Validation of the OMI Surface UV Data

NIVR - FMI - NASA - KNMI

Aapo Tanskanen (1), Anu Määttä (1), Nickolay Krotkov (2), Jussi Kaurola (1), Tapani Koskela (1), Alex Karpetchko (3), Vitali Fioletov (4), Germar Bernhard (5)
(1) Finnish Meteorological Institute, Helsinki, Finland; (2) GEST Center, University of Maryland, Baltimore, USA; (3) FMI's Arctic Research Centre, Sodankylä, Finland;
(4) MSC/Environment Canada, Ontario, Canada; (5) Biospherical Instruments, San Diego, USA
correspondence: anu.maatta@fmi.fi

Introduction

Ozone Monitoring Instrument (OMI) onboard the NASA EOS Aura spacecraft is a UV/Vis spectrometer with a 2600 km wide swath capable of daily, global contiguous mapping. Mission requirements include monitoring of ozone and other trace gases, cloud pressure and reflectivity and aerosols [1]. OMI is the successor to the NASA TOMS instrument but with 8-fold better ground resolution (13 by 24 km in nadir) and wide spectral coverage from 270 to 500 nm. The OMI measurements are used as inputs to the radiative transfer model to estimate the ultraviolet (UV) radiation reaching the Earth's surface. The OMI surface UV algorithm inherits from the TOMS UV algorithm developed by NASA/GSFC [2, 3, 4, 5]. We present the first OMI surface UV product validation results. We have compared the OMI UV data with other satellite UV products as well as ground based spectral UV measurement data.

Comparison of the local solar noon erythemal irradiances from OMI and Earth Probe TOMS

The noontime erythemal surface irradiances derived from the OMI measurements were compared with those provided by NASA from the Earth Probe TOMS measurements. Direct comparison of the gridded data for July 15, 2005 (Figure 1) revealed that the surface UV irradiances from OMI were in general lower over land and higher over sea than those derived from the TOMS. Moreover, the different overpass times of the Earth Probe and Aura satellites explain some of the small scale differences, and positive bias was found in regions where the effect of absorbing aerosols was expected. Secondly, we compared zonally and monthly averaged data. In Figure 2 is shown the zonally and monthly averaged noontime erythemal surface irradiance in April. The comparison implied that the erythemal irradiances from OMI were of the order of 10% higher than those from the Earth Probe TOMS.

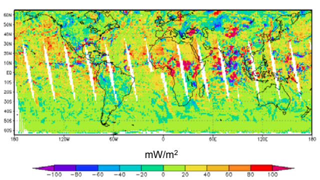

Figure 1. The absolute difference between the gridded noontime erythemal irradiances on July 15, 2005 from OMI and EP/TOMS.

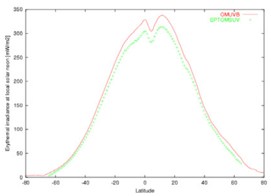

Figure 2. Zonally and monthly averaged noontime erythemal surface irradiance in April.

Validation of the OMI UV data with ground-based spectral UV measurement data

The erythemal daily doses derived from the OMI measurements were compared with those calculated from the ground-based spectral UV measurements. The ground-based reference data was obtained from six measurement sites and from seven spectroradiometers listed in Table 1.

Table 1. Sources of reference data

Instrument	Site	Geolocation	Validation Period
Brewer Mk-III #107	Jokioinen	60.81°N 23.50°E	6.9.2005 - 1.9.2005
Brewer Mk-II #037	Sodankylä	67.37°N 26.63°E	17.8.2004 - 30.9.2005
[a]Brewer Mk-II #014	Toronto	43.78°N 79.47°W	6.9.2004 - 28.6.2005
[a]Brewer Mk-III #145	Toronto	43.78°N 79.47°W	9.9.2004 - 9.6.2005
[b]SUV-100	San Diego	32.77°N 117.20°W	8.10.2004 - 1.10.2005
[b]SUV-100	Ushuaia	54.82°S 68.32°W	6.9.2004 - 1.10.2005
[b]SUV-100	Barrow	71.32°N 156.68°W	6.9.2004 - 1.10.2005

[a]preliminary data: calibration errors of 3-5% are possible
[b]preliminary Version 0 data: cosine corrections have not been made; Version 2 data will be higher than Version 0 data by 4-10%

