GLOBAL INVENTORY OF NITROGEN OXIDE EMISSIONS CONSTRAINED BY SPACE-BASED OBSERVATIONS OF NO2 COLUMNS

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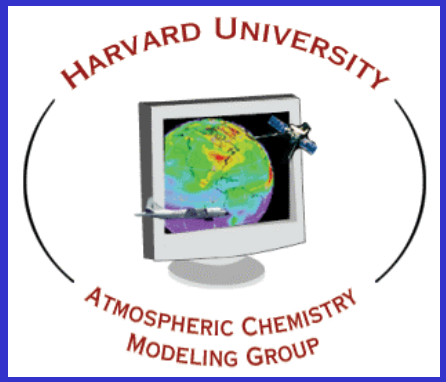
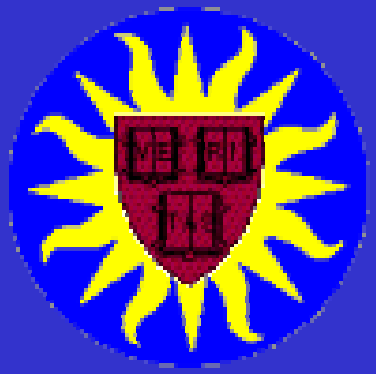
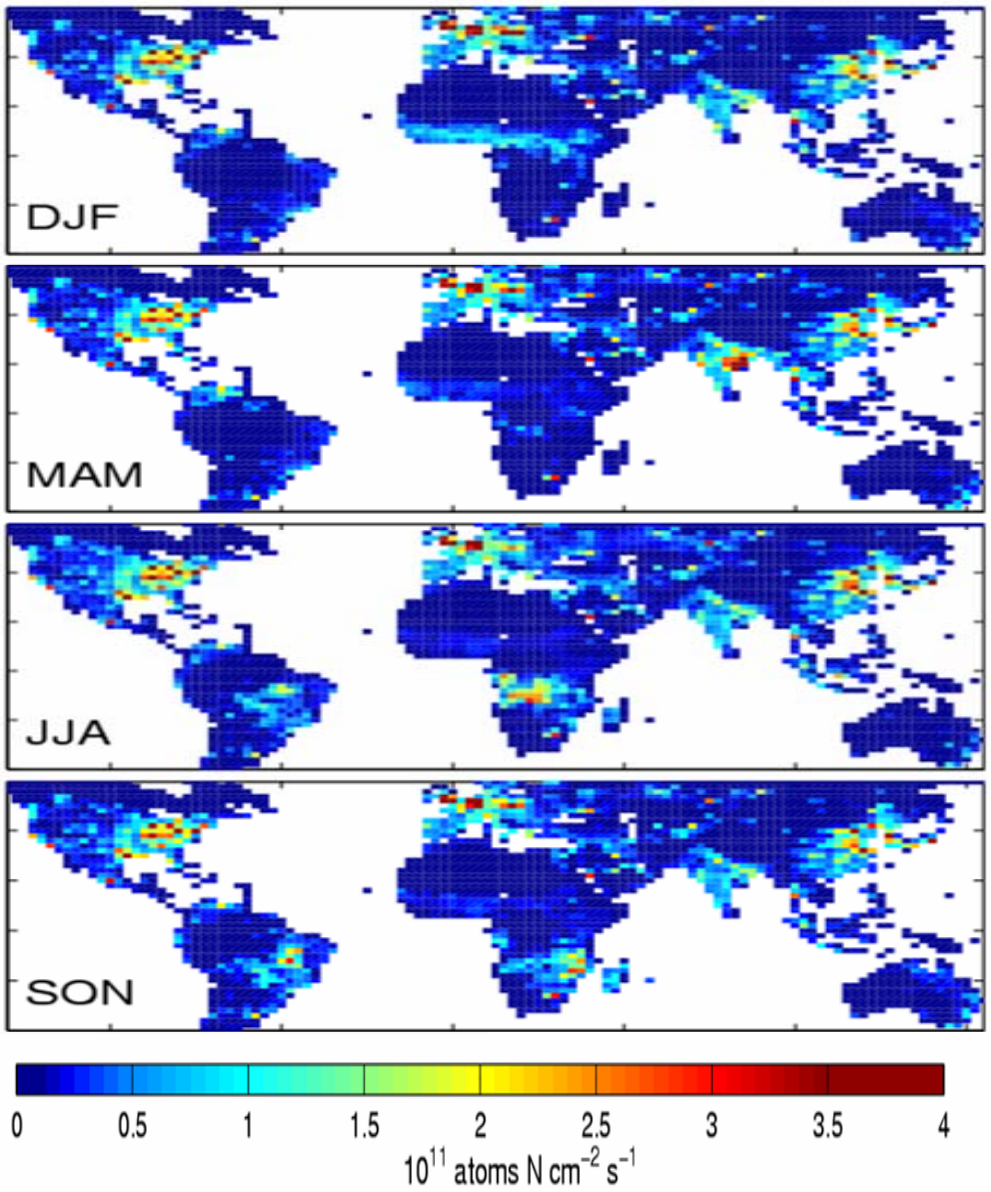




