Improved cloud screening for Aerosol Optical Depth measurements with a Brewer spectrophotometer

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1 INTRODUCTION

Previous research showed that the Langley Plot Method (LPM) can be used to retrieve Aerosol Optical Depth (AOD) values at 340nm from Brewer sun scan measurements (De Bock et al. 2010). Together with this retrieval method, a cloud screening algorithm was developed to remove cloud perturbed AOD measurements from the results. However, analysis of the cloud screened data indicated that the performance of the screening technique was not optimal. Therefore an improved cloud screening algorithm was developed.

2 AOD RETRIEVAL METHOD

The AOD retrieval method uses sun scan measurements (from 335 to 345 nm, convoluted with the Cimel band pass filter at 340nm) from the Brewer spectrophotometer (Fig. 1) at Uccle, Belgium (50°48'N, 4°21'E, 100m asl) and applies the LPM in a similar way as described in Cheymol and De Backer (2003). A set of criteria is defined to select the days ('cloudless days') on which the LPM can be applied. For each of the cloudless days, one AOD and one Calibration Factor (CF) can be determined. The average Calibration Factor will then be used as the mean calibration coefficient of the instrument and enables the calculation of AOD values for each individual clear sky observation.

Figure 1. Brewer#178 MKIII spectrophotometer at Uccle

3 ORIGINAL VERSUS IMPROVED CLOUD SCREENING

3.1 *Original cloud screening*

- Step 1: Remove all AOD values >2.
- Step 2: Verify whether there is a direct sun observation within 5 minutes of each individual AOD measurement.
- Step 3: Plot the measured irradiance (photoncounts) for days with AOD measurement(s) >1.5 (Manual screening). If the graph shows clear signs of cloud perturbation, remove the measurement.

After applying the original screening method, it appeared that some of the resulting AOD were still too high for Uccle. This was verified by comparing the monthly averages from our Brewer instrument with those from the co-located Cimel sunphotometer. This indicated that the screening technique was in need of further improvement.

3.2 *Improved cloud screening*

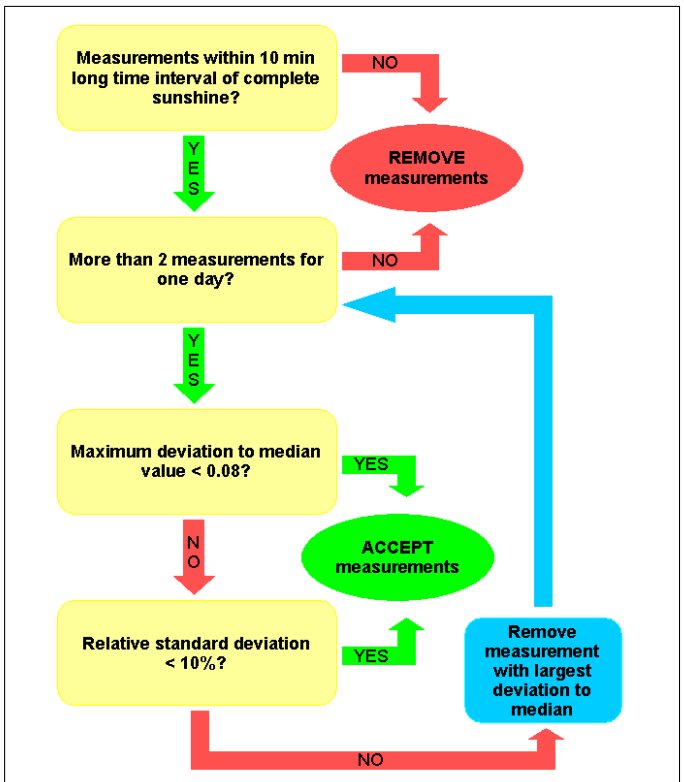

Figure 2. Overview of the improved cloud screening method

The improved algorithm (Fig. 2) makes use of sunshine duration data (from 4 pyrheliometers at Uccle) and is also based on the assumption that the AOD should remain quite stable during the course of one day. This method runs completely automatic, which means no manual verification is needed afterwards!

