Retrieval of Single Scattering Albedo values from Brewer spectrophotometer irradiance measurements at Uccle, Belgium

De Bock, V., De Backer, H., Mangold, A.
Royal Meteorological Institute of Belgium

1 INTRODUCTION

Several studies (such as IPCC, 2007) indicate that significant uncertainties in global columnar single scattering albedo (SSA) may constitute the largest single source of uncertainty in the current modeling estimates of aerosols climate forcing. Therefore it is necessary to improve our knowledge on the SSA.

What will be presented on this poster?

- reverse engineering procedure using UV irradiance measurements from the Brewer spectrophotometer, coupled with a Radiative Transfer Model (RTM)
- first preliminary resulting SSA values

2 METHOD

The SSA are determined for cloudless days by comparing measured and modeled UV irradiances.

2.1 *Measured UV irradiances*

The Brewer#016 spectrophotometer (single monochromator) performs UV measurements between 290 and 325nm with wavelength steps of 0.5nm. The instrument is located at Uccle, Belgium (50°48'N, 4°21'E, 100m asl).

Figure 1. The Brewer spectrophotometer at Uccle.

2.2 *Modeled UV irradiances*

The Tropospheric Ultraviolet and Visible Radiation Model (TUV model version 3.0, Madronich 1993) is used to model the UV irradiances for cloudless days.
The TUV model needs different input parameters:

- Aerosol Optical Depth: at Uccle, we have developed different methods to retrieve the AOD from Brewer measurements at different wavelengths, using either the direct sun (DS) measurements (which lead to AOD at 306, 310, 313, 316 and 320nm) or the sun scan measurements (which enabled the retrieval of AOD at 340nm) (De Bock et al. 2010). For this study, we used the values retrieved from the DS measurements at the 5 different wavelengths to derive the SSA at the same wavelengths.
- Total ozone column: we use the DS ozone values from the Brewer#016 instrument
- Surface albedo: value of 0.05
- Cloud optical depth: value of 0.0 (since we model the UV irradiance for cloudless days)

2.3 *Reverse engineering procedure: Step by step*

First we selected the cloudless days for a time period between September 2006 and December 2010. This selection is done manually by checking the UV index plots (Fig. 2). For this time period, 84 days are cloudless.

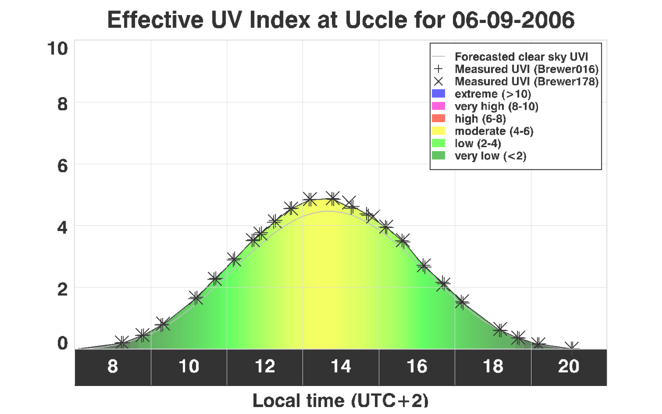

Figure 2. Example of a UV index plot, used to check if a day is cloudless.

- Step 1: Select ozone and AOD values closest to the time of the UV scan as input for the TUV model
- Step 2: Run the TUV model
- Step 3: Compare model output at the selected wavelength with the measured irradiance
- Step 4a: If the difference between the modeled and measured irradiance is less than 1% $=>$ accept the SSA value + change the SSA value and repeat steps 2 to 4 untill the difference becomes larger than 1%.
- Step 4b: If the difference between the modeled and measured irradiance is more than 1% $=>$ increase or decrease the SSA value and return to step 2.

NOTE: at present, the SSA values are calculated once each day ($=>$ we use the UV measurement closest to 12UT to determine the SSA range for this time period). Only in Figures 5a and 5b, SSA values were calculated for an entire day.

3 RESULTS

For each day, we get a range of SSA values for which the modeled and measured UV irradiances agree within 1%. For days with lower AOD (AOD at 320nm < 0.2), the range of accepted SSA values is much larger than for days with high aerosol load. For the graphical presentation of the resulting SSA, the average SSA values (calculated from the individual SSA ranges) are used. Figure 3 shows the resulting SSA values for the selected cloudless days.

