

Linear Fit SO₂ Retrieval Algorithm with TOMS V8 Total O₃

Kai Yang

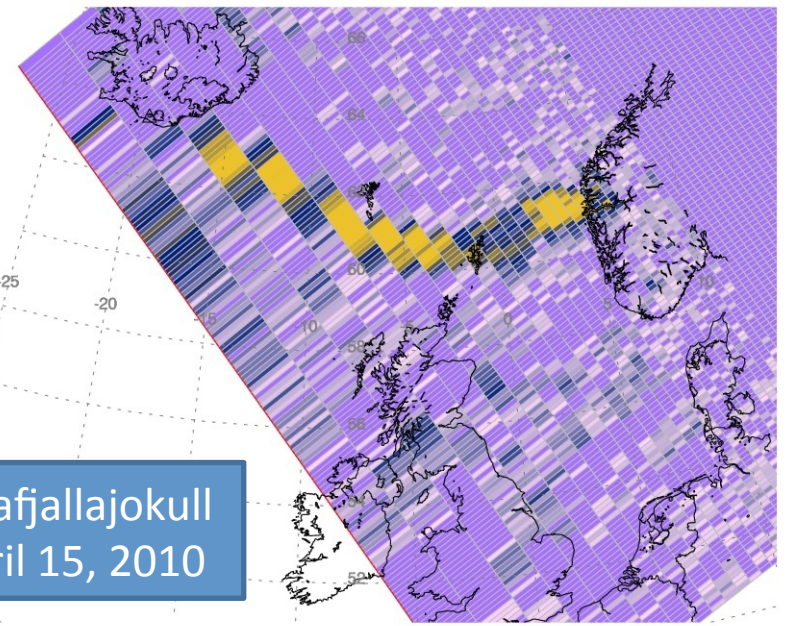
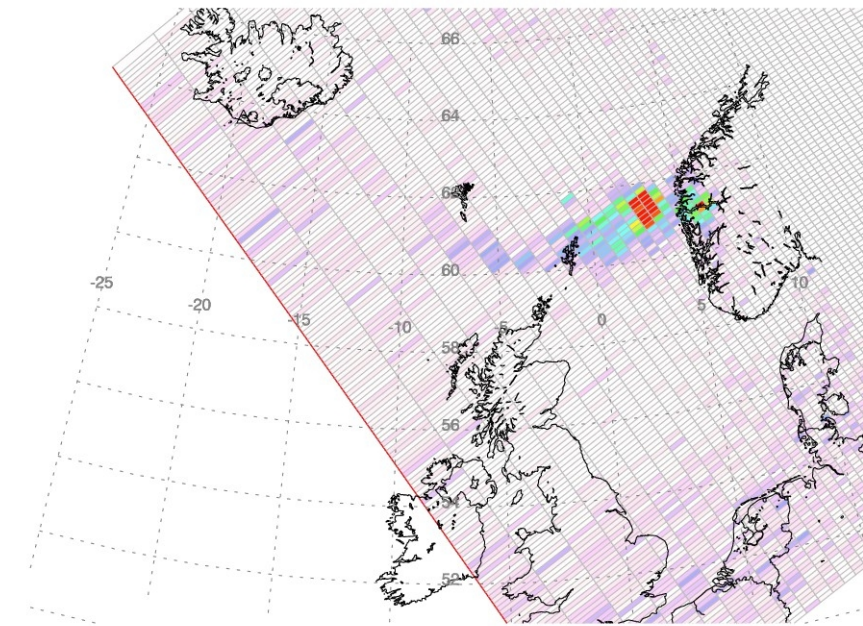
UMCP

