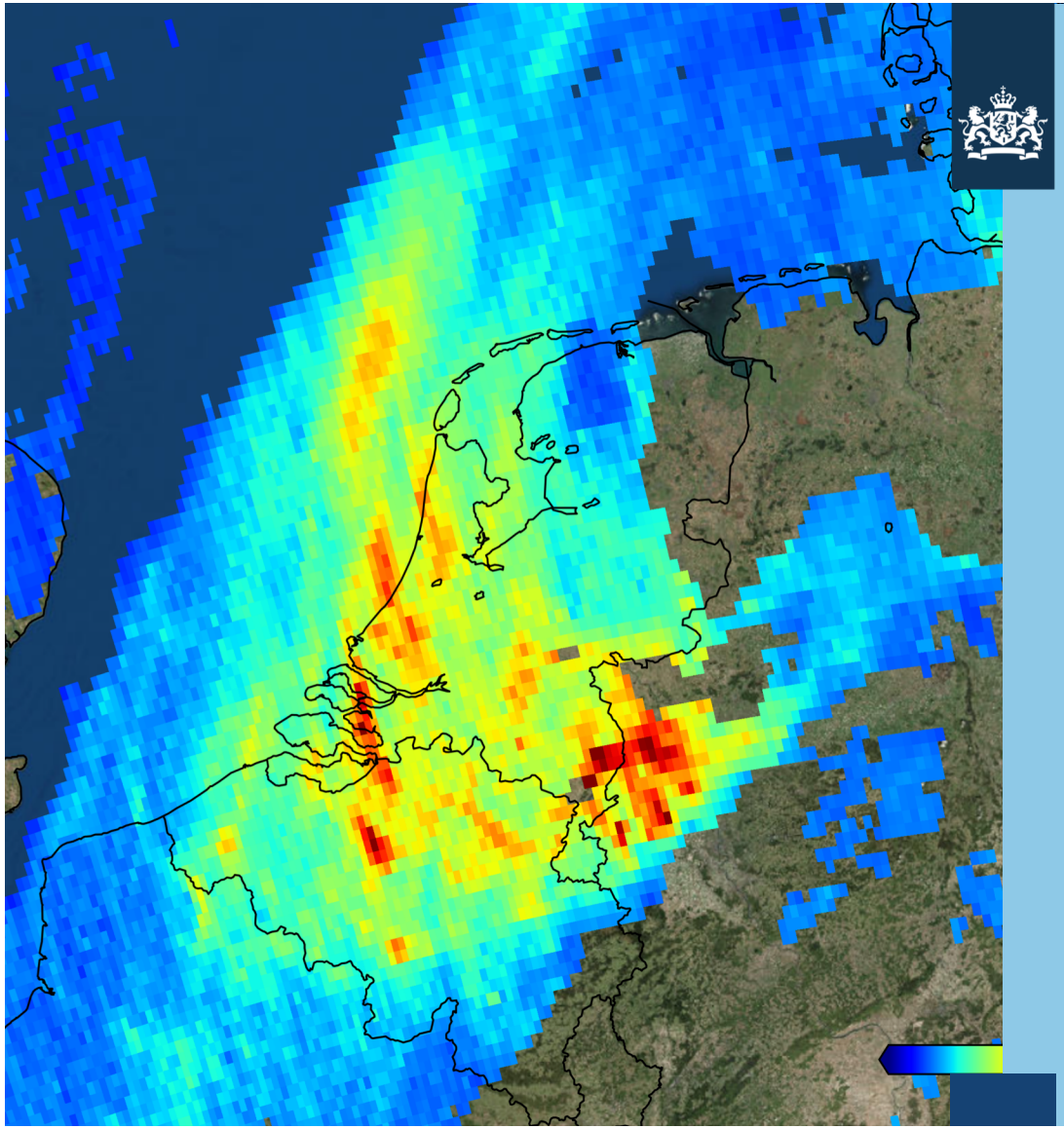


Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu

Sentinel-5P TROPOMI: first results for CO, NO2, HCHO

Henk Eskes & Pepijn Veefkind - KNMI

Jos van Geffen, Folkert Boersma, Maarten Sneep, Mark ter Linden (TROPOMI NO2 L2)

