

Koninklijk Nederlands  
Meteorologisch Instituut  
*Ministerie van Infrastructuur en Milieu*

# One Year of Sentinel-5P TROPOMI Nitrogen Dioxide observations

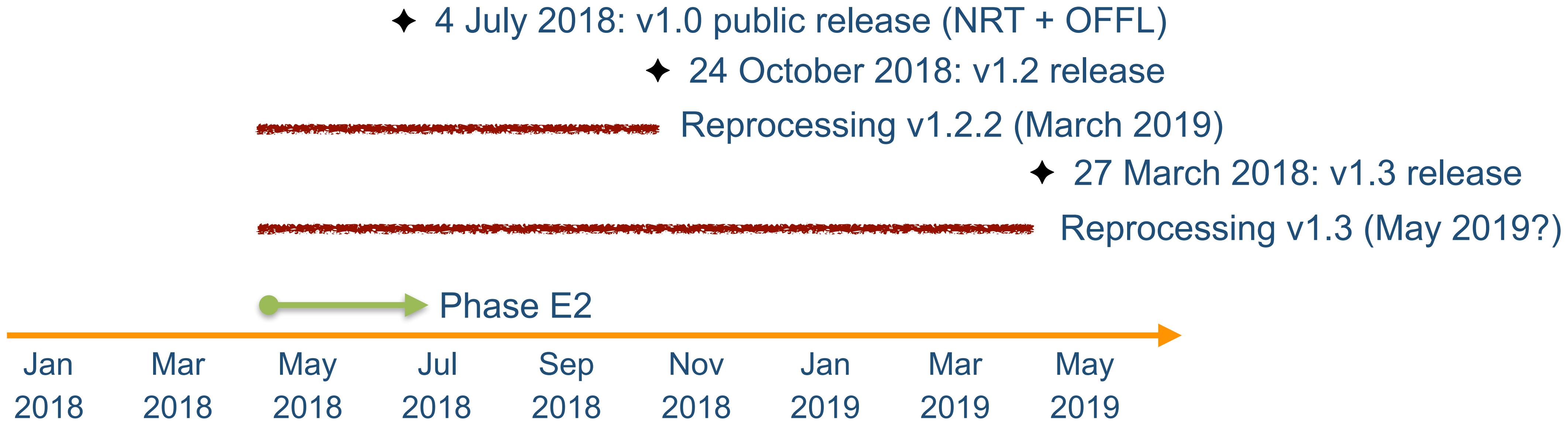
**Henk Eskes (KNMI)**

Jos van Geffen, Folkert Boersma,  
Maarten Sneep, Mark ter Linden,  
Kai-Uwe Eichman,  
Robert van Versendaal, John Douros,  
Pepijn Veefkind (TROPOMI NO<sub>2</sub> L2)

Colleagues from: ESA, DLR, BIRA, SRON,  
UBremen, MPI

EGU 2019  
8 April 2019

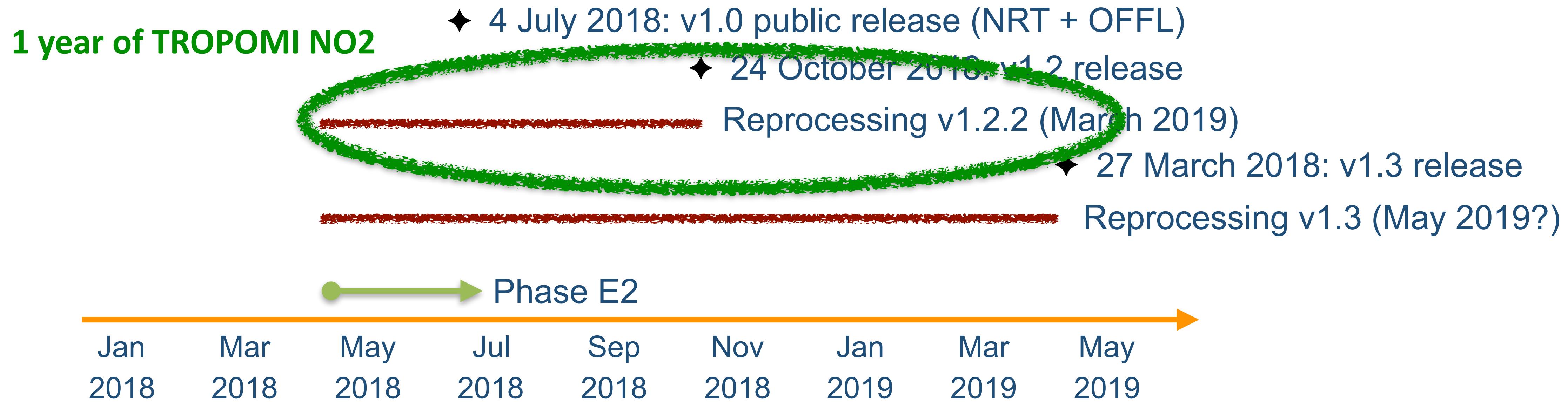
# NO2: upgrades and reprocessing



Each of these releases accompanied with documentation updates:

- **ReadMe (PRF)**
- **Product User Manual (PUM)**
- **Algorithm description (ATBD)**

# NO<sub>2</sub>: upgrades and reprocessing



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# S5P MPC: Mission Performance Center





Home Search VDAF

# VALIDATION FACILITY

## SENTINEL 5P MISSION PERFORMANCE CENTER

Ozone O<sub>3</sub> profile Nitrogen dioxide Sulfur Dioxide Formaldehyde Surface UV-B Aerosols Carbon Monoxide Methane Cloud

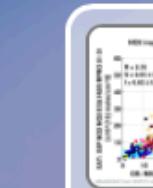
Most recent contributions



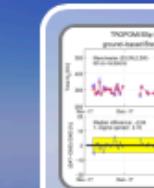
First comparison results for the S5P CH<sub>4</sub> product based on correlative reference measurements acquired by FTIR instruments contributing to NDACC and TCCON networks. This VDAF web article gives further details on the first comparison results presented in the CH<sub>4</sub> product readme file for the methane data product release (see <http://www.tropomi.eu/data-products/methane>). The main conclusion is that the product quality of this initial L2 CH<sub>4</sub> dataset complies with the S5P mission requirements.



Quarterly Validation Report of the Sentinel-5 Precursor Operational Data Products #01: July – October 2018  
This document reports consolidated results of the routine operations validation service for the Sentinel-5 Precursor Tropospheric Monitoring



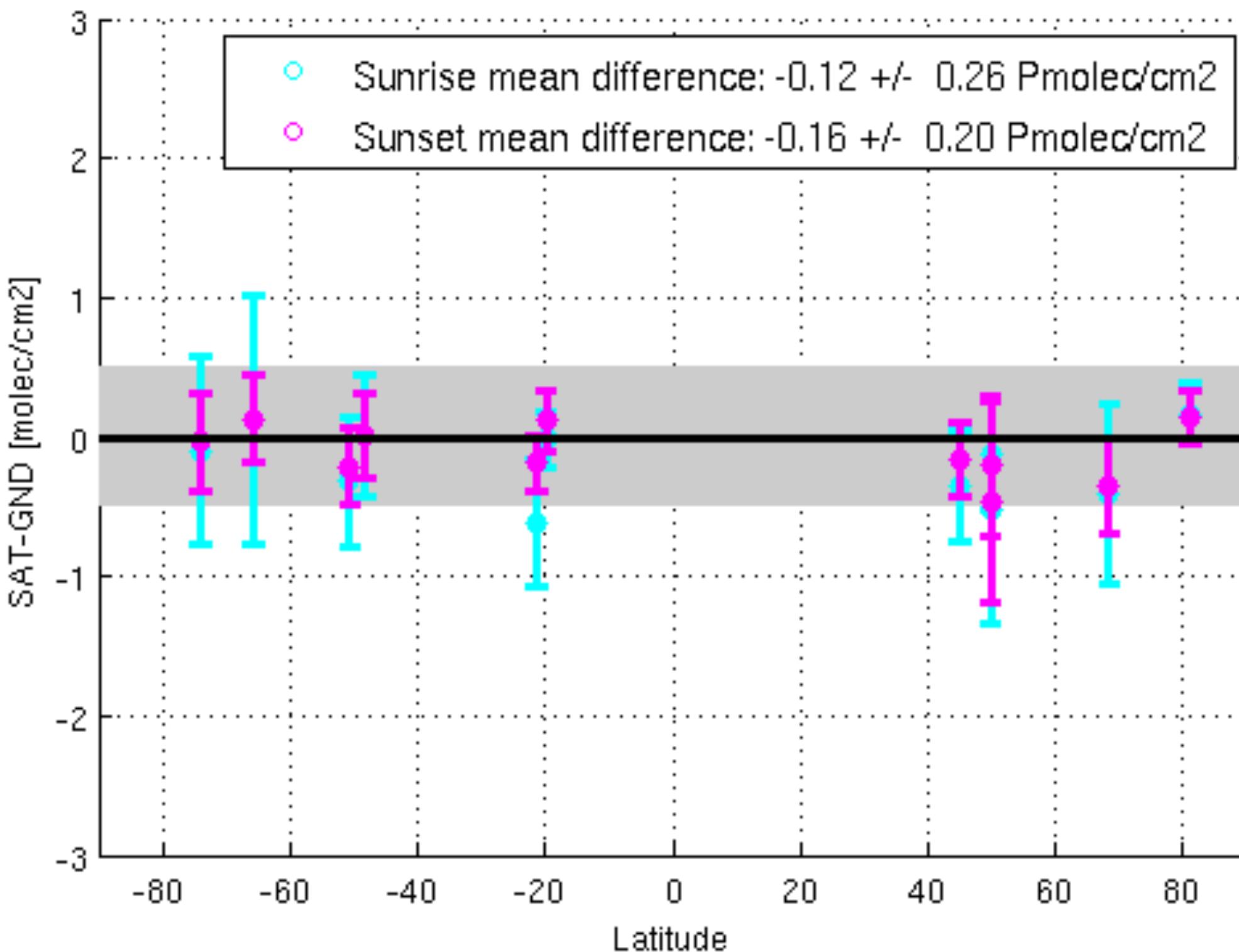
First validation results for Sentinel-5p NO<sub>2</sub> column data. This report describes initial validation results for Sentinel-5p TROPOMI L2\_NO<sub>2</sub> tropospheric column, stratospheric column and total column data: tropospheric and