Simon Carn

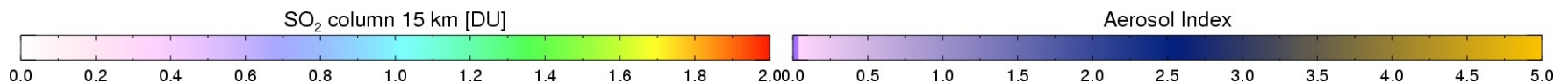
MTU

Aura/OMI - 04/15/2010 11:58-12:04 UT - Orbit 30584

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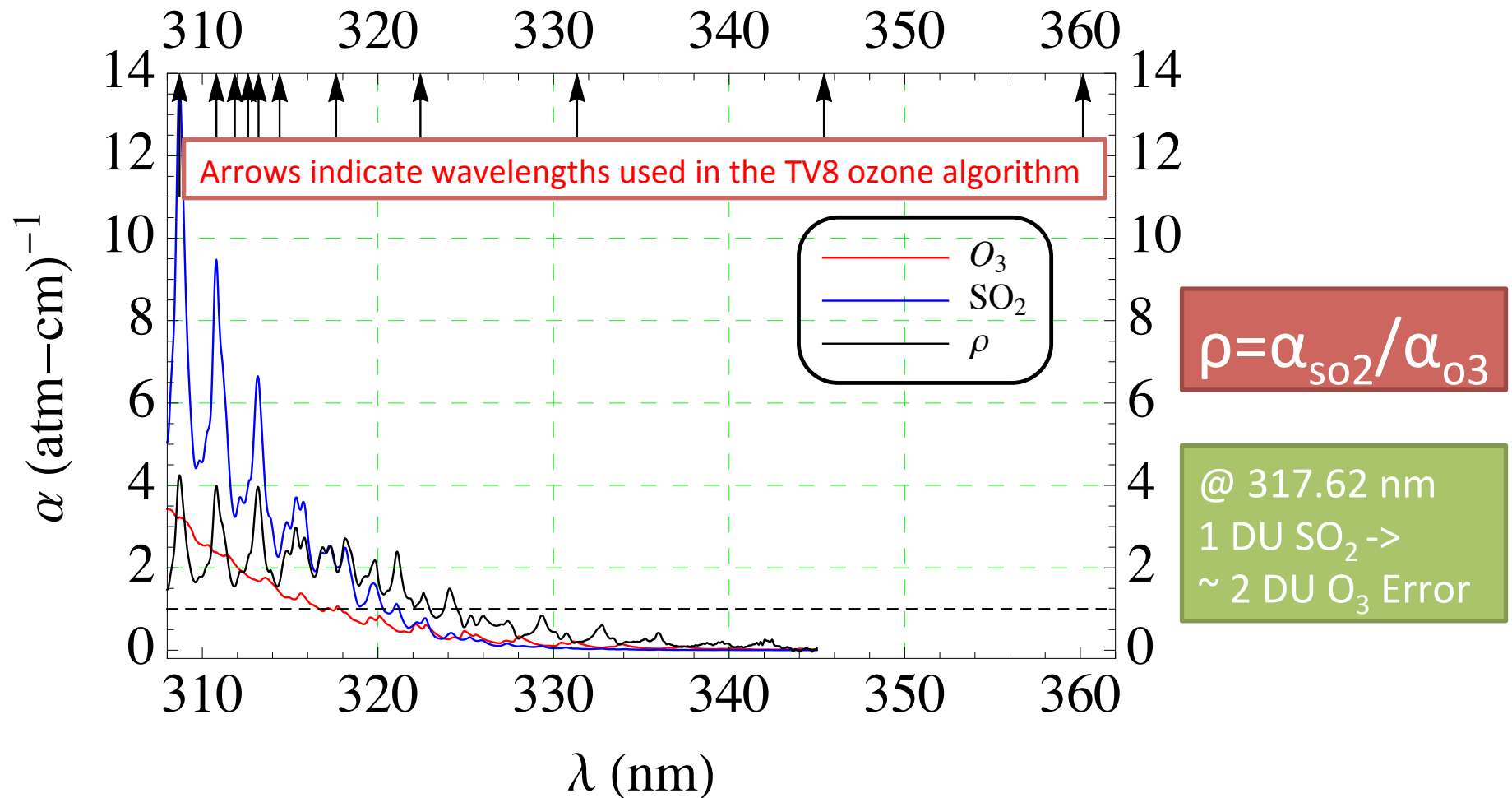
Eyjafjallajökull
April 15, 2010



Outline

- Algorithm Basis
- V8 Total O₃ and Linear Fit (LF) SO₂ Retrieval
- SO₂ Retrieval Sensitivity
- Limitation and Mitigation
- Radiance Residual Correction
- OMPS LF SO₂
- Unexpected achievements from OMPS

O₃ and SO₂ Absorptions in UV



Linear Fit SO₂ Algorithm

Basic idea: Minimization between measured (I_{obs}) and modeled (I) radiance measurements.

