



# Impact of NO<sub>2</sub> Profile Shape in OMI Tropospheric NO<sub>2</sub> Retrievals



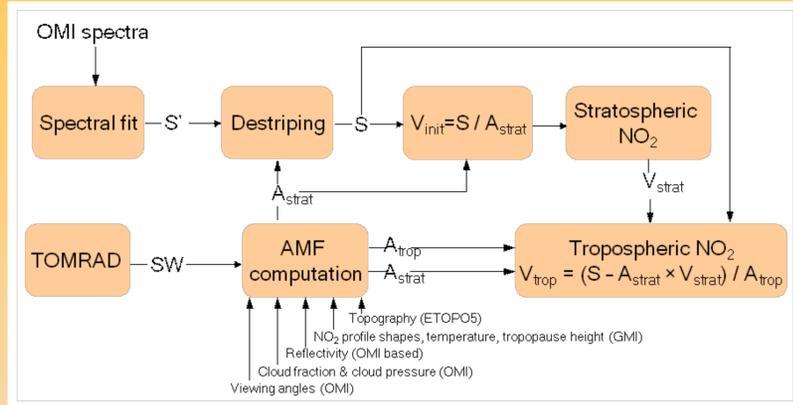
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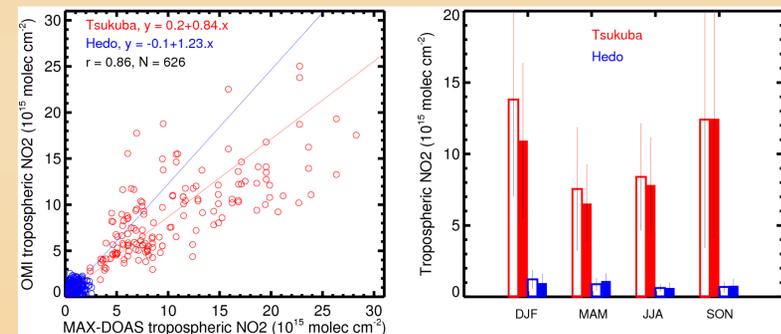
## Overview

Nitrogen oxides (NO<sub>x</sub> = NO + NO<sub>2</sub>) are key actors in air quality and climate change. Tropospheric NO<sub>2</sub> columns from the nadir-viewing satellite sensors have been widely used to understand sources and chemistry of NO<sub>x</sub>. We have implemented several improvements to the operational algorithm developed at NASA GSFC and retrieved tropospheric NO<sub>2</sub> columns. Here, we present some validation studies of the new product using ground-based and in-situ aircraft measurements. We show how vertical profile of scattering weight and a-priori NO<sub>2</sub> profile shapes, which are taken from chemistry-transport model, affect air mass factor (AMF) and therefore tropospheric NO<sub>2</sub> retrievals. Users can take advantage of scattering weights information that are made available in the operational NO<sub>2</sub> product. Improved tropospheric NO<sub>2</sub> data retrieved using thoroughly evaluated high-resolution NO<sub>2</sub> profiles are helpful to test models.

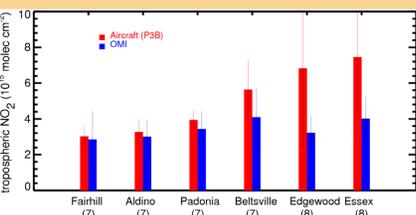
## Operational OMI NO<sub>2</sub> retrieval and validation



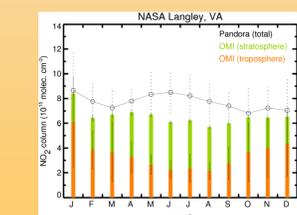
$S'$  → measured slant column density,  $S$  → destriped slant column density,  $SW$  → scattering weight,  $A_{trop}$  → tropospheric AMF,  $A_{strat}$  → Stratospheric AMF.



Comparison of OMI tropospheric NO<sub>2</sub> with MAX-DOAS measurements at a polluted (Tsukuba) and an unpolluted site (Hedo) in Japan. Measurement period covers 2006-2011.



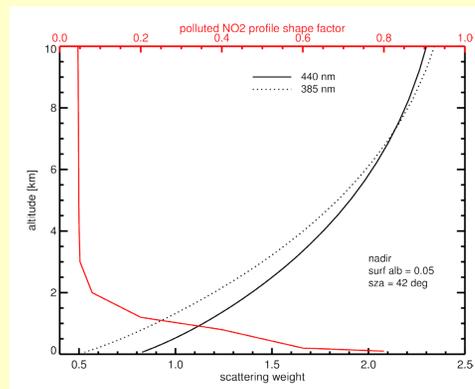
Comparison of OMI tropospheric NO<sub>2</sub> with P3B measurements during DISCOVER-AQ in July 2011.



