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Surface UV Irradiance from OMI on EOS Aura

**Atmospheric Science Conference
ESRIN, 8-12 May 2006**

Aapo Tanskanen





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OMI Surface UV Algorithm

N. Krotkov /GEST Center, University of Maryland

J. Herman /NASA GSFC

A. Tanskanen, A. Arola /FMI

paper: "Surface Ultraviolet Irradiance from OMI", IEEE TGRS Aura Special Issue, May 2006

Validation of the OMI Surface UV Data

A. Määttä, A. Tanskanen, J. Kaurola, T. Koskela, A. Karpetchko /FMI

V. Fioletov / MSC Environment Canada

G. Bernhard / Biospherical Instruments

poster: "Validation of the OMI surface UV data" in the AGU fall meeting, 5-9 Dec, 2005

OMI is a contribution of NIVR in collaboration with FMI to the EOS Aura mission of NASA. Scientific use of OMI data is coordinated by KNMI, NASA and FMI.

NIVR-FMI-NASA-KNMI





Some Background Information about UV

UV radiation affects

- Human health: skin cancer, cataracts, immune system, vitamin D synthesis
- Aquatic and terrestrial ecosystems
- Materials
- Additionally, UV is involved in various atmospheric and other processes by photochemical reactions

Surface UV depends on

- Solar zenith angle
- Total column ozone
- Clouds
- Aerosols
- Surface albedo
- Topography

There is a need for UV forecasts and longterm monitoring of UV. These services are being developed for example within the PROMOTE GSE of ESA.

<http://www.gse-promote.org/>



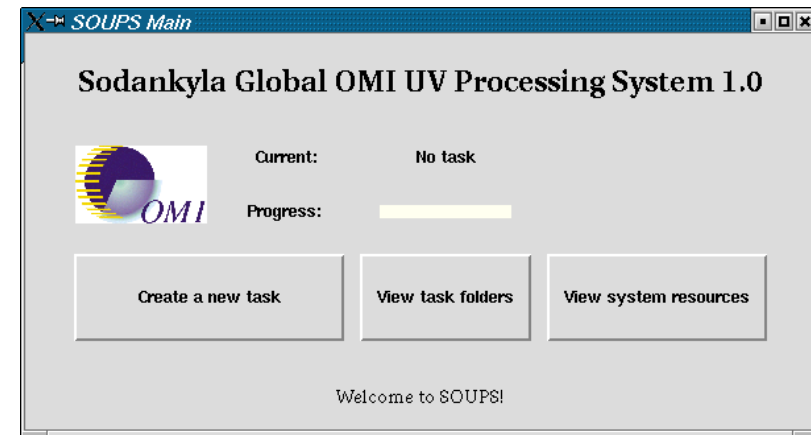
OMI Surface UV Algorithm and Surface UV Products

- **Inherits from the TOMS UV algorithm based on look-up-tables made with various radiative transfer models.**
 1. Calculate clear-sky surface UV irradiance
 2. Define cloud optical depth τ that gives the measured TOA radiance
 3. Make cloud correction using the obtained τ
 4. Aerosol correction to be added in the future
- **Input: OMI Level 2 total ozone column data from NASA**
- **Products:**
 - Erythemal dose rate at local solar noon (UV Index)
 - Erythemal daily dose
 - Irradiances at 305, 310, 324 and 380 nm at local solar noon
- **Processing, archiving and dissemination of the OMI surface UV data are performed at FMI's Satellite Data Centre in Sodankylä**



Current Processing Status

- Currently, some 7000 granules out of the total 8000 ECS Collection 2 OMT03 granules have been processed.
- The data corresponds to a time period from August 17, 2004 to February 4, 2006.
- The OMI UV data (OMUVB) are archived locally in Sodankylä and have been submitted to the Aura Validation Data Center. AVDC provides overpass data for some 80 sites for OMI validation teams.
- There are plans to reprocess all the data as a new version of the OMT03 data becomes available.



<i>Dataset</i>	<i>Number of HDF5 granules</i>	<i>Size in GBytes</i>
<i>OMT03</i>	<i>8000</i>	<i>400</i>
<i>OMUVB</i>	<i>7000</i>	<i>60</i>



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FMI Satellite Data Archive



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- FMI has developed a satellite data archive in Sodankylä as a part of the EUMETSAT's O3MSAF project primarily for MetOp data
- The archive is an Oracle based relational database with WWW user interface for search, online plotting and download of data
- OMI surface UV data is used for testing of the archive and the user interface