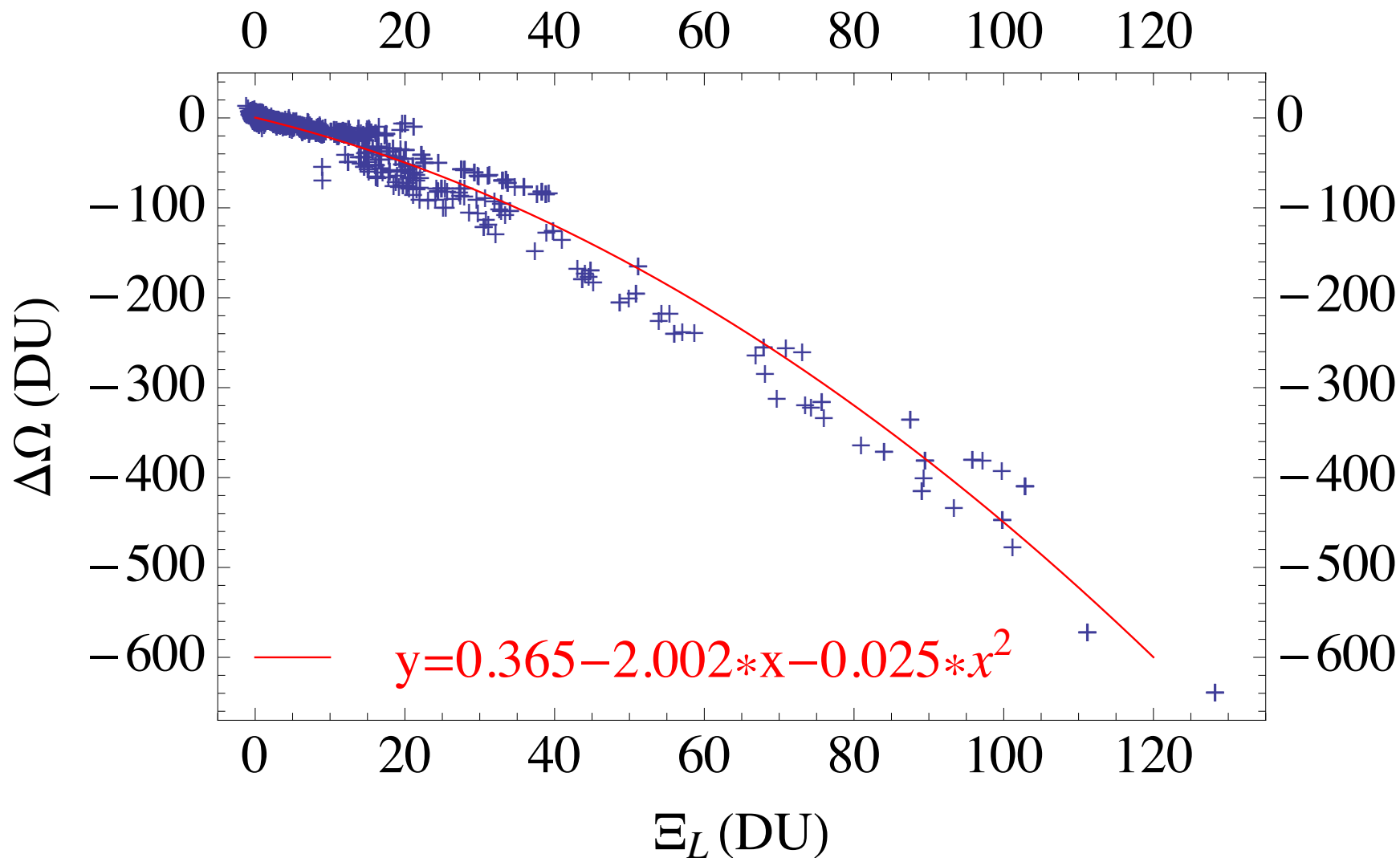
Algorithm Steps:

- **Linearization:** TOMS V8 total O₃, reflectivity, climatology cloud pressure, no SO₂
- **Linear equations:** each for one spectral band (λ)

$$\ln I_{obs} - \ln I = \Delta\Omega \frac{\partial \ln I}{\partial \Omega} + \Delta\Xi \frac{\partial \ln I}{\partial \Xi} + \left(\Delta R + \sum_{i=1}^N c_i (\lambda - \lambda_0)^i \right) \frac{\partial \ln I}{\partial R} + \varepsilon$$

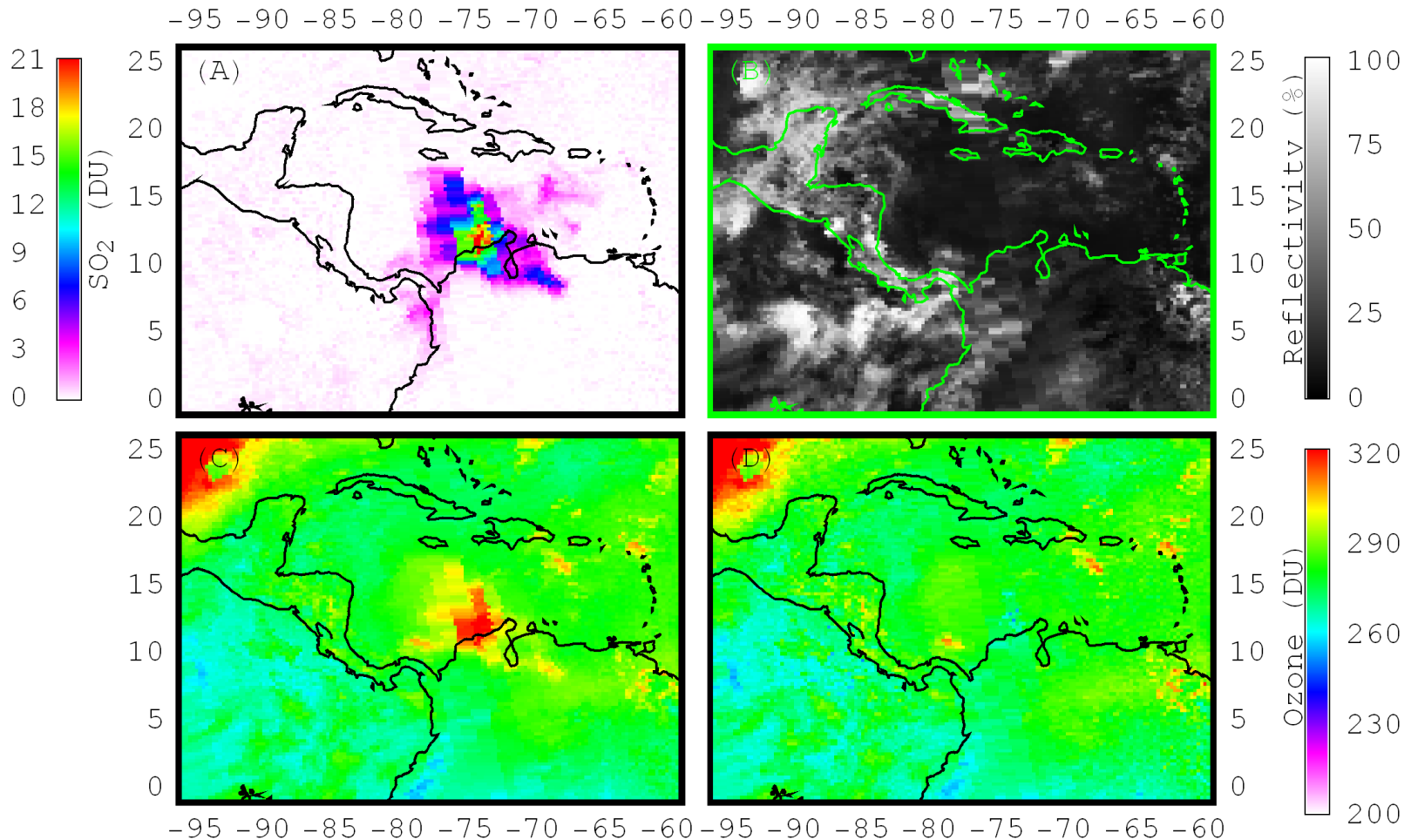
- **Least square fit of weighting functions:** determine adjustments to ozone (Ω), SO₂ (Ξ), surface reflectivity (R) or cloud fraction (fc), and AI (c_1).