HOW DO WE EVALUATE AND IMPROVE BOTTOM-UP INVENTORIES?

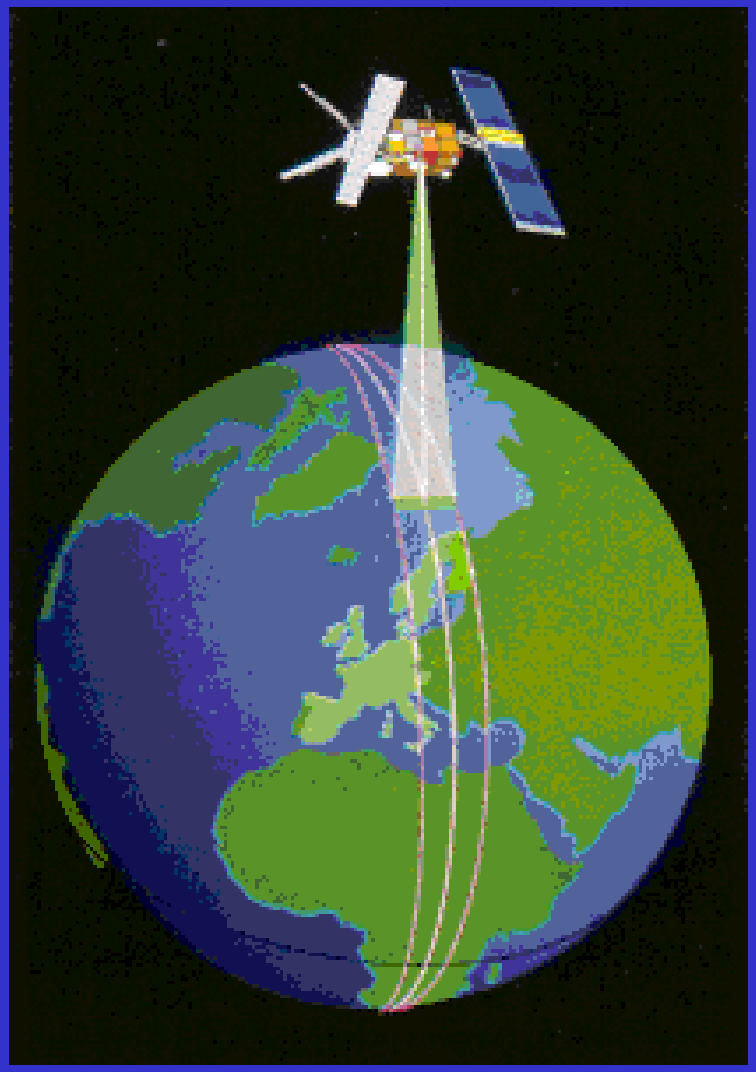
Surface NO_X



Global NOx Emissions (Tg N yr^{-1})
Fossil Fuel (20-33)
Biomass Burning (3-13)
Soils (4-21)