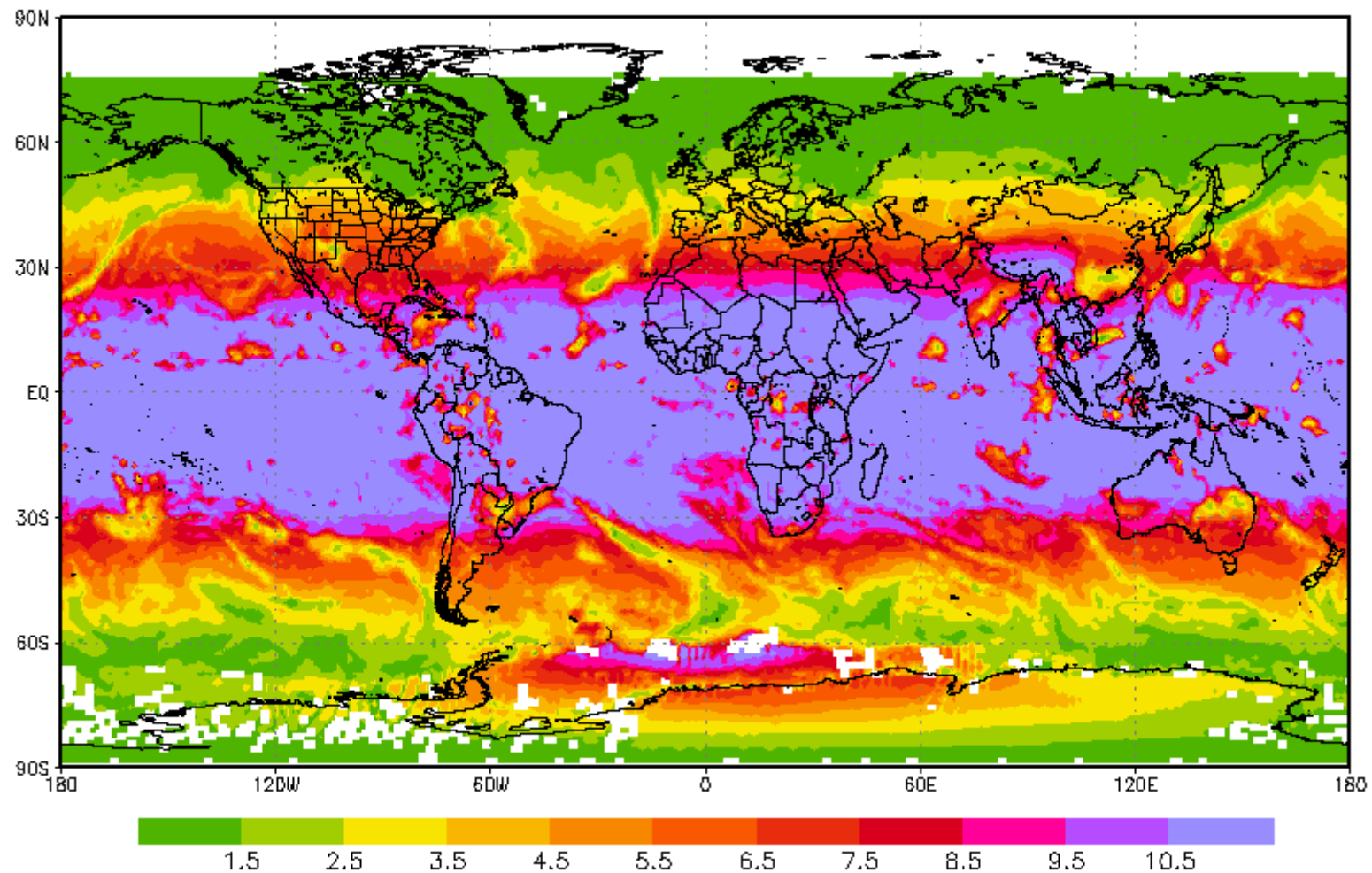
<i>Data user group</i>	<i>Level 2 OMUVB data in HDF-EOS5</i>	<i>Online plotting of gridded data</i>	<i>Local time series in ASCII</i>
Registered scientific users	✓	✓	✓
UV effect research		✓	✓
General public		✓	✓



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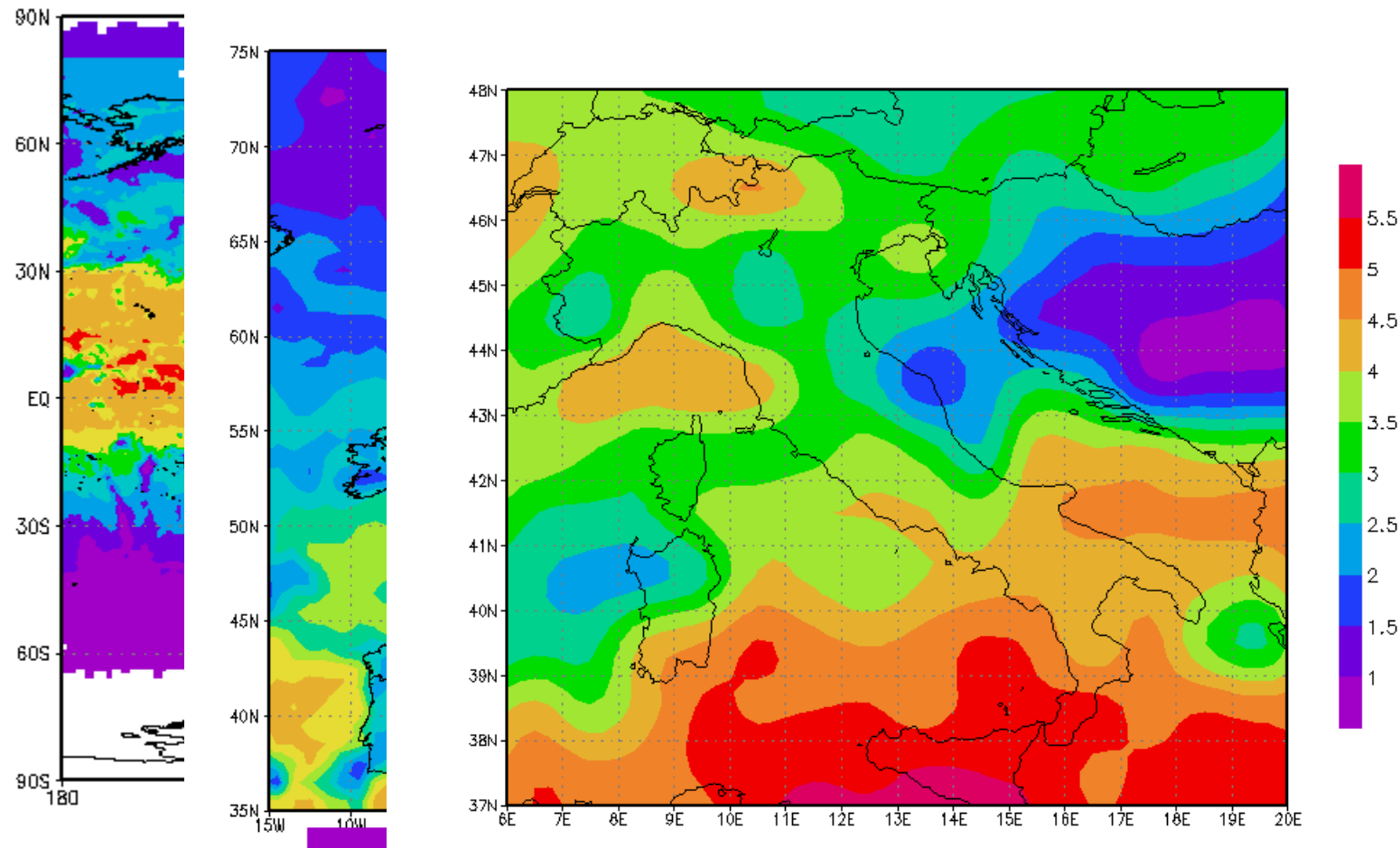


