Next Generation Aura/OMI SO2 Retrieval Algorithm: Introduction and Implementation Status

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Background and Motivation

- SO2 is a designated air pollutant emitted from both anthropogenic and volcanic sources. As a precursor of sulfate aerosols, it also influences weather and climate.
- The Ozone Monitoring Instrument (OMI) aboard the NASA/Aura satellite provides capabilities of monitoring SO2 globally on a daily basis, with much improved sensitivity as compared to other satellite instruments.
- The current operational OMI retrieval algorithm has relatively large noise and unphysical biases (Figure 1).
- We have developed a next generation retrieval algorithm that uses the full spectral content from OMI while maintaining computation efficiency.

Methodology

- Use of PCs in spectral fitting to account for various interferences in SO2 retrievals and other instrumental features.
- Measured Sun-normalized radiance spectrum:

\[ N(\omega, \Omega_{SO2}) = \sum_{i=1}^{n} \omega_i y_i + \omega_{SO2} \frac{\partial N}{\partial \omega_{SO2}}. \]

- PCs from SO2-free regions for processes (O3 absorption, RRS, etc.) other than SO2 absorption.
- Pre-calculated SO2 Jacobians (assuming O3 profiles, albedo, etc.).

New PCA Algorithm Reduces Noise and Artifacts

PCA algorithm reveals major SO2 point sources (below, circles), with much reduced noise and artifacts.

First few PCs obtained from one row of an orbit over the Pacific are related to known physical processes.

- PC #1: Mean spectrum
- PC #2: O3 absorption
- PC #3: Surface reflectance (also RRS or Ring signature)

First five PCs explain over 99.99% of variance.

Inclusion of SO2 Jacobians in fitting reduces residuals.


Figure 1. Current operational BRD (band residual difference) algorithm is sensitive to anthropogenic pollution in the boundary layer (PBL), but has unphysical biases.

Max Data Continuity between Instruments

OMI and OMPS PCA SO2 data show similar seasonal patterns and SO2 signals.

Implementation Status and Next Steps

- The PCA algorithm has been operationally implemented for OMI PBL SO2 retrievals.
- Forward processing ongoing.
- Reprocessing of the entire OMI mission finished within five days.
- Initial evaluation done, public release pending approval.
- Preliminary intercomparison with TROPOMI pre-launch algorithm shows good agreement.
- A new version with more comprehensive error analysis and SO2 Jacobians look-up table under development.
- The same algorithm also being implemented on GOME-2 and OMPS for a long-term dataset on anthropogenic SO2 pollution.

For More Information


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