

Reply to comments by Anonymous Referee #1

on the manuscript "Quality assessment of solar UV irradiance measured with array spectroradiometers" by Egli et al., submitted to *Atmospheric Measurement Techniques*.

Thank you very much for your favorable assessment of our manuscript and detailed and helpful comments. We have carefully considered each of your general and specific comments. The original comments are copied below (in italic font), followed by our specific responses (in regular font). The changed new text is written between quotation marks and reference is given to respective changes in the revised manuscript. We are convinced that thanks to the reviews the manuscript is improved and we believe that it is acceptable for publication in *Atmospheric Measurement Techniques*.

Thanks for your efforts, with Best Regards,

Luca Egli and Co-Authors

General Comments:

1) The paper describes a blind comparison of spectral UV irradiance measurements. The results of 14 detector array spectroradiometers were compared with those of a doublemonochromator based reference instrument. The overall results are a bit disilluioning because none of the tested detector array instruments really performed convincingly although half of them were already optimized in a dedicated project to improve their performance.

We agree with the Referee's conclusion that the performance of the array spectroradiometer is generally poor. Interestingly, the performance could not substantially be approved by efforts within a joint research project. Because array spectroradiometer are more and more used for solar UV radiation measurements, we also agree with the Referees judgement, that "*Nevertheless the paper is important because it shows the state of the art. It should be published after minor revision.*"

2) Various combinations of entrance optics and radiometers from different manufacturers were used in this comparison, as well as different evaluation procedures. So the approach does not seem to be well suited to systematically investigate what is behind the poor performances.

The approach of this study was to assess the performance of array spectroradiometers as they are prepared and/or modified by different end-users to investigate a general performance of this wide range of different setups. This implies that various combinations of entrance optics and instruments from different manufactures were compared. After this study, which revealed a general poor performance, one may focus on one combination of entrance optics and instrument and investigate systematically the reasons of the poor performance. Current efforts are addressing this approach. However, this will be a follow up study based on the findings from this publication.

Specific comments:

1) More information on the calibration of instruments should be given. It is merely noted in the Introduction that "characterization and calibration services" were provided. I assume all calibrations were performed on the site with the same spectral irradiance standard lamp?

Yes the calibrations were performed on the site using the same laboratory setup for all participants. We have added a respective remark in the revised manuscript (page 4 line 17-18):

“The aim of the intercomparison was to provide identical characterization and calibration services (e.g. standard lamp for spectral irradiance) for the participants ...”

2) Are all employed array spectroradiometers sensitive enough to measure spectral UV-B (or UV indices) in the first place? For example Figure 1 in Blumthaler et al., 2013 implies that integration times of several seconds may be necessary not only for the calibration, but also for the measurements in order to obtain a sufficiently small noise equivalent spectral irradiance.

We agree that after the analysis of the intercomparison a larger integration can be recommended to be applied to the instruments (if possible) in order to reduce the noise equivalent irradiance (Blumthaler et al. 2013). However, this will result in the disadvantage of slower acquisition of spectra, which is one of the advantages of array spectroradiometers compared to scanning spectroradiometers. The relevance of the noise equivalence is stated on page 13631 lines 13 -17. We included an additional note on this subject on page 20 lines 1-8 in the revised manuscript:

“Due to the selected measurement interval (see table 2) and the corresponding small noise equivalent irradiance, we may assume that the measurement procedure of the other instruments, may be improved to reduce the noise of the measurements.”

3) Some of the instruments show ratios well below unity (around 0.8, Fig. 4) even at wavelengths where stray light should be no issue. As mentioned in the text, ratios that decrease with increasing SZA probably indicate a poor cosine response but in the case of ARN and UEX there is no such indication. What could cause a 20% difference here (and a 20% difference between 450 nm and 495 nm in the case of UEX)?

Sine this is a blind intercomparison, we have analysed the data as provided by the end-users after their final post processing. The reason for these large biases is unknown. We may speculate that these effects originate from errors during the data post processing. This is likely because the data processing of these two instruments were provided by end-users collaborating together. We have added a respective sentence in the revised manuscript (p 15: lines 4-6):

“The reason for these large biases is unknown. We may speculate that they are attributed to non-proper post-processing of the data (e.g. application of the irradiance calibration) by the end-users.”

4) The numbers in Tab. 3 have limited meaning. They'll depend on measurement times and conditions, synchronization etc. So it makes little sense to report the number with the current precision. I would skip at least one digit.

We fully agree with the Referee's comment and we have adjusted Table 3 according to the suggestion.

5) I don't understand the remark on page 13623, line 27: "However, in terms..." First the authors explain the advantages of making the comparison under clear sky conditions then they put all data together.

We agree that these are somehow ambiguous information. For clarification: Clear sky is from sunset to sunrise is needed to investigate the cosine error of entrance optics. Since we have seen that this effect is minor compared to the overall performance of the instruments and we used as much data as possible including overcast days. This has the advantage to show also the performance of non-ideal cases. We have re-written this paragraph in the revised manuscript (p 12, lines 24 – 29).

For the analysis of the cosine response of the entrance optics clear skies from sunrise to sunset as for day 197 are needed. The analysis of day 197 regarding cosine response showed that the effect of the cosine response is minor compared to the overall quality of the measurements. Therefore, and also to assess the performance of the instruments including effects of scattering of clouds and to analyze as much data as possible, also overcast days are included in the study.

6) *I don't understand the remark on page 13630, line 17: "However, a large deviation..."*

We have clarified this statement in the revised manuscript (page 18, lines 26-28):

"However, a large deviation of the single UV index estimates from the mean value (Figure 5) is found for this instrument. This may indicate that the compensation effect may not account for the different atmospheric conditions."

7) *Apparently, the deficiencies of the array spectroradiometers are not specific for any manufacturer. If this is the case it should be stated clearly to avoid that a particularly good or poor performance is associated with a certain manufacturer.*

This is a very fair point to be addressed. There is no final conclusion which allows to state that an instrument of a specific manufacturer performs better than the others. We highlighted this in the revised manuscript as a bullet point in the conclusions (page 21, lines 13-14):

"The assessment based on this study does not allow recommending a specific instrument or manufacturer exhibiting a superior quality of solar UV measurement."

All technical comments and typos are corrected in the revised manuscript.