



Tropospheric NO₂ and SO₂ retrievals from GOME-2 measurements

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Outline

- GOME-2 instrument and Ozone Monitoring SAF
- Tropospheric NO₂ column from GOME-2
 - tropospheric NO₂ over China
 - tropospheric NO₂ and O₃ in the tropics
 - initial validation with ground-based measurements
- Tropospheric SO₂ column from GOME-2
 - exemplary results of anthropogenic SO₂ pollution
 - accuracy and initial validation
- Conclusions

GOME-2 instrument



- GOME-2/MetOp-A is part of EUMETSAT Polar System (EPS)
 - MetOp-A launched: 19 Oct. 2006
 - GOME-2 L1 and L2 data: Jan. 2007 - onwards
- GOME-2 spatial/temporal coverage
 - Orbit: sun-synchronous, 09:30h (descending node)
 - Spatial resolution: 80x40 km²
 - Global coverage in ~1.5 days
- EUMETSAT Polar System: three MetOp satellites (2006, 2012, 2016)
 - Continuous GOME-2 time-series from 2007-2020



Ozone and Atmospheric Chemistry Monitoring SAF



<http://o3msaf.fmi.fi>

Objectives

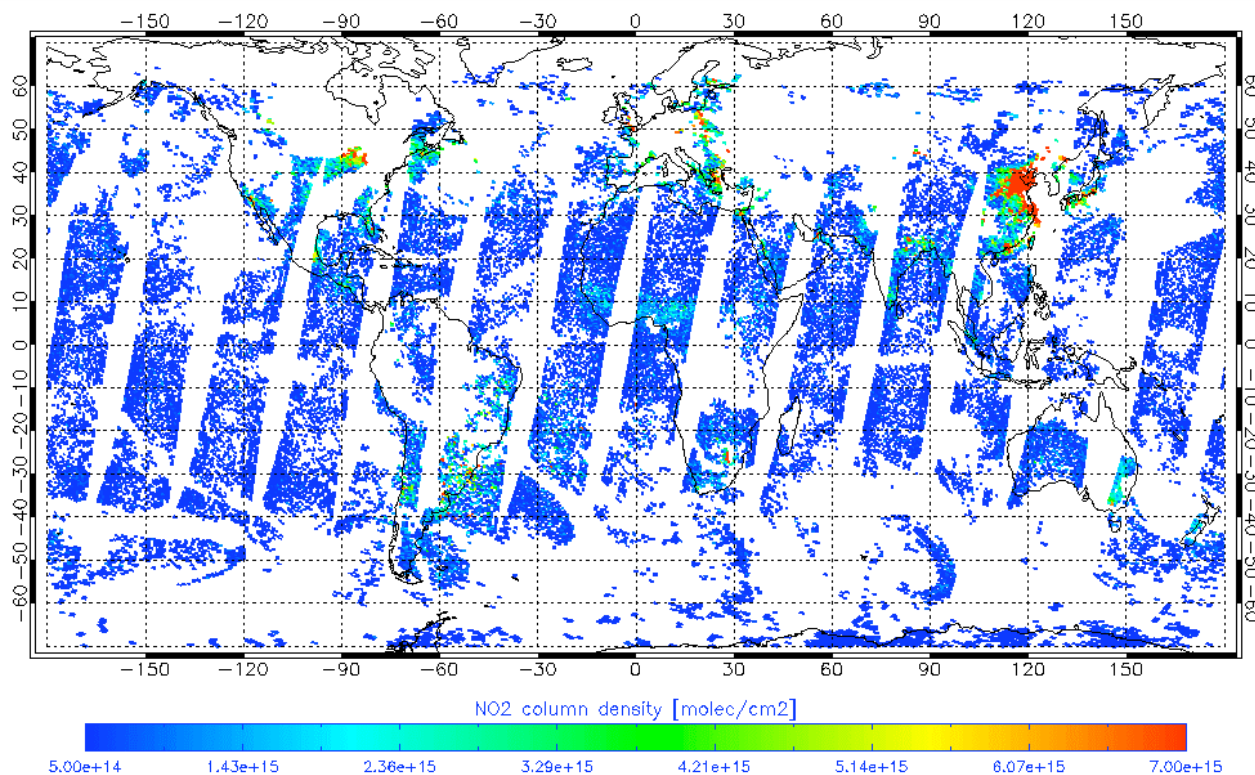
- Operational Near Real Time (NRT) products and Off-line products based on GOME-2 data
 - Ozone profiles (KNMI)
 - Ozone and minor trace gas columns (DLR)
 - Aerosol products (KNMI)
 - UV products (FMI, DMI)
 - Validation service for each product (AUTH, RMI, BIRA)



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Tropospheric NO₂ column retrieval (GDP 4.3)

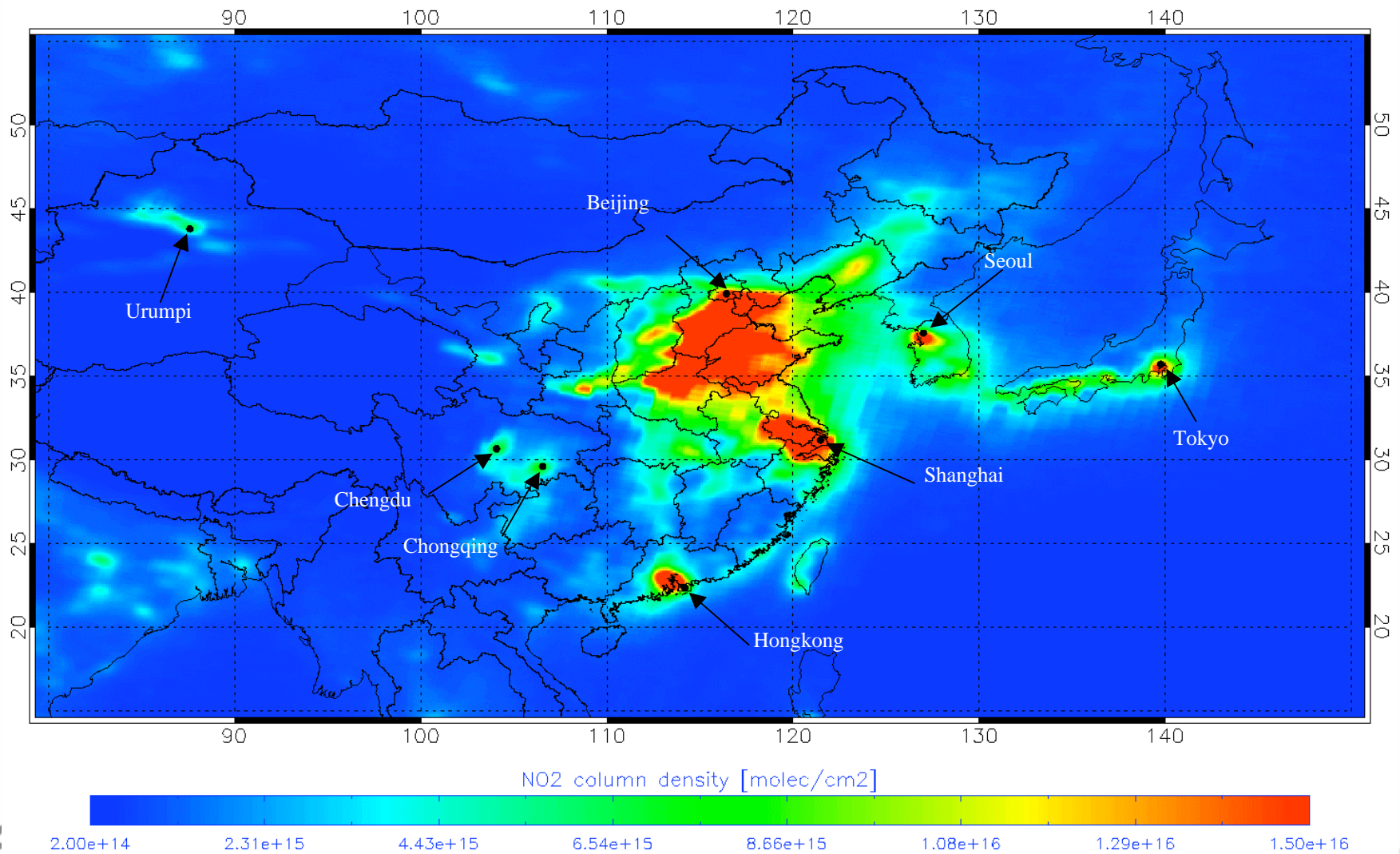
- Retrieval of total NO₂ slant column density with DOAS method
 - fitting window: 425-450 nm
- Estimation of stratospheric NO₂ component using spatial filtering
- Tropospheric AMF based on MOZART-2 NO₂ climatology (Univ. Bremen)
- Calculation of tropospheric NO₂ column using cloud correction



