Atmos. Chem. Phys. Discuss., 9, C1296–C1301, 2009
www.atmos-chem-phys-discuss.net/9/C1296/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Spatial and temporal UV irradiance and aerosol variability within the area of an OMI satellite pixel" *by* S. Kazadzis et al.

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Received and published: 28 May 2009

We would like to thank the anonymous referee for his/her comments on the manuscript. The referee's initial comments are included in this manuscript.

Ref: This paper is well written and very clear, but incomplete, on the scientific subject under discussion. As mentioned in an earlier comment, it would be very instructive if the authors could include some of the particulars from the satellite retrieval (ozone, cloud amount, and aerosol estimate) that caused the overestimate along with the same values observed from the ground. The paper is good on presentation of the difference between ground-based and satellite measurements (as has been done many times before), but very weak on the analysis of the differences. Is it caused by ozone differences, aerosol differences (likely), cloud radiance transmission estimates (likely), or

some combination of both. Without an examination of the underlying physics, this paper is weak. The authors should make an attempt to obtain the data that went into the satellite estimate of UV on the ground and compare these quantities with those measured in Thessaloniki. Without the extra analysis, this is just another observation that satellites overestimate UV in polluted areas.

We agree that this work does not include a thorough analysis of the main factors affecting the OMI overestimation. Using this 30 day campaign for such an analysis would be not enough for achieving statistically important results. But all the above analysis has been include in the work: S. Kazadzis, A. Bais, A. Arola, N. Krotkov, N. Kouremeti, and C. Meleti, Ozone Monitoring Instrument spectral UV irradiance products: comparison with ground based measurements at an urban environment Atmos. Chem. Phys., 9, 585–594, 2009

There ground based and OMI ozone comparison, cloudless spectral UV is compared and differences are attributed to aerosol optical depth and aerosol absorption optical depth and finally cloudy condition data are statistically interpreted. In addition there is a section describing in detail how OMI product is calculated and the factors included in this calculation.

One technical problem involved with the above discussion is that the above mentioned paper and this work were submitted with a few weeks difference. So when this work was reviewed this paper was not accepted for publication and probably not available for the reviewers. In addition, even if it was cited during the text it was not included in the initial reference list of this work. This reference was added in the revised manuscript.

To follow the reviewer's suggestion we decided to include the following text providing a summary of this cited work and also on OMI retrieval basics.

Text added in the introduction section:

For the area investigated here Kazadzis et al., 2009, have compared spectral ultraviolet overpass irradiances from OMI against ground-based Brewer measurements at Thessaloniki, Greece from September 2004 to December 2007. It is demonstrated that OMI overestimates UV irradiances by 30%, 17% and 13% for 305nm, 324nm, and 380nm respectively and 20% for erythemally weighted irradiance. Cloudless and cloudy conditions were investigated separately and for cloudless conditions aerosols play the most important role for such deviations. Comparing total column ozone values retrieved from OMI and GB measurements we found a small OMI ozone underestimation in the order of 1.2% (mean). The effect of this difference in the irradiance comparison at 305nm varies from 2% to 4% for the solar zenith angle range of OMI overpasses and it is negligible for the irradiance comparisons at higher wavelengths.

Text added in the instrumentation section:

The OMI surface UV algorithm is an extension of the TOMS UV algorithm developed at NASA Goddard Space Flight Center (GSFC) [Krotkov et al., 1998; Herman et al., 1999; Krotkov et al., 2001; Tanskanen et al., 2006]. The OMI surface UV algorithm is used for offline production of the global surface UV data using as input the OMI TOMS total column ozone [Bhartia and Wellemeyer, 2002] and reflectance at non-absorbing wavelength (360nm). A more detailed summary of the OMI-UV retrieval can be found in Kazadzis et al., 2009.

Referenes added:

Krotkov, N.A., P.K. Bhartia, J.R. Herman, V. Fioletov, and J. Kerr, Satellite estimation of spectral surface UV irradiance in the presence of tropospheric aerosols 1. Cloud-free case, Journal of Geophysical Research D: Atmospheres, 103 (D8), 8779-8793, 1998.