Here in Tg N yr^{-1} (based on)
Fossil Fuel 24 (GEIA)
Biomass Burning 6 (Logan/Duncan)
Soils 5 (Yienger and Levy)

TOP-DOWN INFORMATION FROM THE GOME SATELLITE INSTRUMENT



Spectral Fit (423-451 nm)

Total NO_2 Slant Column

Remove Stratosphere

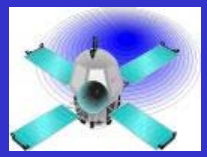
Tropospheric NO_2 Slant Column

Calculate AMF

Tropospheric NO_2 Column

- Spatial resolution 320x40 km^2
- Complete global coverage in ~3 days

USE RETRIEVED NO_2 COLUMNS TO MAP NO_x EMISSIONS



GOME

Tropospheric NO_2 column ~ E_{NOx}

BOUNDARY LAYER

$NO/_{NO2}$ ↑ ↑ W ALTITUDE

NO ⇌ NO_2

lifetime ~hours

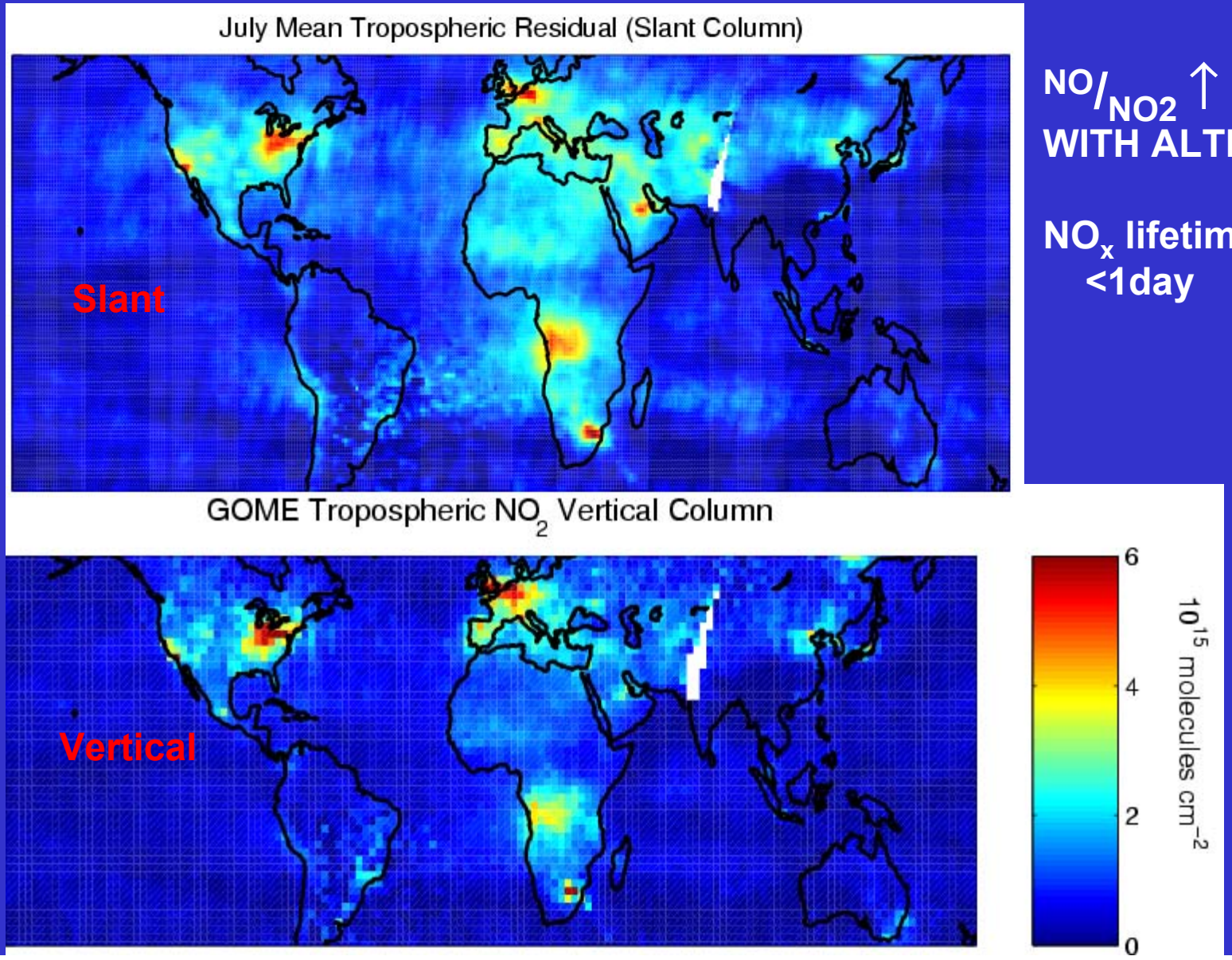
HNO_3

Emission

NITROGEN OXIDES (NO_x)