O₃ adjustments vs. LF SO₂



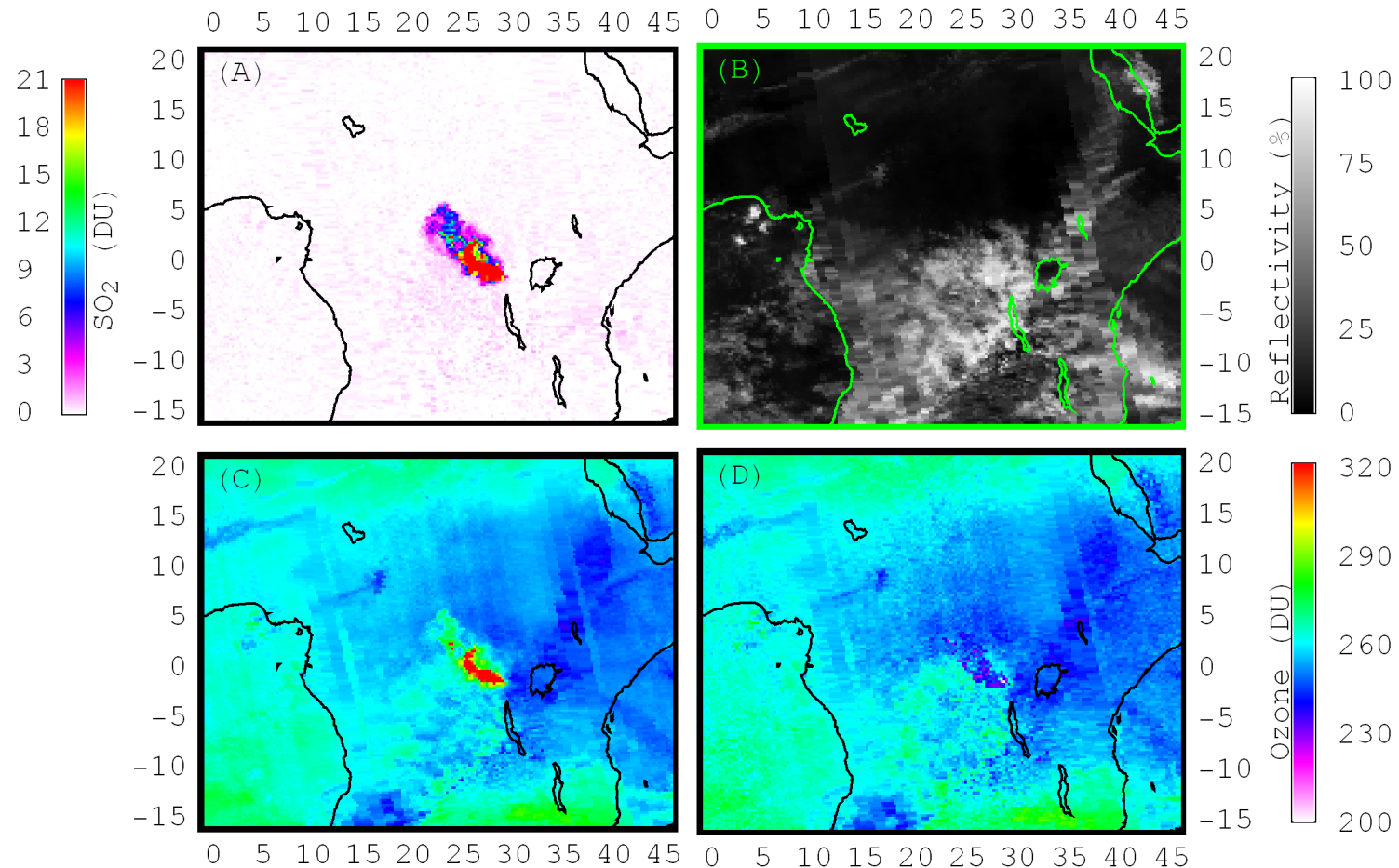
LF Sample Results: OMI

Soufriere Hills Volcano 05/21/2006

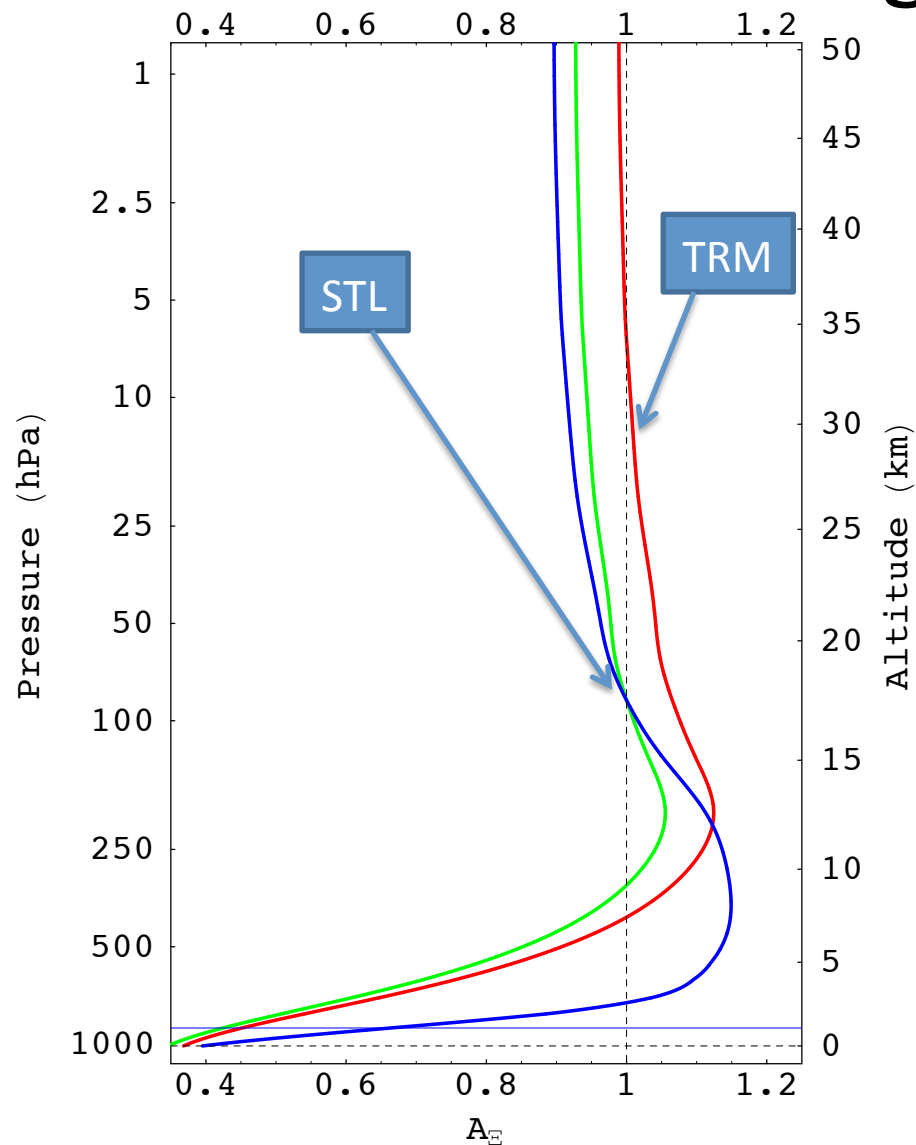


LF Sample Results: OMI

Nyamulagira Volcano 11/28/2006



SO₂ Retrieval Sensitivity: LF Averaging Kernels



Three LF products:

- Lower Troposphere (**TRL**) :
0 – 5 km, pollution and volcanic degassing SO₂
- Middle Troposphere (**TRM**) :
5 – 10 km, volcanic degassing and eruption SO₂
- Lower stratosphere (**STL**) :
15 – 20 km, volcanic eruption SO₂

Limitation and Mitigation

Limitation

- Non-linear effect leads to LF underestimation of large SO₂ columns (> 100 DU)

Mitigation

- Use only longer wavelengths (≥ 315 nm, weaker absorption) for LF SO₂ retrieval
- Use improved algorithm: Iterative Spectral Fitting