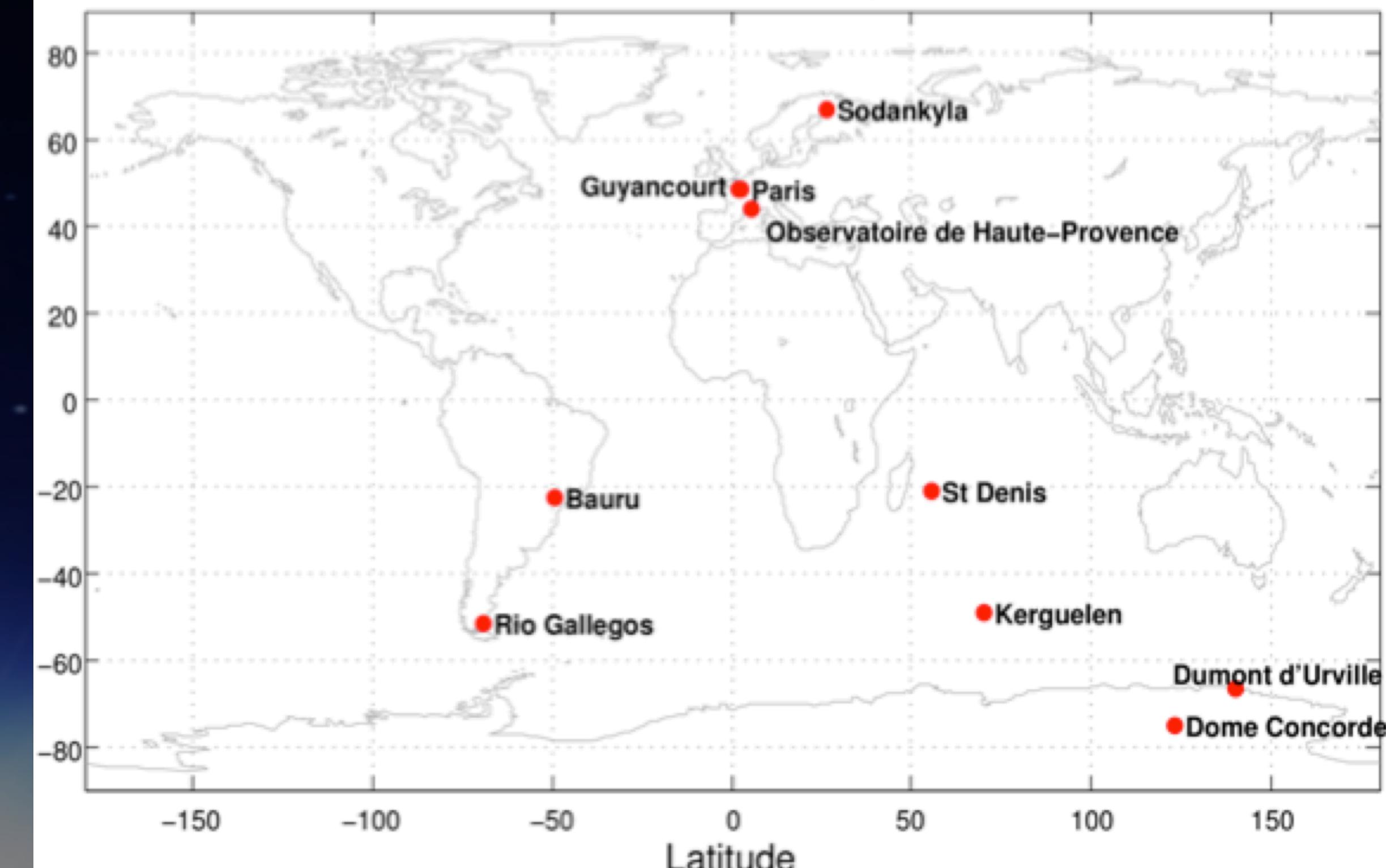
A first validation against NDACC and WOUDC ground-based data confirms that the TROPOMI/S5p NRTI total O<sub>3</sub> (L2\_O<sub>3</sub>) product meets mission requirements. Initial Sentinel-5p TROPOMI L2\_O<sub>3</sub> O<sub>3</sub> column data retrieved with the PDGS NRTI processor (v1.0.0) have been

# S5P MPC: TROPOMI vs SAOZ

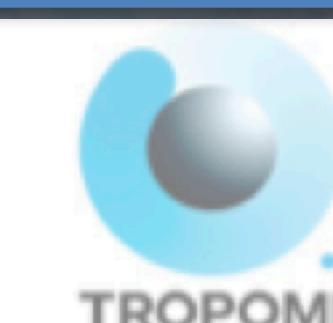
S5p stratospheric NO<sub>2</sub> (OFFL Phase E2 up to 1 April 2019) vs.  
NDACC SAOZ (LATMOS\_RT) measurements



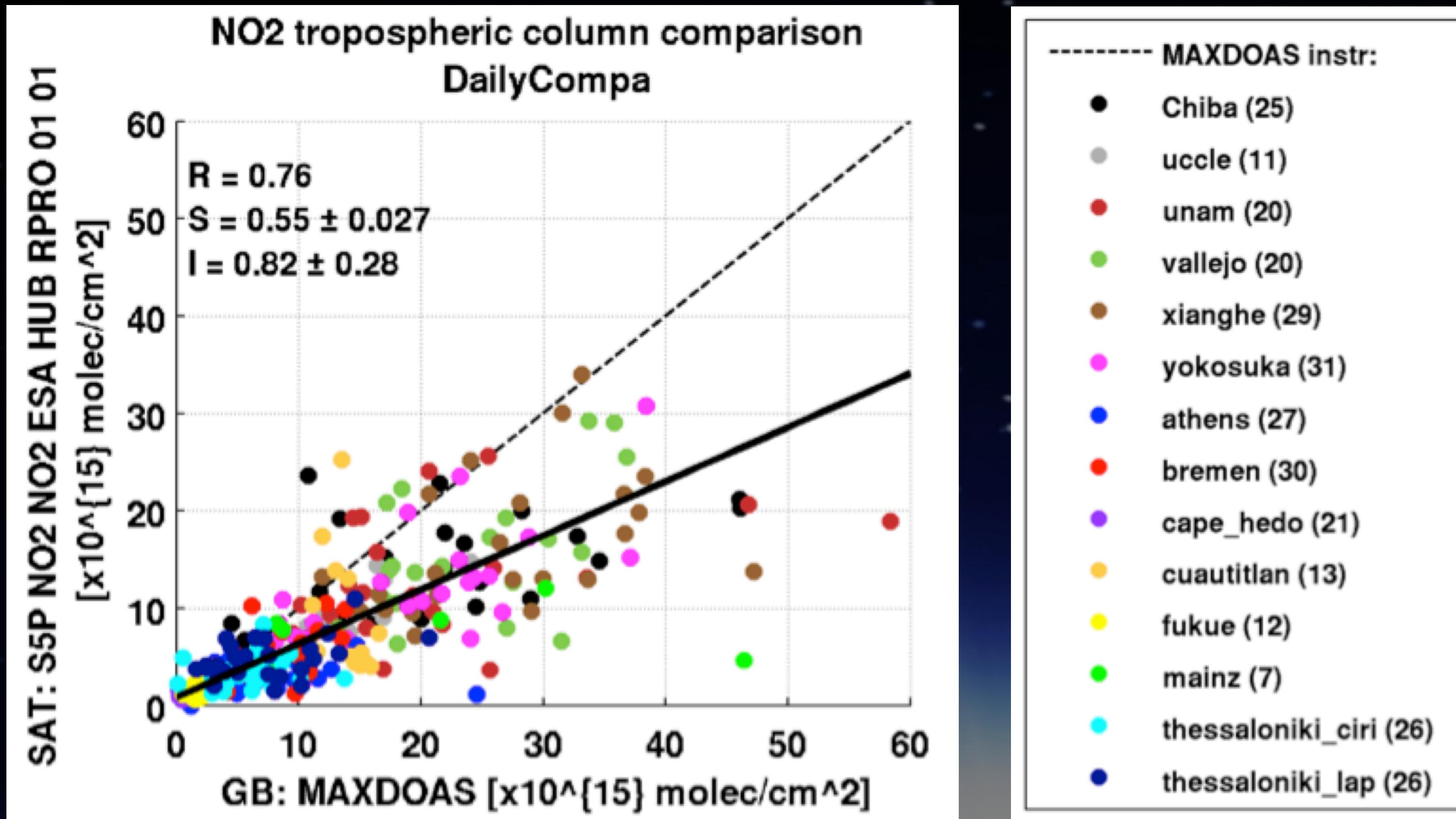
NDACC SAOZ stations with S5p co-locations



Steven Compernolle, Tijl Verhoelst, Gaia Pinardi, José Granville, Jean-Christopher Lambert (BIRA-IASB), Kai-Uwe Eichmann (IUP-B)