Comparison of OMI NO<sub>2</sub> with PANDORA measurements at NASA Langley during 2006-2011.

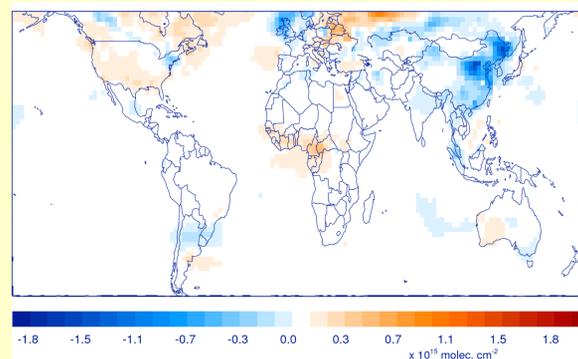
## Modeled a-priori NO<sub>2</sub> vertical profile shape and NO<sub>2</sub> column retrievals

### NO<sub>2</sub> shape factor and scattering weight for AMF



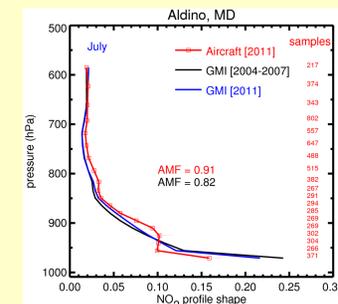
NO<sub>2</sub> vertical profile shape for polluted condition (red line) and scattering weight for a measurement condition (black line) at two wavelengths; 440 nm represents the middle of NO<sub>2</sub> spectral fitting window. Tropospheric AMF derived from the two is critically important for NO<sub>2</sub> vertical column retrievals.

### Retrievals benefit from NO<sub>2</sub> profiles with updated emissions



Difference in OMI tropospheric NO<sub>2</sub> retrievals due to emission changes. Tropospheric NO<sub>2</sub> columns were retrieved with GEOS-Chem NO<sub>2</sub> profiles simulated with emissions for the year 2000 and 2005. Use of outdated emission leads to lower columns over China and higher column over the US.

### Both the emissions and resolution matter

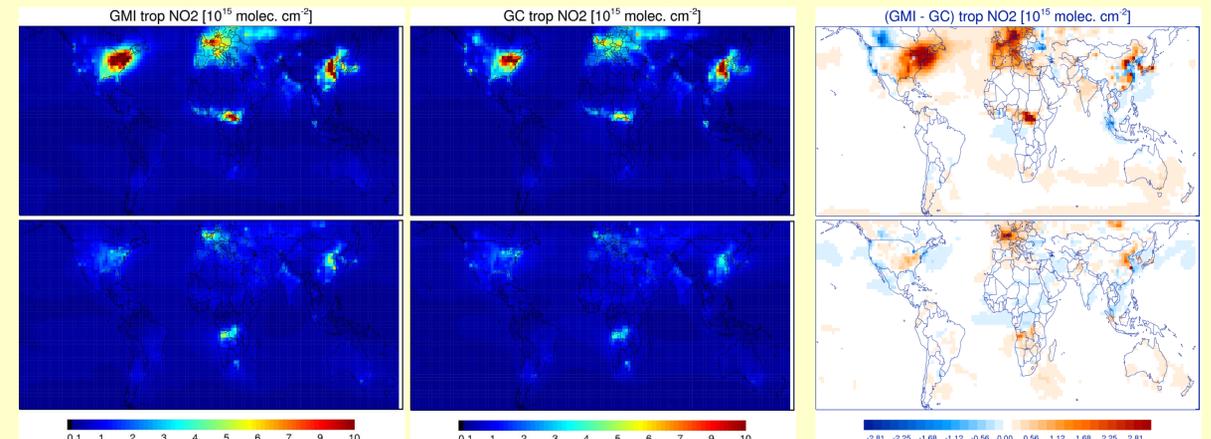


Comparison of NO<sub>2</sub> profile shape from aircraft (red) with those from GMI simulations with old (black) and updated emissions (blue). Models benefit from emission updates, but have difficulties to capture the true profile shape that can lead to errors of up to 15% in AMF.

