Pergamon

J. Aerosol Sci., Vol. 28, Suppl. 1, pp. S73–S74, 1997

Printed in Great Britain
PII:S0021-8502(97)00083-9
0021–8502/97 $17.00+0.00

CHEMICAL COMPOSITION AND LIGHT SCATTERING OF THE ATMOSPHERIC AEROSOL AT A REMOTE SITE IN THE NEGEV DESERT, ISRAEL

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KEYWORDS

atmospheric aerosols, aerosol types, sulphate, mineral dust, light scattering, Israel

METHODS

Since early 1995 long-term chemical, physical, and radiative aerosol measurements are being conducted at Sede Boker (30°51'N, 34°47'E, 470 m asl), Israel. For the chemical measurements, 2- or 3-day collections are performed on a continuous basis with a "Gent" PM10 stacked filter unit (SFU) sampler, which separates the particles into a coarse (2-10 μm equivalent aerodynamic diameter (EAD)) and a fine (<2 μm EAD) size fraction (Maenhaut *et al.*, 1994). The SFU samples are analyzed for the particulate mass (PM), black carbon, major ionic species, and over 40 elements. The total and back scattering coefficients at 450, 550, and 700 nm (40 nm band pass) for the in-situ aerosols are determined with an integrating nephelometer (TSI 3563) and total vertical column optical and physical aerosol characteristics are obtained with an automatic tracking combined sun-photometer/sky radiometer (CIMEL Electronique 318A). Daily isentropic air mass back trajectories for the Sede Boker site are obtained from the German Weather Service.

RESULTS AND DISCUSSION

From over two years of SFU samplings (up to mid-February 1997; over 340 samples), it was found that the coarse PM (CPM) varied quite substantially (mean ± s : 43 ± 54 μg/m^3) and increased to over 100 μg/m^3 during large scale dust events. Such events occur rather irregularly throughout most of the year, except during summer (July to mid-September), and are due to long-range transport of mineral dust from the Sahara or other deserts. The largest event took place on 9 and 10 February 1996, when CPM (3-day mean value) rose to over 800 μg/m^3. On average, mineral aerosol made up 70% of the CPM, with silicates and $CaCO_3$ contributing 40% and 30%, respectively. In contrast to CPM, fine PM (FPM) showed relatively little variability (mean ± s : 16 ± 5 μg/m^3). On average, FPM consisted for 50% of sulphates and for 25% of mineral dust, but during the dust events the contribution from mineral aerosol to FPM rose to over 50%.

The total light scattering coefficient (at 550 nm) and the FPM for the period mid-December 1995 to the end of September 1996 are presented in Fig. 1. The two aerosol parameters covary well with each other, except during large dust events. A similar covariance existed between the other scattering coefficients and FPM. In order to derive the contributions from fine and coarse aerosols and from the different aerosol types to the light scattering coefficients, various multiple linear regressions (MLRs) were performed, including MLRs according to the following equation:

$$\sigma_\lambda = k + \alpha_{\lambda,CPM}\,[CPM] + \alpha_{\lambda,FPM}\,[FPM] \qquad (1)$$

with σ_λ the scattering coefficient and α the mass scattering efficiency. The α-values derived from the latter MLRs (3 for the total scattering coefficients, 3 for the back scattering coefficients) for the

9-month period of Fig. 1 are given in Table 1. The number of cases in each of these 6 MLRs was 121; the extreme dust event of 9-10 Feb. 1996 was always excluded. The multiple linear correlation coefficient was in all 6 MLRs around 0.9. Both the total and back scattering efficiencies for FPM clearly decrease with increasing wavelength. The total scattering efficiency for CPM, in contrast, increases with wavelength, whereas the back scattering efficiency for CPM remains constant. It further appeared that over two thirds of the total scattering coefficients was attributable to the FPM.

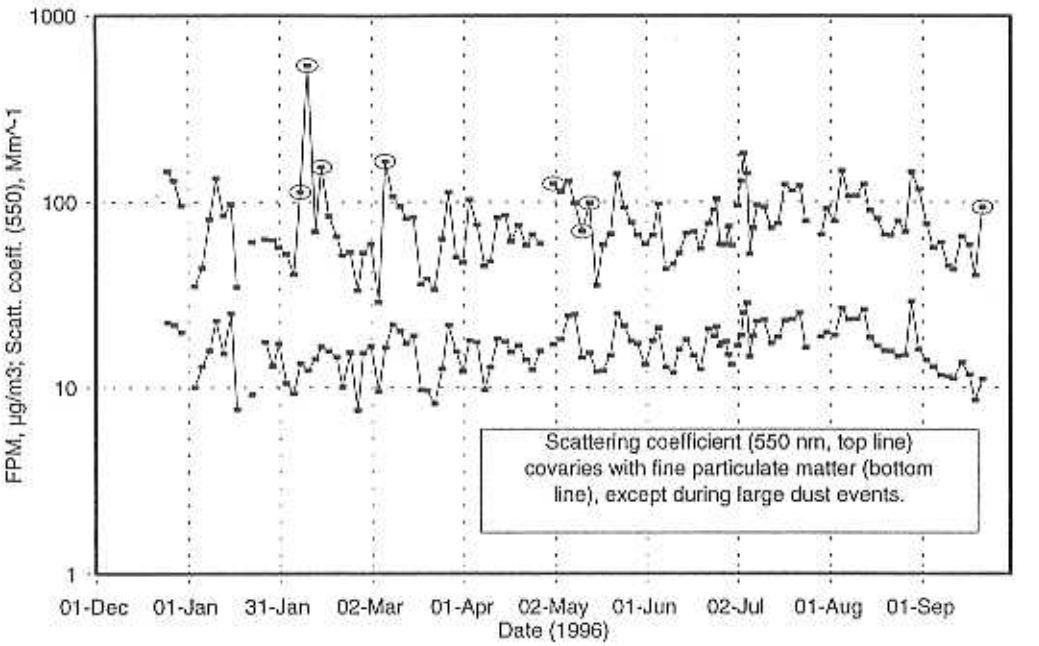

Fig. 1. Time trends of the total scattering coefficient (at 550 nm) and of the fine particle mass (FPM) for boundary layer atmospheric aerosols at Sede Boker, Israel. The scattering coefficients in circles indicate cases when coarse PM (CPM) was larger than 100 µg/m^3.

Table 1. Mass scattering efficiencies (α), in m^2/g, and associated standard errors for coarse and fine aerosols at Sede Boker, Israel.

	450 nm	550 nm	700 nm
Total scattering			
$\alpha_{\lambda,CPM}$	0.19 ± 0.06	0.34 ± 0.04	0.45 ± 0.03
$\alpha_{\lambda,FPM}$	7.1 ± 0.4	5.2 ± 0.3	3.1 ± 0.2
Back scattering			
$\alpha'_{\lambda,CPM}$	0.076 ± 0.004	0.084 ± 0.004	0.081 ± 0.003
$\alpha'_{\lambda,FPM}$	0.60 ± 0.03	0.46 ± 0.03	0.34 ± 0.02

ACKNOWLEDGEMENTS

The financial support from the Belgian FWO and OSTC is gratefully acknowledged.

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