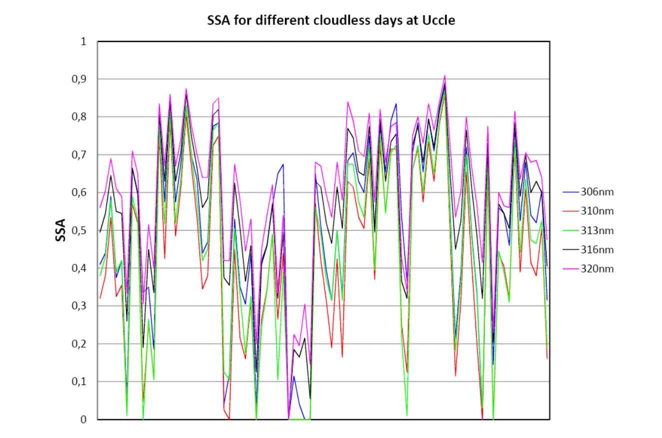

Figure 3. Resulting SSA values (average values calculated from the SSA ranges) for the 84 cloudless days.

Figure 4 shows the relationship between the used input AOD values and the resulting average SSA values. It is clear that for low AOD values, the SSA values become extremely low. For some days with low AOD values, it was not even possible to determine the SSA values.

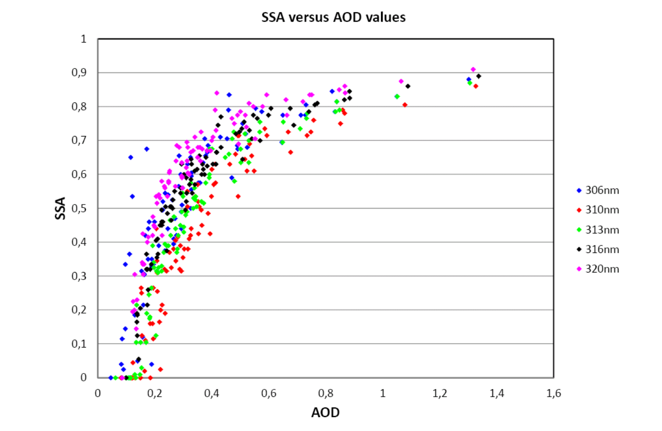

Figure 4. SSA versus AOD at the different wavelengths at Uccle.

Figures 5a and 5b show the diurnal SSA for a day with high and low aerosol load respectively. The Cimel level 1.5 SSA values at 440nm are added to the plots for comparison.

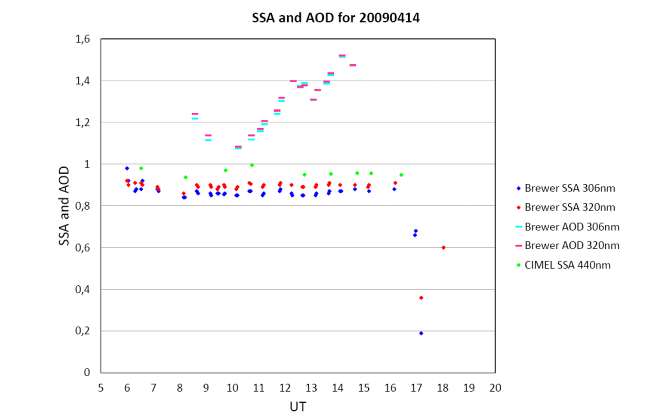

Figure 5a. Diurnal SSA values for a day with high aerosol load.

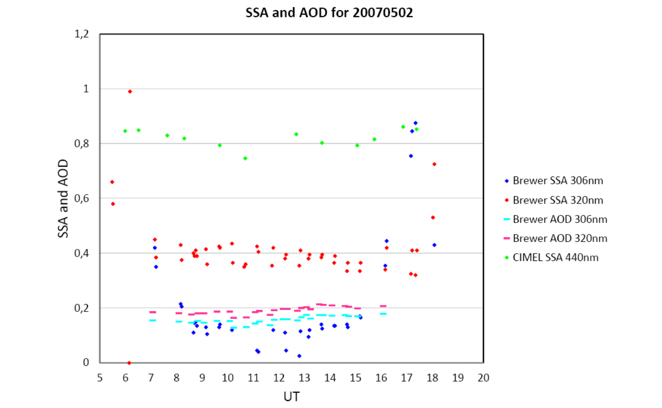

Figure 5b. Diurnal SSA values for a day with low aerosol load.

4 CONCLUSIONS

The calculated SSA values are the lowest at 310 and 313 nm, whereas the values at 320nm are the highest.

There is a clear relationship between AOD and SSA: the lower the AOD, the lower the SSA values. For some days with very low AOD, it was not even possible to determine the SSA range. The uncertainty in SSA decreases as the AOD increases.

References

- De Bock, V. et al.: Aerosol Optical Depth measurements at 340nm with a Brewer spectrophotometer and comparison with Cimel sunphotometer observations at Uccle, Belgium, Atmos. Meas. Tech., 3, 1577-1588, doi:10.5194/amt-3-1577-2010, 2010.
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De Bock V., De Backer, H. and Mangold, A., Royal Met. Inst., Ringlaan 3, B-1180 Brussels, Belgium.
Veerle.DeBock@meteo.be

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