New OMI NO_2 Standard Product (OMNO2 SP version 3)

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OMI NO_2 version 3

NASA team is releasing a new version (V3) of NO_2 Standard Product (OMNO2 SP V3.0) based on:

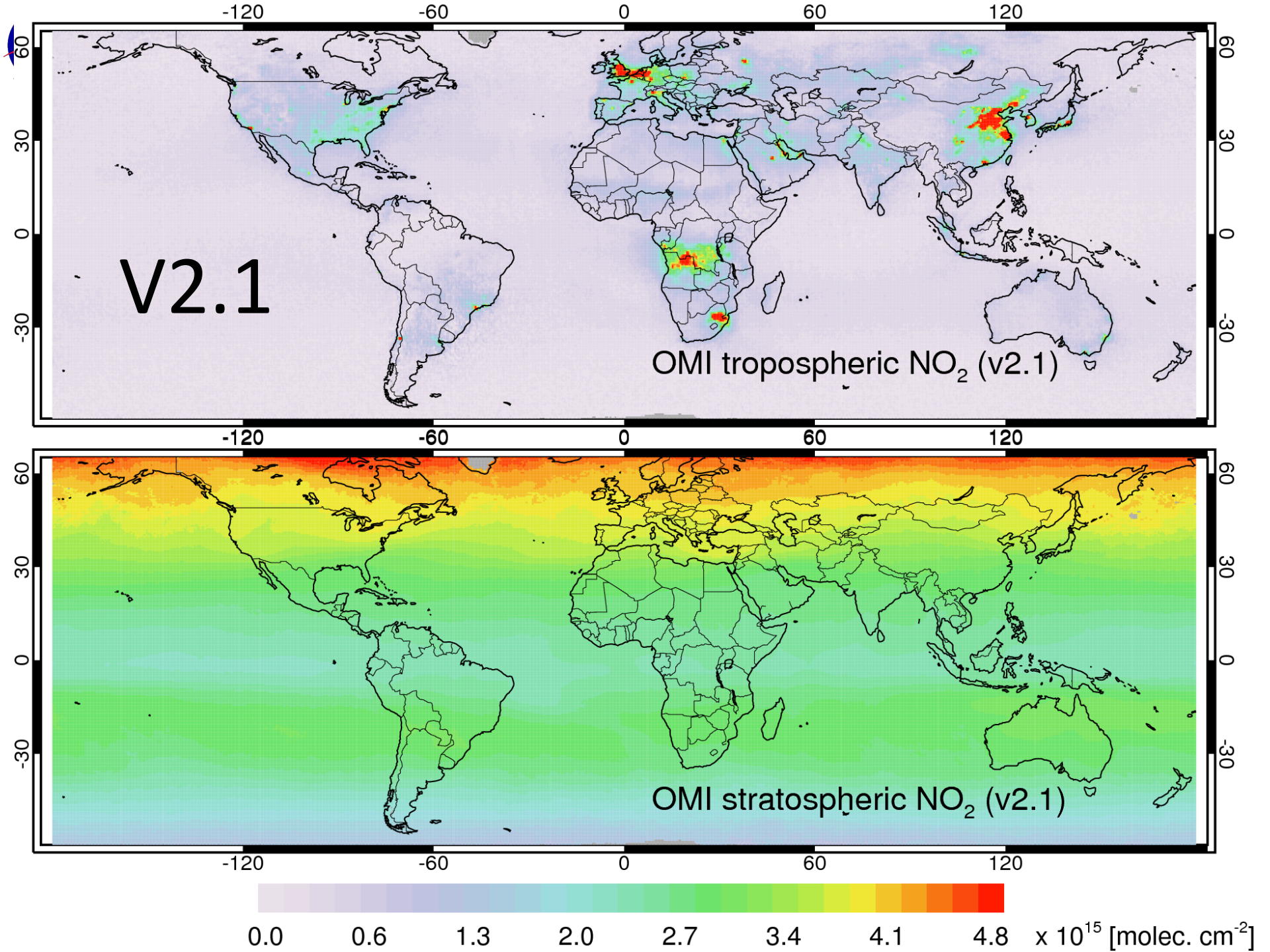
- New SCDs based on iterative micro-window fitting algorithm and new error estimates [Marchenko *et al., JGR* 2015];
- New GMI global high-resolution (1^o x 1.25^o) monthly *a priori* NO_2 profiles with year specific emissions;