Radiance Residual Correction

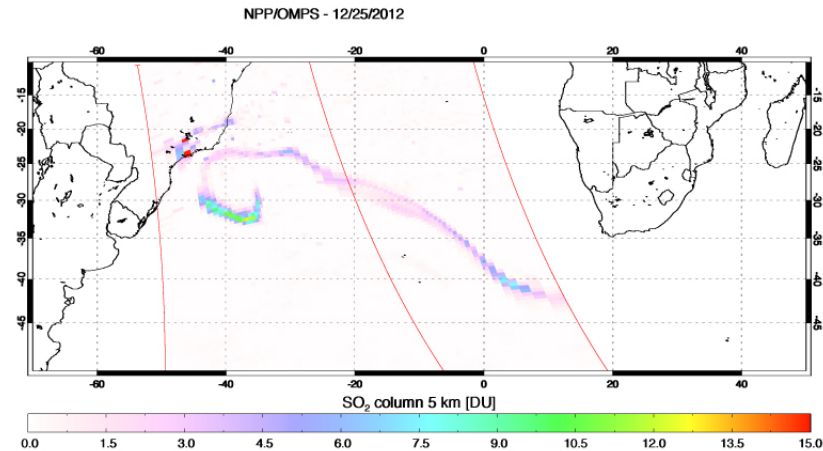
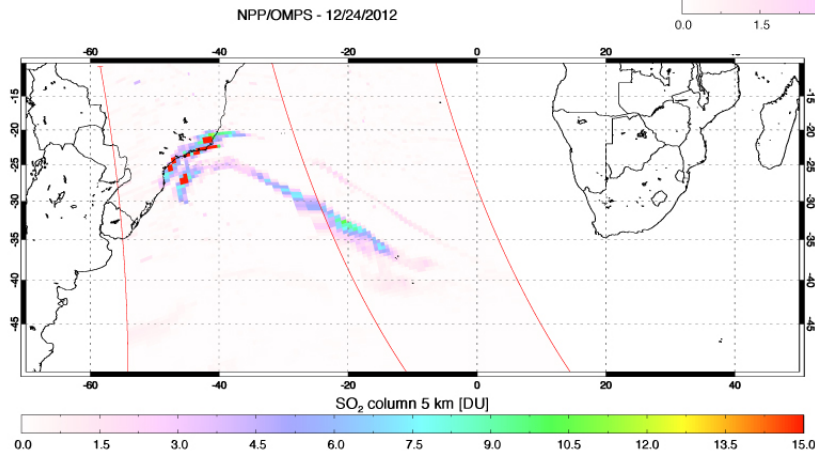
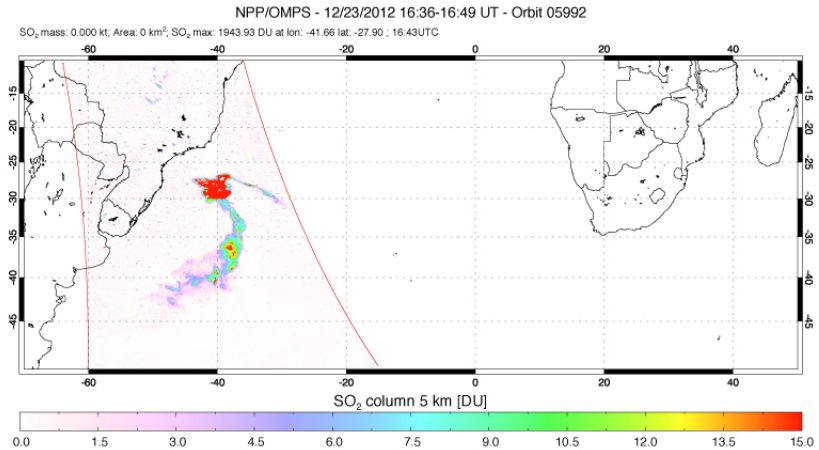
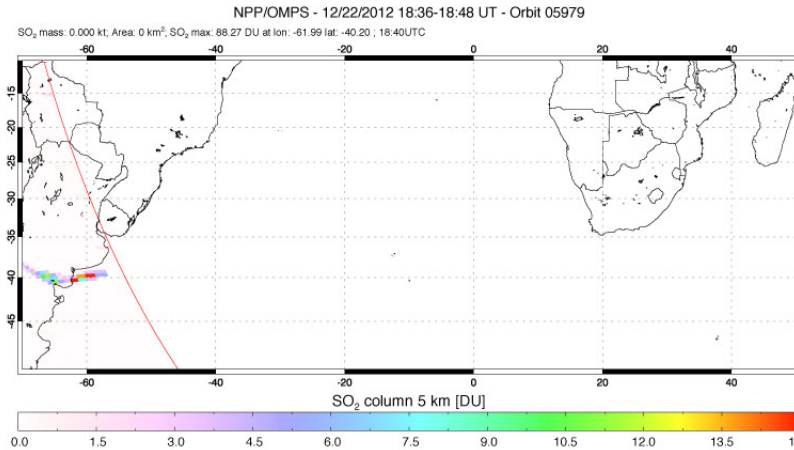
LF Retrieval are severely impacted by systematic errors:

- Additive radiance errors, ozone retrieval error, forward model error, etc ...

