

CARBONACEOUS AEROSOLS AND CHEMICAL MASS CLOSURE FOR FINE AND COARSE PARTICLES AT A KERBSIDE IN BUDAPEST, HUNGARY, IN SPRING 2002

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INTRODUCTION

In the past, we have investigated the chemical composition of size-fractionated aerosols at various sites in Budapest (Salma *et al.*, 2001, 2002), but in these earlier studies little attention was paid to the carbonaceous aerosol. To address this shortcoming, we conducted a new campaign at two sites in Budapest in spring 2002. One of the sites was a kerbside, the other was an urban background site. Here, we only present results from the kerbside.

METHODS

The aerosol collections and measurements at the kerbside in Budapest took place at 5, Rákóczi Street, in the downtown. The equipment was installed on the first-floor balcony at a height of about 7.5 m above the street level. The street can be characterised by width, height and length parameters of 30, 25-30 and 600 m, respectively. Several filter samplers and cascade impactors were deployed at the site. Among the filter samplers were: (1) a PM_{2.5} filter holder with two pre-baked Whatman QM-A quartz fibre filters in series [PM_{2.5}(Q)], (2) a PM₁₀ filter holder, also with two pre-baked Whatman QM-A filters [PM₁₀(Q)], and (3) a Gent PM₁₀ stacked filter unit (SFU) sampler, with coarse and fine Nuclepore polycarbonate filters (pore sizes: 8 µm and 0.4 µm, respectively) in series [PM₁₀(N)]. All filters had a diameter of 47 mm, and all samplers operated at a flow rate of 17 L per min. The cut point (d_{50} -value) between the coarse and fine size fractions in the SFU sampler was 2 µm aerodynamic diameter (AD). The purpose of the second quartz fibre filter in the PM_{2.5}(Q) and PM₁₀(Q) filter holders was to assess artifacts (i.e., losses of semi-volatile compounds and/or adsorption of volatile organic compounds (VOCs)) in the collection of carbonaceous aerosols (Turpin *et al.*, 2000). The campaign started in the evening of 23 April 2002 and lasted until the morning of 5 May. Separate day and night collections were done with the three filter samplers, starting at 7 am and 7:30 pm local time, respectively, and a total of 23 parallel collections were done.

The particulate mass (PM) was obtained from weighing each filter before and after sampling with a microbalance. The weighings were done at 20°C and 50% relative humidity and the filters were pre-equilibrated at these conditions for at least 24 hours. All quartz filters were analysed for organic carbon (OC) and elemental carbon (EC) by a thermal-optical transmission (TOT) technique (Birch & Cary, 1996). The coarse and fine Nuclepore filters from PM₁₀(N) were subjected to instrumental neutron activation analysis (INAA) and particle-induced X-ray emission spectrometry (PIXE). The combination of these two techniques provided concentration data for up to 46 elements (from Na to Th).

RESULTS AND DISCUSSION

The median PM₁₀ aerosol mass concentrations (and ranges), as derived from PM₁₀(Q) and PM₁₀(N), were 54 (21-107) and 48 (18-98) µg/m³, respectively. That PM data from quartz fibre filters are higher than those from Nuclepore (or Teflon) filters is normally found in our studies (e.g., Maenhaut *et al.*, 2001), and is mainly attributed to the adsorption of gaseous compounds by the quartz filters. The PM average ratios and associated standard deviations for PM_{2.5}(Q)/PM₁₀(Q) and PM₂(N)/PM₁₀(N) were 0.53±0.14 and 0.38±0.11,

respectively (both with N=23). Low fine/PM10 ratios were found during polluted time periods, when re-suspension of local coarse street dust was important (Salma *et al.*, 2003). The analyses with the TOT instrument indicated that the average ratio (2nd filter)/(1st filter) for OC was 0.15 ± 0.02 for PM2.5(Q) and 0.10 ± 0.02 for PM10(Q). EC was insignificant on the 2nd filter. The OC on the 2nd quartz fibre filter was assumed to be mainly due to adsorption of VOCs (positive artifact), and it was subtracted from the OC on the 1st filter in order to arrive at artifact-free OC data. The median concentrations (and ranges) for corrected OC and for EC, as derived from the PM2.5(Q) samples, were 6.8 (3.5 - 14.9) and 3.3 (0.9 - 10.8) $\mu\text{g}/\text{m}^3$, respectively. From the PM10(Q) samples, medians (and ranges) of 10.6 (4.6 - 24) and 3.4 (0.9 - 10.2) $\mu\text{g}/\text{m}^3$ were obtained for corrected OC and for EC, respectively.

Aerosol chemical mass closure calculations were done for the separate fine (PM2) and coarse (2-10 μm AD) size fractions, and this for each of the 23 parallel samplings. As gravimetric PM data we used the values from the PM10(N) collections. For reconstituting this gravimetric PM, six aerosol types (or components) were considered: (1) organic aerosol, which was estimated by multiplying the corrected OC by a factor of 1.4 (Turpin *et al.*, 2000); (2) EC; (3) sulphate, estimated by multiplying PIXE S data by 3.0; (4) sea salt; (5) crustal matter; and (6) other elements. The OC and EC data were obtained from the PM2.5(Q) and PM10(Q) samplers, thereby applying a minor correction for converting from the PM2.5 to PM2 size range. The last three aerosol types (components) were derived from the INAA and PIXE results for the PM10(N) samples, as described by Maenhaut *et al.* (2001). The average percentage attributions of the gravimetric PM to each of the 6 aerosol types (components) are given in Table 1. Note that ammonium and nitrate were not included (data for these components will be obtained from analyses by ion chromatography). The sums (in percent) of all included components are 92% and 104% for the fine and coarse size fractions. The fact that these sums are already close to 100% suggests that the contributions from ammonium and nitrate cannot be very large.

Table 1. Average percentage attribution of the gravimetric aerosol mass (PM) to 6 aerosol types (components) for the fine and coarse size ranges (based on 23 samplings).

	Size fraction <2 μm AD	Size fraction 2-10 μm AD
Organic aerosol	43 \pm 10	34 \pm 8
Elemental carbon	17 \pm 9	4.5 \pm 1.1
Sulphate	17 \pm 6	5.5 \pm 2.7
Sea salt	0.9 \pm 0.6	2.6 \pm 1.2
Crustal matter	14 \pm 4	57 \pm 20
Other elements	0.5 \pm 0.2	0.7 \pm 0.3
Sum	92 \pm 17	104 \pm 29

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