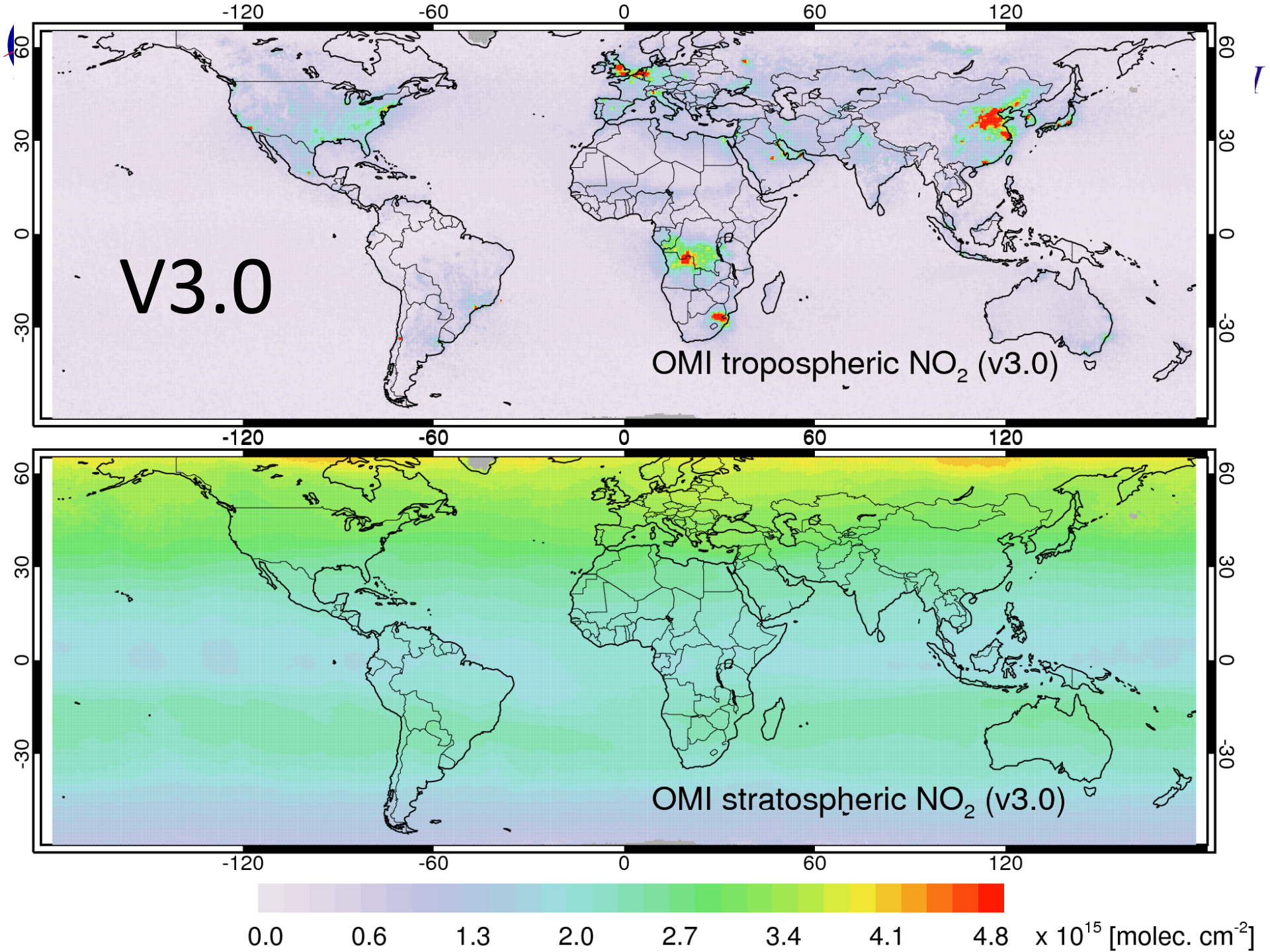
- Same Stratosphere-Troposphere Separation (STS) algorithm [Bucsela *et al., ACP* 2013]
- Same Air-Mass Factor (AMF) calculation based on:
  - cloud correction algorithm uses OMI O_2-O_2 KNMI product (OMCLDO2)
  - Surface monthly LER climatology OMLER [Kleipool *et al.,* 2008]
  - No explicit aerosol and snow correction

Take home message

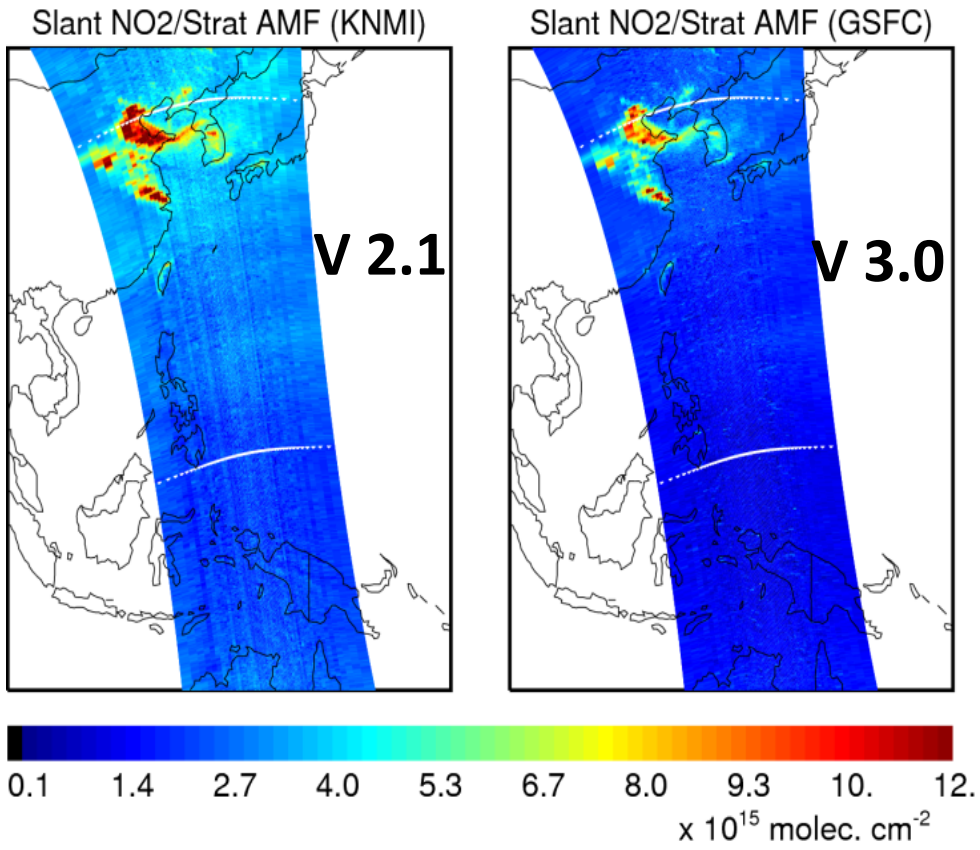
New OMI NO_2 version 3

- Removes high bias (10% -30%) in stratospheric NO_2;
- Improves comparisons with independent satellite data;
- Improves comparison with ground based FTIR data;
- Reduces spectral fitting errors and *a priori* NO_2 profile shape errors