Trop. NO₂ column
10 Feb. 2009

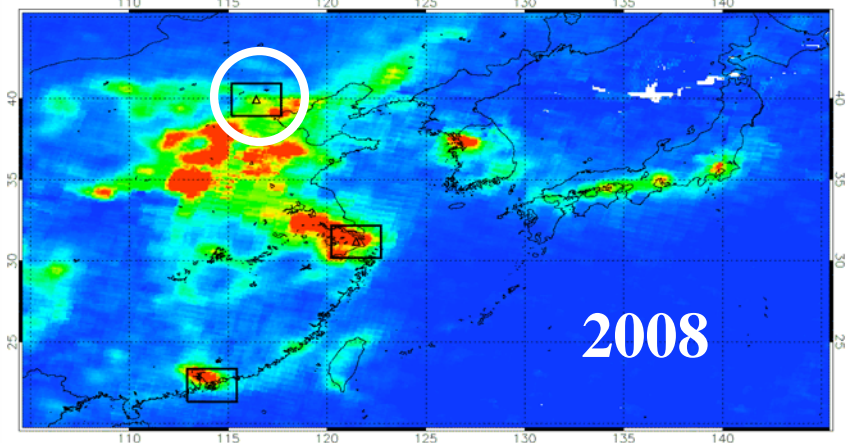
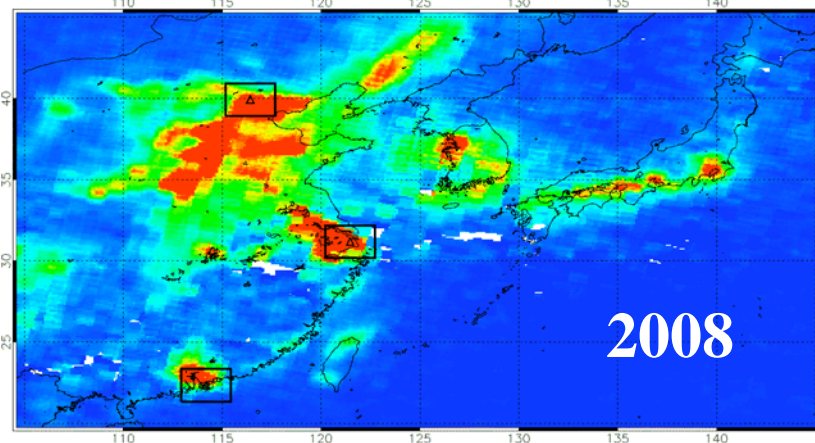
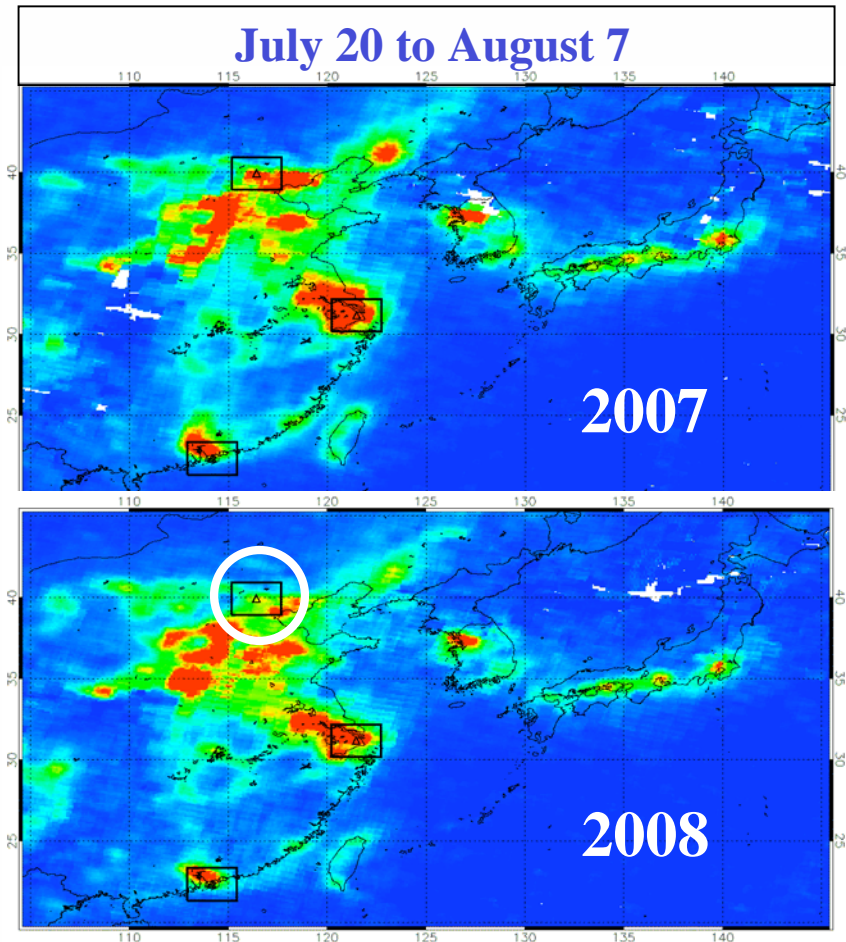
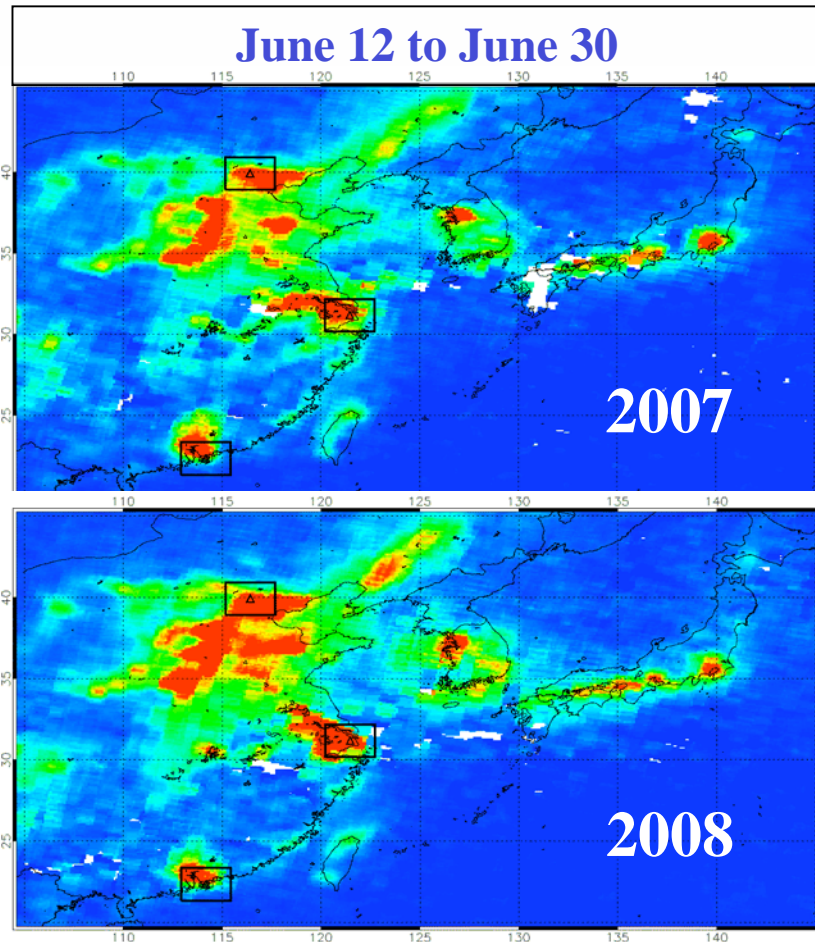
GOME-2 tropospheric NO₂ in East Asia

