RELATIONSHIP OF URBAN AEROSOL TO ROAD TRAFFIC AND LOCAL METEOROLOGY

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INTRODUCTION

In urban environments, it is the road traffic that is recognised to be the main source of particulate air pollution (Colvile *et al.*, 2001). Aerosol particles are emitted directly from the combustion of liquid fossil fuel, or are produced indirectly through reactions in the air invoked by the emissions, or are just resuspended by the mechanical turbulence induced by moving vehicles. Due to the very short distances between the sources and receptors, only few chemical reactions (e.g., photodissociation of NO_2, and reaction between NO and O_3) have significant influence on the urban air quality; most traffic-related pollutants can be considered as practically inert over the typical residence times of pollutants in cities (Vardoulakis *et al.*, 2003). Hence, removal as well as dispersion of particles are mainly governed by local meteorology and topology, and are often limited by street canyon effect in built up areas. Finally, long-range transport of air masses can also influence the actual air quality.

METHODS

As part of an international research project dealing with the comprehensive characterisation of airborne particulate matter and its environmental effects, aerosol samples were collected separately over daylight time and night by several sampling devices including, e.g., stacked filter units (SFUs), while a tapered element oscillating microbalance (TEOM) and an aethalometer were utilised on-line to measure $PM_{2.5}$ mass and black carbon (BC), respectively, during an intensive field campaign from 23 April through 5 May 2002. The equipment was installed on the first-floor balcony at a height of about 7.5 m above the street level at 5, Rákoczi Street, in downtown Budapest, Hungary. The street can be characterised by width, height and length parameters of 30, 25–30 and 600 m, respectively. Synoptic meteorological parameters were recorded at a height of 39 m above ground on a meteorological mast located at a distance of 1.9 km from the field sampling site. The number of vehicles passing the street in both directions was also obtained on line from counting devices mounted into the roadway for controlling the traffic lights.

RESULTS

The median daily concentrations for $PM_{2.5}$ mass and BC were 25 and 2.8 $\mu g/m^3$, respectively. The concentration data exhibit large variability; time trend for BC is presented in Fig. 1a as 15-min averages together with the 6-hour smoothed curve as an example. The correlation coefficient between $PM_{2.5}$ mass and BC is 0.88 indicating that their main source is common, which is unambiguously road traffic. Nevertheless, the time trend for vehicles (Fig. 1b) shows periodicity. On each day, two peaks with a maximum at about 7:30 and 15:30 – corresponding to the morning and afternoon rush hours – can be detected on the smoothed curve. The maximum and location of the daily peaks only differ for holidays from that for workdays. Effect of the periodicity in traffic can be identified in the concentration time trends as well. The morning and afternoon peaks for instance for BC are indeed present on each day, nevertheless their absolute magnitude and relative intensity are very much different from day to day despite the constant traffic intensity on workdays expressed by the daily mean and standard deviation of 543±13 vehicles per 15 min. In order to demonstrate the impact of the local meteorology, the time trend for the horizontal wind speed (WS) is displayed in Fig. 1c. Low wind (WS<2.5 m/s) on 2 and 3 May is

associated with large atmospheric concentrations, while high wind (WS>3.5 m/s) over the night of 29 and morning of 30 April coincides with small concentrations. Two cold fronts passed the city during the field campaign; the first over the morning of 27 April, the second over the night of 29 April, when the $PM_{2.5}$ mass and BC concentrations were the smallest. The precipitation that occurred on 25 April late afternoon and on 26 April around noon decreased the aerosol concentration significantly though for short times (some hours) only, while the rainfall in combination with the front (on 29/30 April) caused better air quality for a longer period (almost a day). As shown in Fig. 1d, the polluted time periods are characterised by small (0.3–0.4) $PM_{2.0}/PM_{10\text{-}2.0}$ (F/C) ratios as obtained from the SFUs which means that the local resuspension dominates, while smaller concentrations are associated with larger (approximately 1) F/C ratios indicating the effect of the long-range transport of air masses.

The road traffic is responsible directly or indirectly for 60–70% of the airborne particulate matter pollution in Budapest, but the actual atmospheric concentrations are much more influenced by local meteorology and long-range transport than by changes in the vehicular emissions.

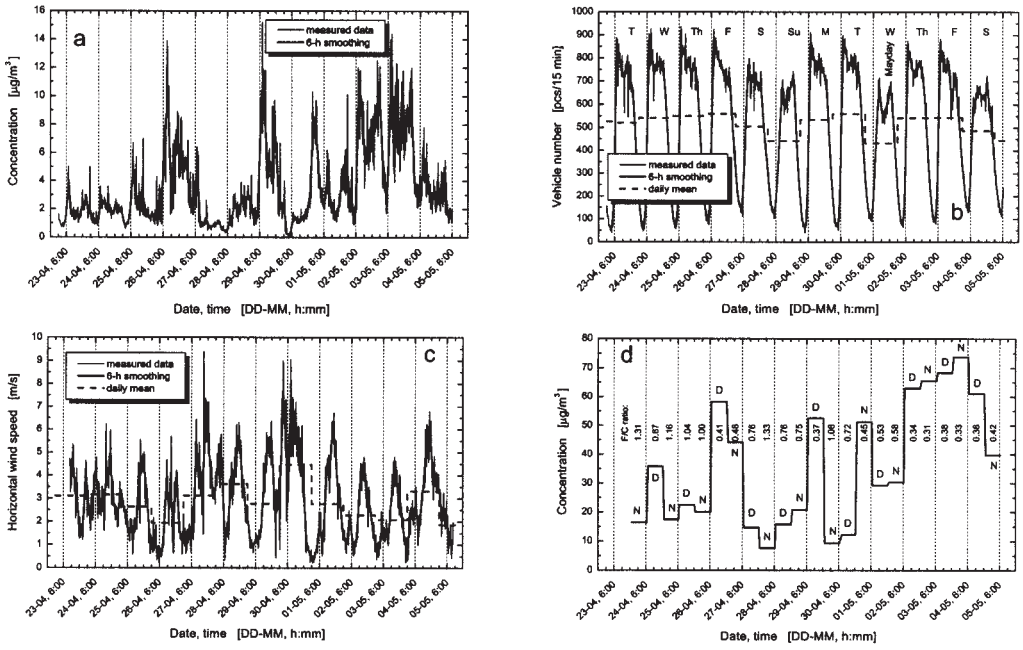

Figure 1. Time trends for black carbon (a), vehicular circulation (b), horizontal wind speed (c) and $PM_{10\text{–}2.0}$ (d) with smoothed curves and daily means (plots b and c), and with $PM_{2.0}/PM_{10\text{-}2.0}$ ratios (plot d).

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