Example: UV Index in October 15, 2005



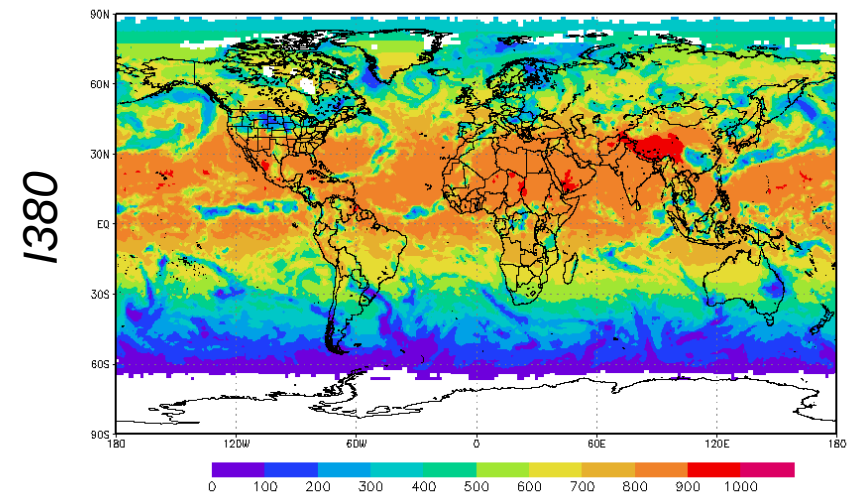
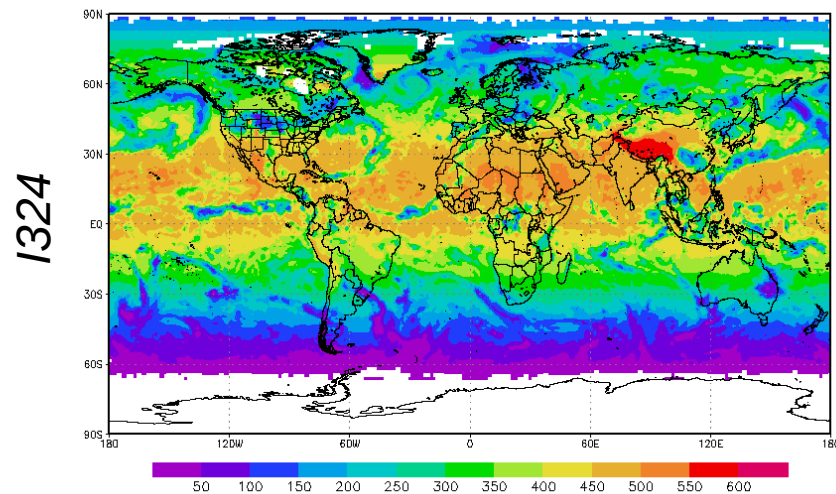
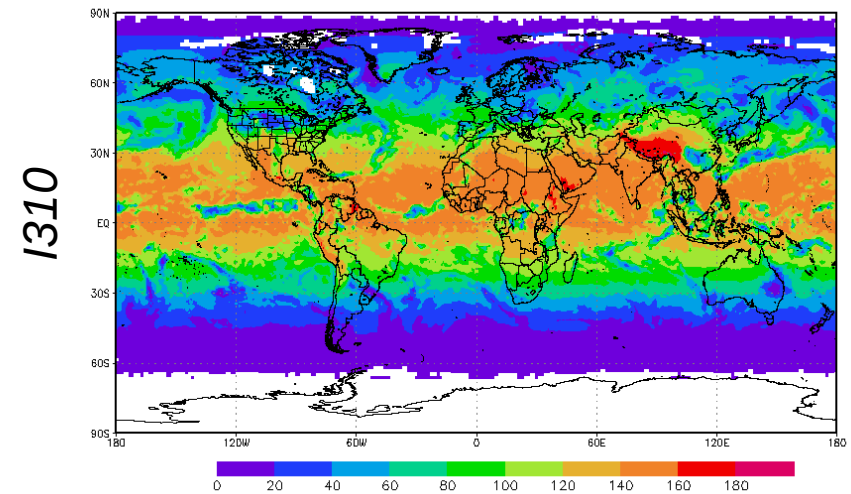
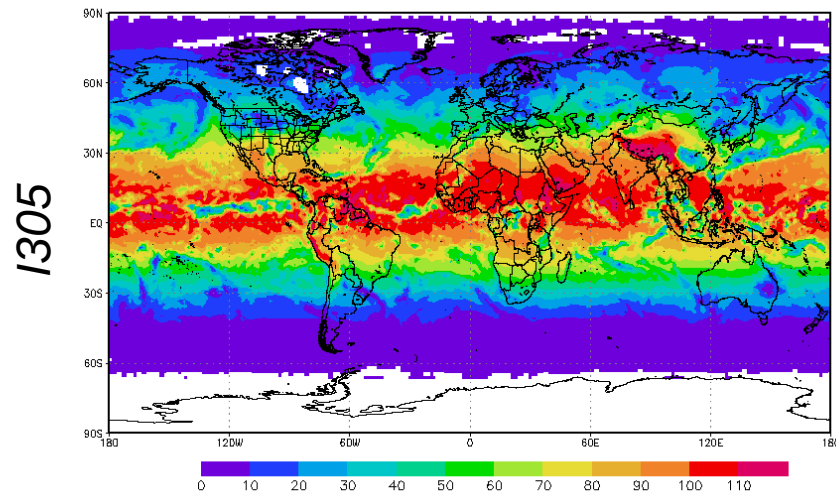


Examples: Daily Erythemal Dose (kJ/m^2) in May 11, 2005





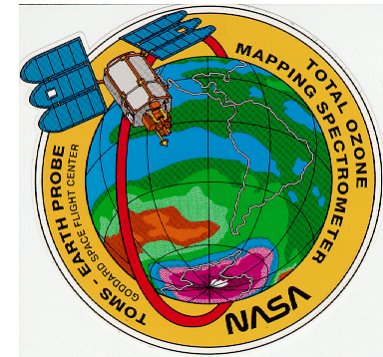
Examples: Spectral Irradiances at noon in May 5, 2005