Jan 2007 - Dec 2008



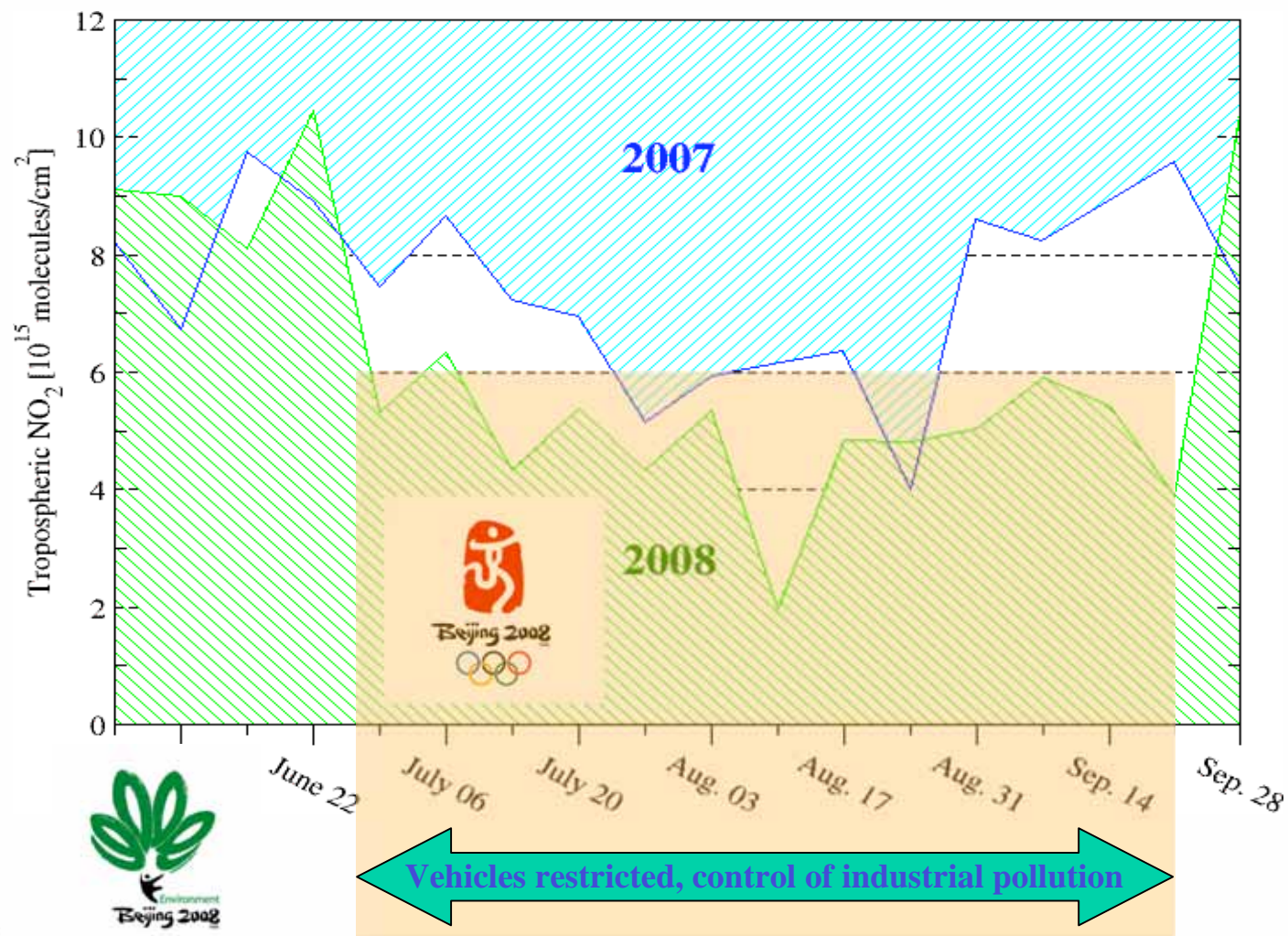


GOME-2 Tropospheric NO₂ in China

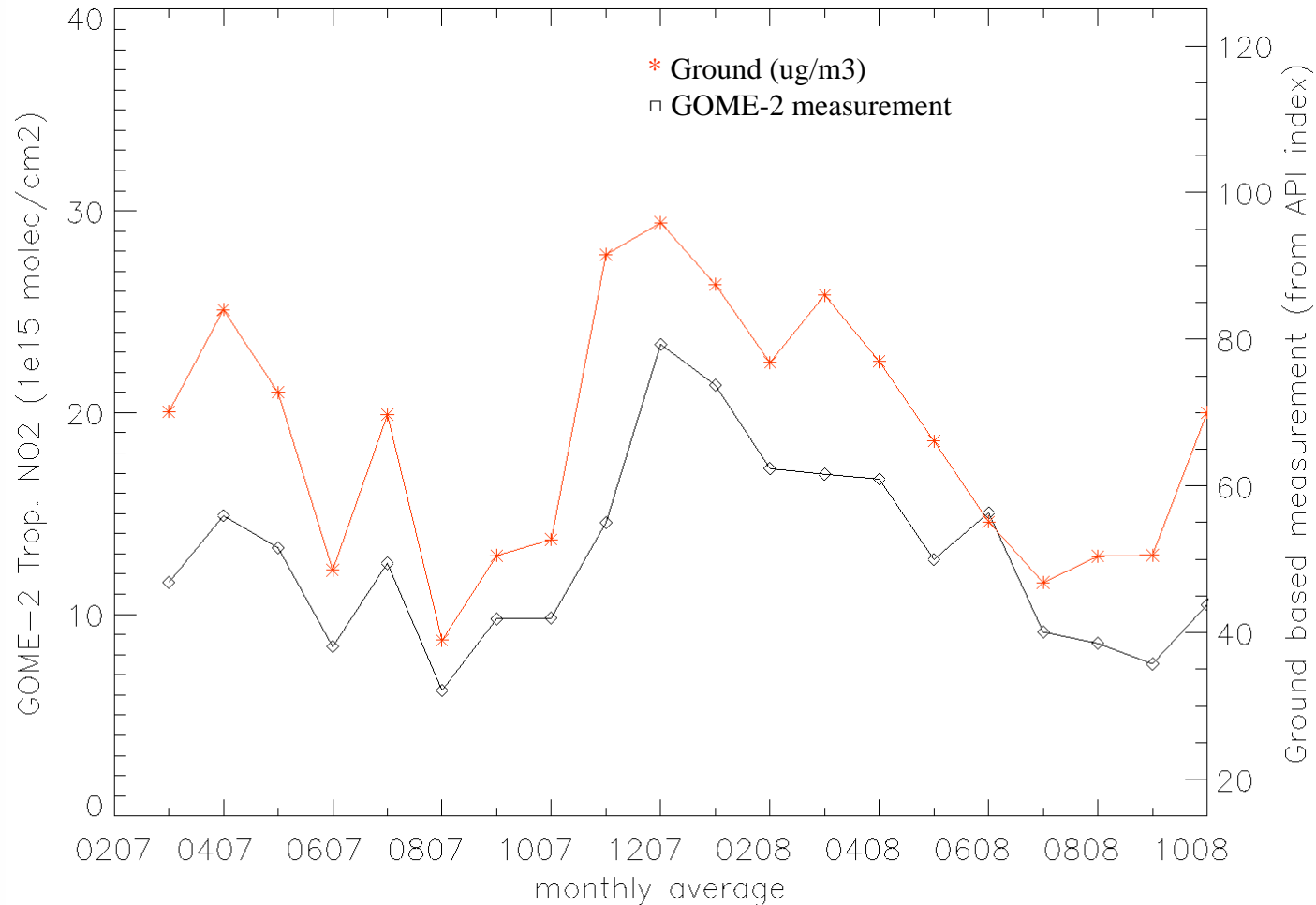


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GOME-2 tropospheric NO₂ in Beijing