# S5P MPC: TROPOMI vs MAXDOAS



TROPOMI 30% lower than MAXDOAS

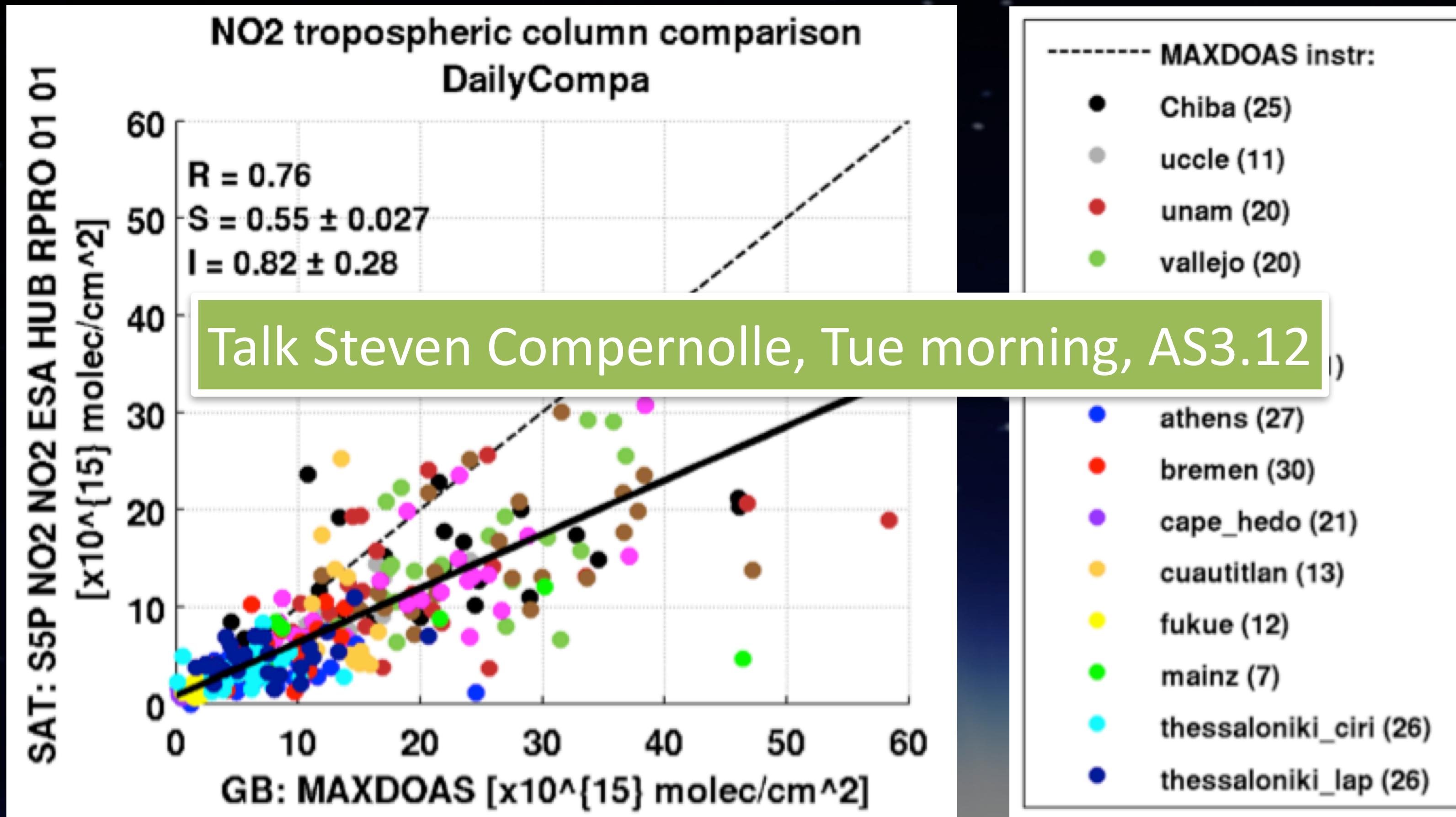
## Bridging the gap ?

- Profile shape
- Clouds
- Local situation
- Kernel difference

Steven Compernolle, Tijl Verhoelst, Gaia Pinardi, José Granville, Jean-Christopher Lambert (BIRA-IASB), Kai-Uwe Eichmann (IUP-B)



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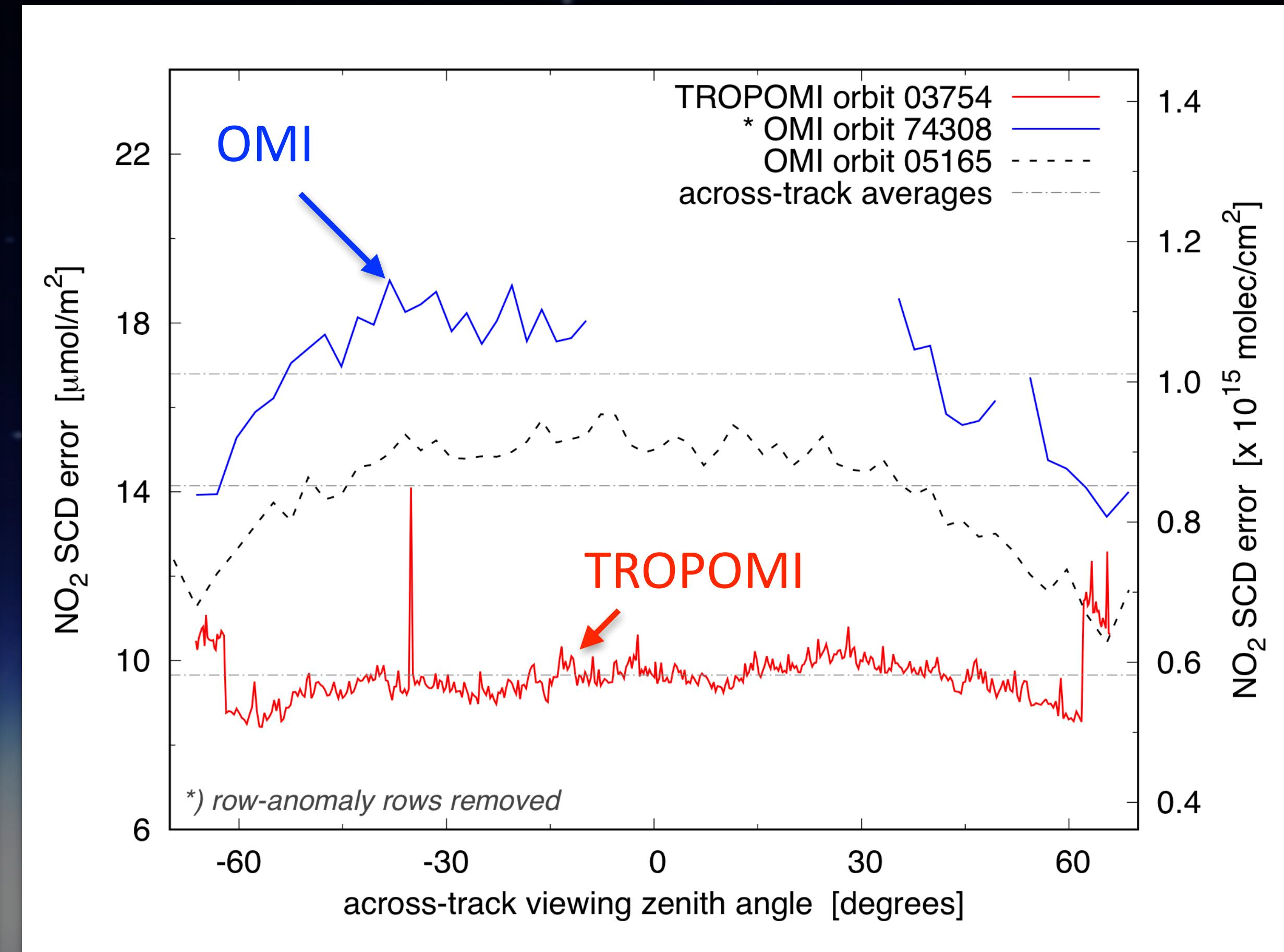
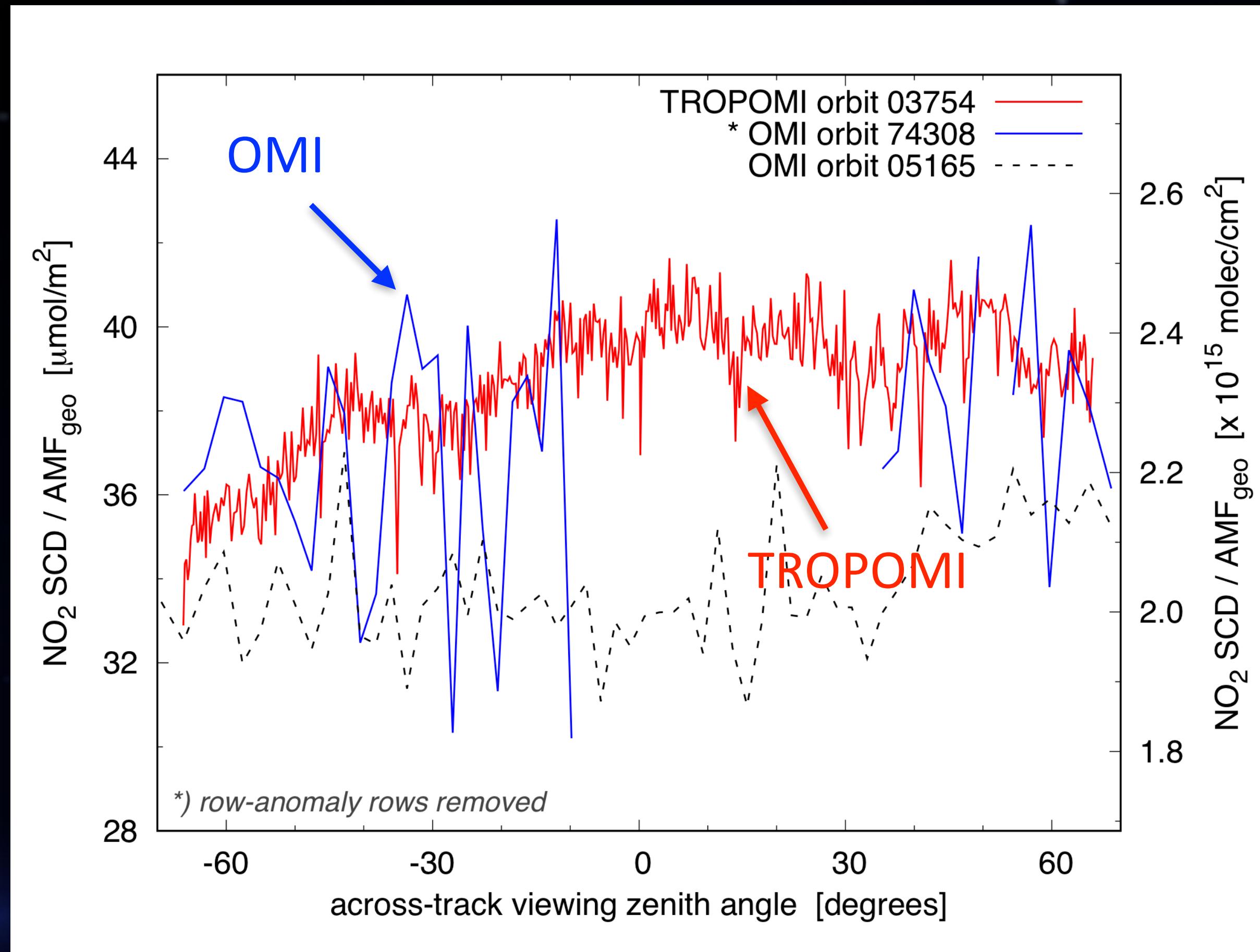
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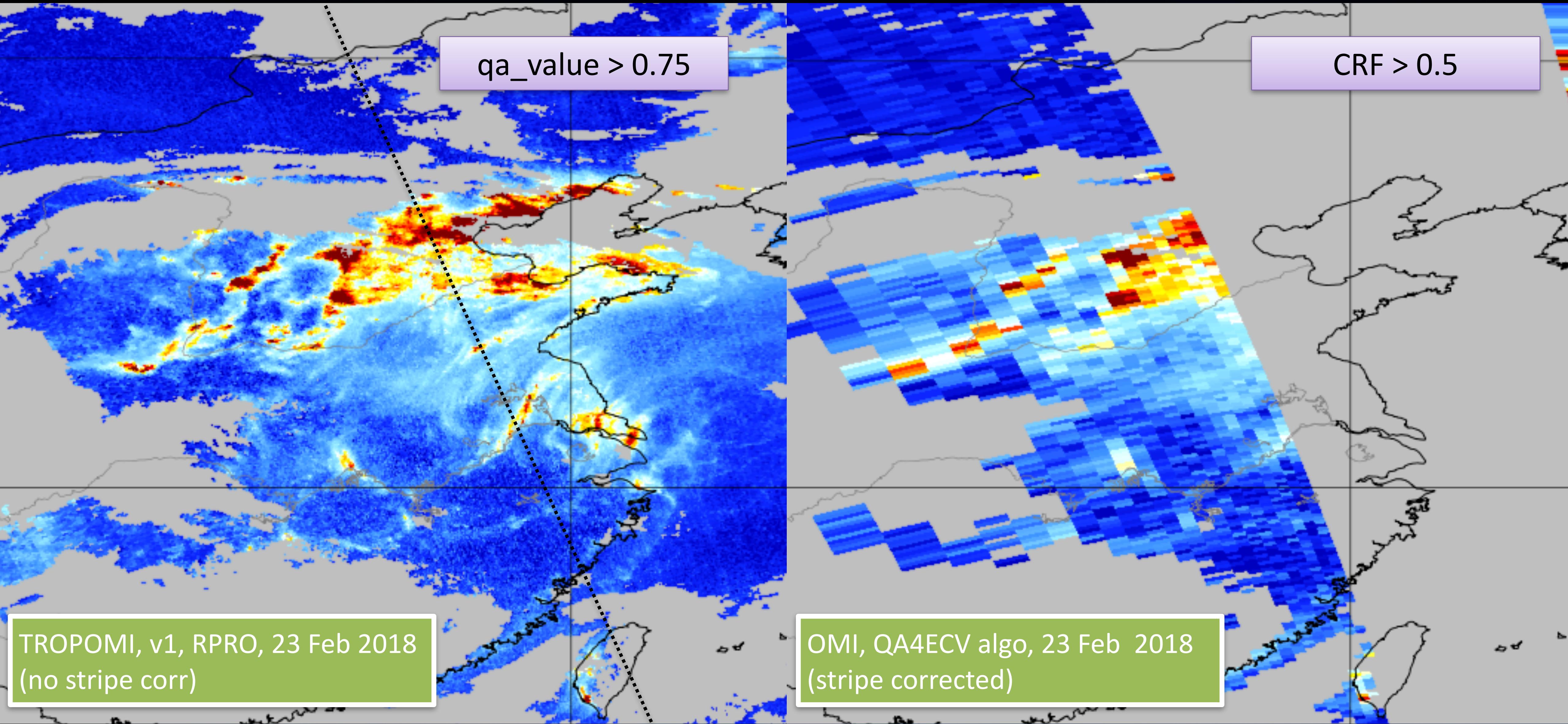


