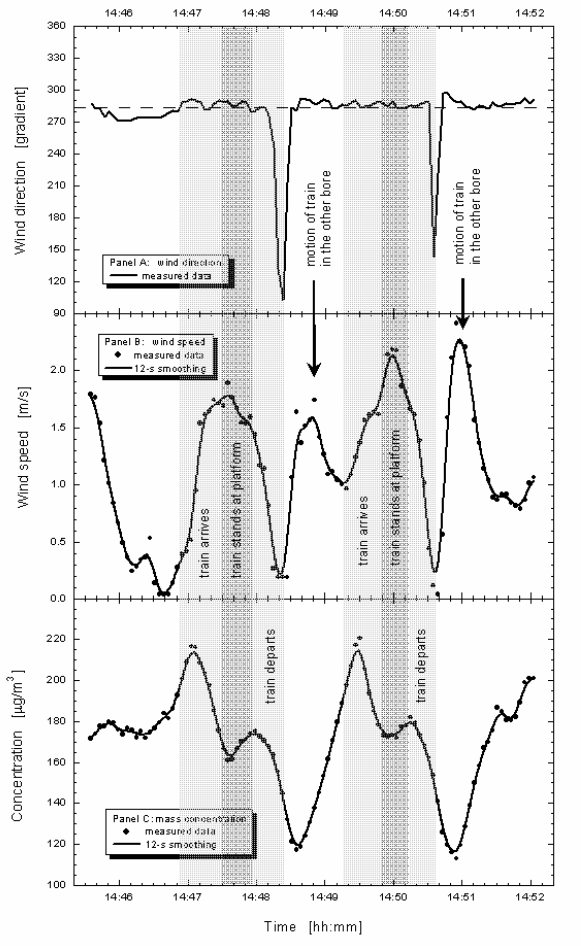

Figure 1. Temporal variation of wind direction, horizontal wind speed, and PM10 mass concentration on 21 April 2006 at the Astoria metro station, Budapest.