Monthly average tropospheric NO₂ comparison GOME-2 versus API index over Shanghai



API index come from the websites

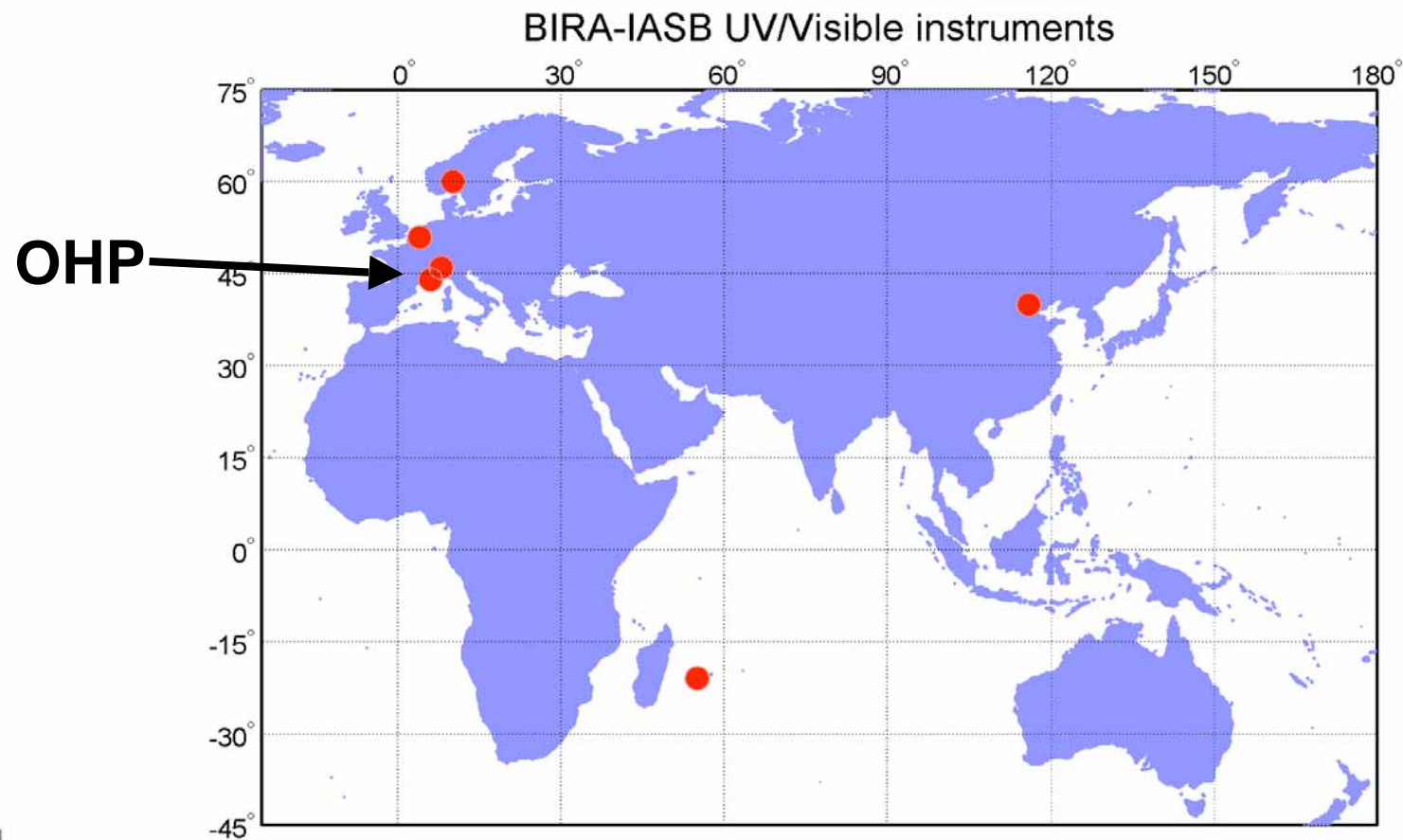
<http://www.envir.online.sh.cn/airnews/index.asp>