# DOAS slant column fits: S5P vs OMI



TROPOMI 10x more (smaller) pixels than OMI  
But each pixel 1.5-2 times lower error bar

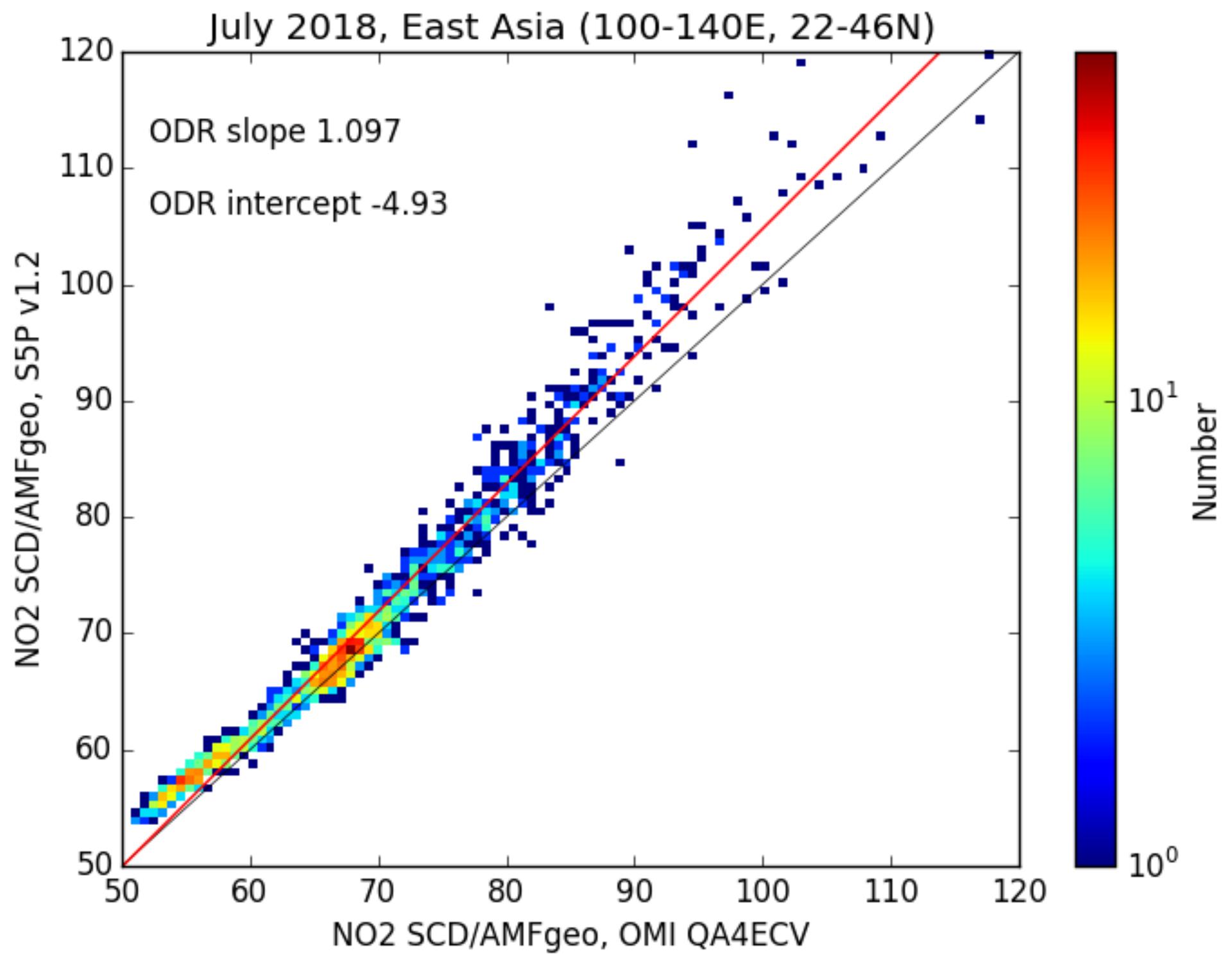
# TROPOMI comparison with OMI - China



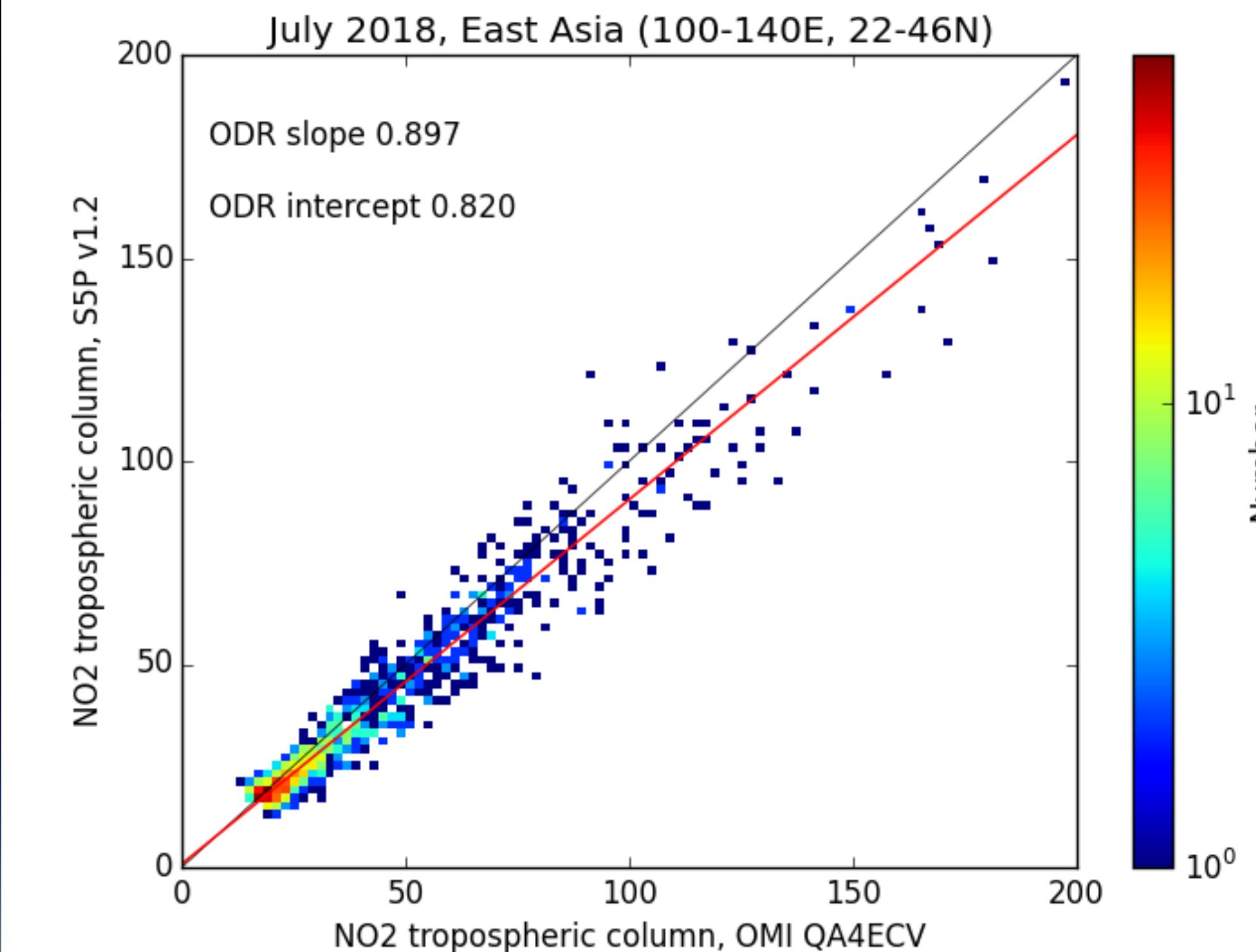