V2.1
OMI tropospheric NO2 (v2.1)
OMI stratospheric NO2 (v2.1)
-120
-60
0
60
120
60
30
0
-30
0.0
0.6
1.3
2.0
2.7
3.4
4.1
4.8
x 10^15 [molec. cm^-2]

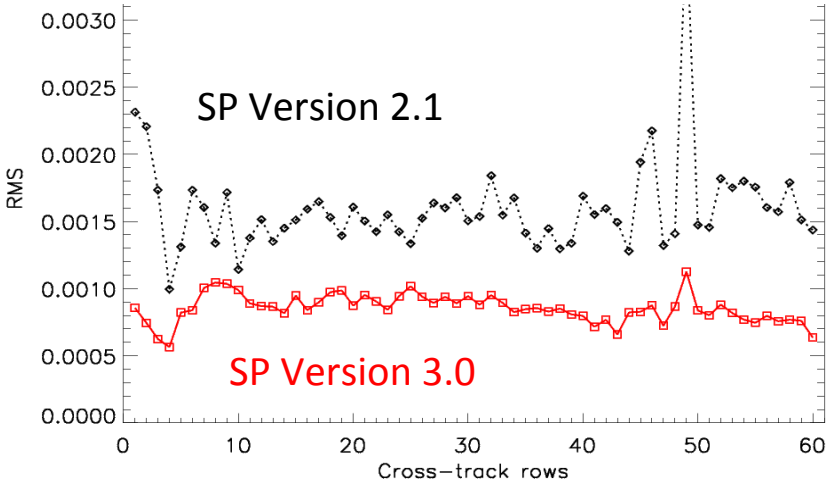

V3.0
OMI tropospheric NO2 (v3.0)
OMI stratospheric NO2 (v3.0)
-120
-60
0
60
120
60
30
0
-30
0.0
0.6
1.3
2.0
2.7
3.4
4.1
4.8
x 10^15 [molec. cm^-2]

New spectral fitting reduces high bias in SCD and residuals



Comparison of NO_2 retrievals for a single OMI orbit. The white cross-track lines denote two scans, one over the Pacific Ocean (clean) and the other crossing through Beijing (polluted).

