

CHEMICAL COMPOSITION AND MASS CLOSURE OF THE ATMOSPHERIC AEROSOL AT K-PUSZTA, HUNGARY, IN SUMMER 2003

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INTRODUCTION

Much aerosol research has already been carried out at the K-pusztá continental background site in Hungary (e.g., Mészáros *et al.*, 1998; Temesi *et al.*, 2001). In one of the studies (Temesi *et al.*, 2001) attempts were made to arrive at chemical mass closure. However, as crustal species were not measured in this study, there was a large fraction of “missing” mass for the coarse particles. In order to address this issue and to provide background information for future studies at the K-pusztá site, we conducted a comprehensive aerosol characterisation campaign in summer 2003, whereby aerosol collections were done for measurement of the particulate mass (PM), of organic and elemental carbon (OC and EC), and of major, minor and trace inorganic and organic constituents, including the crustal elements. Selected data from the campaign and the results of the chemical mass closure exercise are presented here.

METHODS

The 2003 summer campaign at K-pusztá lasted from 4 June to 10 July. Several filter collectors, cascade impactors, and in-situ aerosol measurement instruments were deployed at the site. Among the filter samplers were: (1) a PM10 filter holder with two pre-baked Whatman QM-A quartz fibre filters in series [PM10(Q)], (2) 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(NN)], and (3) a second Gent PM10 SFU sampler, but with a Pall Teflo filter (pore size: 2 µm) as fine filter [PM10(NT)]. All filters in these three samplers 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 samplers was 2 µm aerodynamic diameter (AD). The purpose of the second quartz fibre filter in the PM10(Q) filter holder 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). Separate day and night collections were generally performed with the three filter samplers, starting at 7 am and 7 pm local time, respectively, and a total of 63 parallel samplings were made.

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 OC and EC by a thermal-optical transmission (TOT) technique (Birch & Cary, 1996). The coarse and fine Nuclepore filters from PM10(NN) 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). The coarse and fine filters of the PM10(NT) sampler were analysed for major anionic and cationic species by ion chromatography (IC).

RESULTS AND DISCUSSION

The median PM10 aerosol mass concentrations (and ranges), as derived from PM10(Q), PM10(NN), and PM10 (NT) were 24 (8-35), 23 (10-37), and 24 (10-38) µg/m³, respectively. The PM average ratios and associated standard deviations for PM2(NN)/PM10(NN) and PM2(NT)/PM10(NT) were 0.57±0.08 and

0.58±0.10, respectively. The analyses with the TOT instrument indicated that the average ratio (2nd filter)/(1st filter) for OC was 0.14±0.06 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 PM10(Q) samples, were 6.2 (2.4-9.5) and 0.11 (0-0.49) µg/m³, respectively.

Aerosol chemical mass closure calculations were done for the PM10 aerosol, and in part also for the separate fine (PM2) and coarse (2-10 µm AD) size fractions, and this for each of the 63 parallel samplings. As gravimetric PM data we used the values from the PM10(NN) collections. For reconstituting this gravimetric PM, eight aerosol types (or components) were considered: (1) organic aerosol, which was estimated by multiplying the corrected OC by a factor of 1.8 (Temesi *et al.*, 2000); (2) EC; (3) ammonium; (4) nitrate; (5) sulphate; (6) sea salt; (7) crustal matter; and (8) other elements. The OC and EC data were obtained from the PM10(Q) samples, while ammonium, nitrate, and sulphate were obtained from the IC analyses of the PM10(NT) samples. The last three aerosol types (components) were derived from the INAA and PIXE results for the PM10(NN) samples, as described by Maenhaut *et al.* (2002).

The average percentage attributions of the gravimetric PM to each of the 8 aerosol types (components) are given in Table 1. The sum (in percent) of all included components is 98% for the PM10 aerosol. Organic matter (46%), crustal matter (24%), and sulphate (18%) provide the major contributions to it. It further appears that 46% of the coarse aerosol consists of crustal matter.

Table 1. Average percentage attribution of the gravimetric aerosol mass (PM) to 8 aerosol types (components) for the PM10 aerosol and for the fine and coarse size ranges.

	PM10	Fine (<2 µm AD)	Coarse (2-10 µm AD)
Organic aerosol	46 ± 9		
Elemental carbon	0.6 ± 0.5		
Ammonium	8.0 ± 2.3	12 ± 2	1.7 ± 1.1
Nitrate	2.7 ± 1.1	1.5 ± 1.6	4.5 ± 1.1
Sulphate	18 ± 5	26 ± 5	4.0 ± 2.4
Sea salt	1.2 ± 0.9	0.7 ± 0.6	1.8 ± 1.3
Crustal matter	24 ± 7	7.4 ± 3.5	46 ± 8
Other elements	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1
Sum	98 ± 4	48 ± 6	57 ± 5

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