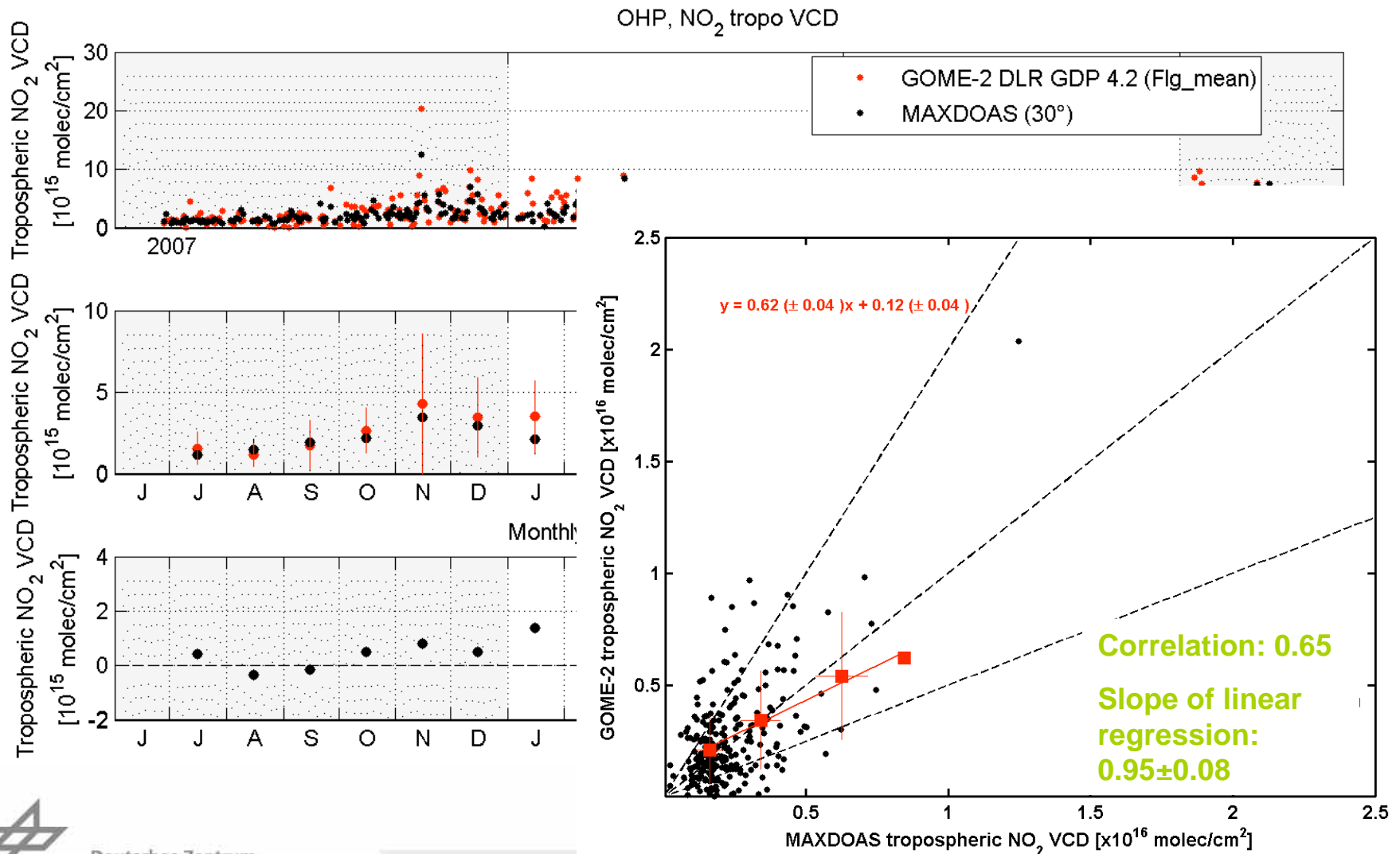
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Initial validation with ground-based measurements

Tropospheric NO₂: comparison against MAX-DOAS (BIRA-IASB)

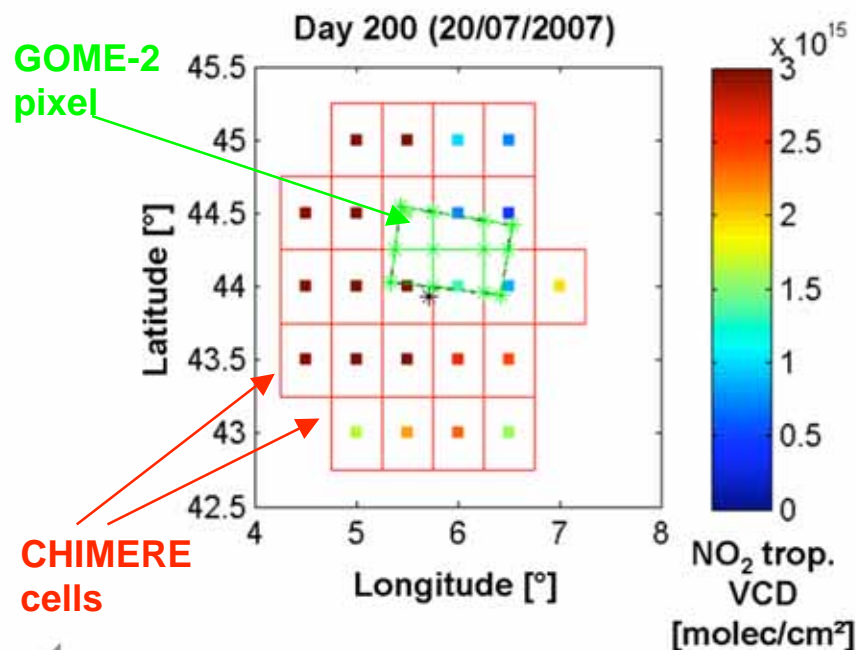


Comparison with MAX-DOAS at Obs. de Haute Provence



Improving satellite against MAX-DOAS comparisons

-
- Differences in NO₂ field sampled by satellite and MAX-DOAS
- Reduce air-mass differences:
use CHIMERE model as transfer standard to link satellite and MAX-DOAS measurements



“simulation” of NO₂ field seen by GOME-2

Under-development (RMI / BIRA)



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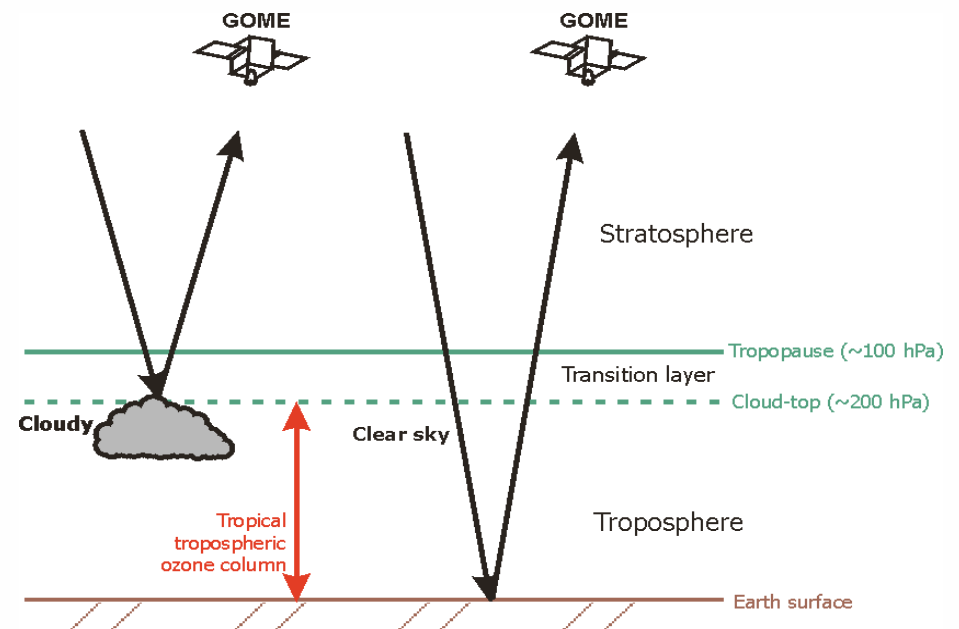
GOME-2 Tropical Tropospheric Ozone algorithm