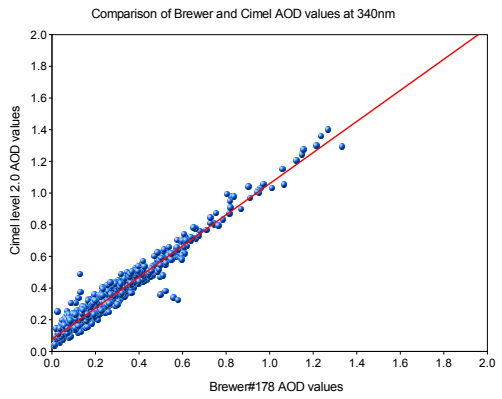

Figure 3. Comparison of the cloud screened (improved method) Brewer and Cimel AOD values at Uccle at 340nm.

4 RESULTS

4.1 *Comparison with Cimel measurements*

The cloud screened AOD values are now compared to quasi-simultaneous Cimel level 2.0 values (maximum time difference of 3 minutes). Due to the delayed availability of the level 2.0 Cimel values, the period of comparison is limited to a period from 1 Sep 2006 until 11 Sep 2010. For this period, 665 individual AOD values are compared and the correlation coefficient, slope and intercept of the regression line are respectively 0.9760, 0.9816 +/- 0.0085 and 0.0776+/-0.0030 (Fig. 3).

4.2 *Analysis of the AOD time series*

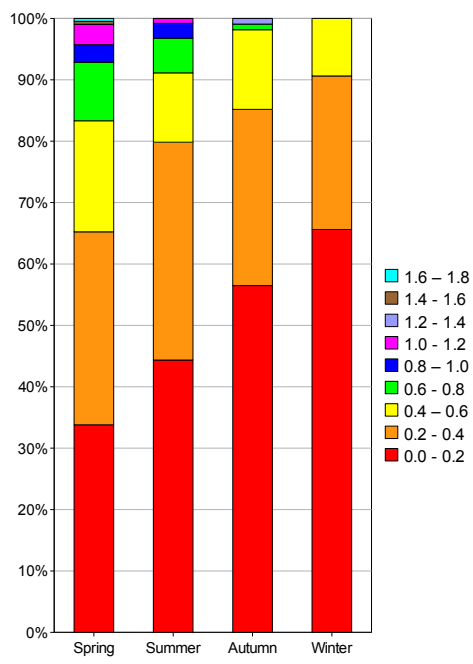

Figure 4. Seasonal frequency distribution of the Brewer AOD at Uccle for a period between 1 Sep 2006 and 31 Jul 2011

Figure 4 shows the seasonal frequency distribution of the AOD at Uccle and table 1 contains the monthly mean values for a period from 1 Sep 2006 until 31 July 2011. It is clear that the highest values occur mainly in spring (and also to some degree in summer), whereas the winter and autumn values are much lower.

	2006	2007	2008	2009	2010	2011
Jan	-	-	-	0.23	-	0.26
Feb	-	0.34	0.13	0.31	0.09	0.14
Mar	-	0.39	0.21	0.27	0.21	0.30
Apr	-	0.43	0.60	0.51	0.34	0.46
May	-	0.30	0.23	0.36	0.20	0.25
Jun	-	0.25	0.33	0.35	0.34	0.24
Jul	-	0.25	0.25	0.42	0.23	0.25
Aug	-	0.18	0.24	0.23	0.15	-
Sep	0.27	0.32	0.28	0.32	0.28	-
Oct	0.18	0.16	0.20	0.22	0.12	-
Nov	0.20	0.13	0.17	0.06	-	-
Dec	-	-	-	-	-	-

Table 1: Monthly mean AOD values at Uccle. For complete years, the highest values are shown in red, whereas the ones in blue are the lowest values.

5 CONCLUSIONS

An improved cloud screening method is developed, which uses sunshine duration data and is based on the assumption of stable AOD throughout one day.

The improved cloud screening method runs completely automatic and thus reduces significantly the time to produce quality assured AOD values.

The retrieved Brewer AOD show good agreement with Cimel values which proves that the AOD measurements are of good quality.

References

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