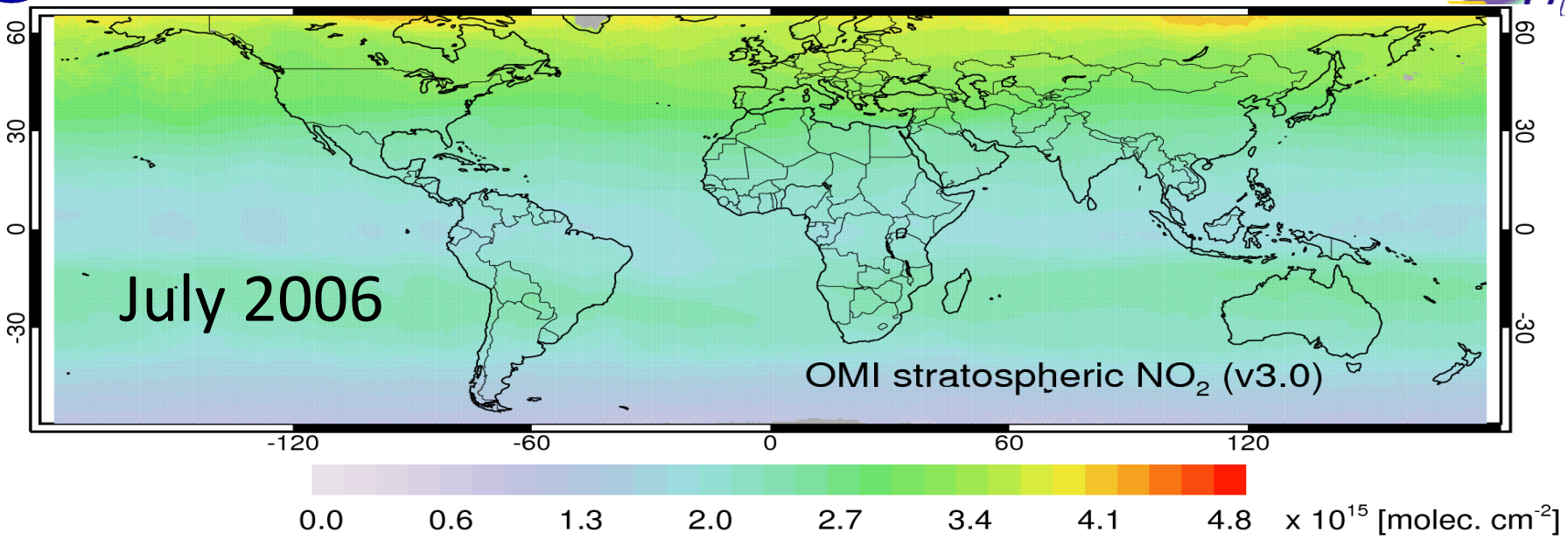
V3 Reduces fitting RMS errors

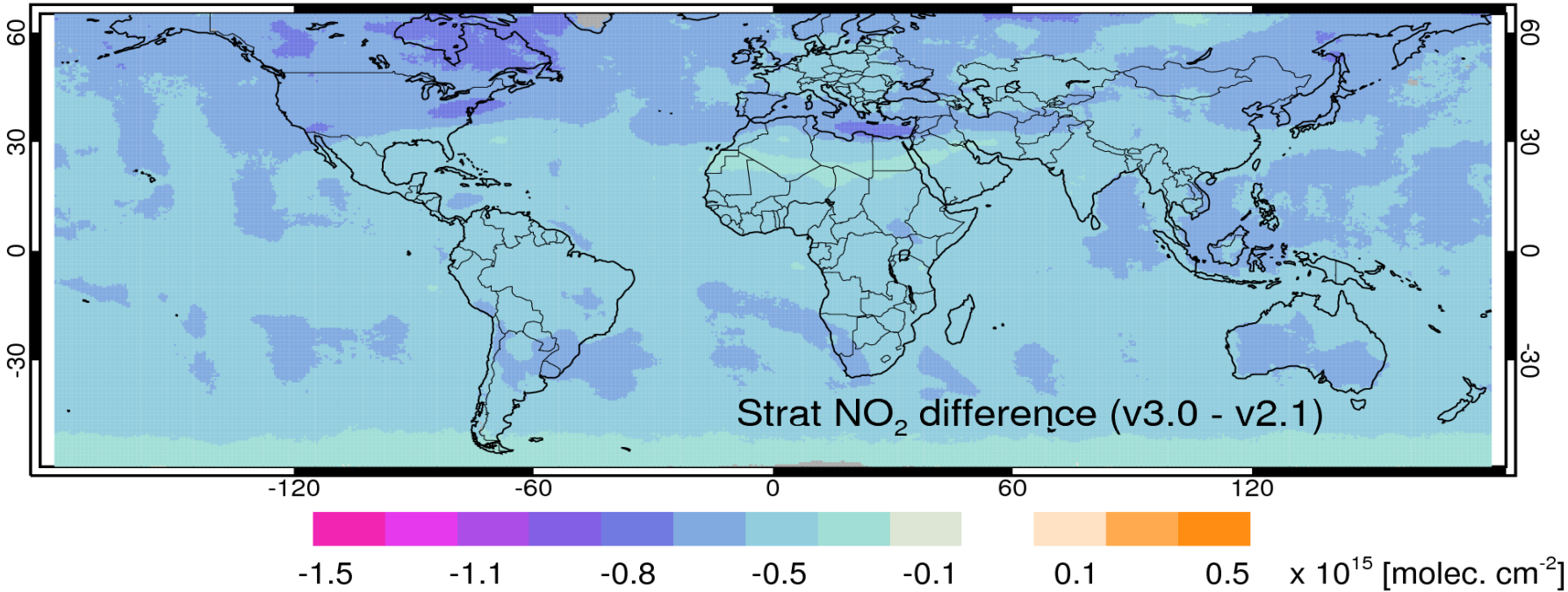


RMS of the fitting residuals of the swath over the Beijing area. New V3 RMS residuals are lower consistent with signal-to-noise in OMI Level-1 measurements

Plots adapted from Marchenko *et al.*, [*JGR* 2015]