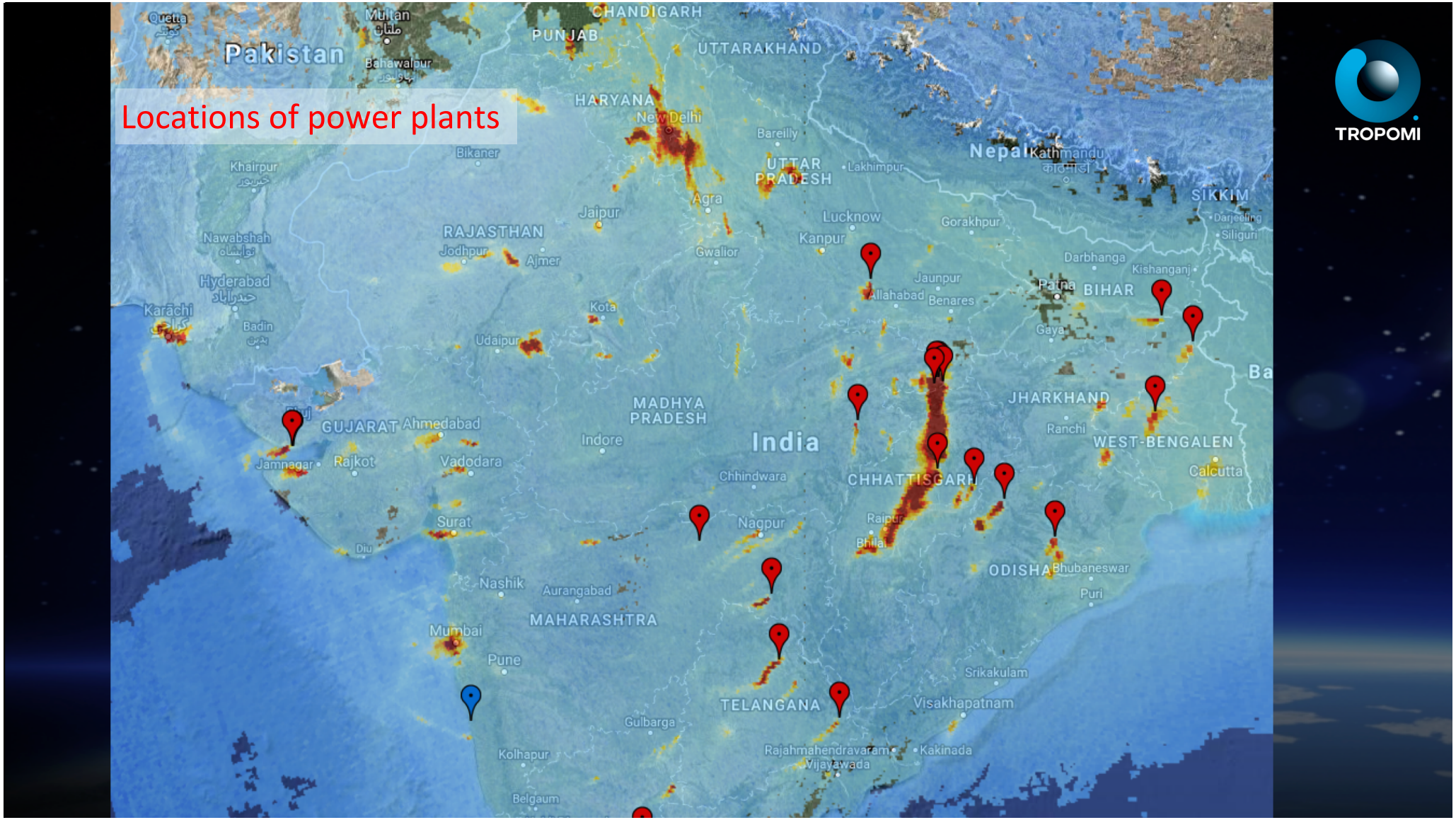
Tobias Borsdorff, Jochen Landgraf, Ilse Aben

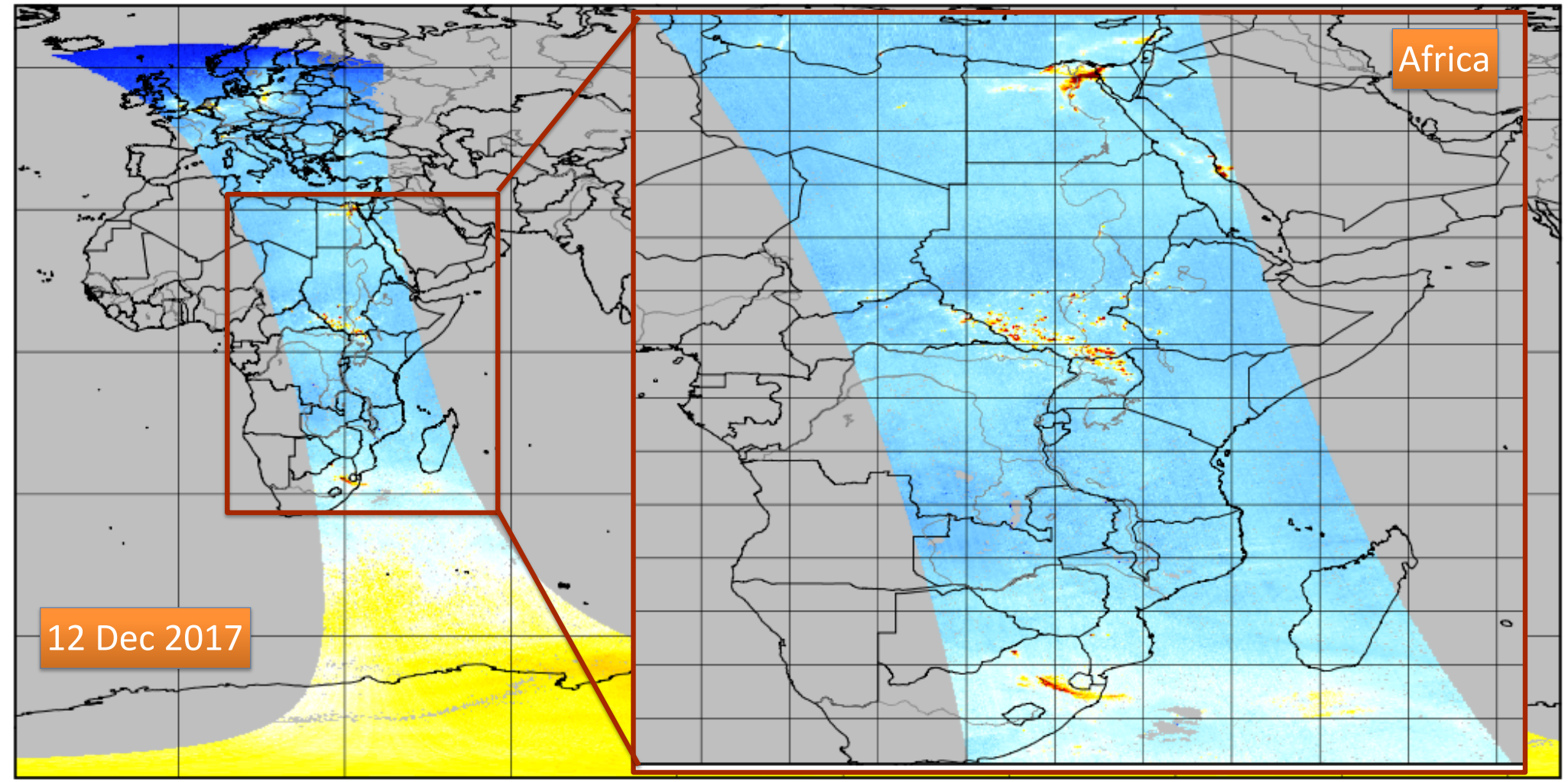
Isabelle De Smedt, Nicolas Theys, Huan Yu, Christophe Lerot, Jonas Vlietinck, Michel Van Roozendael,