# Comparison with OMI



SCD / AMFgeo



Tropospheric column

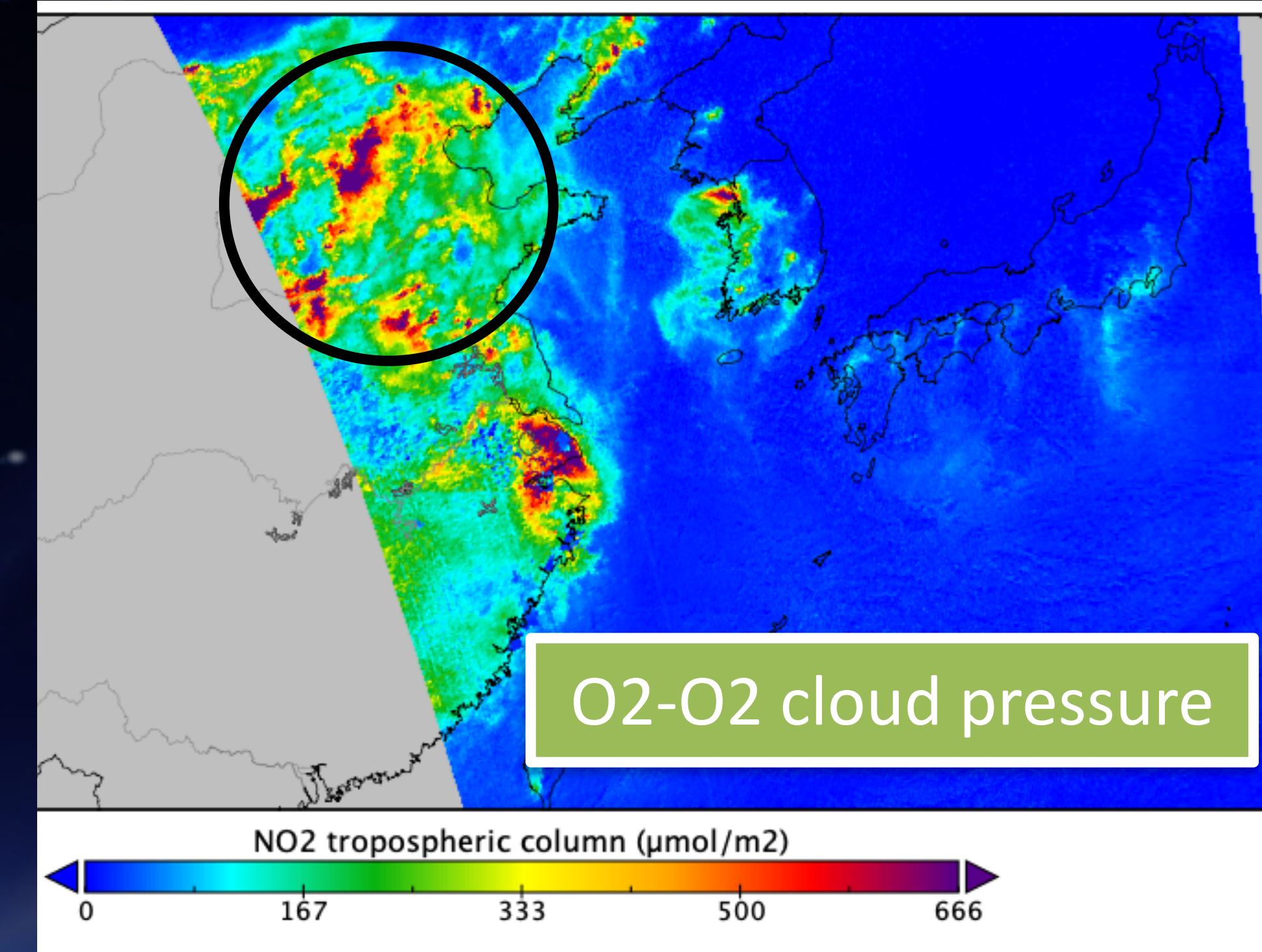
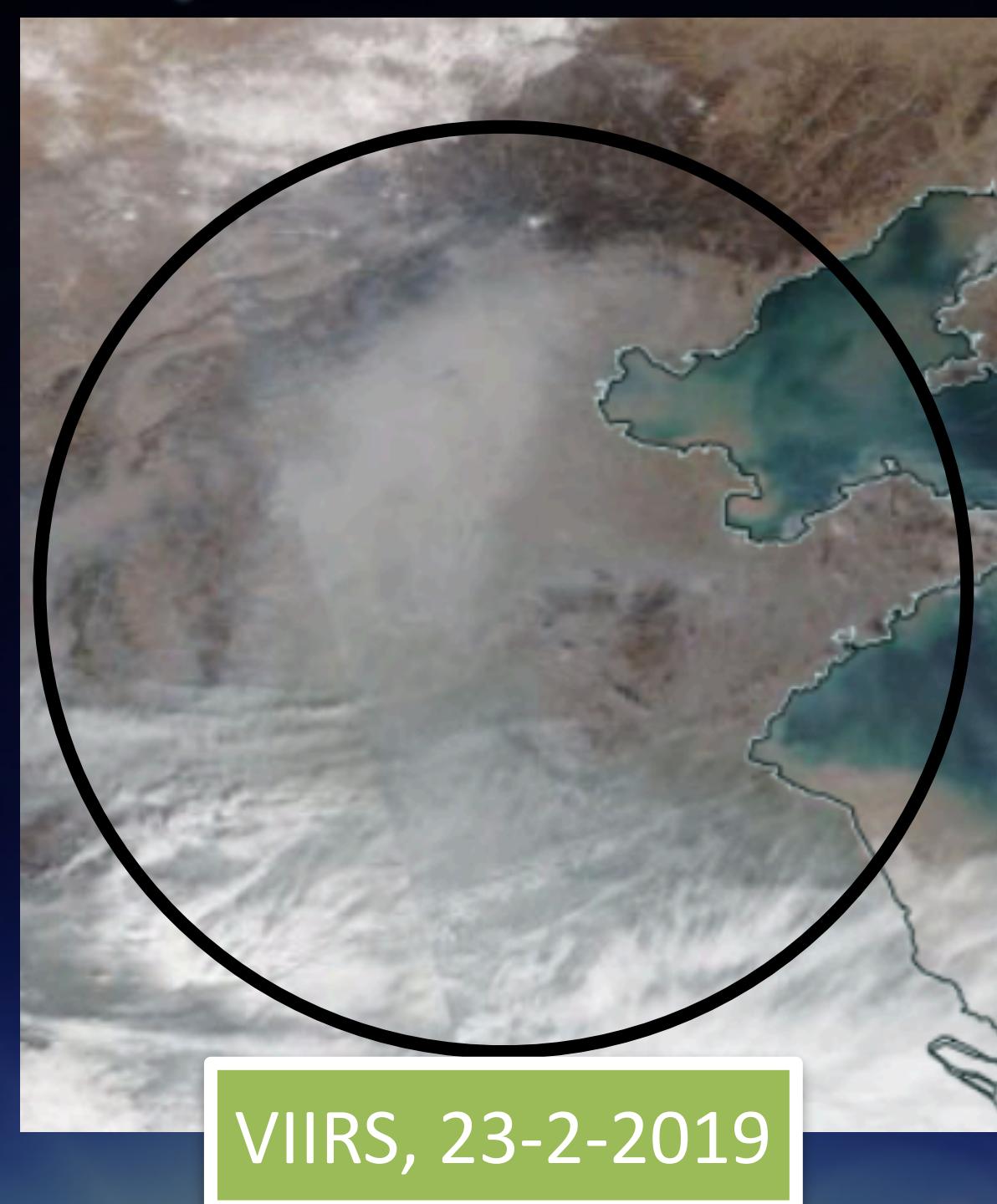
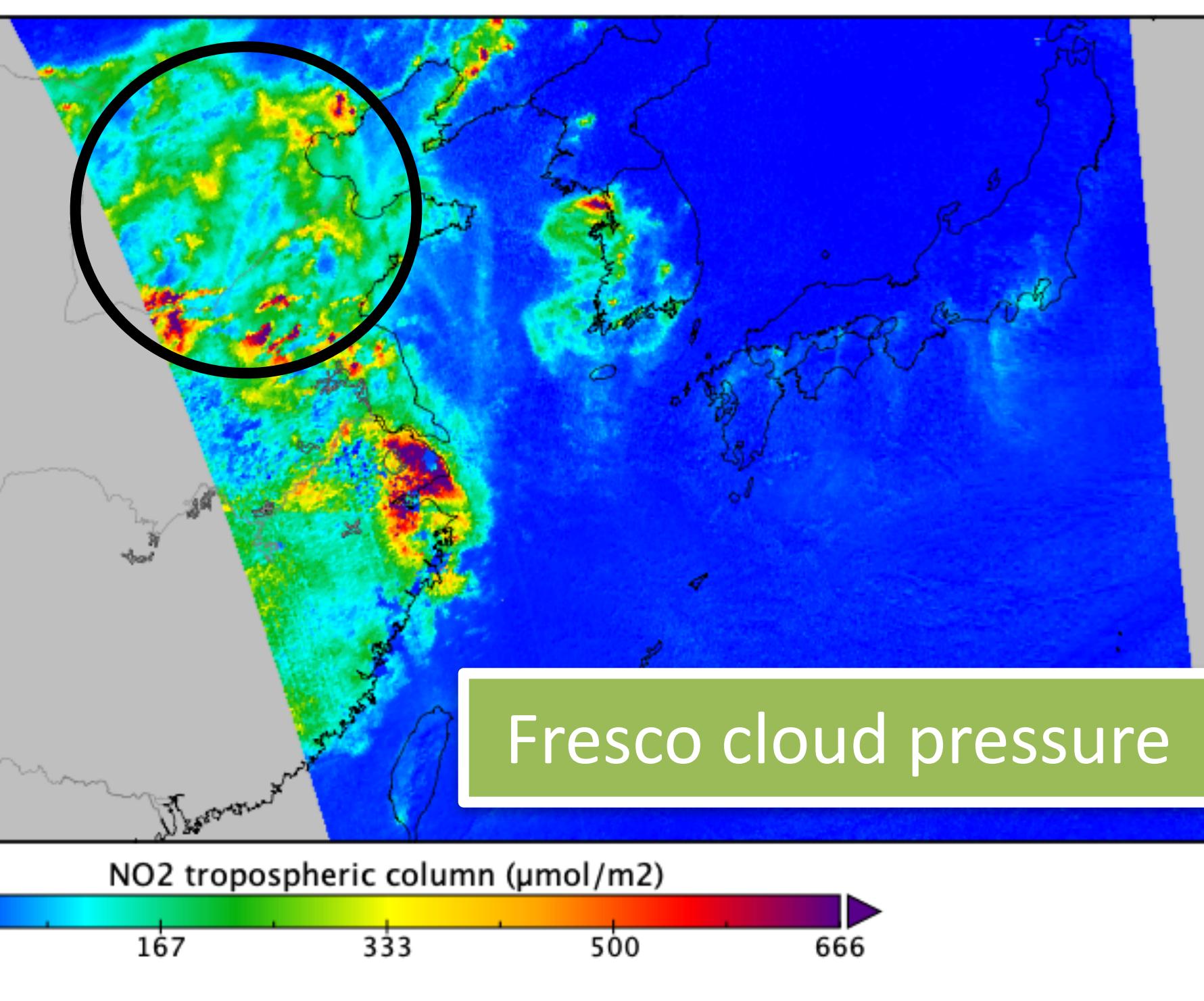


