High spatial resolution retrievals of NO$_2$: Insights from OMI

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Conclusions

Observations and models at 4 km spatial resolution with hourly repeats will dramatically improve our understanding of mechanisms and processes related to AQ.

By the time GEOCAPE is launched we will have an excellent idea of how to build accurate and precise NO$_2$ products at that resolution.
Columns and mole fraction

\[1 \times 10^{15} \text{ molecules/cm}^2 \sim 400\text{ppt}\]

\[1 \times 10^{16} \text{ molecules/cm}^2 \sim 4 \text{ ppb}\]

within a 1 km thick well mixed boundary layer
2008 summer weekday

Fires

Farms??

Fires

San Francisco
San Jose
Fresno
Sacramento
Los Angeles
San Diego
My goals for GEOCAPE Science

Observations that will change our understanding of mechanisms and processes affecting AQ
R.C. Hudman, et al.  
*Interannual variation in soil NOx emissions observed from Space*  
ACP, 10, 9943-9952, 2010.

T.H. Bertram, et al.,  
*Satellite measurements of daily variations in soil NOx emissions*, Geophys. Res. Lett. 2005
A. Mebust, et al.

Characterization of wildfire NO$_x$ emissions using MODIS fire radiative power and OMI tropospheric NO$_2$ columns

submitted to ACP
Fire in Nevada, 08.25.2008

Latitude

Longitude

$\mathrm{NO}_2$ column (molecules cm$^{-2}$)
OMI: ~7%/year decrease
Inventory: ~4% / year
On spatial resolution of observations, retrievals and models

Observation of slant column NO$_2$ using the super-zoom mode of AURA OMI

A high spatial resolution retrieval of NO$_2$ column densities from OMI: Method and Evaluation,
Atmos. Chem. Phys. Disc. 11, 12411-12440, 2011

Effects of model spatial resolution on the interpretation of satellite NO$_2$ observations,
Top-of-Atmosphere Reflectance MODIS (500 m) vs OMI (7 km fwhm on-ground)
NO$_2$ Slant Column

Rihand, India

PP4 1600 MW
PP2 1600 MW
PP1 4600 MW
PP3 1000 MW

50 km

Seoul

50 km

Super-Zoom

Operational - 13x24 km$^2$

Operational - 6 day avg

SCD NO$_2$ (molecules cm$^{-2}$)
Dubai – Lifetime from gradient; Downtown plume (NE) vs Port (SW)
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*Observation of slant column NO$_2$ using the super-zoom mode of AURA OMI*

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Clouds and Albedo

(a) OMI Cloud Fraction
(b) MODIS Albedo
(c) MODIS Cloud Fraction
## Correlations with aircraft NO$_2$ observations

<table>
<thead>
<tr>
<th></th>
<th>OMI cloud fraction $&lt; 20%$</th>
<th>MODIS cloud fraction $= 0%$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard Product</strong></td>
<td>$y = 0.99x + 4 	imes 10^{14}$  $R^2 = 0.72$</td>
<td>$y = 1.04x + 5 	imes 10^{14}$  $R^2 = 0.86$</td>
</tr>
<tr>
<td><strong>DOMINO</strong></td>
<td>$y = 1.78x - 1 	imes 10^{15}$  $R^2 = 0.65$</td>
<td>$y = 1.70x - 5 	imes 10^{13}$  $R^2 = 0.83$</td>
</tr>
<tr>
<td><strong>BEHR</strong></td>
<td>$y = 0.96x - 5 	imes 10^{14}$  $R^2 = 0.83$</td>
<td>$y = 1.03x - 1 	imes 10^{14}$  $R^2 = 0.91$</td>
</tr>
</tbody>
</table>
On spatial resolution of observations, retrievals and models

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Effects of model spatial resolution on the interpretation of satellite NO$_2$ observations, submitted to Atmos. Chem. Phys. Disc.
Effects of model resolution on NO$_2$ Columns—Los Angeles
Effects of model resolution on NO$_2$ Columns—Los Angeles

![Image showing concentration maps for different resolutions](image_url)

- **c)** 48x48km$^2$
  - $VCD_{\text{avg}} = 5.8 \times 10^{15}$ cm$^{-2}$

- **d)** 96x96km$^2$
  - $VCD_{\text{avg}} = 3.1 \times 10^{15}$ cm$^{-2}$
Conclusions

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Luke Valin

Ashley Russell

Acknowledgments