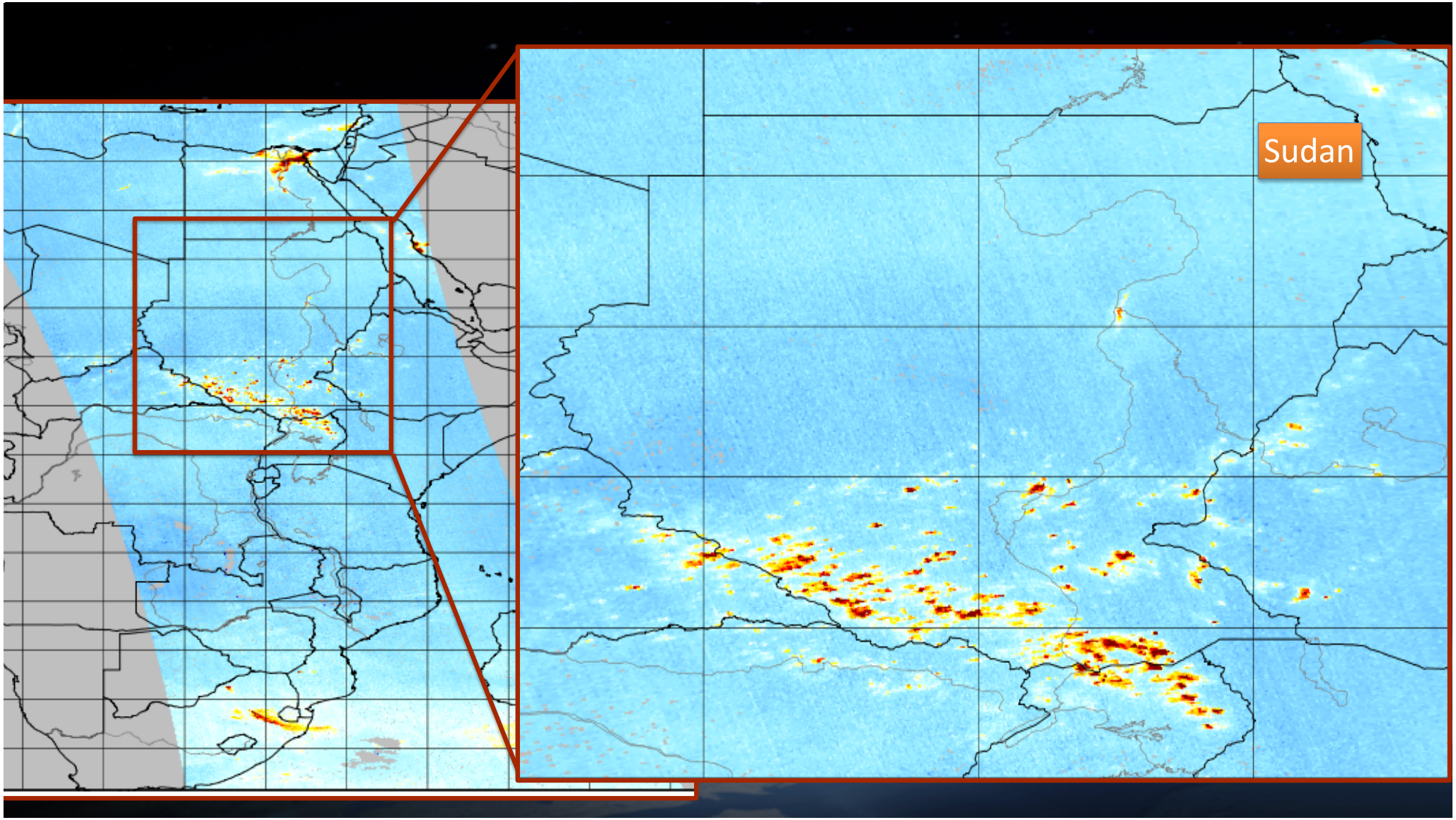
Colleagues from ESA, NSO, Airbus, TNO, DLR, TriopSys, S[&]T and NLR, SRON, BIRA, IUP-Bremen, MPIC, RAL, FMI …