Radiance residuals errors are corrected for LF Retrieval

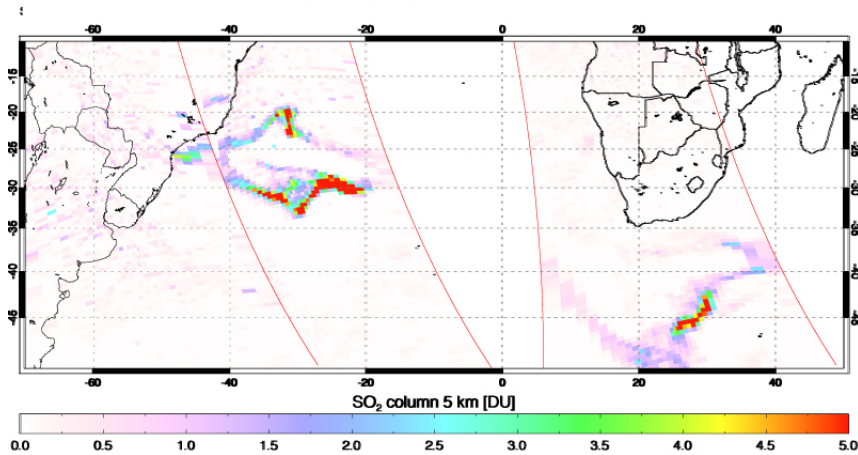
- Each cross-track position has its own correction
- Full orbit data: sliding median
- Partial orbit data: latitude-band ($\sim 10^\circ$, smaller is OK) average