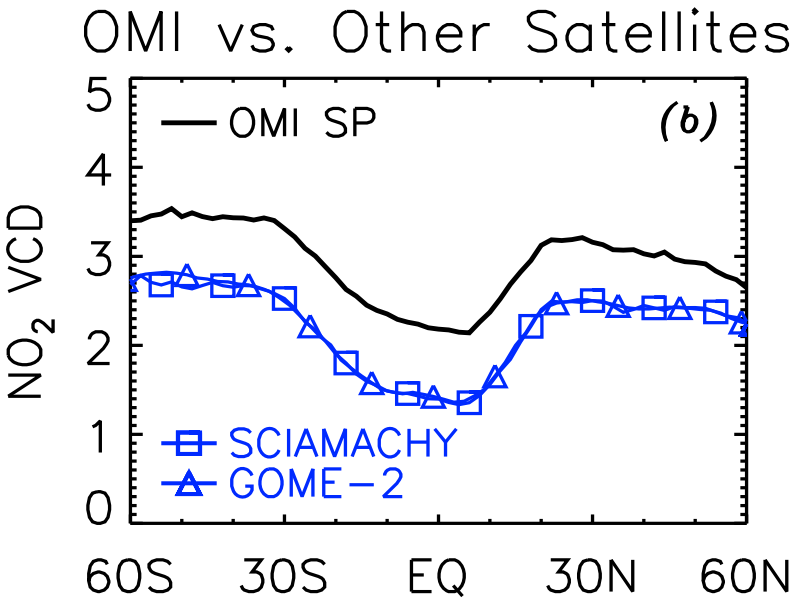
OMNO2 SP Version 3: Stratospheric NO_2

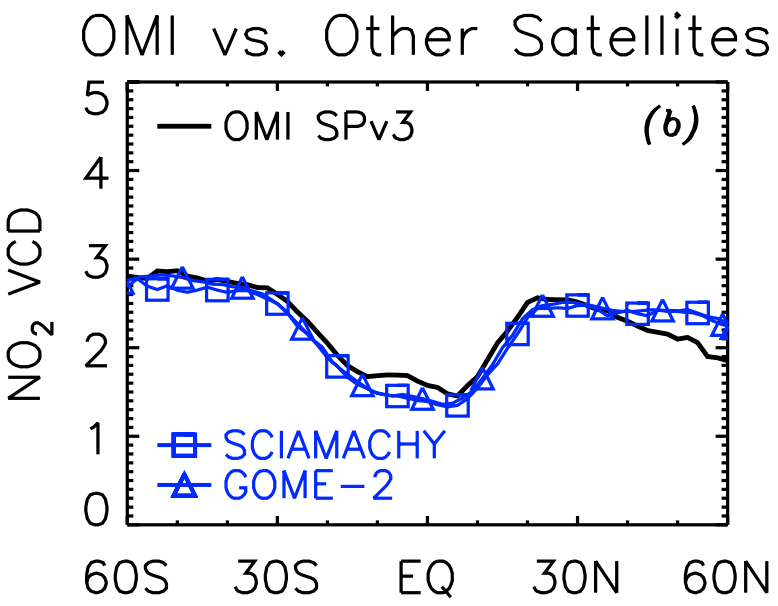




OMNO2 V3 reduces bias compared to other satellite measurements

Version 2.1 → **Version 3.0**

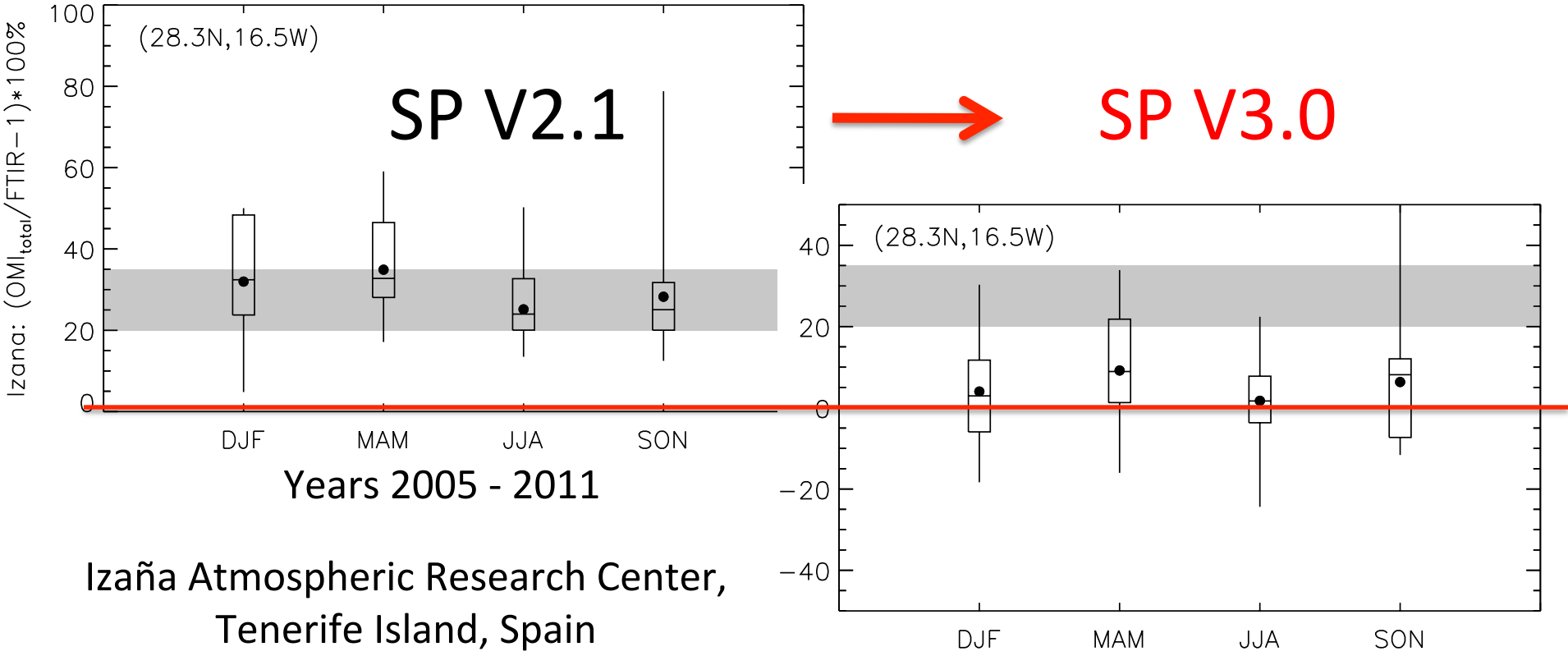




Monthly Pacific (140W- 180W) zonal mean NO_2 columns for March 2010:

- Old V2.1 was 20-30% higher than the data from ENVISAT/SCIAMACHY and MetOpA/GOME-2 sensors, adjusted to the OMI overpass time.
- **New V3.0 agrees better than~10%, except above 50N**