OMI Surface UV Validation

- **Comparison of the OMI UV data with the EP/TOMS satellite data**
 - Direct comparison of the daily values
 - Comparison of the monthly zonal averages



- **Validation of the OMI UV data with ground-based spectral UV measurement data**
 - Comparison of the daily doses
 - Reference data from FMI, NSF, MSC



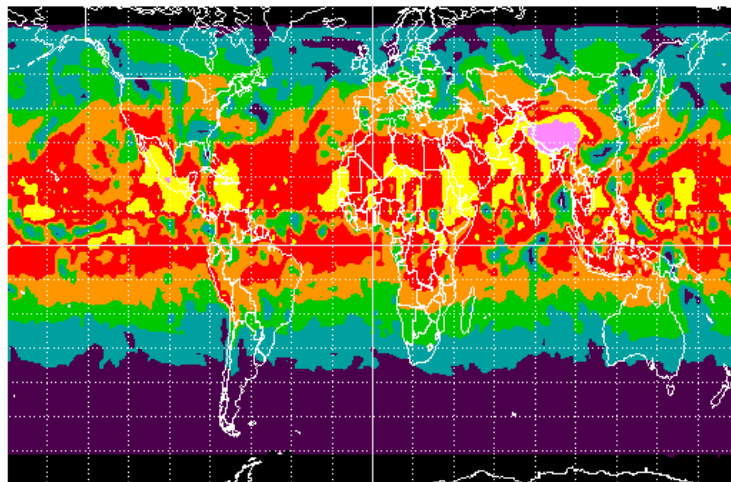
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Comparison of the Local Solar Noon Erythemat Irradiances from OMI and EP/TOMS

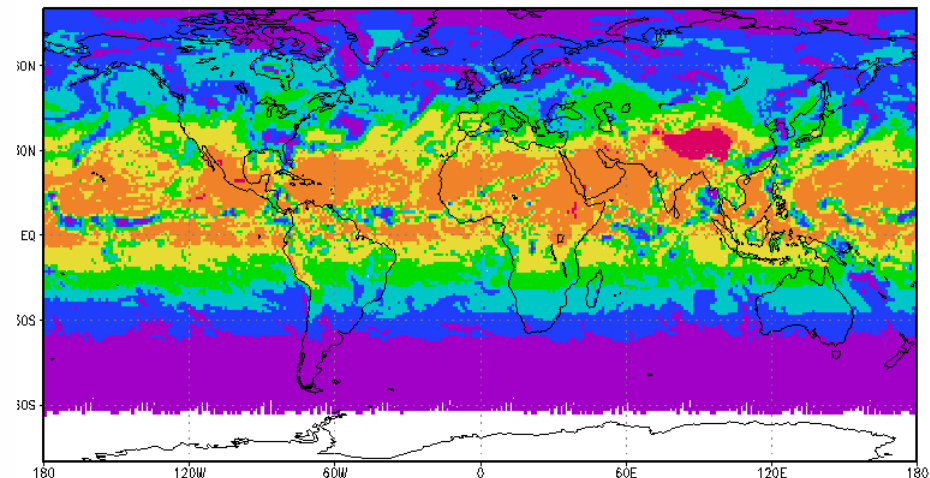
- The erythemat irradiances were found to be in the same range and similar patterns of cloud attenuation were identified
- However, the OMI provides higher spatial resolution and more complete global coverage

Earth Probe TOMS Version 8 Local Noon Erythemat UV Irradiance
on June 01, 2005



0 60 120 180 240 300 360 420>
Local Noon Erythemat UV Irradiance (mW/m²)

Goddard Space
Flight Center

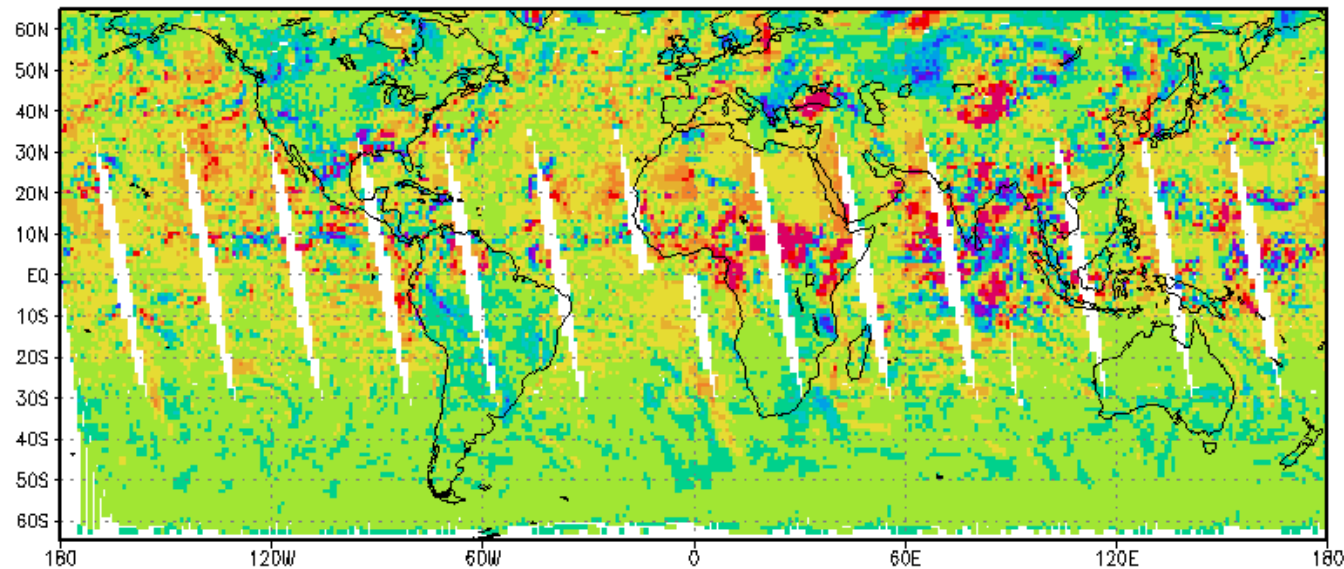


60 120 180 240 300 360



OMI Surface UV vs. EP/TOMS Surface UV

- The erythemal local solar noon irradiances from OMI were in general lower over land and higher over sea than those from the EPTOMS
- Difference in the overpass time of the Earth Probe and Aura satellites accounts for some small scale differences related to clouds
- Positive bias is expected in regions affected by absorbing aerosols