### References:

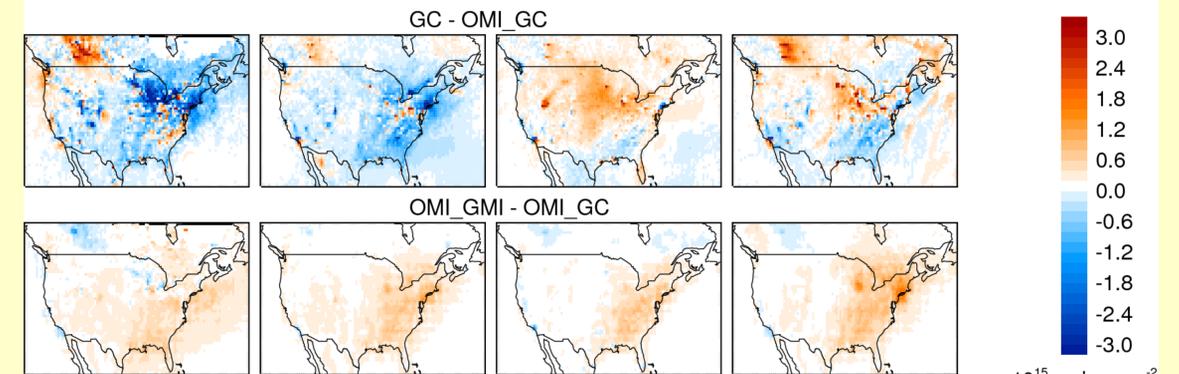
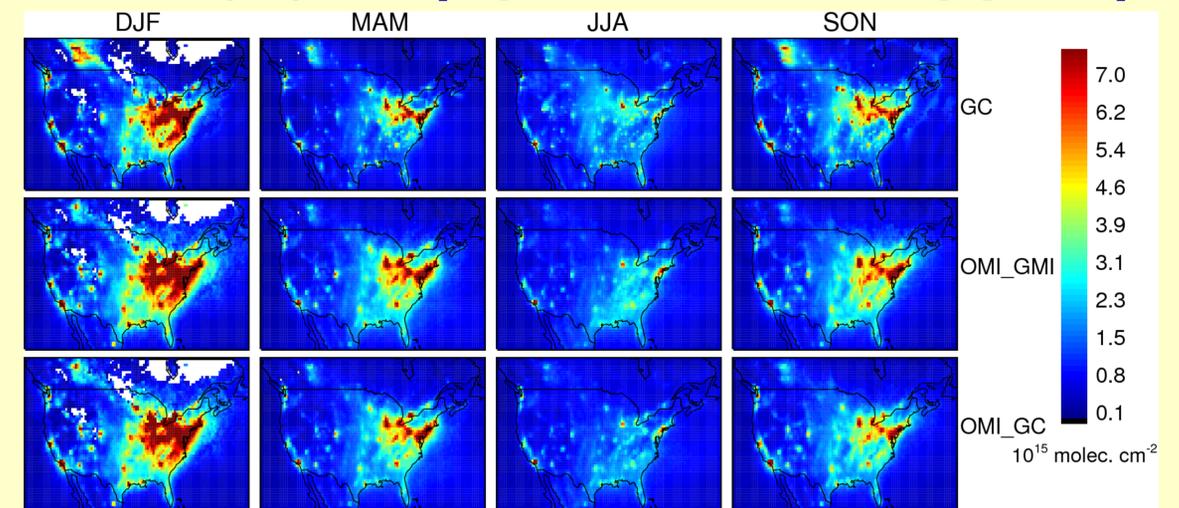
Bucsela et al. (2013), A new algorithm stratospheric and tropospheric NO<sub>2</sub> retrieval algorithm for nadir-viewing satellite instruments: applications to OMI, AMTD.  
Lamsal et al. (2013, in preparation), Evaluation of improved operational standard tropospheric NO<sub>2</sub> retrievals from Ozone Monitoring Instrument using in situ and surface based NO<sub>2</sub> observations.

### Models differ in NO<sub>2</sub> simulation



Tropospheric NO<sub>2</sub> columns from (left) GMI and (middle) GEOS-Chem simulations for (top) January and (bottom) July, 2005. The difference between the GMI and GEOS-Chem simulations in the right panel largely reflect the difference in emissions.

### Use of scattering weight and NO<sub>2</sub> shape factor to calculate AMF and tropospheric NO<sub>2</sub>



The operational OMI NO<sub>2</sub> product makes scattering weights available to users that allow calculation of their own AMF and tropospheric NO<sub>2</sub>. Use of improved high-resolution NO<sub>2</sub> profile shapes can eventually reduce the errors due to a-priori profiles.

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