Convective-cloud-differential (CCD) method

- above cloud and clear-sky ozone column measurements
- Tropical tropospheric ozone columns (TTOC) below 200 hPa

GOME-2 data required:

- Total ozone columns
- Effective cloud fractions and cloud-top pressures (OCRA and ROCINN)



Valks et al., JGR, Vol. 108, 2003

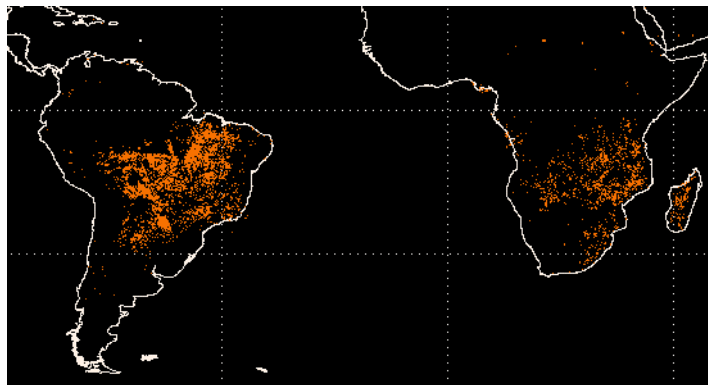
GOME-2 tropical tropospheric NO₂ and ozone

Tropospheric NO₂

September, 2007

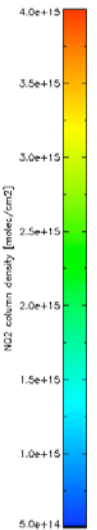
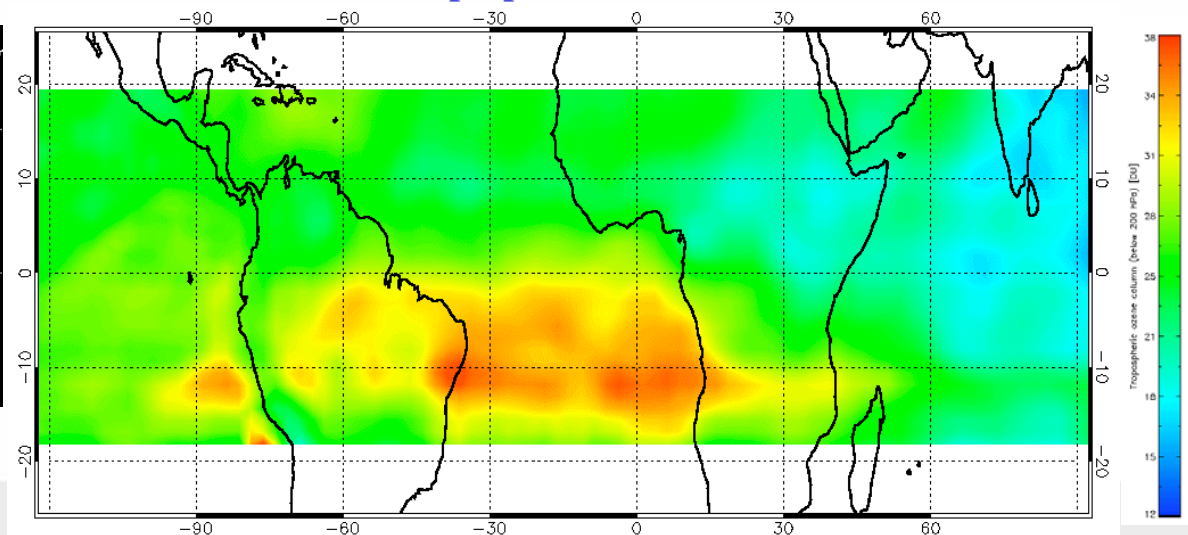
Southern hemisphere biomass
burnings