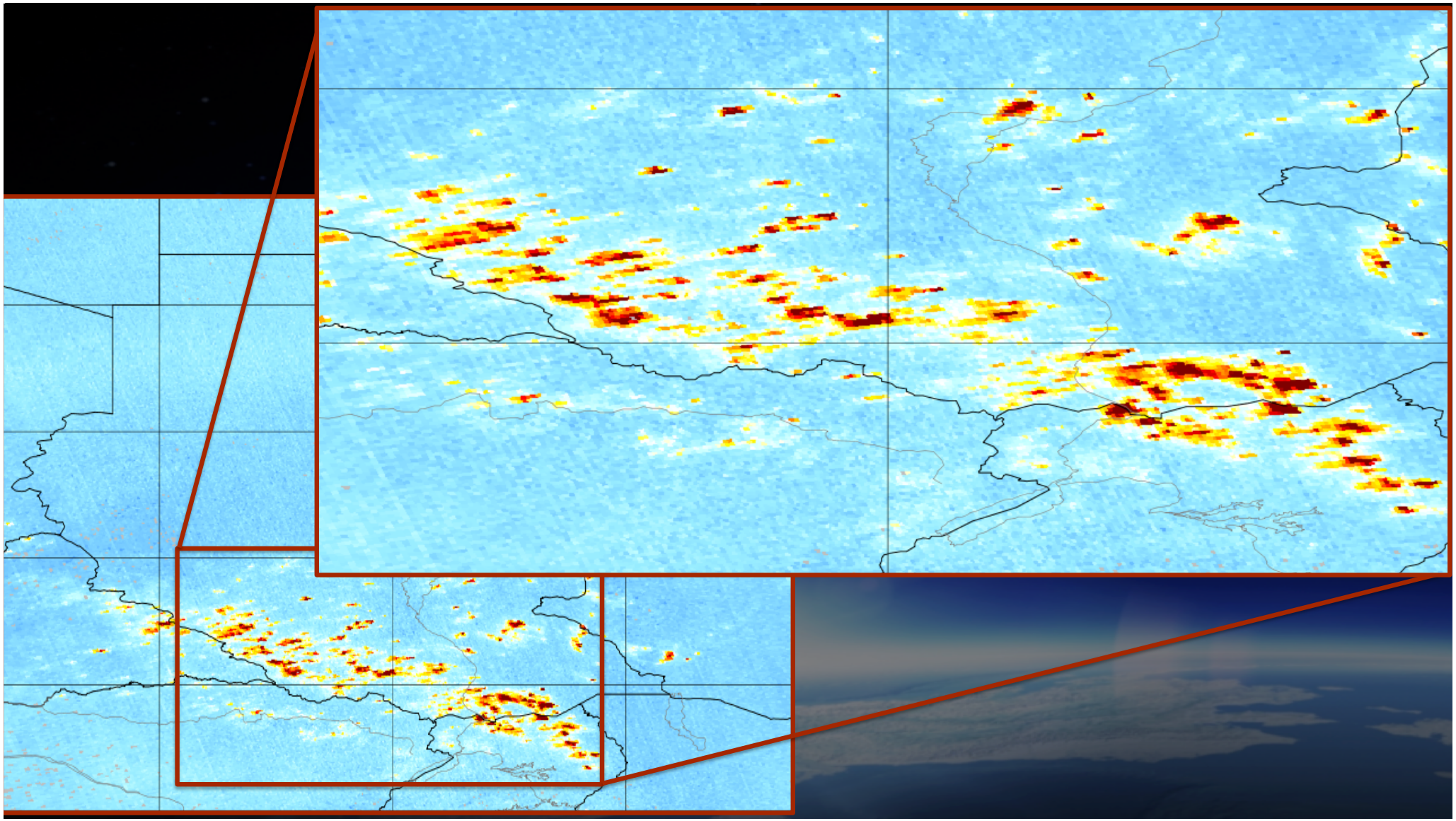
CEOS AC-VC, May 2018

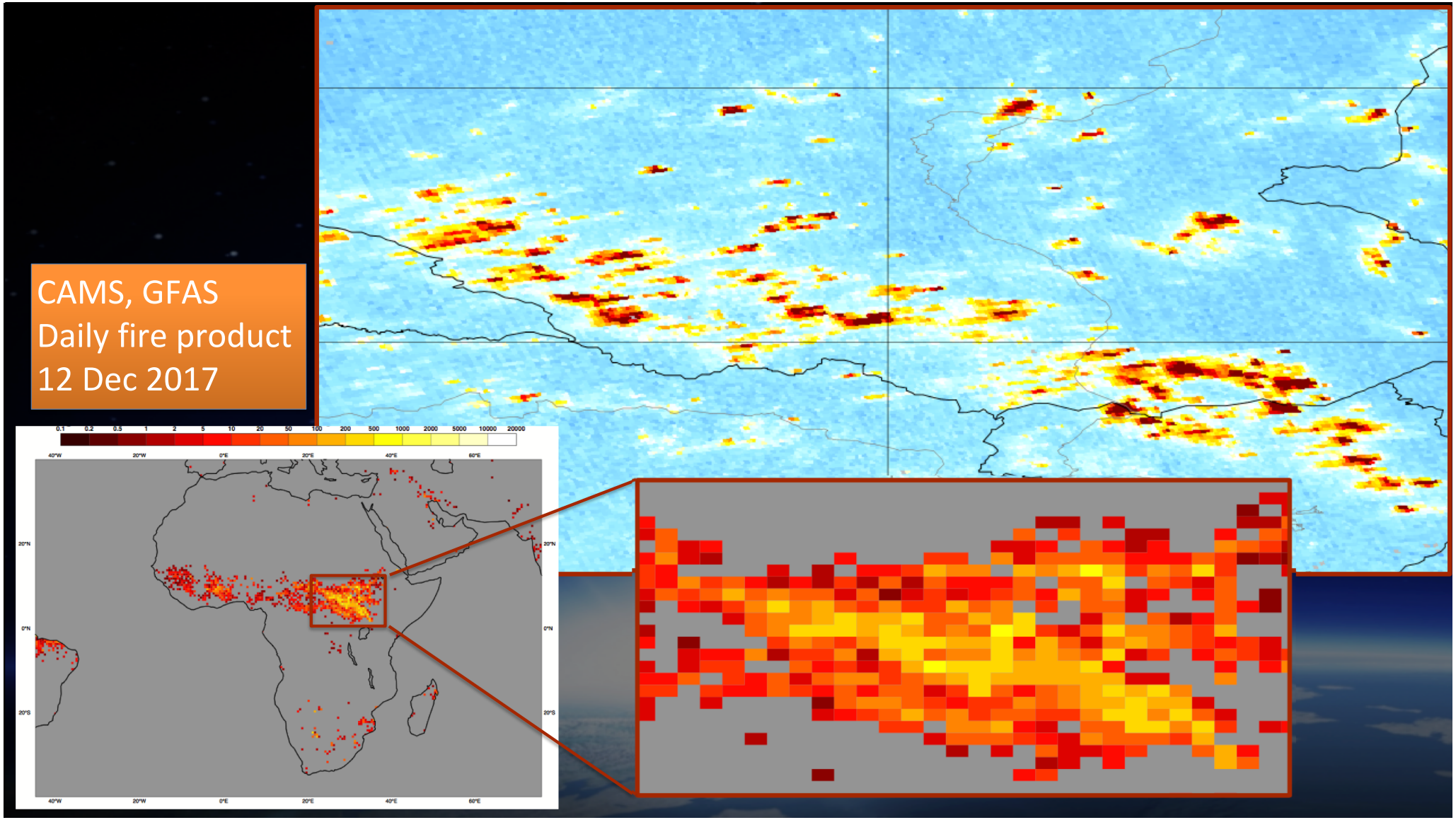
opernicus
Europe's eyes on Earth


Locations of power plants
TROPOMI
Pakistan
Quetta
Multan
Bahawalpur
CHANDIGARH
PUNJAB
UTTARAKHAND
HARYANA
New Delhi
Bareilly
Bikaner
Khairpur
UTTAR PRADESH
Lakhimpur
Nepal
Kathmandu
SIKKIM
Darjeeling
Siliguri
Agra
Jaipur
Lucknow
Gorakhpur
RAJASTHAN
Nawabshah
Jodhpur
Ajmer
Gwalior
Kanpur
Darbhanga
Kishanganj
Jaunpur
Hyderabad
Allahabad
Benares
Patna
BIHAR
Karāchi
Badin
Kota
Udaipur
Gaya
JHARKHAND
MADHYA PRADESH
GUJARAT
