First Look at the SO2 index Calculated from OMI Observations

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INTRODUCTION

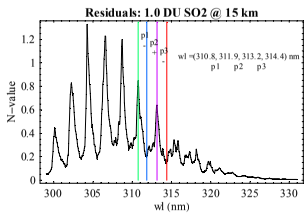
The Ozone Monitoring Instrument (OMI) onboard the Aura spacecraft makes hyper-spectral radiance measurements in the Ultra-Violet (UV) and Visible (VIS) range. The OMI measurements covers the globe daily and has a nadir resolution of 13x24 km^2. These characteristic of OMI offer an improved capabilities for monitoring ozone and other trace gases, such as SO2, in the atmosphere.

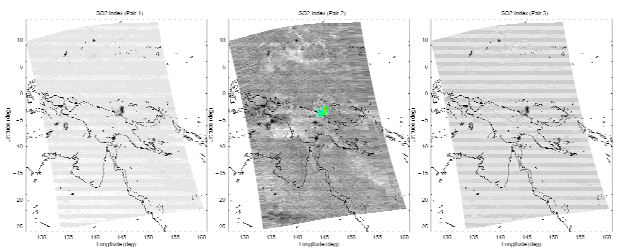
We have applied the TOMS total ozone algorithm to the OMI UV2 spectral radiance measurements, with spectral range from 306 to 370 nm at a sampling distance of 0.15 nm/pixel and a resolution of 0.45 nm. We examine the residuals that are calculated as the difference between the measured and the computed theoretical radiances that account for the effects of ozone, Ring, and surface reflectivity. Analysis of these residuals is very useful in detecting instrument artifacts and calibration errors as well as unusual atmospheric conditions. Sulfur dioxide (SO2) has a strong absorption in the wavelength range 306-340 nm. Residuals in this wavelength range show distinctive features if a significant amount of SO2 is present in the atmosphere, such as in the case of volcanic clouds or air pollution. However, SO2 is absent over most of the Earth and residuals are sensitive diagnostics of instrument performance.

SO2 Index

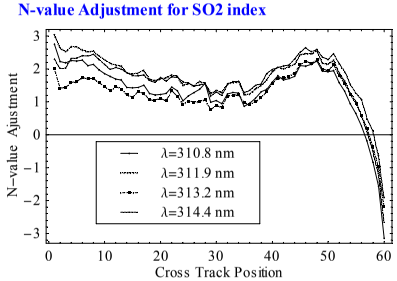
For this study, we show maps of SO2 index, defined as the residual differences between selected pairs of wavelengths, which have large differential sensitivity to the SO2 absorption.

Three pairs of wavelengths are selected for OMI SO2 index calculation, as illustrated in the figure shown on the right. This plot shows the N-value residuals for 1.0 DU of SO2 is present at 15 km of altitude. Note that the residual differences, i.e., the SO2 indices show a distinct pattern: pair 1 and pair 3 indices are expected to be negative, while pair 2 inde is expected to be positive, when SO2 is present in the atmosphere. Many other factors may contribute the residuals, but when the three pairs show the distinct pattern illustrated here, one can be reasonably confident that SO2 is detected.





N-value Adjustment for SO2 index



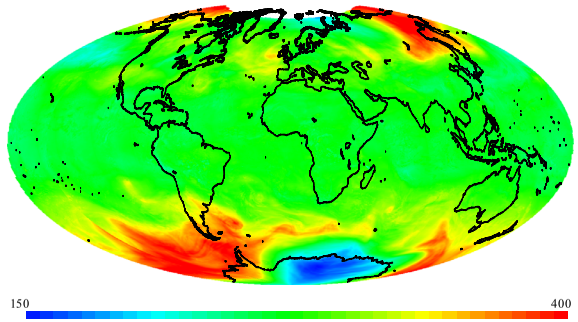
- N-value = -100 Log_{10}(Rad/Irrad)
- Cross-Track bias is present in OMI L1B data due to calibration imperfection.
- N-value adjustments can be derived to correct scan bias. For a detail description of this techniques, please see poster # A33A-0133.
- For SO2 index calculation, N-value adjustments shown here are the average of the residual at the respective wavelength in the equatorial region.

