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Atmospheric Measurement Techniques Discussions

Interactive comment on "Influence of the calibration on experimental UV index at a midlatitude site, Granada (Spain)" *by* M. Antón et al.

M. Antón et al.

mananton@unex.es

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(* Reviewer comment, ++ Our response)

Concerning the manufacturer calibration

* It has to be mentioned when this has been measured and if the company has provided any recommendation on instrument re-calibration of any of the calibration components (angular, spectral absolute response) in a period of time from the first calibration.

++ The manufacturer does not provide any information about the measured date of

calibration factors. Regarding the recommendations, the manufacturer suggests that the UVB-1 instruments should be periodically calibrated by the own company.

* It is of importance to provide the reasons of the deviations using the manufacturer calibration. Would that be the spectral response ? Is it just the absolute response ? Previous measurements have revealed such issues (ftp://ftp.wmo.int/Documents/PublicWeb/arep/gaw/gaw141.pdf). The authors could probably compare their results to this WMO report.

++ The difference between the calibration factor derived from one-step method and the manufacturer's factor is not related to the spectral or angular responses of the instruments. In the one-step method, the calibration factor is directly inferred from the comparison between the raw signal of the UVB-1 instrument and the erythemally integrated irradiance given by the Brewer spectrophotometer using the standard CIE spectrum. Therefore, this method does not work with the spectral or angular responses obtained in the laboratory. We think that the main causes that explain these differences are the reference spectrophotometer used by the manufacturer and/or the method utilized to derived the calibration factor. The WMO report indicated by the reviewer showed differences up to 20% between the manufacturer's calibration factors and the factors derived from one calibration campaign for the UVB-1 radiometers. In order to clarify this subject, we have added the following comments in the text (Subsection 3.2): "The calibration factors calculated by this method are about 10% lower than the fixed value provided by the manufacturer. This result is in agreement with the calibration campaign of broadband UV radiometers performed in Thessalonica in 1999 (Bais et al., 1999) which showed differences up to 20% between the manufacturer's calibration factors for UVB-1 instruments and the individual factors derived from this campaign. These differences could be related to uncertainties in the spectral UV measurements recorded by the reference spectrophotometer used by the manufacturer and/or the method utilized to derived its calibration factor. This fact shows evidence that each instrument needs a sound calibration in order to obtain reliable UV measurements."

* I do not think that all YES UVB-1's have the same calibration function provided by the company as it is mentioned in the text.

++ Yes, the manufacturer adjusts the gain of the instrument electronically to force the setting of a single calibration factor for all instruments. We find numerous works in literature using YES UVB-1 radiometers with the same calibration given by the manufacturer (e.g, McKenzie et al., 1997; Esteve et al., 2006; Vilaplana et al., 2006) which coincide exactly with our manufacturer's calibration. Nevertheless, we have decided to remove this comment from the text.

- Esteve, A.R., M. J. Marin, J. A. Martinez-Lozano, F. Tena, M. P. Utrillas and J. Cafiada: UV Index on Tilted Surfaces, Photochemistry and Photobiology, 82: 1047-1 052, 2006. - McKenzie, R.L., K. J. Paulin and M. Kotkamp: Erythema1 UV Irradiances at Lauder, New Zealand: Relationship between Horizontal and Normal Incidence, Photochemistry and Photobiology, 66(5): 683-689, 1997. - Vilaplana, J. M., Cachorro, V. E., Sorribas, M., Luccini, E., de Frutos, A., Berjón, A., and de la Morena, B.: Modified calibration procedures for a Yankee Environmental System UVB-1 biometer based on spectral measurements with a Brewer spectrophotometer, Photochem. Photobiol., 82, 508–514, 2006.

* The main differences that can be seen in figure 5 point out the inconsistency of the YES calibration has to deal with high voltages, thus low solar zenith angle measurements. If the problem comes from the provided CF then it is related with the curvature at low angles shown in figure 1 and not any cosine response problems. Could you comment on that?

++ Thanks for your interesting comment. According to your suggestion, we have added the following information in the text (Section 4): "This behaviour is mainly related to the calibration curve given by the manufacturer (Figure 1) which shows that for small SZA values the manufacturer's factors (between 0.140 and 0.145) differs significantly with respect to the calibration factors given by the first-step method (0.1275) and the

absolute calibration coefficient derived from the two-step method (0.1150)."

Concerning one step and two step methods

* It is a very interesting result, the agreement of the two methods on a dataset such as this shown in figure 6. I would expect that the ozone variability over the long term period, would affect the RMSE of the one step method. Why this is not the case?.

++ The influence of total ozone variability on the two-step method is shown in Figure 3 (bottom). It can be seen that the strongest effects are produced for total ozone data below 250 DU. At Granada, only 10 days (0.91% of all cases) present OMI total ozone data below this amount. We expect notable differences between the UV data obtained with one- and two-step models only during that reduced number of cases. Therefore, the RMSE of the one step method is not significantly affected by the ozone variability over Granada.

* Also, it has to be reported that the one step method is using the results of the 2007 campaign over the while period so it seems that the instrument is quite stable over this period concerning the overall calibration.

++ According to the reviewer's suggestion, we have added the following comment in the text (Subsection 2.1): "Several works have shown the high stability of YES UVB-1 radiometers. For instance, Bigelow et al. (1998) analyzed the long term calibration stability of the US government's UV monitoring network over a four year period, showing that the UVB-1 instruments are quite stable."

The following reference has been included in the Reference List: - Bigelow, D.S., J. R. Slusser, A. F. Beaubien, and J. H. Gibson: The USDA Ultraviolet Radiation Monitoring Program, Bulletin of the American Meteorological Society, 79, 601-615, 1998.