ATSR hot spots



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Tropospheric Ozone





GOME-2 SO₂ column retrieval

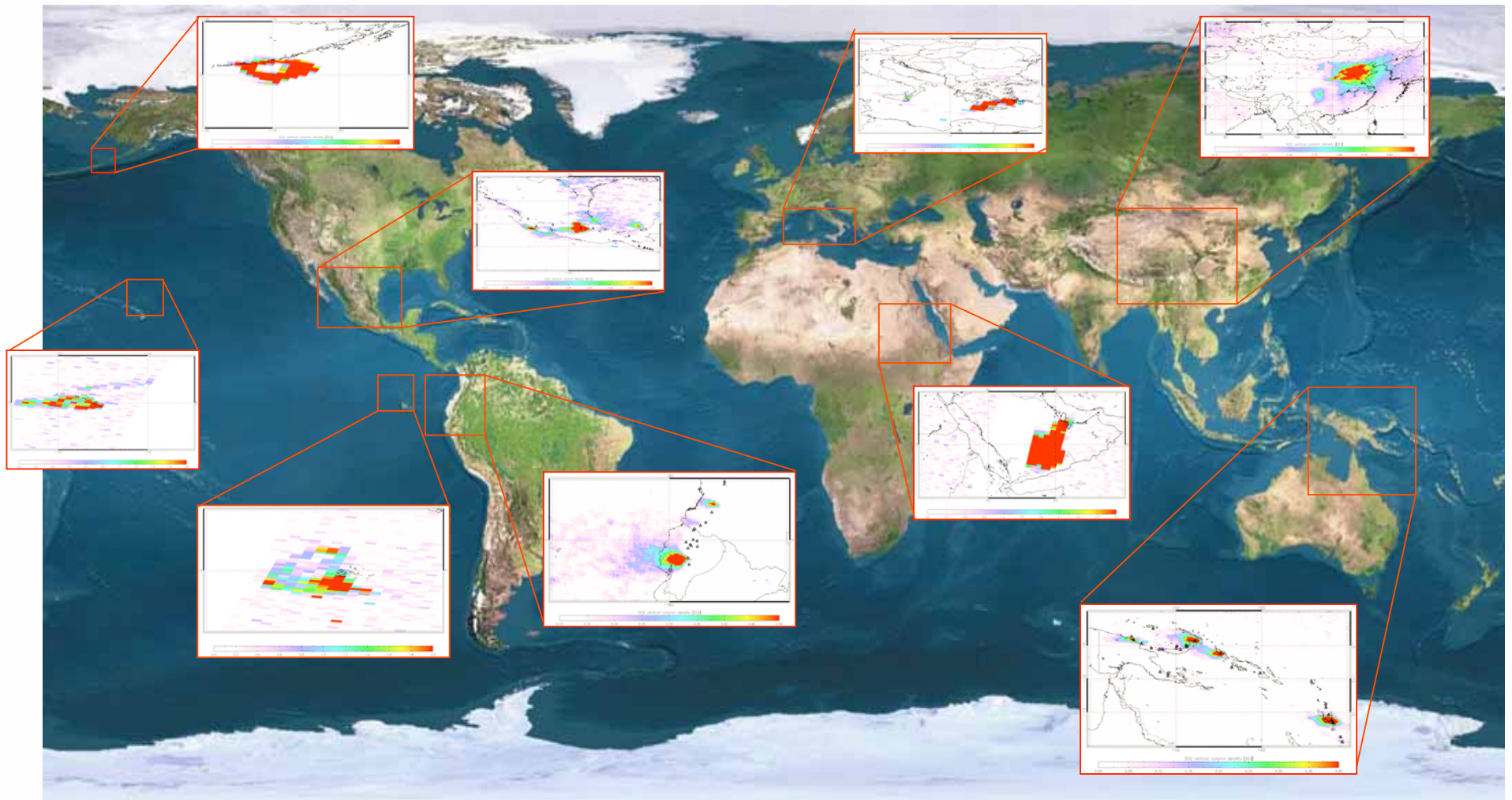
SO₂ slant column algorithm

- SO₂ slant column density with DOAS method
 - fitting window: 315-326 nm
- Background correction
 - interference of SO₂ and ozone absorption features

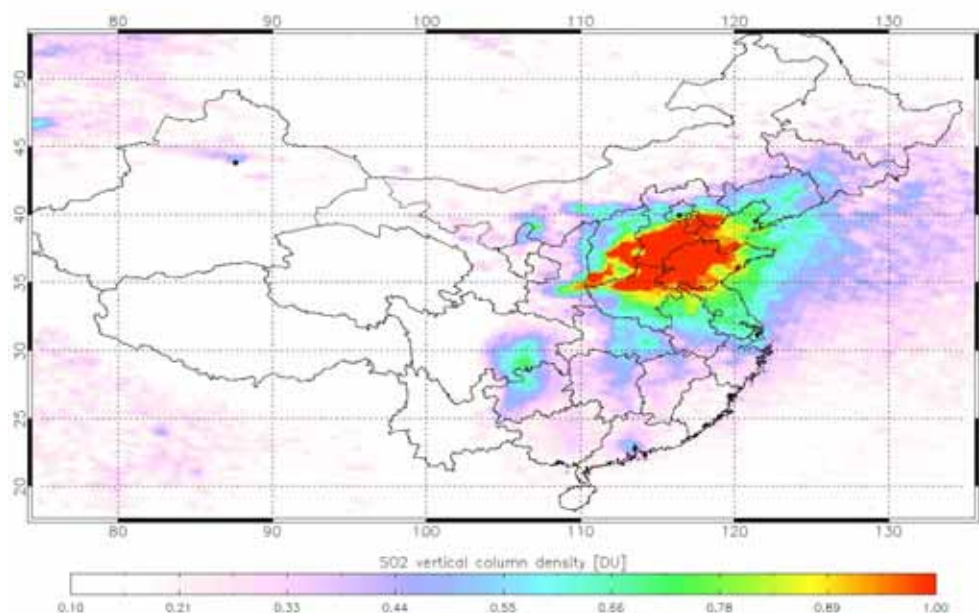
Air Mass Factor and vertical column calculation

- Volcanic and anthropogenic AMFs
 - function of plume height and SO₂ load
 - plume heights: 2.5, 6 and 15 km
- Calculation of vertical SO₂ column using cloud correction