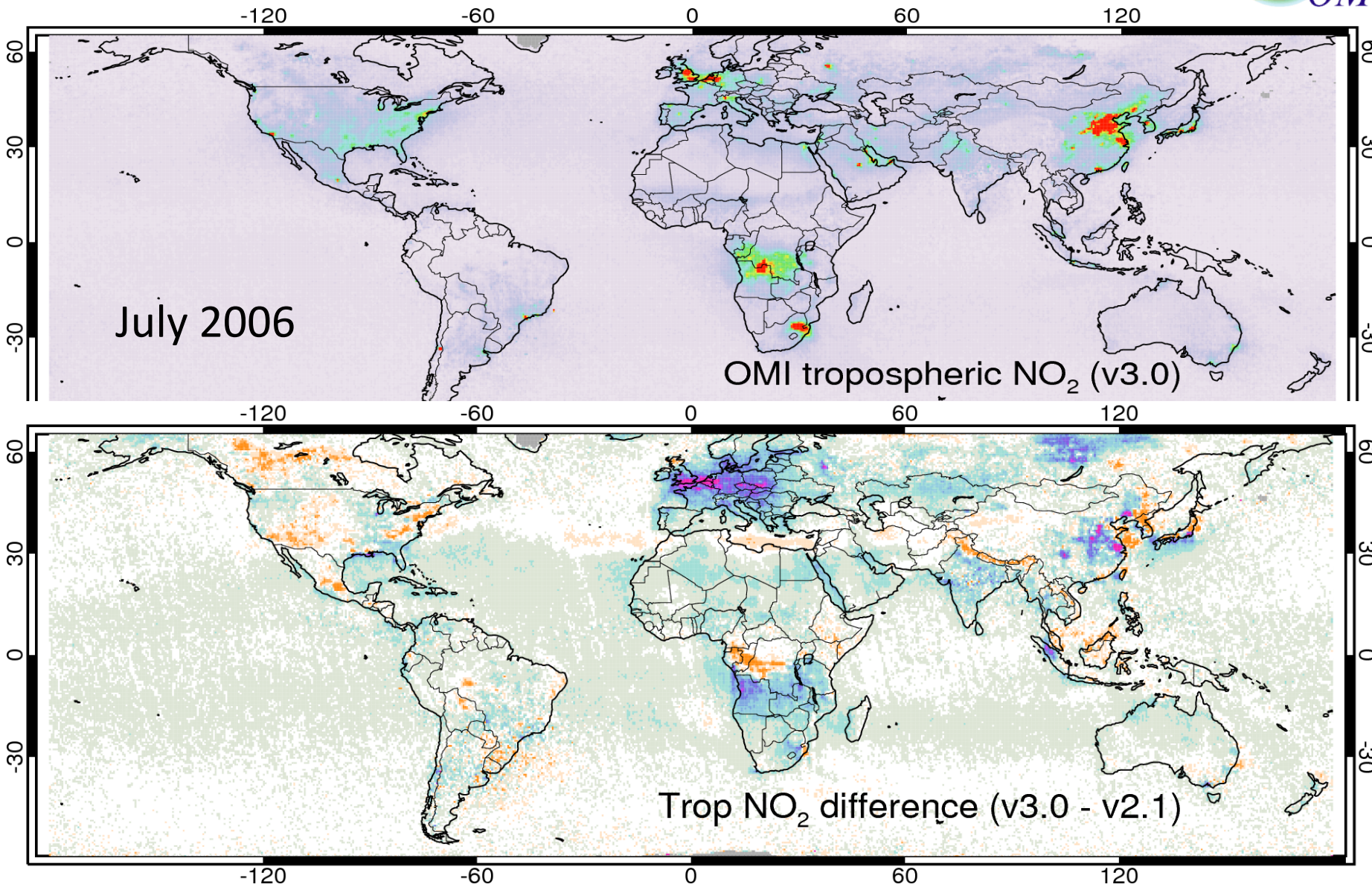
OMNO2 SP V3 reduces bias compared to ground based FTIR measurements