S-NPP OMPS LF SO₂: Copahue (Chile & Argentina), Dec 2012

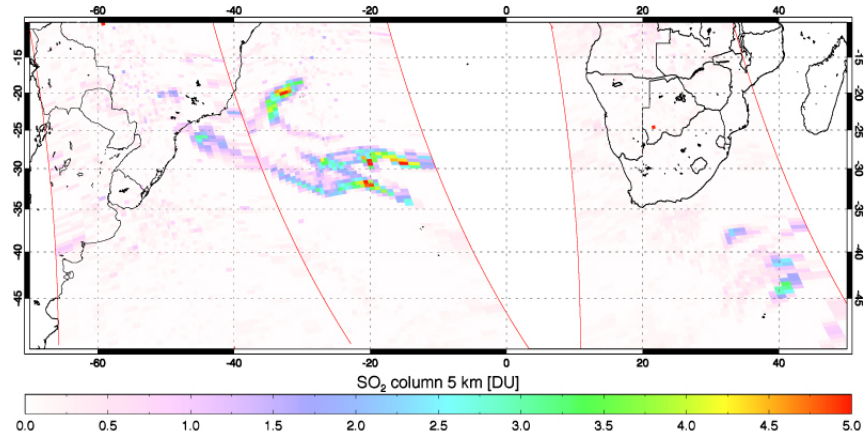


S-NPP OMPS LF SO₂: Copahue (Chile & Argentina), Dec 2012

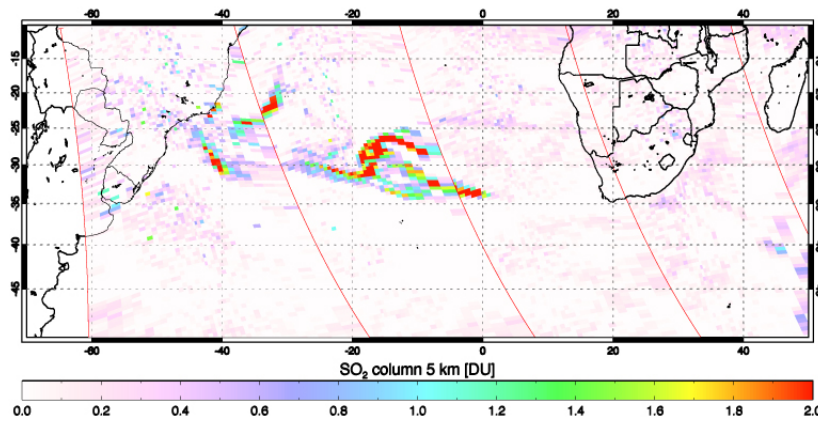
NPP/OMPS - 12/26/2012



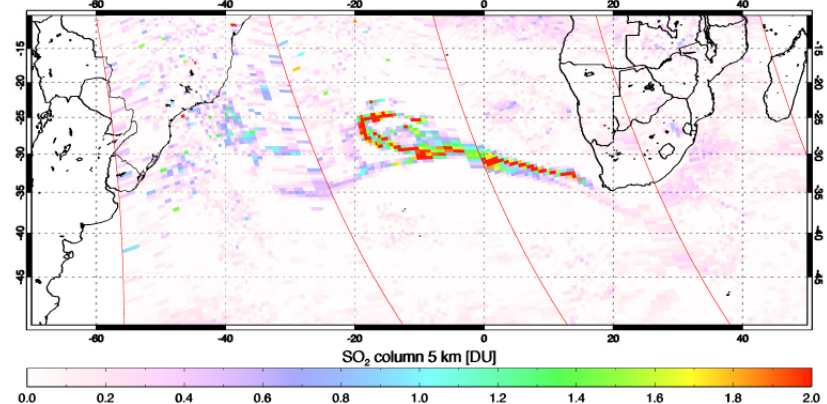
NPP/OMPS - 12/27/2012



NPP/OMPS - 12/28/2012



NPP/OMPS - 12/29/2012



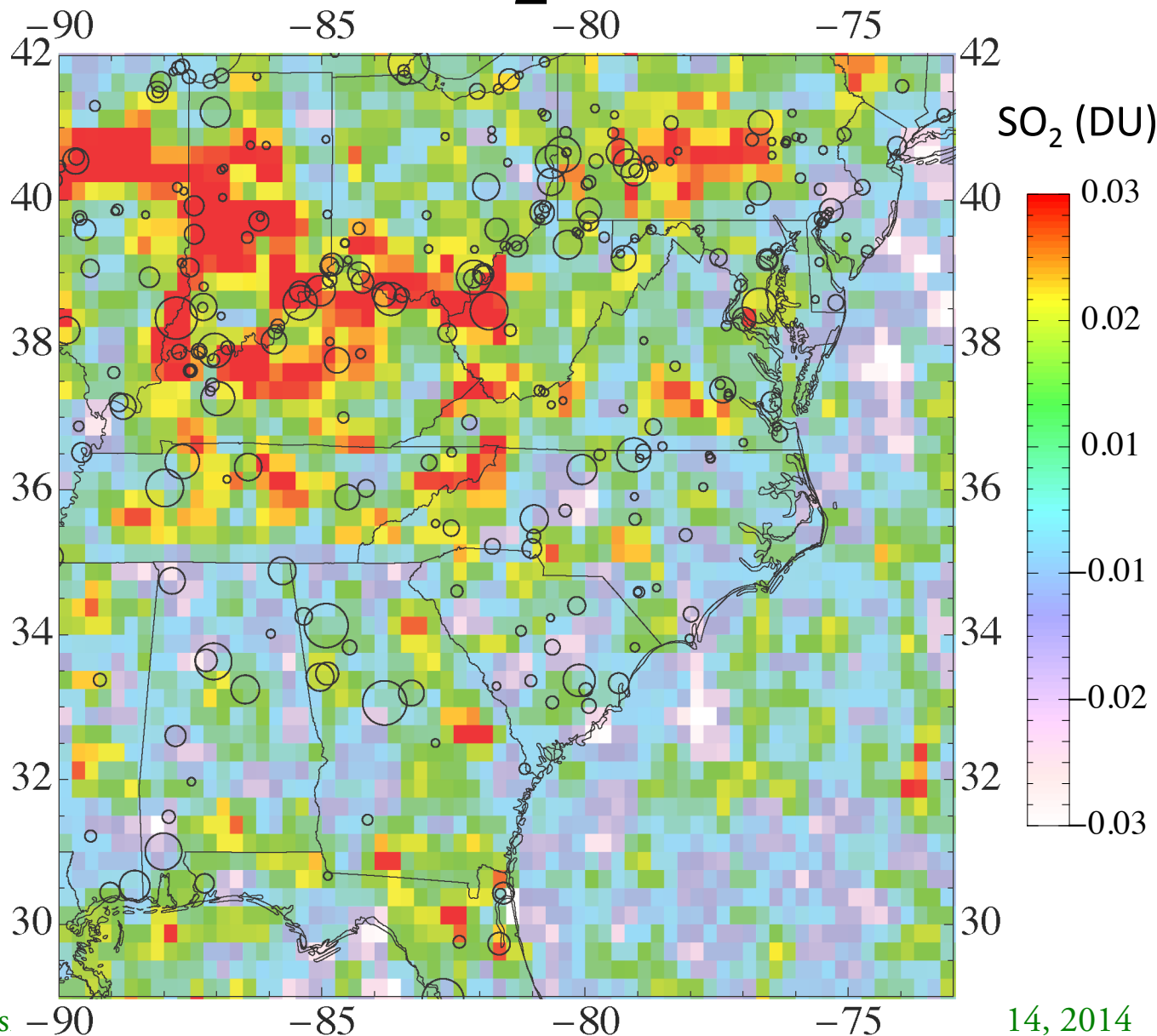
Unexpected results from OMPS Achieved with Algorithm Advances

Unprecedented SO₂ Sensitivity

October 2013
Monthly Mean
ISF Algorithm

ISF sensitivity is an order of magnitude higher than other existing algorithms for boundary layer retrievals:

- 20 to 30 times > BRD
- 5 to 10 times > PCA
- 5 to 10 times > LF



Daily Global Pollution Monitoring with OMPS