GOME-2 SO₂



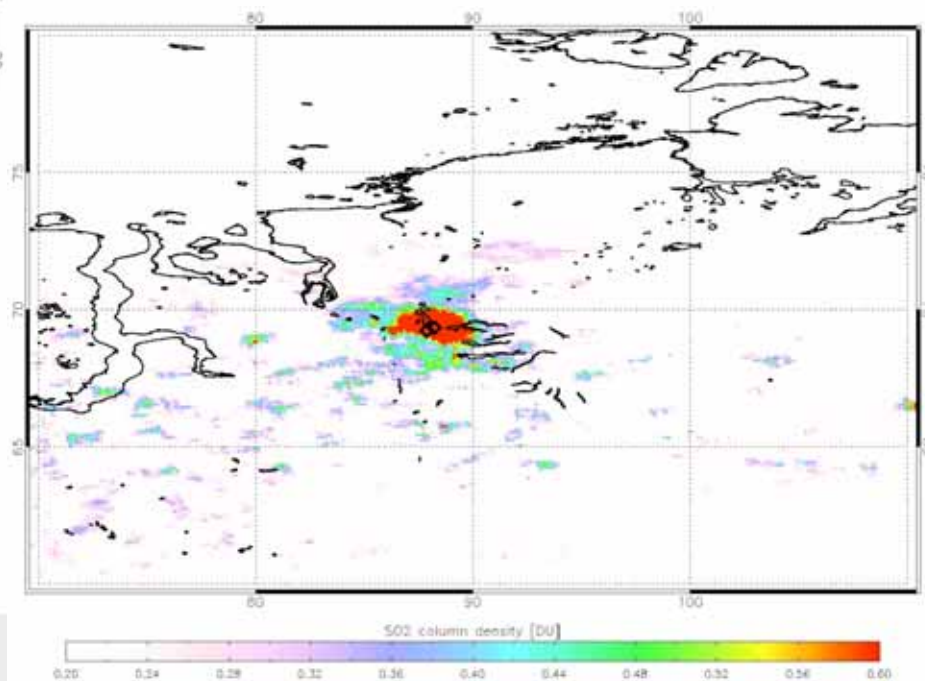
GOME-2 SO₂ from anthropogenic emissions



**Fossil fuel combustion,
Eastern China**

Jan 2007 - Dec 2008

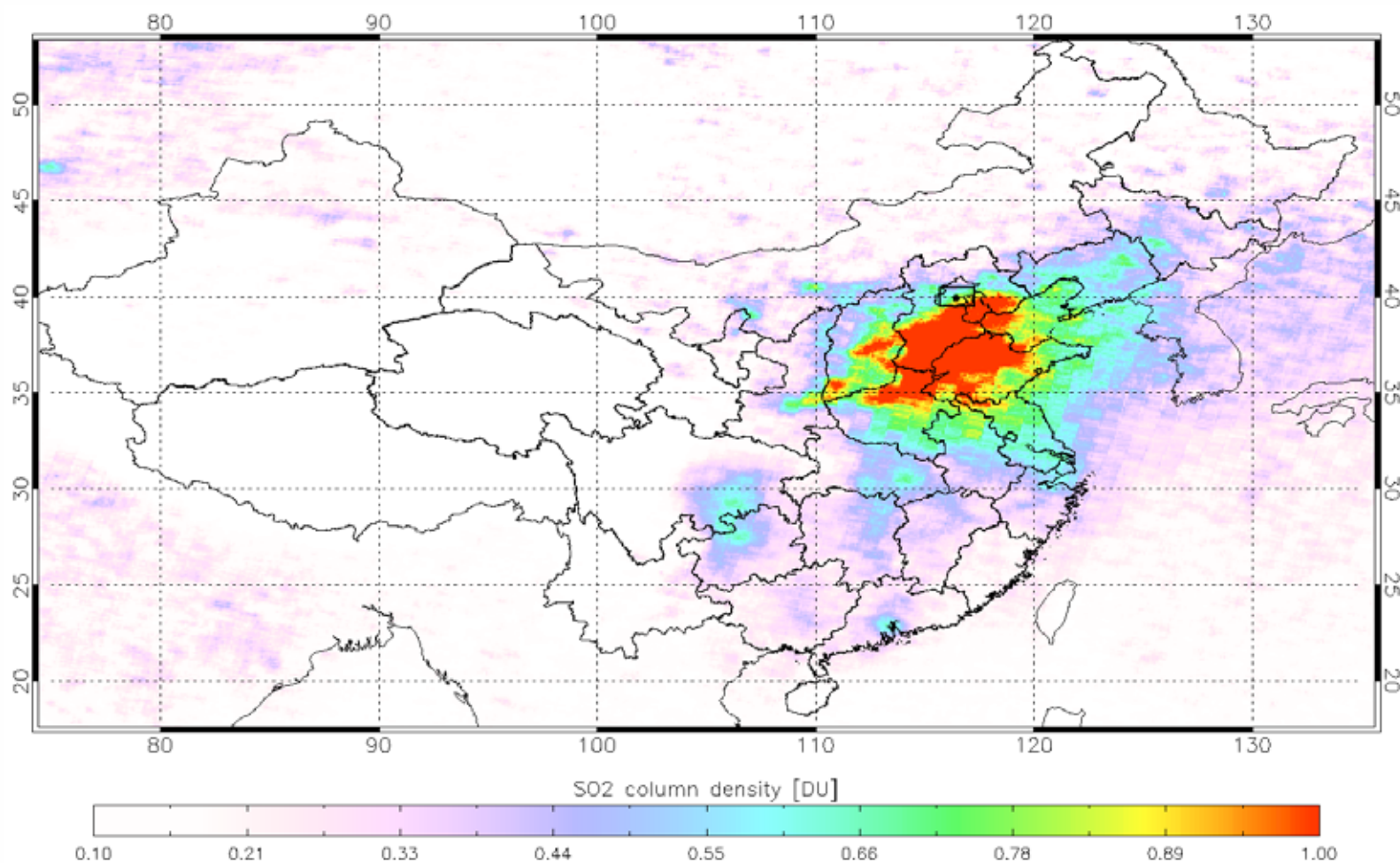
**Norilsk copper smelter,
Russia**



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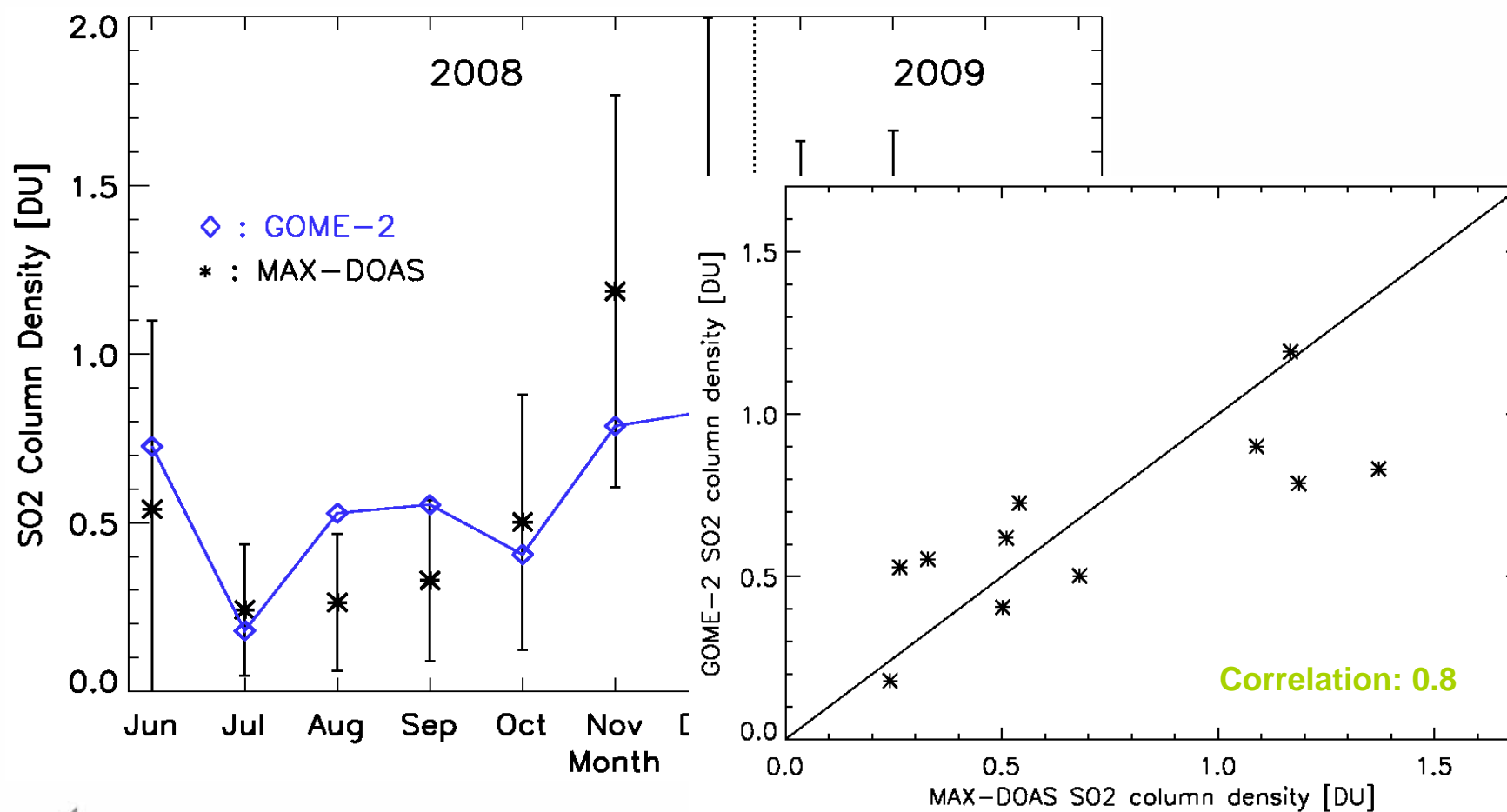
Comparison with ground-based measurements

MAX-DOAS in Beijing (39.9°N, 116.4°E)



Comparison with MAX-DOAS in Beijing

MAXDOAS in Beijing (39.9°N, 116.4°E)



Conclusions



o3msaf.fmi.fi



GOME-2 total and tropospheric NO₂ and SO₂ column products

- operational status since Jan. 2009
- initial validation with ground-based measurements
- improvements in validation methods are under-development

GOME-2 level-2 operational products available via:

- EUMETSAT: EUMETCast (NRT) and UMARF (off-line)
- DLR: EOWEB (off-line) and FTP (NRT/off-line)

GOME-2 NO₂ and SO₂ products (level-3 and value-added):

- World Data Centre WDC-RSAT



wdc.dlr.de/sensors/gome2



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