Tanskanen, A., N.A. Krotkov, J.R. Herman, and A. Arola, Surface ultraviolet irradiance from OMI, IEEE Transactions on Geoscience and Remote Sensing, 44 (5), 1267-1271, 2006.

Bhartia, P.K., and C.W. Wellemeyer, TOMS-V8 total O3 algorithm, in OMI Algorithm

Theoretical Basis Document, NASA Goddard Space Flight Cent., Greenbelt, Md., 2002.

Ref: The fact that multiple measurements were made inside an OMI footprint is only marginally interesting without a more complete discussion of the underlying physics.

As mentioned in the first comment the aim of this work was not to explain the OMI vs ground based irradiance differences and the effect of aerosols, ozone and clouds in the OMI UV algorithm retrievals. We think that these questions were answered in a certain extend for the specific area, in Kazadzis et al., 2009. The variability inside the OMI footprint is something that only Weihs et al., 2008 have been investigating and the spatial variability for all the above factors is an additional uncertainty when comparing satellite and ground based measurements. Investigating spatial variability of clouds Weihs et al., 2008 showed clearly the limitations of any satellite UV validation attempt. In the case of aerosols, we believe that a large number of instruments from UV or aerosol Networks worldwide are situated in or near urban areas-cities. Practically to universities, institutes e.t.c. So to investigate the spatial variability of UV inside a satellite pixel in an urban area provides an idea of the limits of the agreement between satellites and ground based measurements when analyzing long term series of synchronous measurement data.

Ref: Since the measured UV irradiance differences were largest at smaller wavelengths, were the differences caused by an ozone error or by increased aerosol absorption at shorter UV wavelengths? The authors should at least discuss the possibilities underlying the differences. Would a small change in the ozone amount assumed by the satellite retrieval remove most of the wavelength dependence of the difference between the satellite irradiance estimates and the ground-based measurements?

The text included in the introduction analyzes the ozone effect in the 3.5 years of measurements analyzed in Kazadzis et al., 2009.

New text: Comparing total column ozone values retrieved from OMI and GB measurements we found a small OMI ozone underestimation in the order of 1.2% (mean). The effect of this difference in the irradiance comparison at 305nm varies from 2% to 4% for the solar zenith angle range of OMI overpasses and it is negligible for the irradiance comparisons at higher wavelengths.

We also include here a figure showing the OMI – GB ozone measurements comparison base on the 3.5 years data, for Thessaloniki, Greece. Brewer double monochromator #086 ozone measurements are compared with synchronous (within 30 minutes from OMI overpass time) OMI ozone measurements.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 7273, 2009.

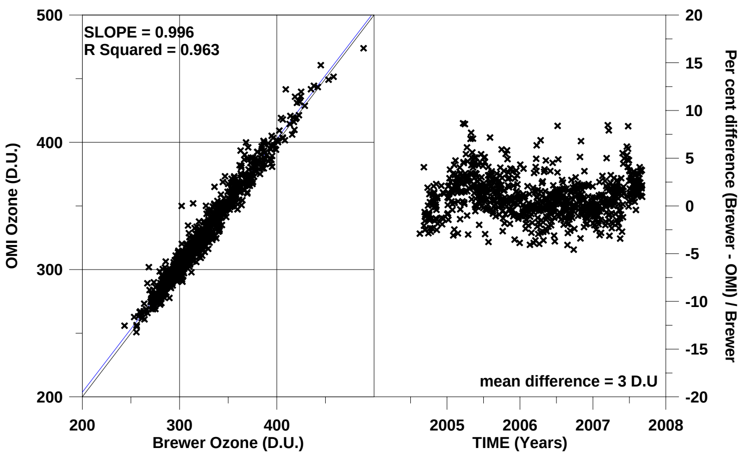

Fig. 1. Brewer and OMI ozone comparison 2004-2008