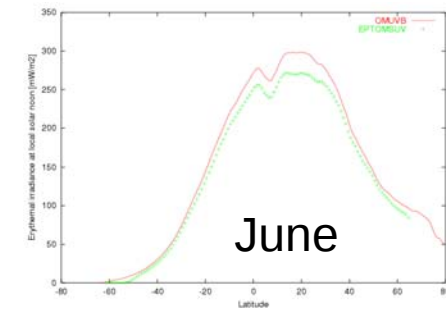
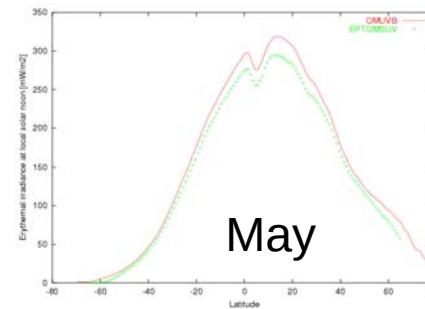
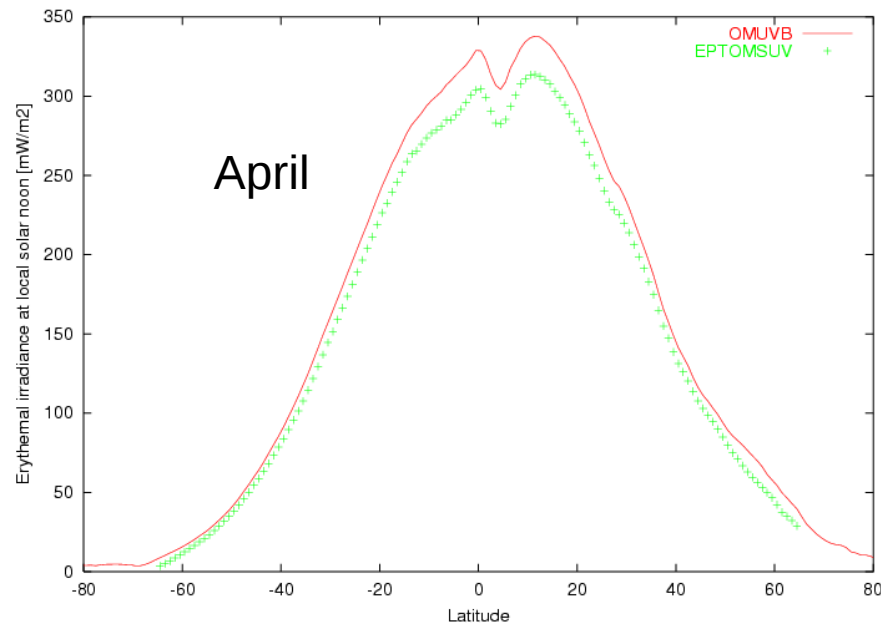
July 15, 2005



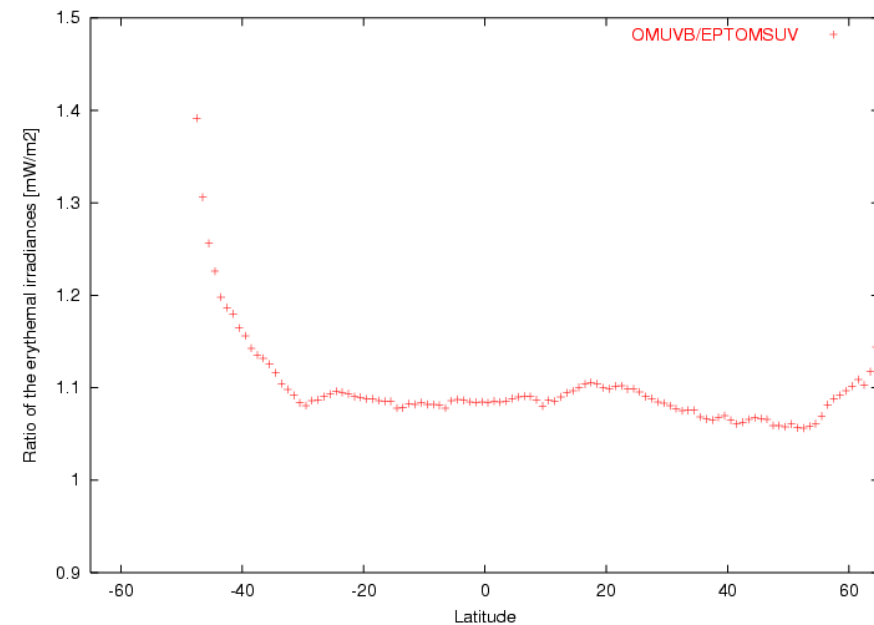
mW/m²



Comparison of the monthly zonal means



The erythemal noontime OMI UV irradiances were some 10% higher than those from the EPTOMS. The relative differences are even larger at high latitudes