Differences in AMF ?

- Cloud product is different: Fresco (compare with O2-O2)



# Dependence on cloud retrievals: Fresco vs O2-O2



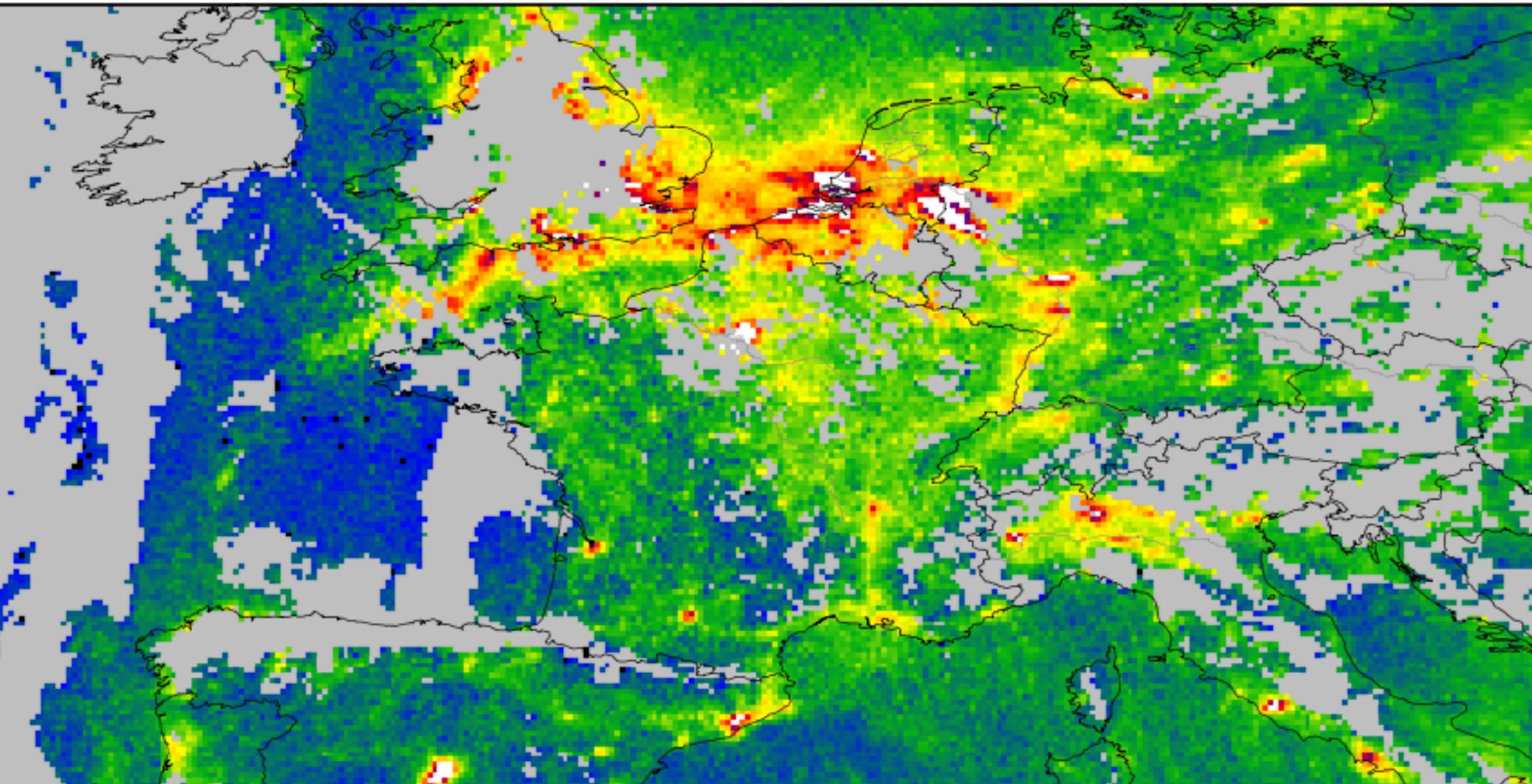
Retrieval sensitive to cloud height over  
area's with thick aerosol pollution



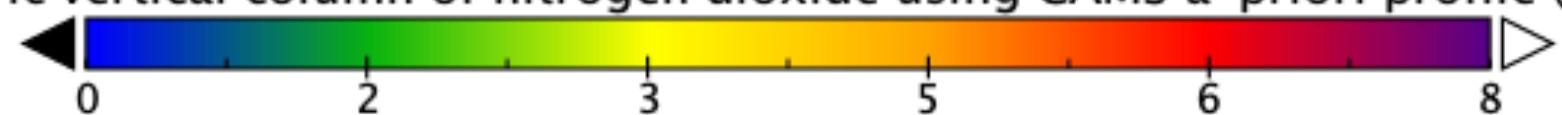
# Using a-priori profiles from CAMS-regional



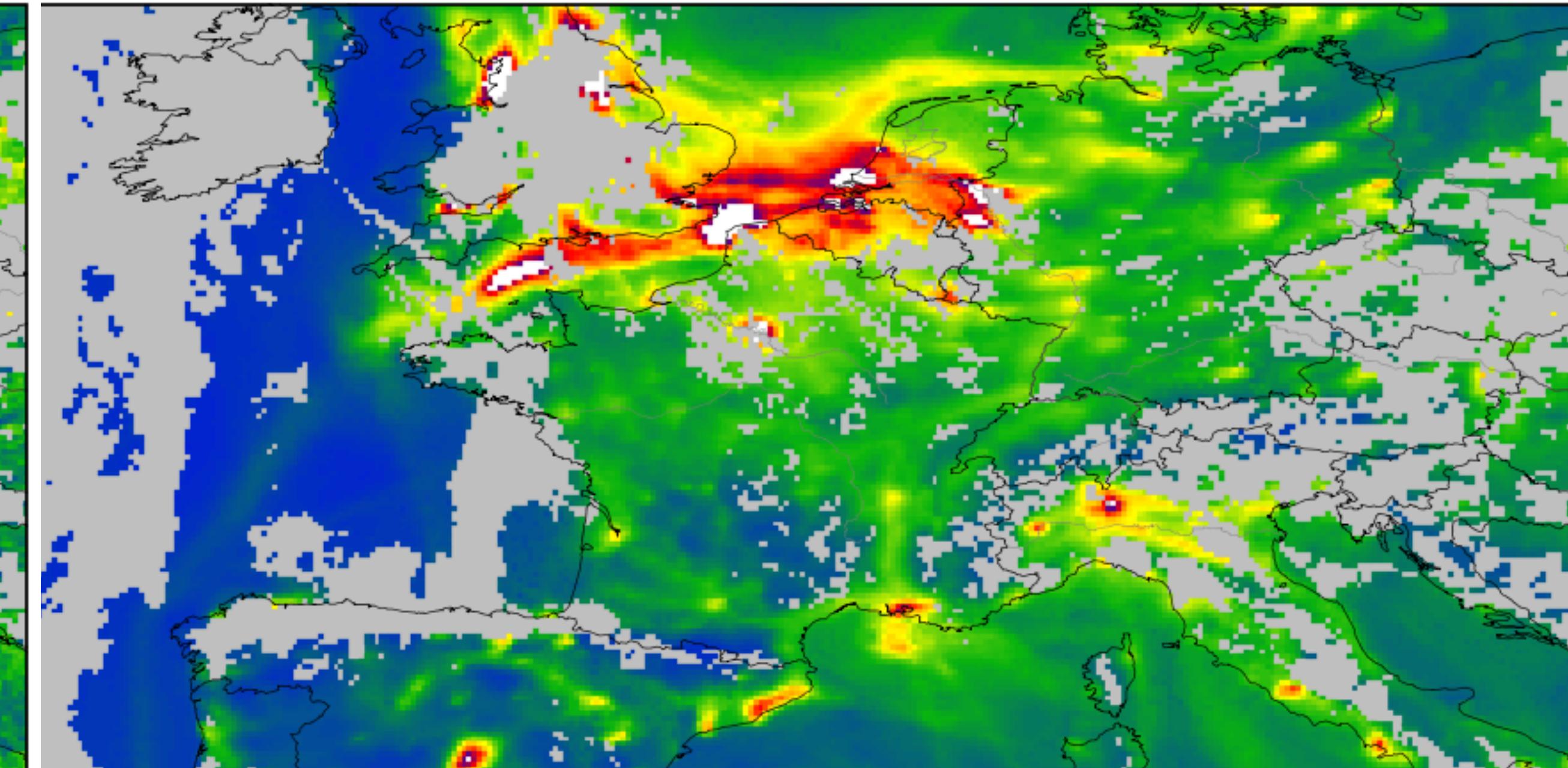
TROPOMI NO<sub>2</sub> based on CAMS-regional a-priori