Validation results

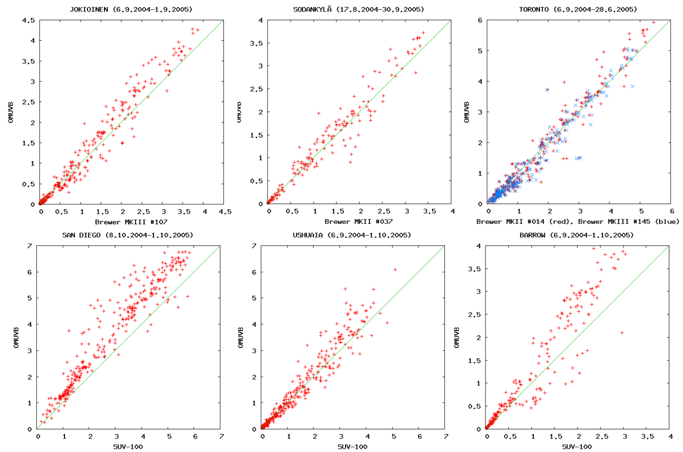

Figure 3. Comparison of the erythemal daily doses [kJ/m²] derived from OMI measurements and ground-based data.

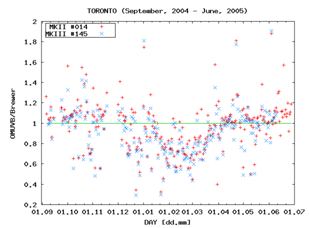

Figure 4. Ratio between OMI-based and ground-based erythemal daily doses for Toronto.

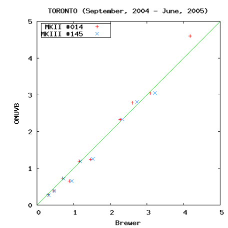

Figure 5. Comparison of the monthly averages of erythemal daily doses [kJ/m2] for Toronto.

$$Bias = \frac{1}{n}\sum_{i=1}^{n}(s_i - g_i) \qquad \%Bias = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{s_i - g_i}{g_i}\right)*100\% \qquad RMS = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(s_i - g_i)^2} \qquad \%RMS = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\frac{s_i - g_i}{g_i}\right)^2}*100\%$$

Table 2. Validation statistics for daily doses [J/m²]

Validation instrument	n	Bias	RMS error	r
Jokioinen Brewer Mk-III #107	292	83 (5.2%)	263 (34%)	0.98
Sodankylä Brewer Mk-II #037	175	50 (7.6%)	234 (22%)	0.97
Toronto Brewer Mk-II #014	262	1 (-3.7%)	336 (24%)	0.98
Toronto Brewer Mk-III #145	232	-92 (-9.4%)	322 (25%)	0.97
San Diego SUV-100	293	768 (31%)	974 (41%)	0.95
Ushuaia SUV-100	339	89 (2.6%)	379 (25%)	0.97
Barrow SUV-100	203	221 (19%)	492 (36%)	0.94

Table 3. Validation statistics for monthly average of the daily doses [J/m2]

Validation instrument	n	Bias	RMS error	r
Jokioinen Brewer Mk-III #107	12	76 (1.2%)	145 (14%)	0.99
Sodankylä Brewer Mk-II #037	7	61 (5.2%)	120 (8.3%)	0.99
Toronto Brewer Mk-II #014	10	13 (-4.3%)	183 (12%)	0.99
Toronto Brewer Mk-III #145	9	-91 (-10%)	153 (15%)	0.99
San Diego SUV-100	12	750 (28%)	839 (28%)	0.99
Ushuaia SUV-100	13	79 (0.4%)	189 (8.8%)	0.99
Barrow SUV-100	8	222 (17%)	421 (27%)	0.96

Discussion and conclusions

The validation results imply improvements in the accuracy of the satellite UV data thanks to the improved spatial resolution of the OMI instrument and advances of the new surface UV algorithm [6]. However, there are still several sources of uncertainty that affect the quality of the satellite estimates of the daily erythemal dose. In sites with temporary snow or ice the agreement between the satellite and ground based data is better in summer than in winter. Because the current surface UV algorithm does not account for absorbing aerosols, there is a systematic positive bias in satellite estimates for sites affected by aerosols from urban or natural sources. Furthermore, the satellite estimate of the daily dose is based on a single observation of the cloud conditions, which causes extra variance, and in some cases even a systematic bias that depends on the satellite overpass time. Monthly averaging results in better agreement between the satellite and ground based data. We plan to continue the validation effort by including more validation sites and by extending the uncertainty analysis.

References

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