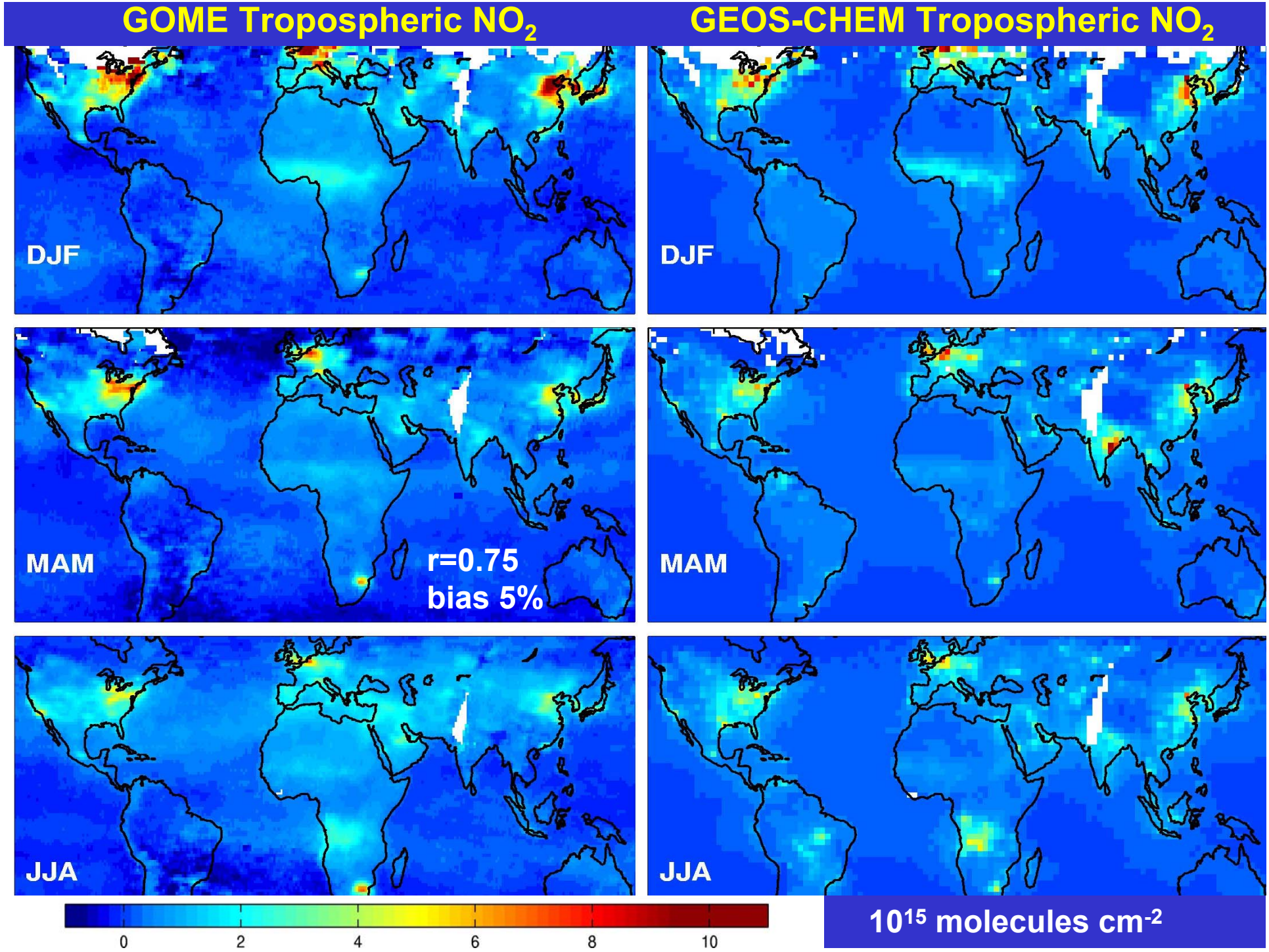
VERTICAL COLUMNS CONFINED TO REGIONS OF SURFACE EMISSIONS

Cloud/albedo artifacts removed by AMF calculation



$NO/_{NO2}$ ↑ ↑ WITH ALTITUDE

NO_x lifetime <1day


GOME Tropospheric NO2
GEOS-CHEM Tropospheric NO2
DJF
DJF
MAM
r=0.75
bias 5%
MAM
JJA
JJA
0
2
4
6
8
10
10^15 molecules cm^-2

STRATEGY: OPTIMIZE INVENTORIES USING *A PRIORI* BOTTOM-UP AND GOME TOP-DOWN INFORMATION

Top-down emissions

A priori emissions

A posteriori emissions

$$\ln E = \frac{\ln E_t \left(\ln \varepsilon_a\right)^2 + \ln E_a \left(\ln \varepsilon_t\right)^2}{\left(\ln \varepsilon_a\right)^2 + \left(\ln \varepsilon_t\right)^2}$$