TROPOMI tropospheric vertical column of nitrogen dioxide using CAMS a-priori profile ( $10^{15}$  molecules/cm<sup>2</sup>)

A horizontal color bar with a gradient from blue to red, with numerical labels 0, 2, 3, 5, 6, and 8. It includes a double-headed arrow at the ends and a small triangle symbol at the right end.

CAMS-regional vertical column NO<sub>2</sub>



NO<sub>2</sub> tropospheric column ( $1e15$  molecules/cm<sup>2</sup>)

A horizontal color bar with a gradient from blue to red, with numerical labels 0, 2, 3, 5, 6, and 8. It includes a double-headed arrow at the ends and a small triangle symbol at the right end.

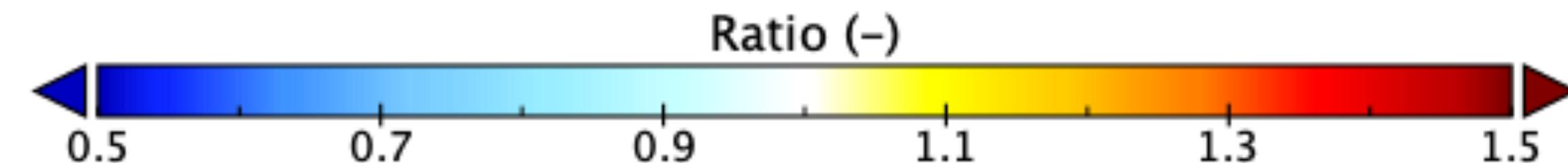
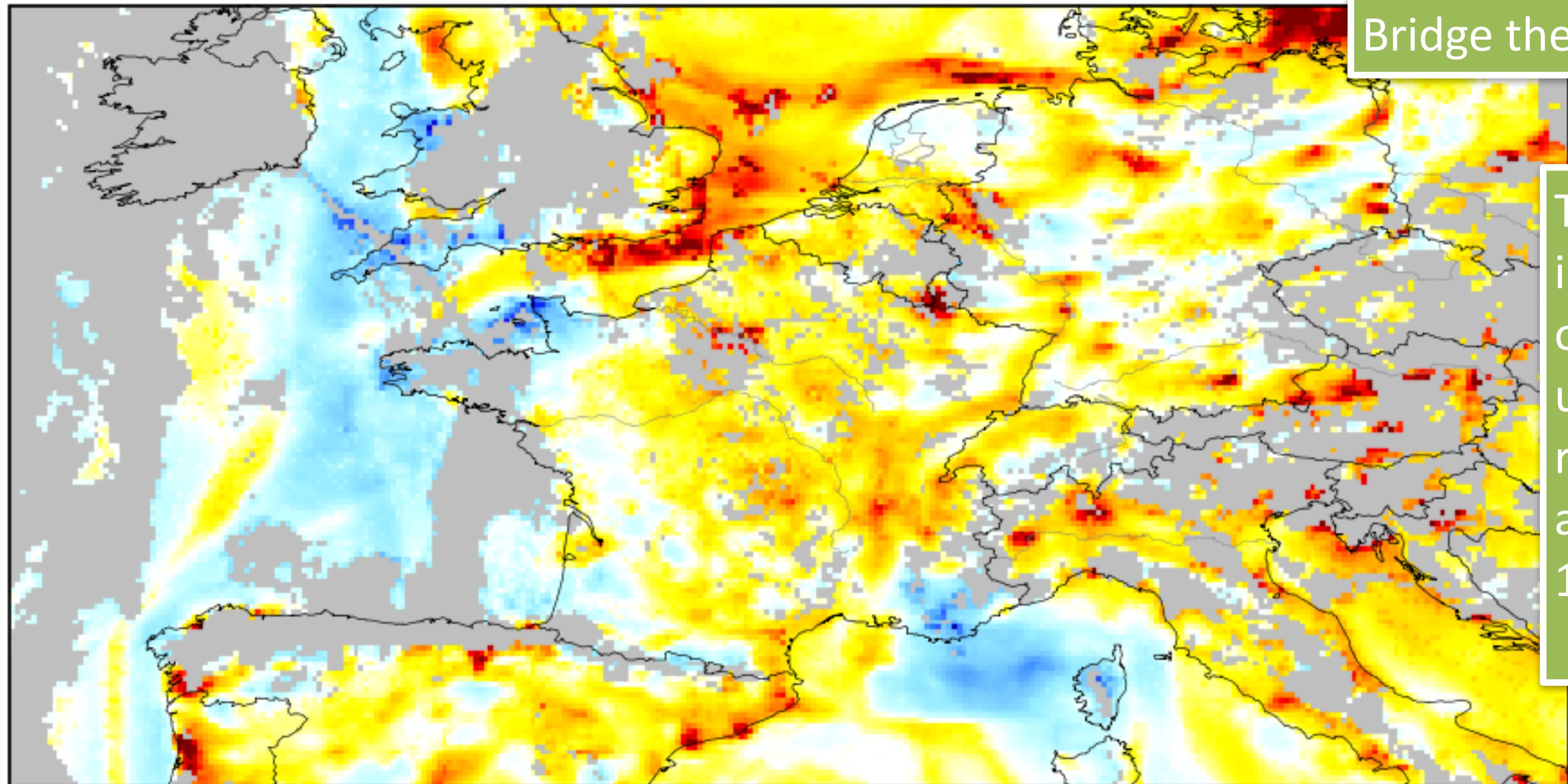
Single overpass, 26 July 2018

