Impact of aerosol particle concentration on UV Index prediction

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1 Introduction

The intensity of the UV-radiation received near the surface depends on:

- Elevation of the sun
- Amount of ozone in the atmosphere
- Cloud cover
- Aerosol particle concentration

We tested the influence of the change of the input AOD (aerosol optical depth) from a standard value to observed valued on the UV index calulated with a radiative transfer model. The results are compared with observed UV indices.

2 Observed data

We use the data of Brewer #016 located at Uccle (Belgium, 50°48'N, 4°21'E). Following data are retrieved:

- Total ozone (standard measurement of the instrument)
- AOD in the UV (320 nm) using the method developed by Cheymol and De Backer [2003] and validated by Cheymol et al [2006]
- The UV-index derived from global spectral measurements in the UV

The instrument is regularly (every 2-3 year) calibrated for the ozone observations against a travelling standard). For UV observations the calibration is checked on a monthly basis with small reference lamps and on larger time intervals with certified 1000 W lamps.

3 Radiative transfer model

Calculations are made with the TUV model of Madronich [1993,1998] on clear days where AOD observations are available. Following input parameters are used:

- Total ozone from Brewer spectrophotometer #016
- Aerosol characteristics from the OPAC model [Hess et al 1998], considering Uccle as an urban site with maritime influence. The following parameters are implemented:
  - the single scattering albedo varies from 0.857 at 250 nm to 0.911 at 400 nm;
  - the asymmetry factor varies from 0.745 at 250 nm to 0.725 at 400 nm
  - the extinction coefficient varies from 0.425 at 250 nm to 0.293 at 400 nm.
- The Eltermann vertical profile rescaled with the AOD observed at 320 nm at Uccle from the Brewer spectrophotometer

4 Method

Different runs of the model are made for 50 selected clear days. In the first run, a constant AOD of 0.5 at 320 nm (median value for Uccle) is used each day. In the second run monthly mean values are used, while for the third run the observed daily mean AOD from Brewer #016 is used.

5 Results

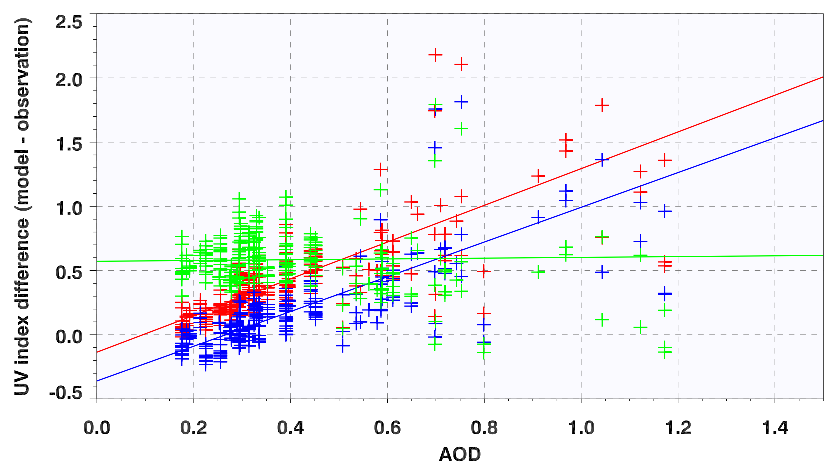

Figure 1. Differences between the modeled and measured UV index for solar zenith angles below 50°. The model run used a constant AOD of 0.5 (represented in red), monthly mean AOD's (in blue) and the observed daily mean AOD (in green). The lines are linear regressions as function of the observed AOD.

The modeled UV index values from the three runs are compared with the observed UV indices from the Brewer Instrument (Figure 1 and Table 1).

- We find correlation coefficients of 0.989, 0.989 and 0.995 for the model calculations with the fixed (0.5), the monthly mean and the daily mean observed AOD's respectively.
- From Figure 1 it is clear that the use of the daily observed AOD reduced the dependency of the UV index on the actual AOD from a slope of 1.43 $\pm$0.17 with the fixed AOD to a slope of 0.03 $\pm$0.17 with the daily mean observed AOD.
- A bias of about 0.6 UV-index units (model higher than observations) is present. This needs further investigation to reveal whether it is caused by one of the assumptions for the aerosol parameters in the model, or by other input parameters. It should be also noted that the error on the observations can be estimated to be of the order of 5 % (corresponding to .3 for a UV index of 6).

Run	AOD	Correlation coefficient	Slope
1	fixed (0.5)	0.989	1.43 $\pm$0.17
2	monthly mean	0.989	1.35 $\pm$0.17
3	daily mean	0.995	0.03 $\pm$0.17

Table 1 Correlation coefficient and slopes of the regression lines in figure 1 for the comparisons of the UV index from the different model runs with the observations.

To estimate amplitude of the impact of the AOD variations on the UV index, we also calculated the relative differences in percent between the UV index calculated using the daily mean AOD and the one calculated with the fixed value of 0.5. The data were split in two series, one with high solar zenith angle ($>$50°), and one with low solar zenith angle ($<$50°). The linear regression lines have slopes of 31%/AOD and 35 %/AOD for low and high solar zenith angles.

Conclusions

The use of daily mean values of AOD effectively removes the AOD dependence of UV indices calculated with a radiative transfer model compared to the use of a fixed AOD values.

The UV-index changes with about 3% for an AOD change of 0.1 at 320 nm

A remaining bias (AOD-independant) needs further investigation.

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