Ahmedabad
India
Ranchi
WEST-BENGALEN
Indore
Jamnagar
Rajkot
Vadodara
Chhindwara
CHHATTISGARH
Calcutta
Surat
Nagpur
Raipur
Bhilai
Diu
ODISHA
Bhubaneswar
Nashik
Aurangabad
Puri
MAHARASHTRA
Mumbai
Pune
Srikakulam
TELANGANA
Visakhapatnam
Gulbarga
Rajahmahendravaram
Kakinada
Vijayawada
Kolhapur
Belgaum


Africa
12 Dec 2017

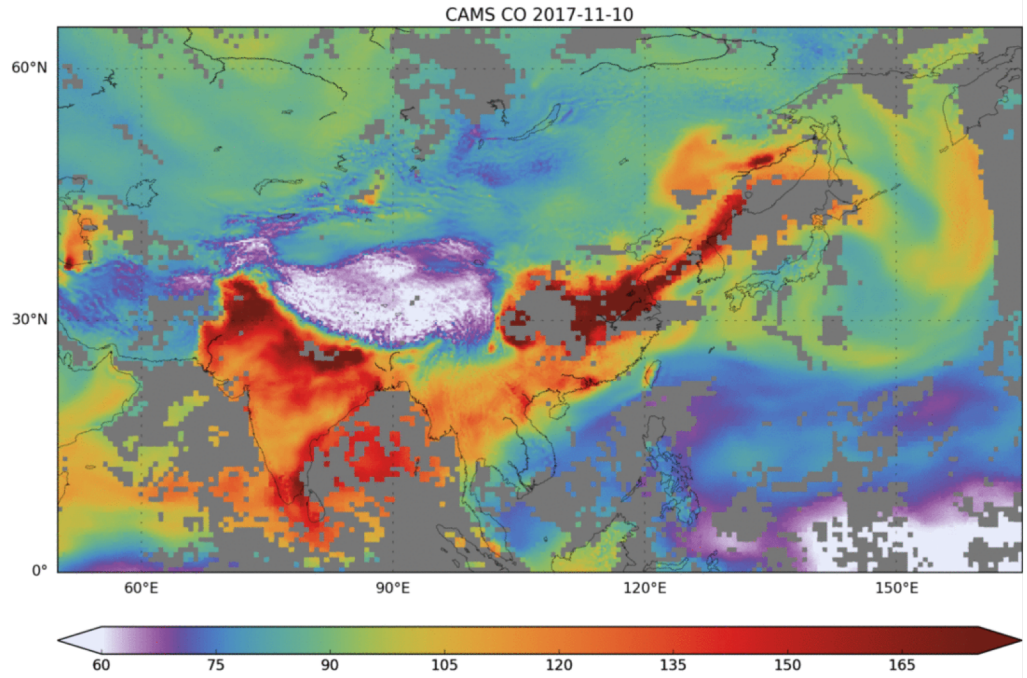

Sudan

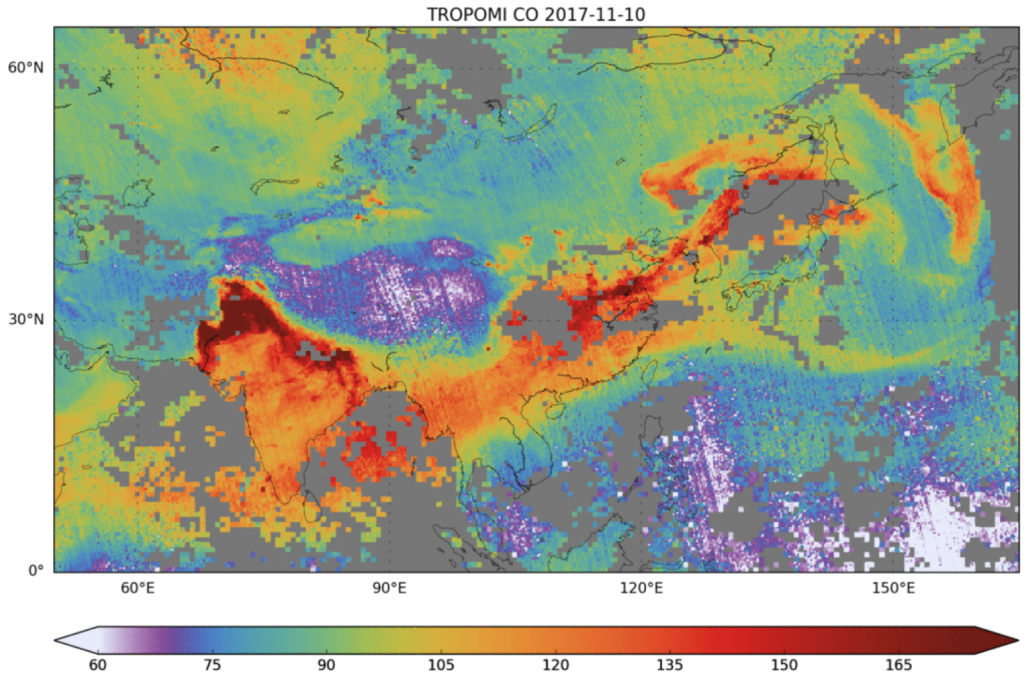



CAMS, GFAS
Daily fire product
12 Dec 2017
0.1 0.2 0.5 1 2 5 10 20 50 100 200 500 1000 2000 5000 10000 20000
40°W 20°W 0°E 20°E 40°E 60°E
20°N
0°N
20°S