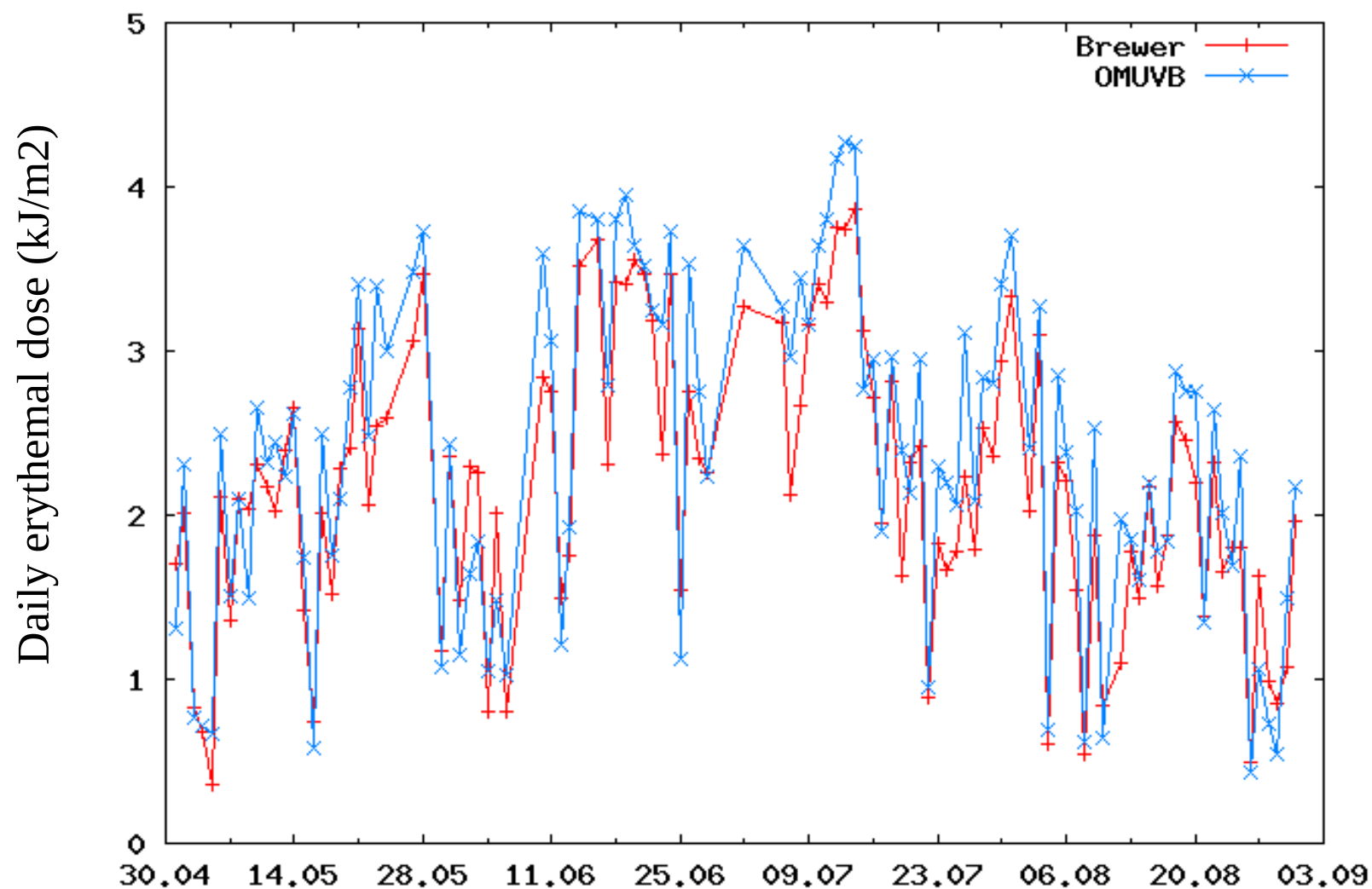
Validation of the OMI UV data with Ground-Based Spectral UV Measurements

- **Comparison of the daily erythemal doses**
- **Ground-based reference data**
 - Brewers in Jokioinen and Sodankylä
 - SUV100 network data by National Science Foundation
 - Canadian Brewer network data from Meteorological Service of Canada
 - Additional data in near future