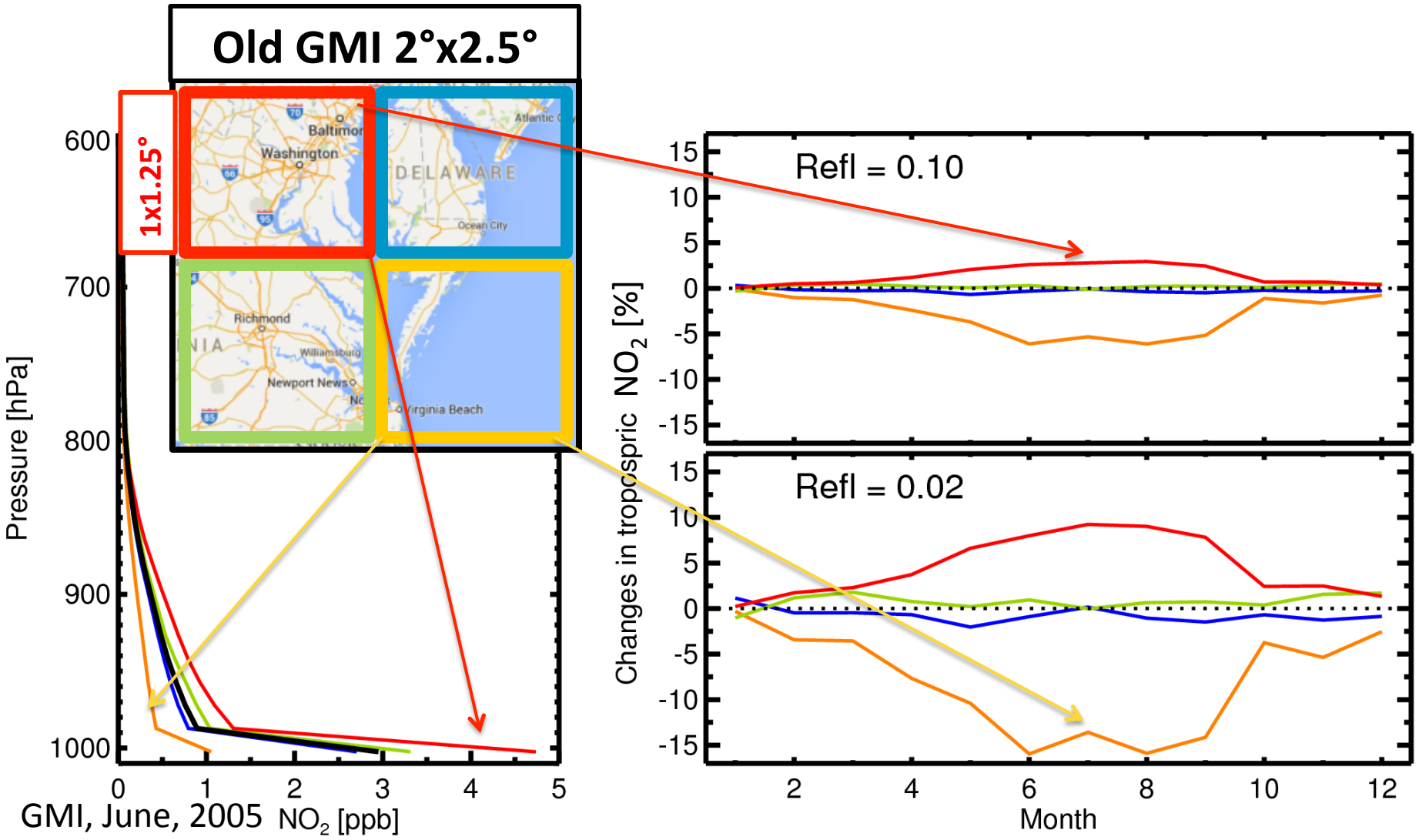
Izaña Atmospheric Research Center,
Tenerife Island, Spain
(28.3 N, 16.5 W, 2367 m a.s.l.)

- SP v2.1 is high biased compared to FTIR data;
- For SP v3.0, agreement of means (dots) is within about 10% all year.

