Inter-comparison campaign of solar UVR instruments at Réunion Island (21.0°S, 55.5°E): findings and recommendations
Jean-Maurice Cadet, Thierry Portafaix, Hassan Bencherif, Colette Brogniez, N. Sébastien, Caroline Lallemand, C. Y. Wright

To cite this version:
Jean-Maurice Cadet, Thierry Portafaix, Hassan Bencherif, Colette Brogniez, N. Sébastien, et al.. Inter-comparison campaign of solar UVR instruments at Réunion Island (21.0°S, 55.5°E): findings and recommendations. European Conference on solar UV Monitoring, Sep 2018, Vienne, Austria. 2018. hal-02098082
**Introduction**

Reunion Island (21.0°S, 55.5°E) is a French and European territory situated in the Indian Ocean in the tropics where solar ultraviolet radiation (UVR) levels are high almost all-year-round. This is mainly due to intense solar radiation combined with weak stratospheric ozone columns. Yet, very few UVR and ozone measurements are available or operational in these regions, especially in the south-west Indian Ocean countries. Since 2009, the Reunion University, a French and European university, started a research program based on ground-based solar UVR and ozone observations. Continuous UVR measurements require instrument monitoring and calibration processes in terms of wavelength and intensity on regular intervals and with regular comparison against a reference instrument. Several UV instruments comparison has already been done [1], but a comparison at high UV level can highlight a different instrument trend. In the framework of the NDCPC (Network for the Detection of Atmospheric Composition Changes) and in collaboration with the LOA (Laboratoire d’Optique Atmosphérique, Université de Lille, Lille, France) a Bentham DM300 spectrometer (BT) is operated at Reunion Island. We recently implemented an inter-comparison campaign between the Bentham spectroradiometer and four UV instruments: a Kipp&Zonen UV-FT200, a Solar Light 501 (SL), a Silvá UV-OS (SG) and a Davis radiometer (DV), with the Bentham spectrometer as a reference. It should be noted that the Kipp&Zonen and Solar Light 501 radiometers were calibrated during the International UV Radiometer Comparison in summer 2017 organized by PMOD/WRC at the WCC-UV in Davos [2]. In order to identify clear sky conditions, an all-sky camera recording cloud fraction (CF) has been operating at the observation site.

**Materials**

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Type</th>
<th>Date range</th>
<th>Parameters</th>
<th>Uncertainty</th>
<th>Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>(BT) Bentham DM300</td>
<td>Spectro-radiometer</td>
<td>10/17 to 06/18</td>
<td>55 min, 0.5 nm, 280-450 nm</td>
<td>±5%</td>
<td>Intensity, Absorbance (mean 3 months)</td>
</tr>
<tr>
<td>(K2) Kipp&amp;Zonen UV-FT200</td>
<td>Radiometer</td>
<td>10/17 to 06/18</td>
<td>5 min</td>
<td>±7%</td>
<td>Intensity, SZA, ozone (08/2017)</td>
</tr>
<tr>
<td>(SL) Solar Light 501</td>
<td>Radiometer</td>
<td>03/18 to 06/18</td>
<td>1 min</td>
<td>±5%</td>
<td>Intensity, SZA, ozone (08/2017)</td>
</tr>
<tr>
<td>(SG) Silvá UV-OS</td>
<td>Radiometer</td>
<td>03/18 to 06/18</td>
<td>1 min</td>
<td>±5%</td>
<td>Intensity (12/2017)</td>
</tr>
<tr>
<td>(DV) Davis UV-camera</td>
<td>Camera</td>
<td>03/18 to 06/18</td>
<td>1 sec</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Methods of comparison**

All data are interpolated on a 1 degree grid of solar zenith angle. The comparison is performed by calculating bias per SZA, MAPE, correlation and RMSE:

\[
\text{Bias} = \frac{1}{n} \sum_{i=1}^{n} (U_{i} - Y_{i}),
\]

\[
\text{MAPE} = \frac{1}{n} \sum_{i=1}^{n} \left| \frac{U_{i} - Y_{i}}{U_{i}} \right| 
\]

\[
\text{RMSE} = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (U_{i} - Y_{i})^2},
\]

\[
\text{r} = \frac{1}{n} \sum_{i=1}^{n} (U_{i} - \bar{U})(Y_{i} - \bar{Y}) \]

**Clear sky filtering**

For manually selected clear sky days, all the sky cover values are between 2 and 10%. Figure 1 shows an example of clear sky day at La Réunion on 11/04/2018 with a constant cloud fraction of 2%. Cloud fraction data from all the sky camera are in good agreement with other clear sky filtering methods [8].

**Conclusion**

The cloud condition doesn’t affect the bias between the instruments. The effect of the cloud cover on the UVI is the same on all the co-localised instruments.

**Recommendations**

The SL501 shift can be corrected by using a new calibration factor according to the bias found, 0.69 Wm\(^{-2}\) instead of 0.8686 Wm\(^{-2}\). A new calibration can also be performed to solve this issue.

---

**Reference**

[1] Lacy, Laboratoire d’Optique Atmosphérique et des Cyclones (UMR 8105 CNRS, Université de La Réunion, Mâtéo France), Saint-Denis de La Réunion 97744, France

[2] International UV Filter Radiometer Comparison PMOD/WCC-UV, Davos, Switzerland, Summer 2017