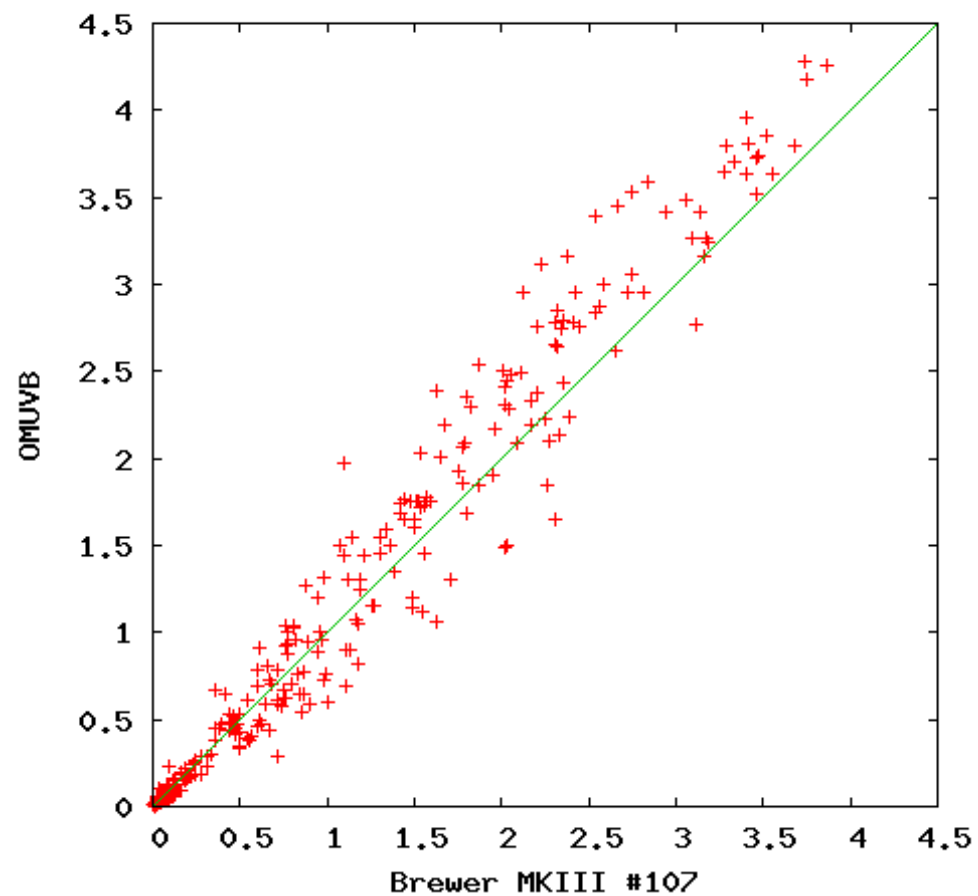


JOKIOINEN summer 2005

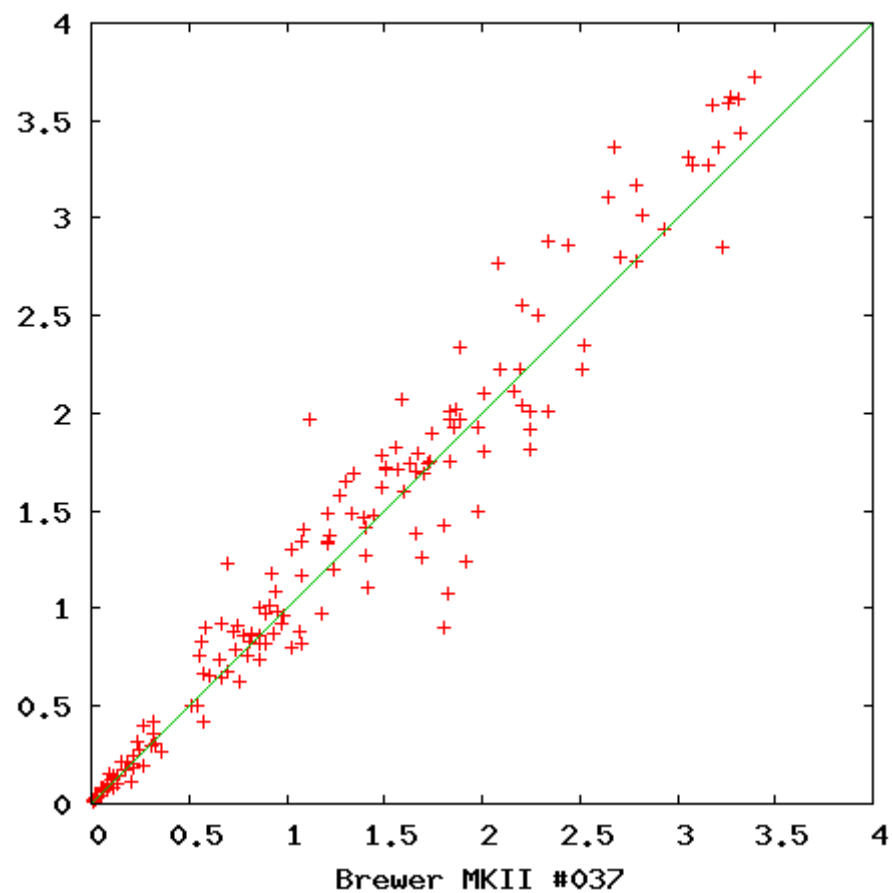


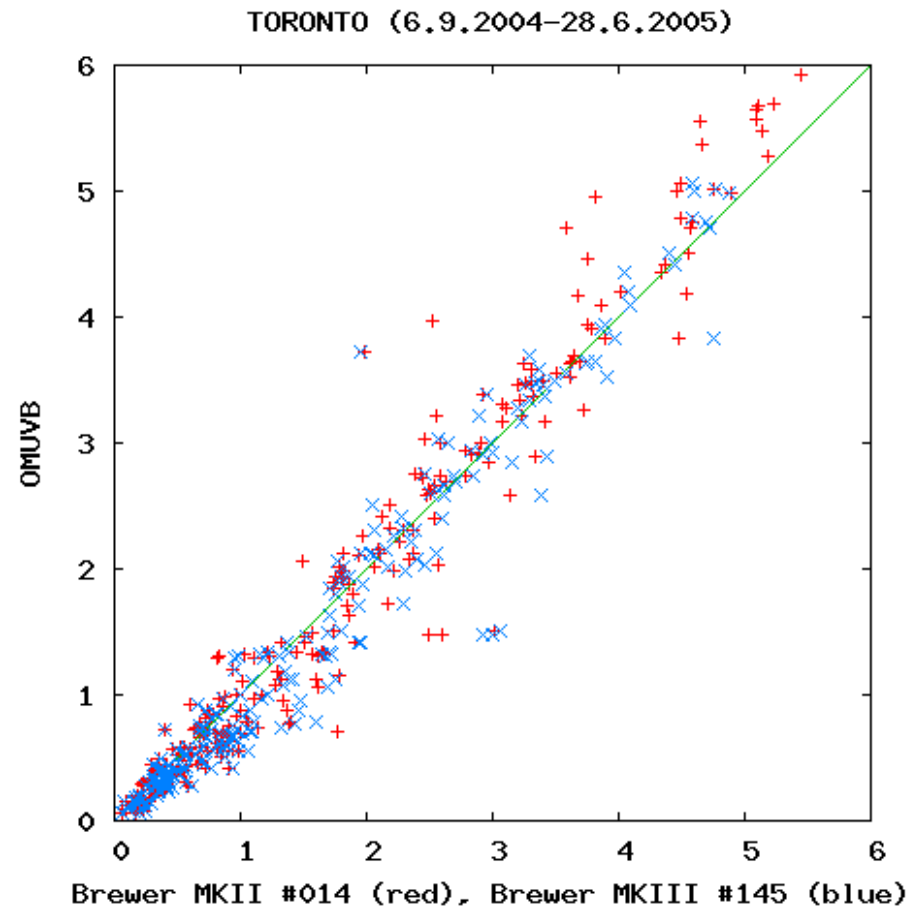


JOKIOINEN (6.9.2004–1.9.2005)



