Aerosol optical thickness measurements in the center of the Netherlands

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Monitoring of aerosols is important for air pollution and atmospheric radiation studies. Important aerosol parameters are the aerosol optical thickness (AOT), which is related to the aerosol load, and the Angström parameter α, which is related to the aerosol particle size. Here we present results of AOT and α for the period June 1997 – December 2002 as measured with a sunphotometer in De Bilt (52.10° N, 5.18° E).

1. Langley regression

Direct solar irradiance is measured with a SPUV-6 sunphotometer (YES, Inc.), on a suntracker, with central wavelengths: 368, 501, 675, 780, 871, and 940 nm (the latter is not used for aerosols). Measurements were performed on 1614 days in the period 1997–2002. The irradiances were averaged over 1 minute. As an example, Fig. A shows the irradiances at 3 wavelengths on a typical day with a clear morning and a cloudy afternoon.

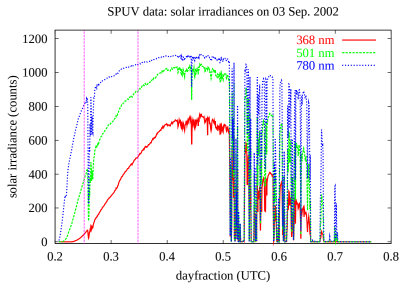

Figure A.

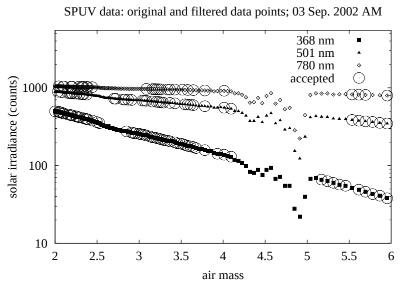

Figure B.

To retrieve the AOT from the irradiance measurements, we use a linear regression of the logarithm of the irradiance as a function of the relative air mass (Langley analysis). The slope of the regression line is equal to the total atmospheric optical thickness. Only irradiances at air masses between 2 and 6 are used (solar zenith angles between 60 and 80 deg). Before Langley analysis is applied, data affected by clouds are removed by a filter. Fig. B shows the cloud filtering of the AM data of Fig. A between air masses 2 and 6. We used a very strict cloud filter, removing all irregular irradiance variations, which might also be due to variations in aerosol amount. AOT is obtained by subtracting the Rayleigh and ozone optical thickness from the total atmospheric optical thickness of each channel. Langley regressions with a large error or a deviating extraterrestrial irradiance were rejected. About 200 Langley regressions (AM: 159, PM:44) remained, which is only 6 % of the halfdays that were analysed. The Angström parameter is found from fitting the AOT to a power law: AOT(λ) $\propto \lambda^{-\alpha}$.

2. Results of AOT and α

The average AOT at 501 nm was 0.170 (AM: 0.175, PM: 0.150), and the average α was 1.398 (AM: 1.442, PM: 1.238). AOT(λ) is shown in Fig. C. Apparently, the Angström relation is followed quite well.

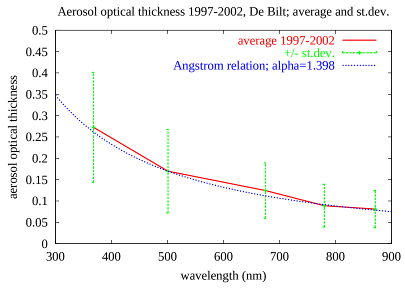

Figure C.

AOT(501 nm) and α as a function of year and month in the period 1997–2002 are shown in Figs. D–G.

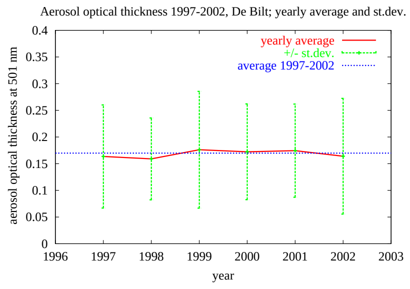

Figure D.

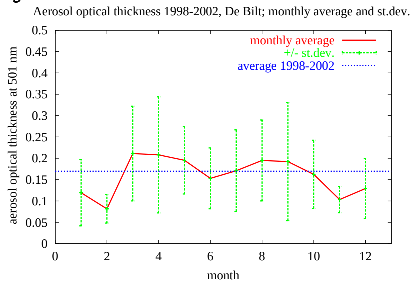

Figure E.

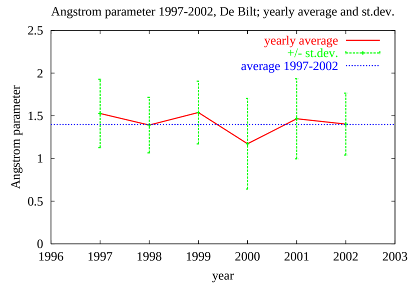

Figure F.

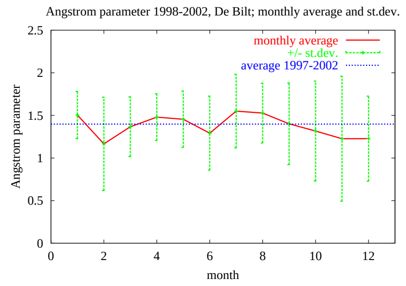

Figure G.

From year to year there is not much variability in AOT, but there appears to be a seasonal dependence: more aerosol and smaller particles in spring and autumn than in winter.

3. Correlations

Correlations of AOT(501 nm) with α and wind direction are shown in Figs. H and I. It appears that for larger AOT, α tends to be larger on average, i.e. smaller particles. Most turbid air comes from SE directions (E=90 deg, S=180 deg). The clearest air comes from NW directions.

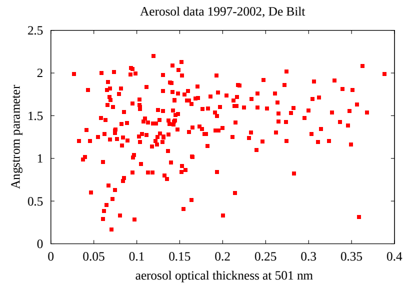

Figure H.

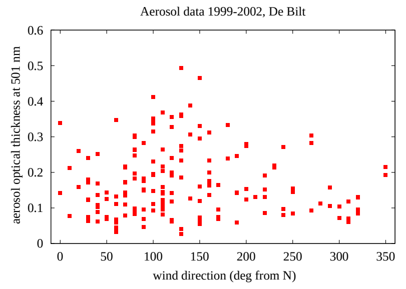

Figure I.

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