Reconstruction of effective UV: comparing various input sources and weighted UV from seven wavelength bands

H. Slaper, P.N. den Outer, A. van Dijk
Content

• Selection of wavelength bands for reconstruction of effective UV

• Comparing UV reconstruction in relation to input data

• UV-maps ..

• Conclusions
Reconstruction of effective UV (and full UV spectrum) from 7 bands

- Selection of wavelength bands (wavelength and width)
- Construct example cases with high and low sun and for various ozone values; check influence of high albedo
  - Thessaloniki; summer day 185 (ozone 200, 330 and 500 DU)
  - Bilthoven: winter day 355 (ozone 200, 330 and 500 DU)
- Construction of examples (Jean Verdebout); single spectra and daily summed spectra, using a variety of interpolation schemes
- Run (single) and daily spectra through SHIC-algorithm to construct full spectrum and effective UV
Example of seven bands spectrum (daily sum for Bilthoven case (day 355))

- Values at the 7 selected wavelengths,
- 5 nm triangular slit function,
- using apm_0_5nm at 0.5 nm solar flux
- spectrum interpolated in a denser LUT.
- integrated irradiance in J/(m2.nm)

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Irradiance (J/(m2.nm))</th>
</tr>
</thead>
<tbody>
<tr>
<td>295.00</td>
<td>7.63167e-03</td>
</tr>
<tr>
<td>300.00</td>
<td>2.78748e-01</td>
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<tr>
<td>305.00</td>
<td>5.11022e+00</td>
</tr>
<tr>
<td>310.00</td>
<td>4.46709e+01</td>
</tr>
<tr>
<td>315.00</td>
<td>1.80616e+02</td>
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<tr>
<td>330.00</td>
<td>1.20397e+03</td>
</tr>
<tr>
<td>360.00</td>
<td>1.55600e+03</td>
</tr>
</tbody>
</table>

From seven bands to spectra and effective UV using SHICrivm

No wavelength shift or spike corrections possible
Example of reconstructed spectrum (0.5 nm step, 1 nm FWHM) from seven bands (ratio versus high resolution) Thessaloniki case SZA17.6

1nm spectra ratio 7L2/HIR

![Graph showing wavelength vs. ratio for a reconstructed spectrum with a ratio curve that remains relatively flat across the range of wavelengths from 295 nm to 395 nm.](image_url)
Reconstruction of daily integrated spectra from 7 wavelength bands using SHIC

Bilthoven day 355: Ratio of SHIC analysed spectra 1 nm low (7 bands) / high resolution start daily-spectra (from J Verdebout)
Reconstruction of daily integrated spectra from 7 wavelength bands using SHIC

Bilthoven day 355: Ratio of SHIC analysed spectra 10 nm summ low (7 bands) / high resolution start daily-spectra (from J Verdebout)
Comparing 7 bands analysis with high resolution spectrum: Bilthoven day 355 (LOW sun case sza >75) CIE-erythemally weighted

<table>
<thead>
<tr>
<th></th>
<th>200 DU</th>
<th>330 DU</th>
<th>330 DU HA</th>
<th>500 DU</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIL_7h1</td>
<td>222.6</td>
<td>136.6</td>
<td>193.2</td>
<td>98.33</td>
</tr>
<tr>
<td>BIL_7h2</td>
<td>210.9</td>
<td>130.1</td>
<td>183.8</td>
<td>94.65</td>
</tr>
<tr>
<td>BIL_7he</td>
<td>207.2</td>
<td>128</td>
<td>180.9</td>
<td>93.41</td>
</tr>
<tr>
<td>BIL_7l1</td>
<td>222.3</td>
<td>136.6</td>
<td>193.1</td>
<td>98.26</td>
</tr>
<tr>
<td>BIL_7l2</td>
<td>210.7</td>
<td>130</td>
<td>183.7</td>
<td>95.58</td>
</tr>
<tr>
<td>BIL_7le</td>
<td>207</td>
<td>128</td>
<td>180.8</td>
<td>93.35</td>
</tr>
<tr>
<td>BIL_hir</td>
<td>203.4</td>
<td>127.56</td>
<td>179.6</td>
<td>94.53</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>7L2/HIR</th>
<th>7HE/HIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>7L2/HIR</td>
<td>1.0358899</td>
<td>1.0191283</td>
</tr>
<tr>
<td>7HE/HIR</td>
<td>1.0186824</td>
<td>1.0034494</td>
</tr>
</tbody>
</table>
Comparing 7 bands analysis with high resolution spectrum: Thessaloniki day 185 (HIGH sun case; daily integrals); CIE-erythemally weighted