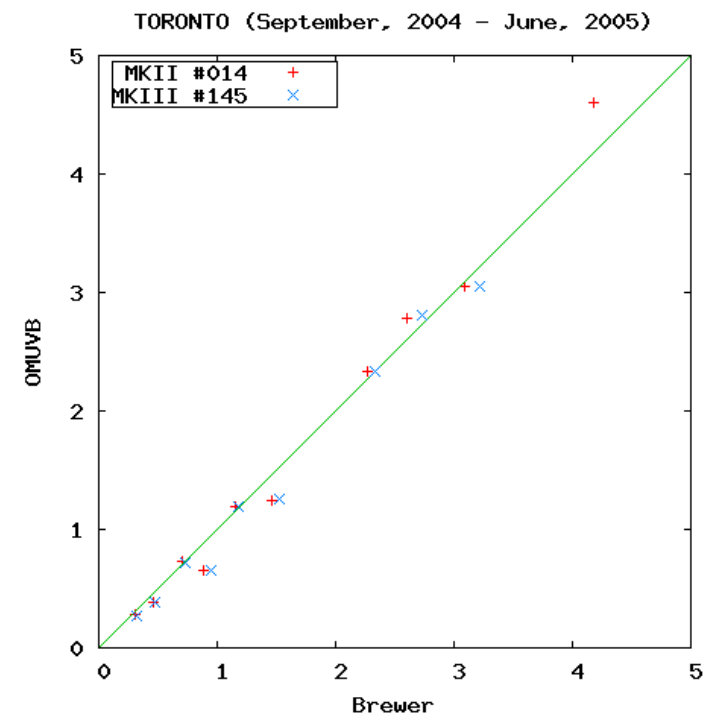
SODANKYLÄ (17.8.2004–30.9.2005)

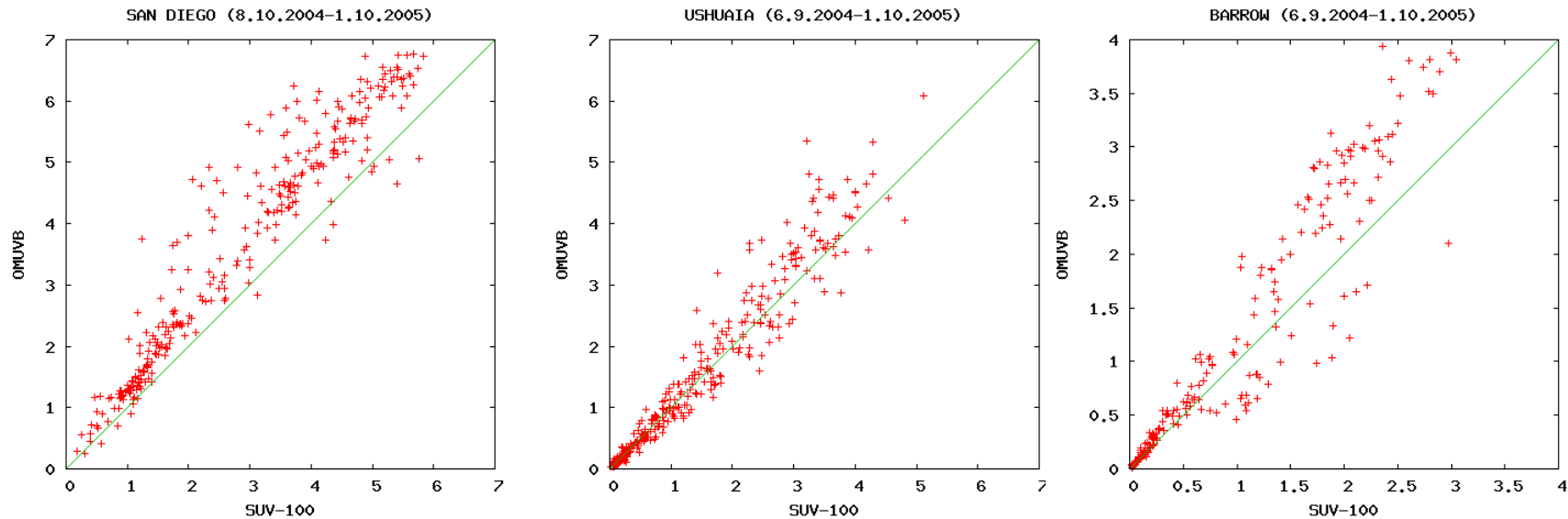




Brewer data provided by
MSC/Environment Canada

Preliminary data: calibration
errors up to 5% are possible





SUV-100 data provided by NSF UV Monitoring Network, operated by Biospherical Instruments Inc. under a contract from the US National Science Foundation's Office of Polar Programs via Raytheon Polar Services Company.

Preliminary Version 0 data: no cosine correction, Version 2 data will be higher by 4-10%



Validation Statistics for Daily Doses from OMI [kJ/m²]

<i>Validation instrument</i>	<i>n</i>	<i>Bias</i>	<i>%Bias</i>	<i>RMS</i>	<i>%RMS</i>	<i>r</i>
Jokioinen Brewer Mk-III #107	292	0.083	5.2%	0.263	34%	0.98
Sodankylä Brewer Mk-II #037	175	0.050	7.6%	0.234	22%	0.97
Toronto Brewer Mk-II #014	262	0.001	-3.7%	0.336	24%	0.98
Toronto Brewer Mk-III #145	232	-0.092	-9.4%	0.322	25%	0.97
San Diego SUV-100	293	0.768	31%	0.974	41%	0.95
Ushuaia SUV-100	339	0.089	2.6%	0.379	25%	0.97
Barrow SUV-100	203	0.221	19%	0.492	36%	0.94

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

r stands for the correlation coefficient



Conclusions

- Analog to the TOMS total column ozone time-series the surface UV time-series are continued with the OMI measurement data applying an algorithm that is similar to the TOMS UV algorithm
- First validation results imply anticipated accuracy of the OMI surface UV data. Thus, the current version data will be published soon!
- The validation effort continues: use more reference data from ground-based instruments, validate also noontime irradiances, elaborate the statistical analysis of validation results
- During the OMI ST meeting in June 20-23 in De Bilt a workshop on the future development of the OMI surface UV algorithm will be organized. Some of the discussion topics are:
 - Correction for absorbing aerosols
 - Additional UV products
 - New methods to account for the effects clouds and snow albedo
 - Homogenization of the UV time-series from multiple instruments



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OMI Very-Fast-Delivery

OMI data is received by Direct Broadcast in Sodankylä and is processed immediately after each overpass of the Aura satellite. Distribution plots for total column ozone, UV Index and Erythmal daily dose are published within 30 minutes after the overpass at

http://omivfd.fmi.fi/index_eng.html