Carbon monoxide

Carbon monoxide: first comparisons with CAMS



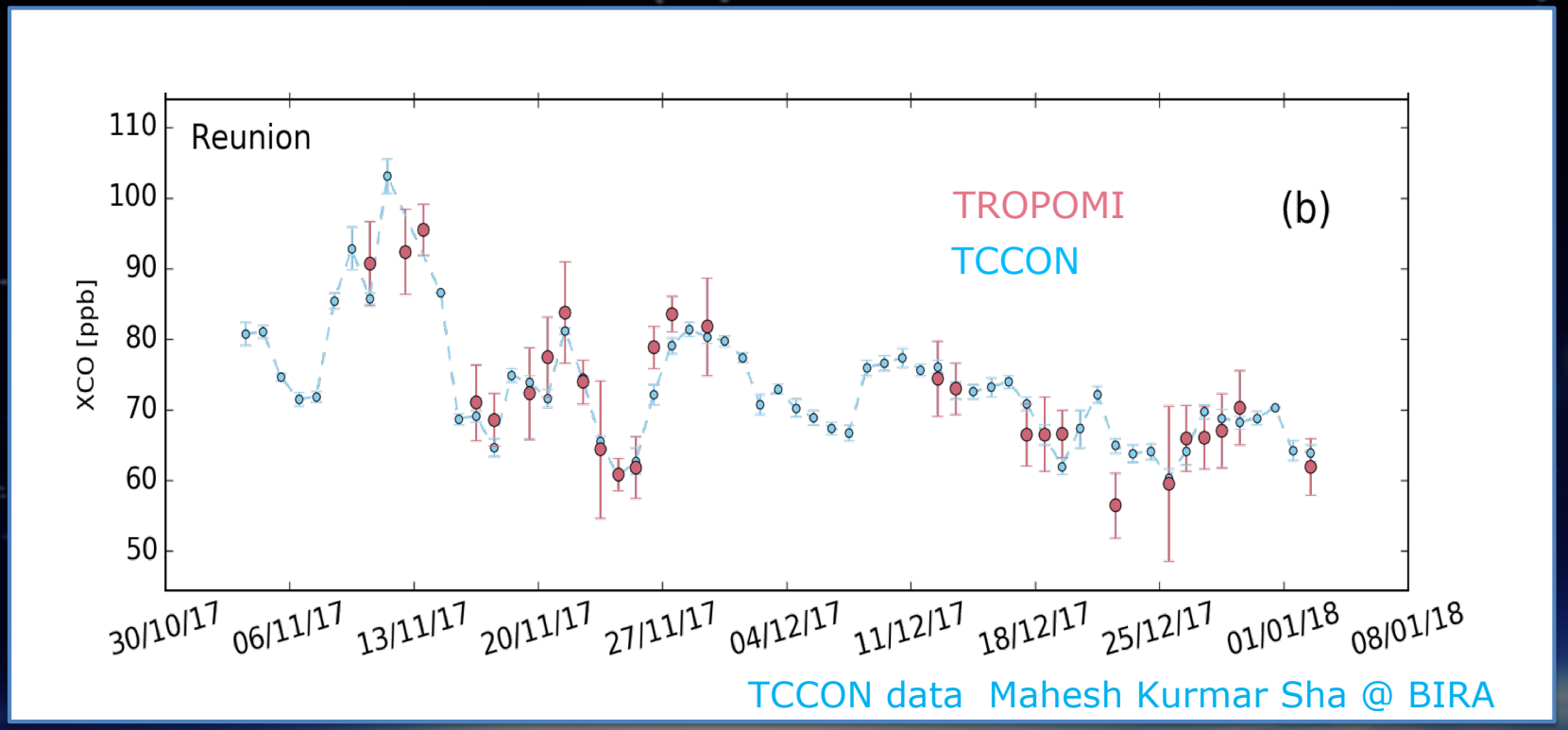


CAMS 10-20 Nov 2017 TROPOMI

Borsdorff et al, GRL, 2018

opernicus
Europe's eyes on Earth

Carbon monoxide: validation with TCCON



TCCON data Mahesh Kurmar Sha @ BIRA

Borsdorff, Landgraf et al. 2018

Formaldehyde

HCHO retrieval algorithm: DOAS

- Slant columns: SCD
  - Fit1: 328.5-359 nm
  - Fit2: 328.5-346 nm (BrO prefit)
  - Mean radiance as I_0 reference (averaged in the Pacific region)
  - Adjusted ISFR using TROPOMI solar irradiance + solar atlas
- Air Mass Factors: AMF
  - Altitude resolved AMF LUT
  - TM5 profiles: daily forecast, 1°x1°
  - S5P cloud product
  - OMI albedo database
- Background correction: SCD_0, VCD_0
  - Up to 1 week of slant columns in the Pacific region
  - Global source of CH_4 oxidation from CTM
- Error estimates, AK, QF