A *priori* errors

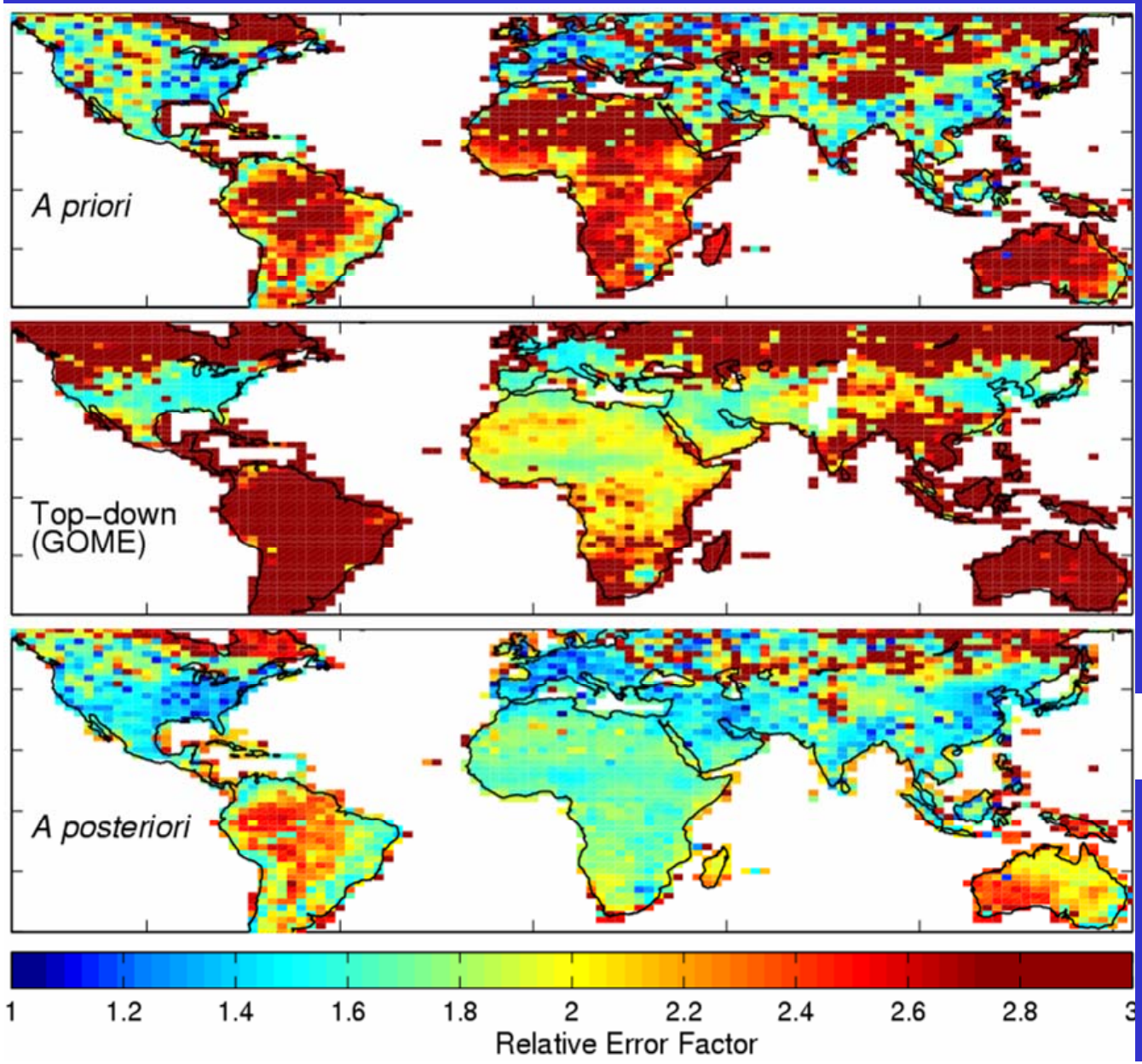
Top-down errors

$$E_t = \Omega_{NO2} \left(\frac{NO_x}{NO_2}\right) \frac{1}{\tau_{NOx}}$$

GOME

GEOS-CHEM

TOP-DOWN INFORMATION FROM GOME REDUCES ERROR IN NO_X EMISSION INVENTORY



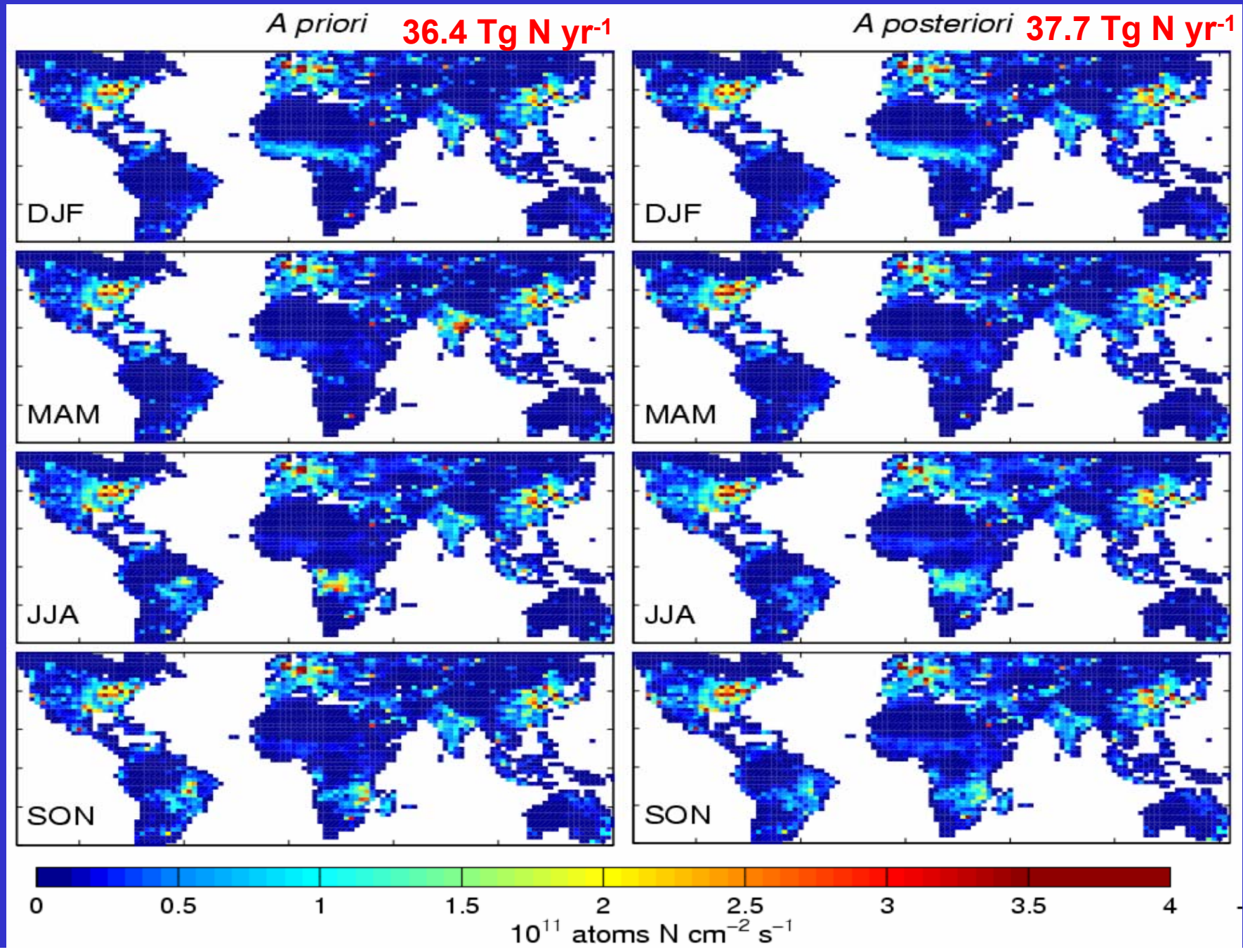
Bottom-up error ε_a
Mean=2.0