* The authors have to clarify the methodology of comparing a 3 (to 7 depending on the instrument) minutes spectroradiometer scan with a 1 minute resolution UVB-1 measurement. Especially the effect on high solar zenith angles.

++ We agree with the reviewer that this issue must be commented in the text. Thus, the following information has been included (Subsection 3.2): “This method need simultaneously records of the UVB-1 radiometer and Brewer spectrophotometer. For this goal, the UVB-1 voltages during the Arenosillo’s campaign 2007 (one measurement every 10 s) were averaged along the one minute period which takes each Brewer scan between 310 nm and 324 nm (range of wavelengths where the UV spectral irradiance weighted by the CIE response function present higher values).”

* The spectroradiometer absolute calibration is based on lamp measurements. This calibration is transferred indirectly to the UVB-1 using the above mentioned methods. Results on the performance of various spectroradiometers and comments about the absolute response and uncertainty levels are reported at (http://iopscience.iop.org/0026-1394/43/2/S14/). Maybe a comment concerning this fact would be valuable for the paper.

++ We agree with the reviewer in that the uncertainties of Brewer measurements must be indicated in the work. In addition, we think that a description of the Brewer spectrophotomer used as reference instrument in our work must also be included in the text. Thus, we have added the following new information in the Subsection 2.1:

“In this work, we have used a Brewer MK-III double monochromator spectrophotometer as reference instrument in order to obtain the calibration factors of the UVB-1 radiometer. This spectrophotometer is located at El Arenosillo (Huelva, Spain) and it measures spectral global UV irradiance between 290 and 363 nm with spectral resolution (FWHM) $\sim$0.6 nm, and wavelength accuracy of 0.05 nm. Besides the everyday tests performed with the internal lamps, this Brewer spectrophotometer is periodically calibrated by comparison with a quartz-halogen NIST-traceable standard lamp (1000W DXW type) with an uncertainty of 1.56% at 250 nm and 1.12% at 350 nm. This calibration transfer produces systematic uncertainties of $\pm$5% in the Brewer spectral irradiance measurements (Vilaplana, 2004). In addition, the Brewer instrument used in this work is also periodically intercompared with respect to the transportable Quality Assur-

ance of Spectral Ultraviolet Measurements in Europe (QASUME) spectroradiometer (European irradiance reference) (Gröbner et al., 2006).”

The following references have been included in the Reference List: - Vilaplana, J. M.: Measurement and analysis of ozone and UV solar radiation at El Arenosillo-INTA (Huelva, Spain) (in Spanish). Ph.D. thesis, Universidad de Valladolid, Valladolid, Spain, 247 pp., 2004. - Gröbner, J., Blumthaler, M., Kazadzis, S., Bais, A., Webb, A., Schreder, J., Seckmeyer, G., Rembges, D.: Quality assurance of spectral solar UV measurements: result from 25 UV monitoring sites in Europe, 2002 to 2004. Metrologia, 43, S66–S71, 2006.

Regarding model calculations

* It would be useful to provide surface albedo and aerosol profiles used as inputs.

++ According to the reviewer’s suggestion, we have added the following information in the text (Subsection 2.2): “We implemented the UVSPEC model using standard profiles from the standard atmosphere midlatitude summer (afglms), and midlatitude winter (afglmw) which comprise 50 levels between 0 and 120 km (Anderson et al., 1986). In all simulations, cloud-free conditions are assumed, with a surface albedo of 0.035. For aerosol, the appropriated spring-summer and fall-winter profiles given by Shettle (1989) were used.”

The following reference has been included in the Reference List: - Anderson, G., Clough, S., Kneizys, F., Chetwynd, J., and Shettle, E.: AFGL atmospheric constituent profiles (0–120 km), Tech. Rep. AFGL-TR-86-0110, Air Force Geophys. Lab., Hanscom Air Force Base, Bedford, Mass., 1986. - Shettle E. P.: Models of aerosols, clouds and precipitation for atmospheric propagation studies’, in AGARD Conference Proceedings No. 454, Atmospheric propagation in the uv, visible, ir and mm-region and related system aspects, 1989.

* Also the Single scattering albedo constant input would have an effect on the RMS of

both one step and two step methods. Interestingly single scattering albedo of 0.9 still leads to a higher measured UVI values (1-step, 2-step) that the ones simulated by the model (on cloudless days and for a given AOD and Angstrom Exponent). This means that it would take even higher SSA values to compensate the difference, but that is unrealistic. Could you comment on that?

++ We obtain MBE values (equation 2) about +1% when the experimental UVI data obtained with the one-step and two-steps methods are compared with model UVI estimations (assuming a fixed SSA value of 0.9). Thus, our experimental data (1-step, 2-step) present a very slight overestimation of the model estimations. As the reviewer comments, the model UVI estimations should be a little higher to compensate the difference. This could be obtained assuming a SSA value larger than 0.9 in the UVSPEC model, but this is unrealistic. The increase of UVI estimations can also be obtained if the daily TOC data used by the model were a little lower. Overall, we think that the experimental-model relative difference about 1% is within of the uncertainties of both model and experimental values.

* Figure 6 includes daily UVI's, so days with clouds also. Since there is no investigation on such cases please mention this while describing the figure.

++ According to the reviewer's suggestion, we have added the following comment in the text (Section 4): "Figure 6 shows the evolution of the daily UVI at Granada during four years (2006-2009) under all sky conditions using the two-steps calibration method and the manufacturer's calibration factors." Regarding this figure, we also stated that "....significant day-to-day variability which is mainly associated with changes in the cloud cover (Alados-Arboledas et al., 2003b)."

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 5645, 2010.