$$VCD = \frac{SCD - SCD_0}{AMF} + VCD_0$$

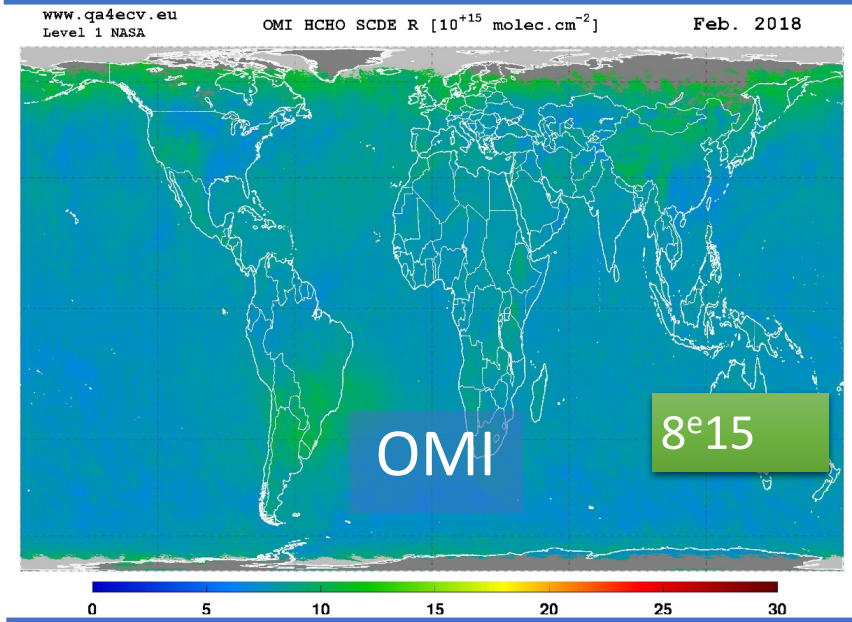
Algorithm Theoretical Baseline for formaldehyde retrievals from S5P TROPOMI and from the QA4ECV project

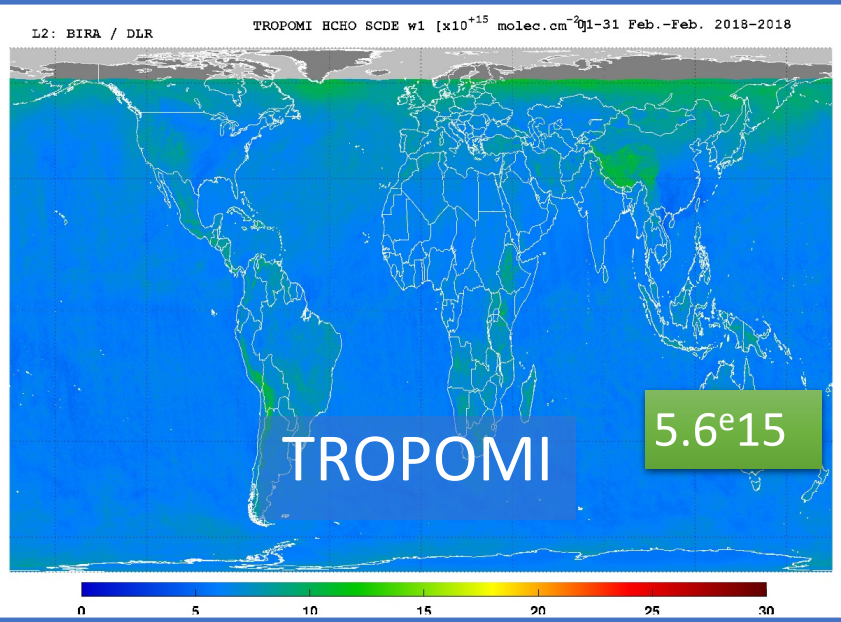
Isabelle De Smedt, Nicolas Theys, Huan Yu, Thomas Danckaert, Christophe Lerot, Steven Compernolle, Michel Van Roozendael, Andreas Richter, Andreas Hilboll, Enno Peters, Mattia Pedergnana, Diego Loyola, Steffen Beirle, Thomas Wagner, Henk Eskes, Jos van Geffen, Klaas Folkert Boersma, and Pepijn Veefkind

AMT 2018, Special Issue: TROPOMI on Sentinel-5 Precursor: data products and algorithms

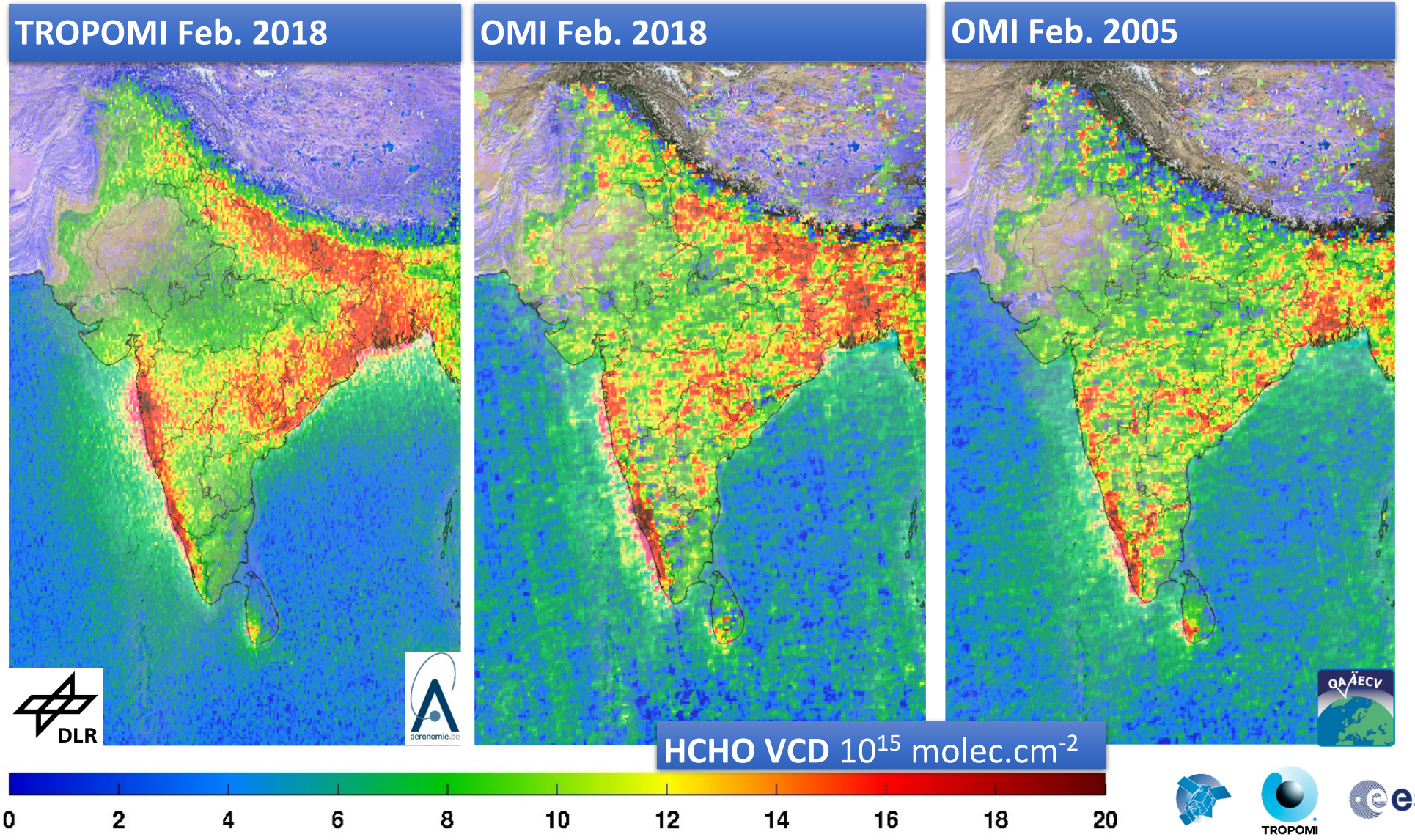
Quality of TROPOMI spectra in the HCHO UV fitting range: **328.5-359 nm**