See the S5P NO<sub>2</sub>  
Product User Manual

# Using a-priori profiles from CAMS-regional



Ratio NO<sub>2</sub> tropospheric column CAMS a-priori / TM5MP a-priori



Bridge the gap with MAXDOAS

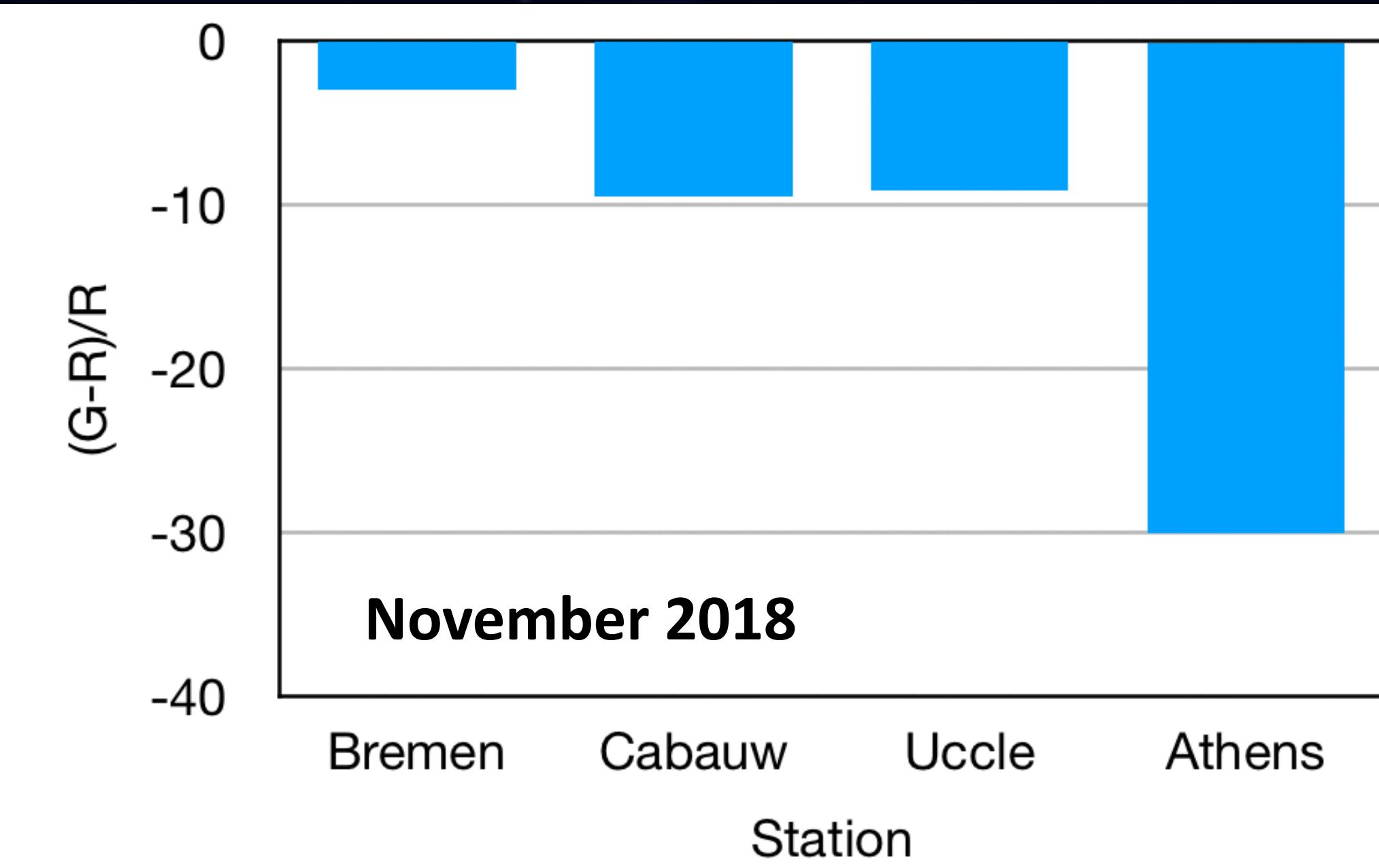
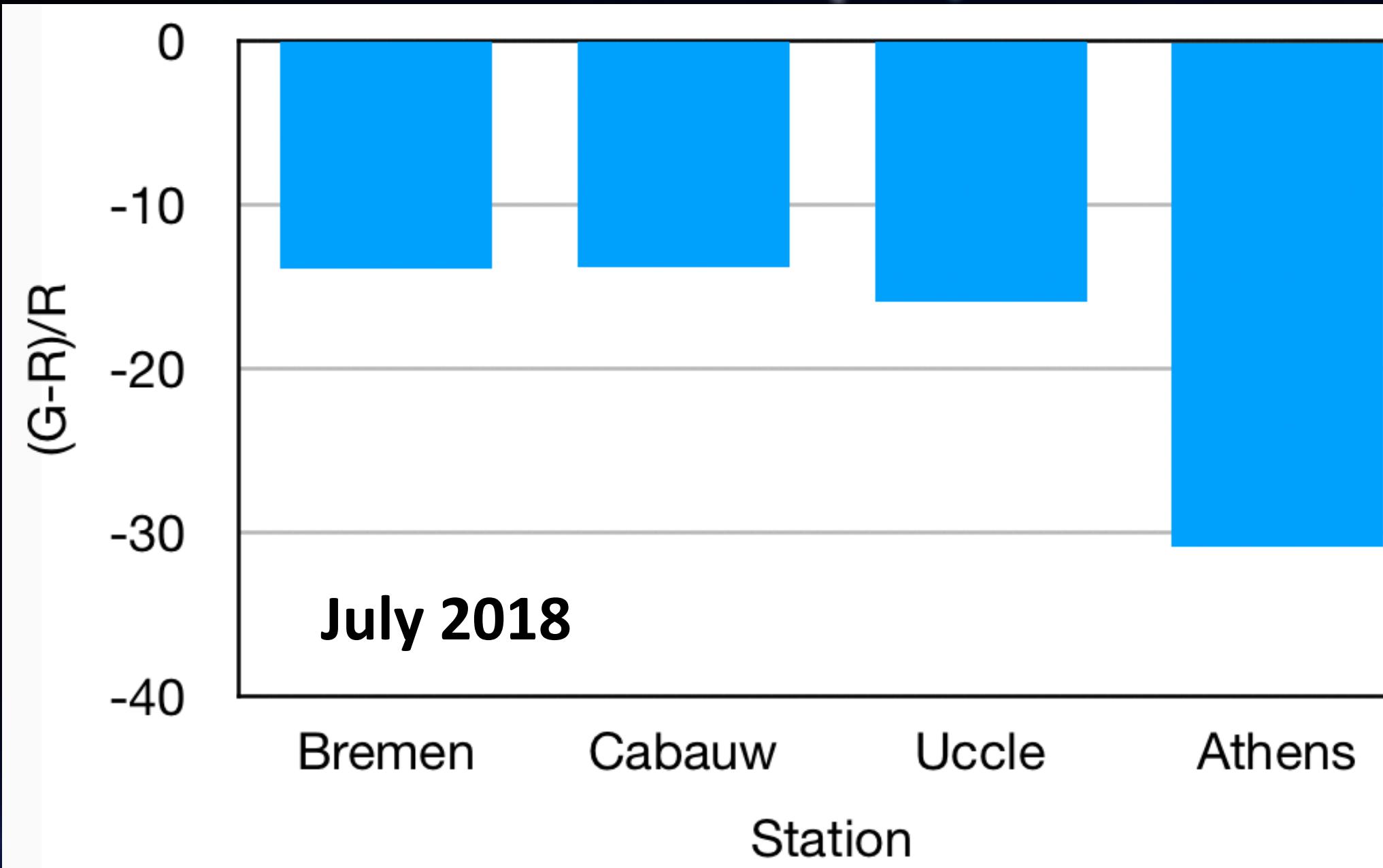
Tropospheric column increases by 10-50% over hotspots when using high-resolution regional model a-priori profiles  
1x1 degree -> 0.1x0.1 degree

# Using a-priori profiles from CAMS-regional



Ratio of retrievals @ MAX-DOAS stations, performed with:

- TM5-MP at a resolution of about 100x100 km
- CAMS-regional (European domain), resolution 10x10 km



# TROPOMI NO<sub>2</sub> summary



- A game changer in resolution and signal-to-noise !
- Version 1.3.0 NRT/OFFL released 27 March 2019  
Reprocessing 30 April-October 2018 (v1.2) available soon  
Together with v1.2 OFFL this is about 1 year of NO<sub>2</sub> data
- SNR / slant columns / stratosphere / assimilation OK  
Troposphere: MAX-DOAS indicates low bias of about 30%  
-> Resolution of the a-priori main source of uncertainty:  
**need for high-resolution regional AQ model profiles**  
-> Sensitivity to cloud pressure (ongoing research)

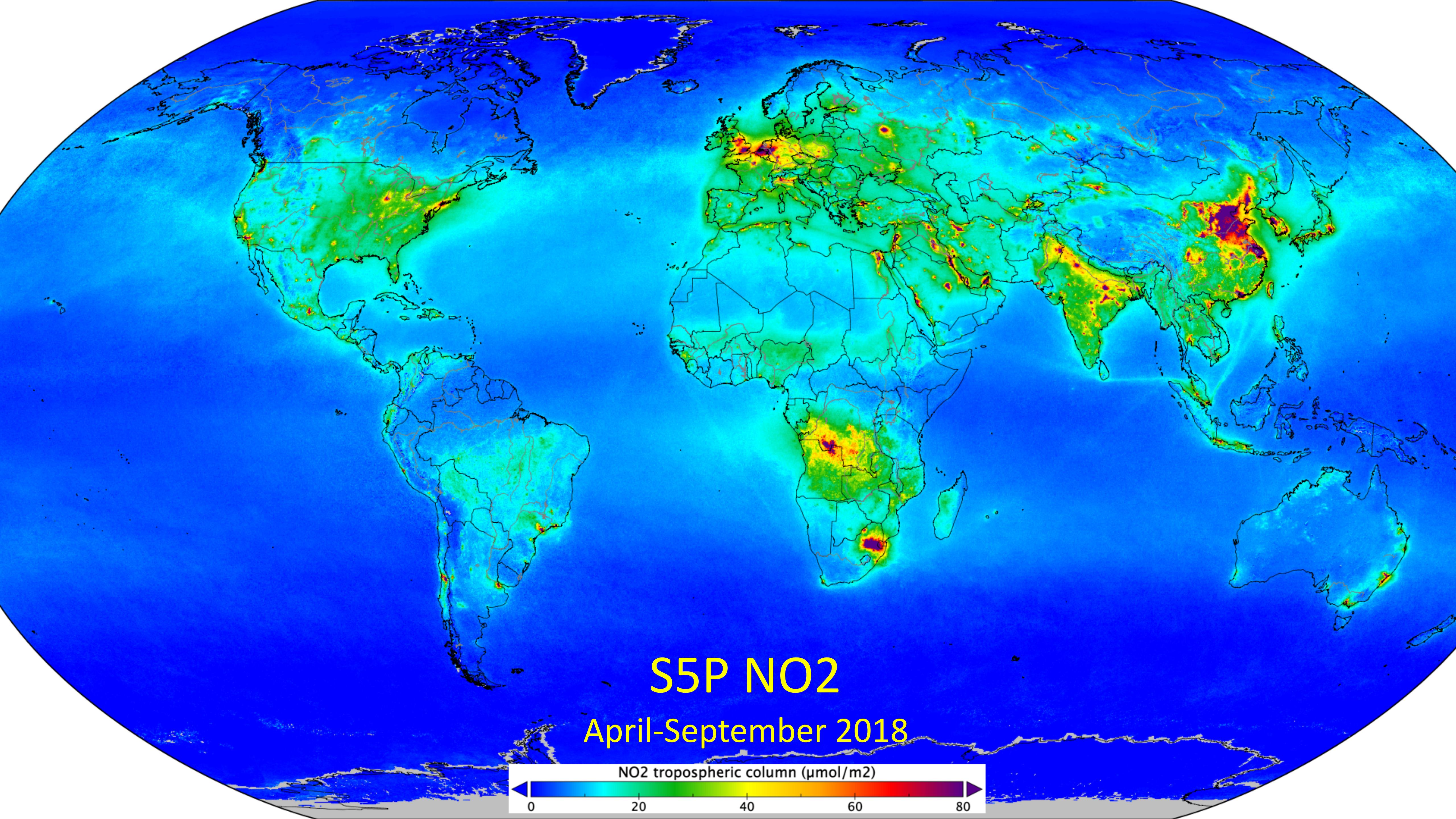
[www.tropomi.eu](http://www.tropomi.eu)

[www.temis.nl](http://www.temis.nl)

[sentinels.copernicus.eu](http://sentinels.copernicus.eu)

[#tropomi, @tropomi](#)





S5P NO<sub>2</sub>

April-September 2018