<table>
<thead>
<tr>
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<th>200 DU</th>
<th>330 DU</th>
<th>500 DU</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE_7h1</td>
<td>9692</td>
<td>5328</td>
<td>3280</td>
</tr>
<tr>
<td>THE_7h2</td>
<td>9669</td>
<td>5300</td>
<td>3279</td>
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<tr>
<td>THE_7he</td>
<td>9661</td>
<td>5296</td>
<td>3277</td>
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<tr>
<td>THE_7l1</td>
<td>9674</td>
<td>5318</td>
<td>3275</td>
</tr>
<tr>
<td>THE_7l2</td>
<td>9652</td>
<td>5290</td>
<td>3274</td>
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<tr>
<td>THE_7le</td>
<td>9644</td>
<td>5286</td>
<td>3272</td>
</tr>
<tr>
<td>THE_hir</td>
<td>9665</td>
<td>5302</td>
<td>3294</td>
</tr>
<tr>
<td>7L2/HIR</td>
<td>0.9986549</td>
<td>0.9977367</td>
<td>0.9939284</td>
</tr>
<tr>
<td>7HE/HIR</td>
<td>0.9995861</td>
<td>0.9988684</td>
<td>0.9948391</td>
</tr>
</tbody>
</table>
Conclusion on the use of 7 bands to reconstruct effective UV

- Seven band spectra at: 295 nm, 300 nm, 305 nm, 310 nm, 315 nm, 330 nm, 360 nm with 5 nm FWHM bands, can be used to reconstruct daily effective UV using the SHIC algorithm

- accuracy usually < 1%
  - winter case: 0.3 - 1.9 %
  - summer case: 0.05 - 0.52 %

- uncertainty due to interpolation methods somewhat larger; for selected method of interpolation (7L2):
  - winter case: 1.1 - 3.6 %
  - summer case: 0.14 - 0.61 %
Comparing ground based modelling and satellite based data in reconstruction

• Data-sources:
  - Ground based ozone and pyranometer in combination with CMF-algorithm from den Outer et al
  - Satellite based ozone from COST-726
  - ERA-40 CMF (as previously provided by Kaurola)
  - ERA-40 CMF-global modified by H Staiger
• (CMF-global transferred to CMF-UV (den Outer); comparison with TOMS-reflectivity derived CMF-UV)
• Creating maps for full 1958-2004 period
• Extract local values for 8 sites (for detailed comparison)
  - Cloudless
  - Cloudy
Cloudless sky. CIE UV, O₃: COST-726 v.s. Ground-Based
Cloudless sky. CIE UV, O₃: COST-726 v.s. Ground-Based
Cloudy sky. O$_3$: COST-726 v.s. g.b. | CMF: ERA40_V1 v.s. Pyranometer
**Cloudy sky.** $O_3$: COST-726 v.s. g.b. | CMF: ERA40_V1 v.s. Pyranometer

**Potsdam, Cloudy Sky**
- Source: Ozone CMF
- COST-726 ERA-40
- COST-726 Pyrano
- G.B. Pyrano

**Lindenberg, Cloudy Sky**
- Source: Ozone CMF
- COST-726 ERA-40
- COST-726 Pyrano
- G.B. Pyrano

**Hradec Kralove, Cloudy Sky**
- Source: Ozone CMF
- COST-726 ERA-40
- COST-726 Pyrano
- G.B. Pyrano

**Thessaloniki, Cloudy Sky**
- Source: Ozone CMF
- COST-726 ERA-40
- COST-726 Pyrano
- G.B. Pyrano
Cloudy sky. O$_3$: COST-726 | CMF: ERA40_V1 v.s. ERA40_V2
Cloudy sky. O₃: COST-726 | CMF: ERA40_V1 v.s. ERA40_V2

Potsdam, Cloudy Sky
Source: Ozone
CMF: COST-726 ERA-40
COST-726 Pyrano
G.B. Pyrano

Lindenberg, Cloudy Sky
Source: Ozone
CMF: COST-726 ERA-40
COST-726 Pyrano
G.B. Pyrano

Hradec Kralove, Cloudy Sky
Source: Ozone
CMF: COST-726 ERA-40
COST-726 Pyrano
G.B. Pyrano

Thessaloniki, Cloudy Sky
Source: Ozone
CMF: COST-726 ERA-40
COST-726 Pyrano
G.B. Pyrano
And now some MAPPING…
sorry Murphy’s law applied….

1958 compared to full data-period 1958 -2004
European UV-climatology (skin cancer weighted)
UV Cloud Modification Factors in Europe

Cloud modification factor

- < 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
Conclusions

• Seven bands in the UV can be used to reconstruct full spectra for the calculation of effective UV (within 1-2% accuracy)

• ERA40 correction for solar radiation SMFsol applied by Henning Staiger, following a transfer to CMF_UV (method den Outer) performs well:
  - in good agreement with reflectivity derived CMF-UV over TOMS-data period
  - the corrected ERA-40 data are in far better agreement with ground based analysis for the 8 locations shown
Thanks for the attention

Harry Slaper, Peter den Outer, Arjan van Dijk