Top-down error ε_t
Mean=2.0

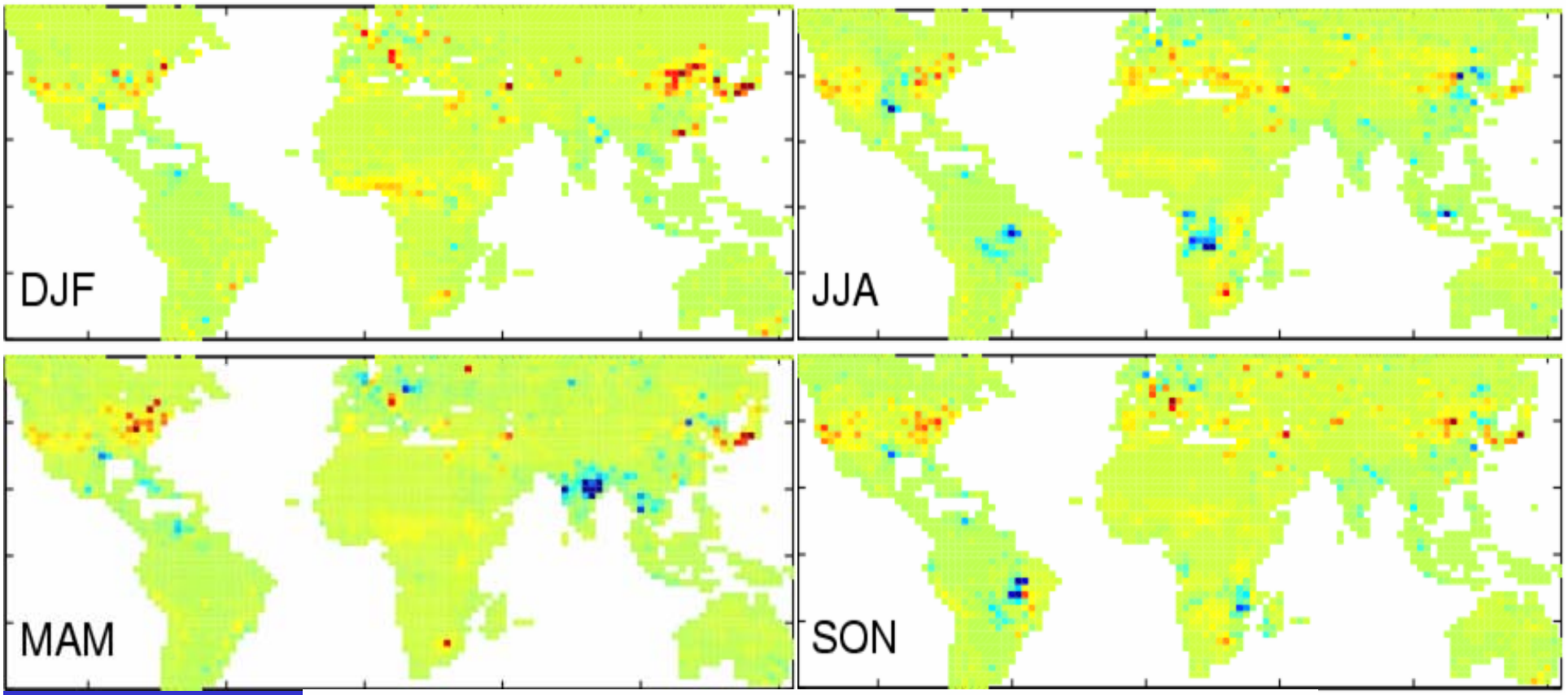
$$\ln^{-2}\varepsilon = \ln^{-2}\varepsilon_a + \ln^{-2}\varepsilon_t$$

Mean=1.6

OPTIMIZED NO_X EMISSIONS



A POSTERIORI MINUS *A PRIORI* EMISSIONS



PRODUCTION OF HIGHER RESOLUTION INVENTORIES:

- SCIAMACHY (30 x 60 km^2), launched in 2002
- OMI (13 x 24 km^2), to be launched in 2004
- Account for transport in the inversion of NO_2 to NO_x

REFERENCES

Martin, R.V., D.J. Jacob, K. Chance, T.P. Kurosu, P.I. Palmer, and M.J. Evans, Global inventory of nitrogen oxide emissions constrained by space-based observations of NO2 columns, *J. Geophys. Res.*, 108(D17), 4537, doi:10.1029/2003JD003453, 2003.

Martin, R.V., K. Chance, D.J. Jacob, T.P. Kurosu, R.J.D. Spurr, E. Bucsela, J.F. Gleason, P.I. Palmer, I. Bey, A.M. Fiore, Q. Li, R.M. Yantosca, and R.B.A. Koelemeijer, An improved retrieval of tropospheric nitrogen dioxide from GOME, *J. Geophys. Res.*, 107(D20), 4437, 10.1029/2001JD001027, 2002.