OMI Daily Global Maps

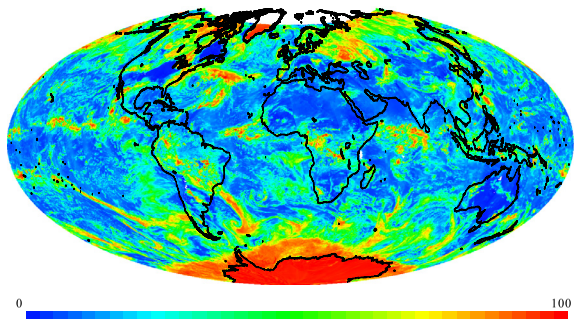
- TOMS-V8 algorithm, which uses a small set of discrete wavelengths, is applied to the OMI data to derive total column ozone and other related parameters. These set of maps shows the total column amount ozone, surface reflectivity at 331 nm, and the pair 2 SO2 index. These are the results after N-value adjustments which remove the cross-track bias.

October 24, 2004

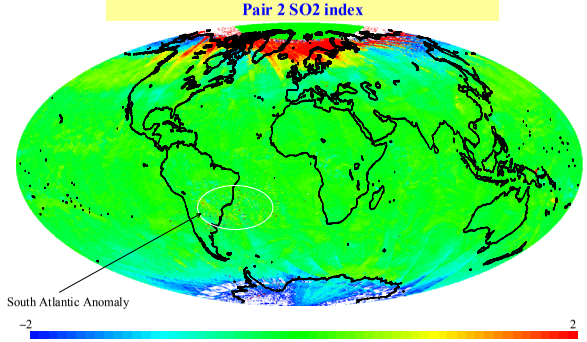
Total Column Ozone



Reflectivity @ 331 nm

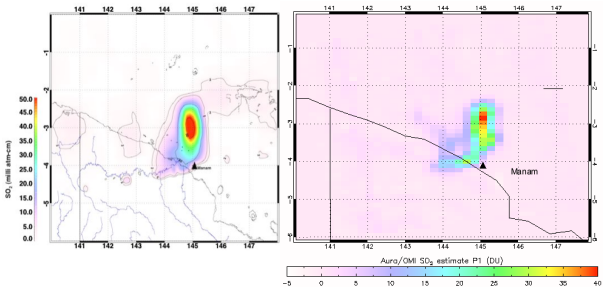


Pair 2 SO2 index



Volcanic SO2 Detection

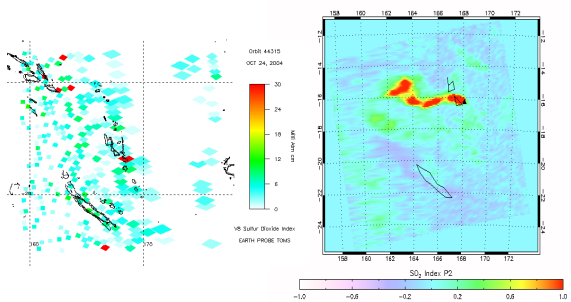
- OMI vs. AIRS: Explosive Eruption, Manam (Papua New Guinea) - Oct 24, 2004



Aqua/AIRS SO_2 column
0400UT
(courtesy A.J. Prata, CSIRO, Australia)

Aura/OMI SO_2 column
0412UT
Upper Tropospheric SO_2

- OMI vs. EP-TOM: Passive degassing, Ambrym volcano, Vanuatu – Oct 24, 2004



Lower Tropospheric SO_2

Summary

- Analysis of the early results from OMI indicates that this instrument is performing very well.
- OMI L1B needs to be corrected for cross-track bias. N-value adjustment works well for this correction.
- SO2 derived from OMI measurement shows good agreement with that from AIRS.
- OMI vs. EP-TOMS comparison demonstrates the higher sensitivity of OMI measurements with less background noise than those of EP TOMS.

Acknowledgment

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