Version 3: Tropospheric NO_2 difference

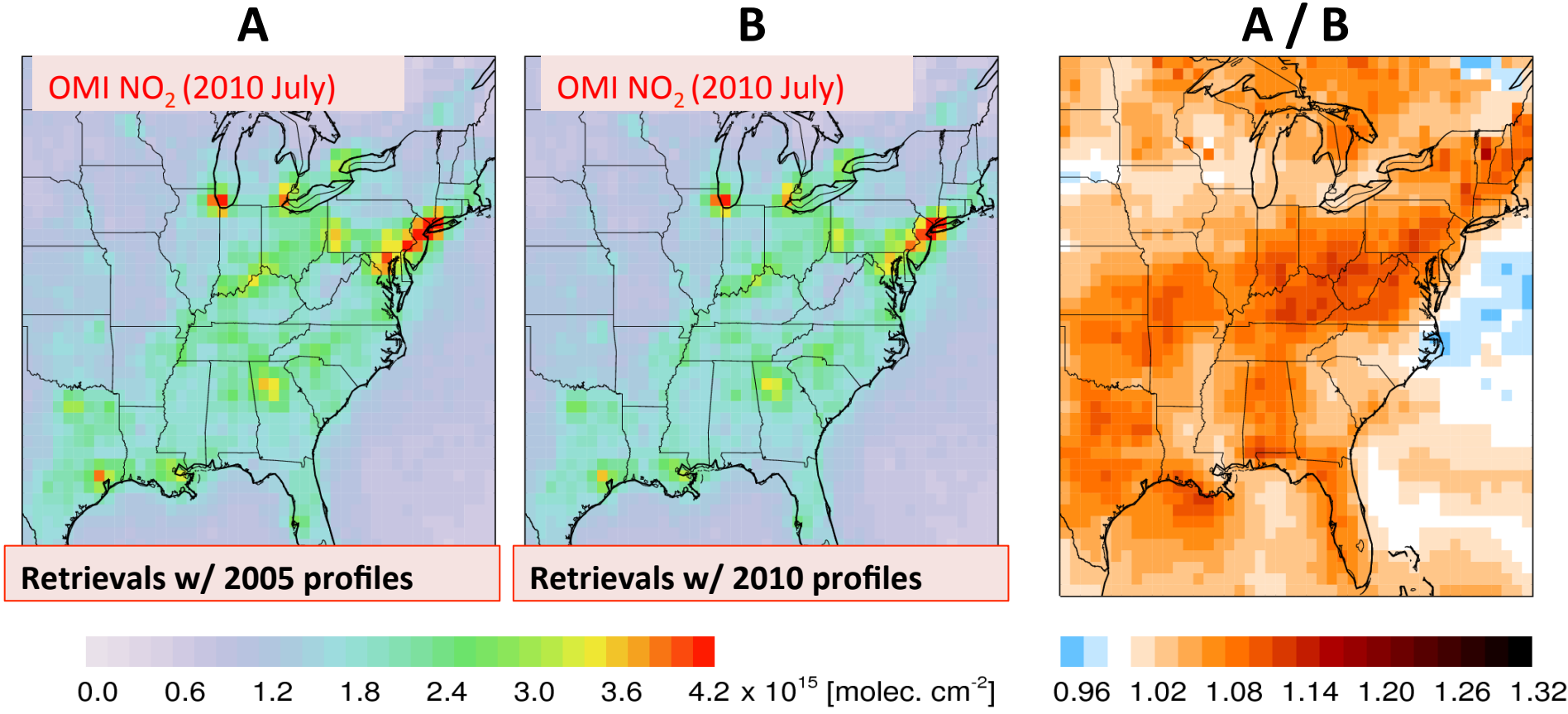


A-Priori NO_2 Profiles: Spatial Resolution



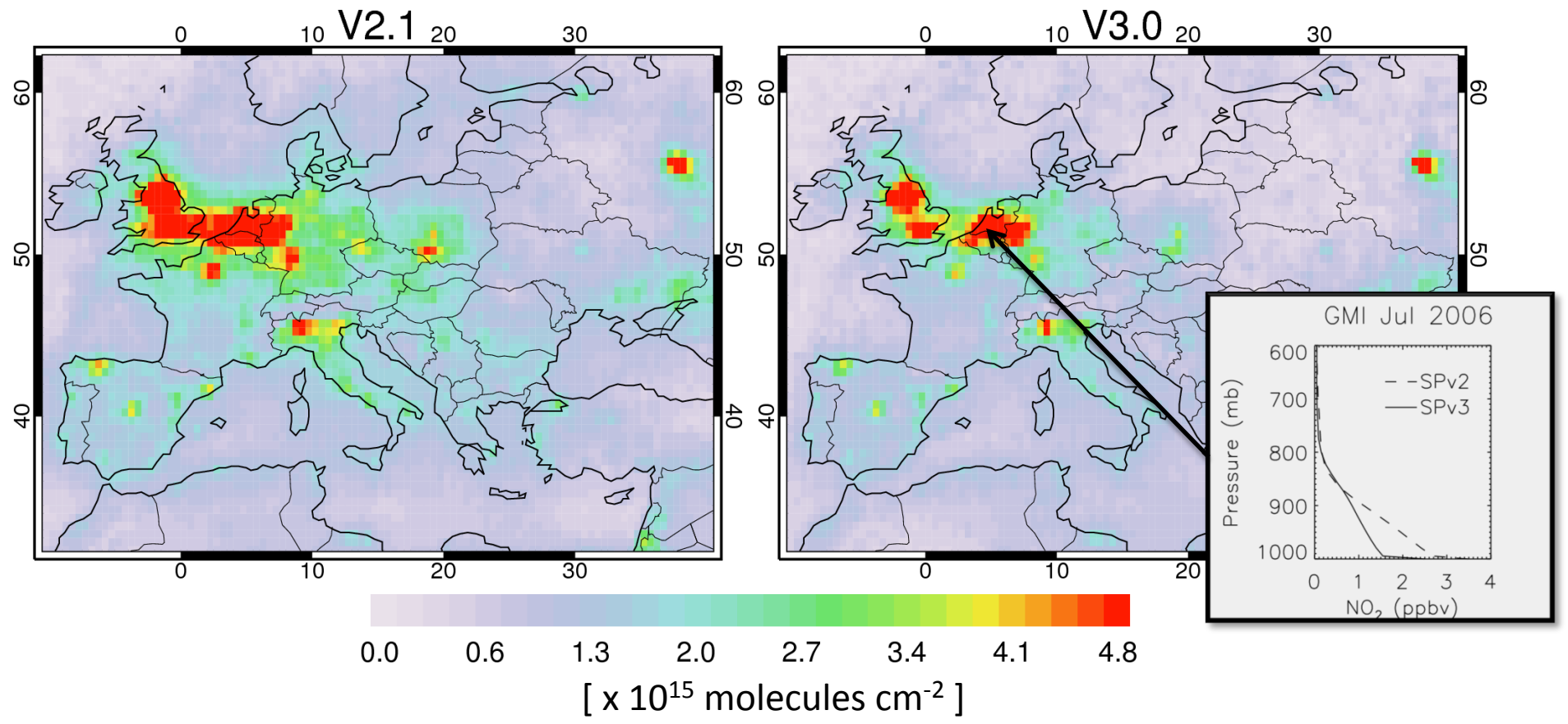
A factor of 4 increase in resolution changes retrievals by up to ~15%

A-Priori NO_2 Profiles: Updated Emissions



Profiles based on outdated emissions can introduce significant retrieval errors – overestimation where emissions have reduced and underestimation where emissions have increased.

Version 3 tropospheric NO_2: Combined effect of New SCDs and New *a priori* NO_2 profiles



Tropospheric NO_2 VCD reduction due to:
(A) reduced year dependent emissions affecting NO_2 profile shapes and (B) higher spatial resolution a priori NO_2 profiles

Work underway

- Version 3 paves a way for further improvements in tropospheric NO_2 AMF calculation*:*
  - *Incorporating Geometry dependent dynamic MODIS-based surface BRDF GLER product developed by US OMI core team.* Expected effect is increasing tropospheric NO_2 VCDs over polluted areas;
  - *Incorporating advanced snow corrections*
  - *OMI NO_2 product will benefit from improvements in OMI effective cloud parameters (CRF and OCP), as input to AMF*
- **Longer –term efforts**
  - Explicit aerosol corrections;
  - More extensive comparison and validation against other measurements and satellite retrievals ;
  - Integrating near simultaneous high resolution A-train aerosol and cloud measurements;