Ten-year study of fine aerosol at Sde Boker, Israel: time trends, seasonal variation, correlations, and source areas for anthropogenic elements

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From January 1995 through December 2004 aerosol samples were collected with a Gent stacked filter unit sampler at Sde Boker, Israel. The samples were collected according to a 2-2-3 day schedule, which resulted in about 150 samples per year. The samples were analyzed for the particulate mass (PM) by weighing, for black carbon (BC) by a light reflectance technique, and for up to 46 elements by a combination of particle-induced X-ray emission (PIXE) and instrumental neutron activation analysis (INAA) (Maenhaut *et al.*, 2001). Here, we report on the fine (PM2) size fraction data for the PM, BC, and the following 9 anthropogenic elements S, V, Ni, Cu, Zn, As, Se, Sb, and Pb.

The annual medians of the PM, BC, and the 9 anthropogenic elements were examined for time trends. The largest changes over the 10-year period were found for S, Ni, Se, Sb, and Pb and they were -34%, -25%, -47%, +26%, and -40%, respectively. Substantial changes were also noted for the PM and Zn, i.e., of -18% and -12%, respectively, whereas no changes were noted for BC and the other elements. The decreases for S and the PM are consistent with those observed by Karnieli *et al.* (2009) for the July and August data from the same site.

The seasonal variation was also examined. The largest variation was seen for S, which exhibited 1.6 times larger concentrations in summer than in the other 3 seasons. As to the other elements, a similar seasonality was observed for As with 1.4 times enhanced concentrations in summer, and to a lesser extent also for the PM and Zn. That the PM follows S is not surprising as sulphate (estimated as 3 times S) accounted, on average, for 36% of the PM2 mass. For V, Ni, and Sb there was a clear tendency for lower concentrations in summer than in the other seasons. Pb exhibited its highest concentrations in fall and winter and virtually no seasonality was seen for BC, Cu, and Se.

S was substantially correlated with the PM ($r = 0.65$), whereas its correlation coefficients with BC and the 9 elements were all lower than 0.5. V and Ni were very highly correlated with each other ($r = 0.94$) and substantially ($0.5 < r < 0.7$) with BC, Sb, and Pb. The correlation between V and Ni, together with the average V/Ni ratio of 2.3±0.5 clearly point to heavy oil burning as the predominant source of both elements. Since BC at the site is thought to originate predominantly from the incomplete combustion of fossil fuels, it is not surprising to see that it is correlated with V and Ni. Cu was best correlated with BC ($r = 0.53$) and the correlation coefficients of Zn, As, and Se with the other elements, BC, and the PM were all lower than 0.5.

Trajectory statistics (Lupu and Maenhaut, 2002), using 10-day back trajectories with arrival at 300 m above ground, was applied to assess the source areas of the PM, BC, and the 9 elements. The trajectories came predominantly from the northwest, but there were seasonal differences in the transport pathways, with westerly ones becoming important in winter and northerly ones important in summer. The concentration field map for S is shown in Figure 1. It appears that the prevailing source region for S was southeastern Europe (i.e., Turkey, Bulgaria, Romania, Ukraine, and southern Russia). As had the southeastern part of European Russia as its prevailing source area, while the source picture for Zn was rather unclear. The other 6 anthropogenic elements and BC seemed to originate mainly from regional sources (i.e., Jordan, Syria, Iraq, and Saudi Arabia).

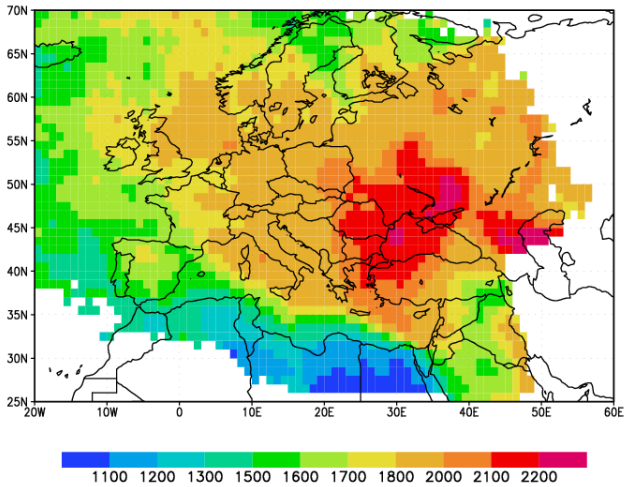

Figure 1. Fine S concentration field (ng/m^3, with the concentration scale shown at the bottom) as computed with trajectory statistics.

Karnieli, A., Derimian, Y., Indoitu, R., Panov, N., Levy, R.C., Remer, L.A., Maenhaut, W. and Holben, B.N. (2009) *J. Geophys. Res.* **114**, D00D19, doi:10.1029/2009JD011870.

Lupu, A and Maenhaut, W. (2002) *Atmos. Environ.* **36**, 5607-5618.

Maenhaut, W., Raes, N. and Wang, W. (2001) *Nucl. Instrum. Methods Phys. Res.* **B269**, 2693-2698.