- Indicators: DOAS fit slant column density error (SCDE), and SCD noise

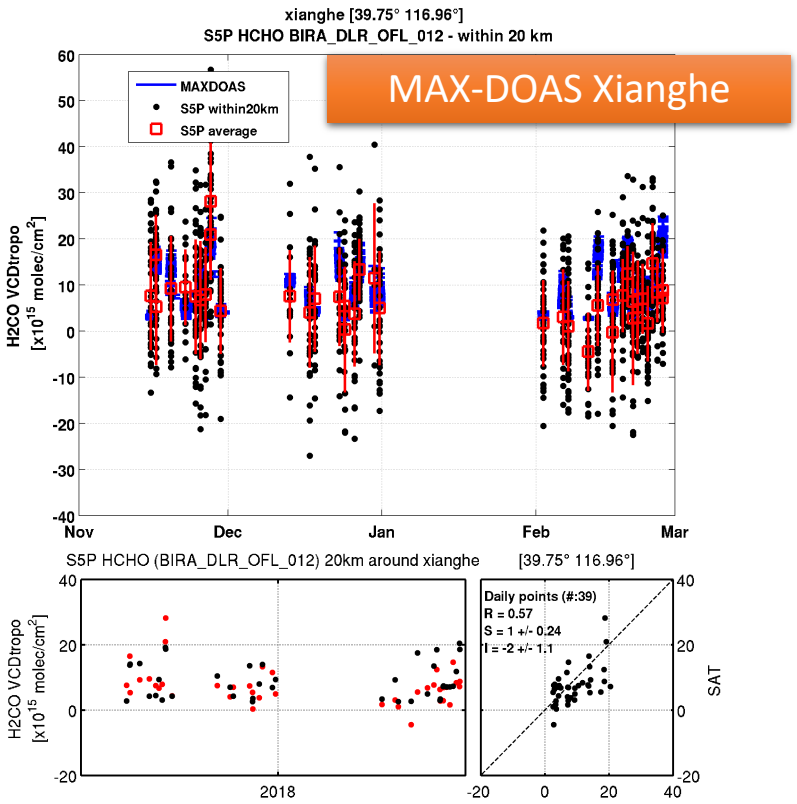




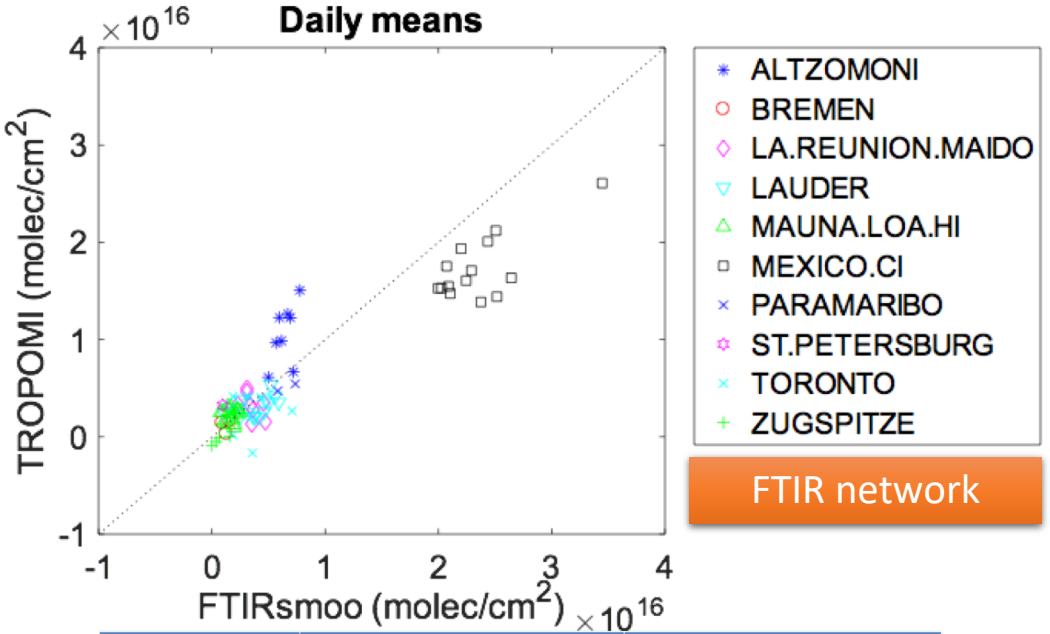
- In UV channel 3, the precision on TROPOMI HCHO slant columns is improved by 30% compared to OMI, at original spatial resolution of each instrument.
- Using the large fitting window allows to reduce the noise by 16% (TROPOMI), 12% (OMI)
- => At the same horizontal resolution, TROPOMI SNR 5 to 6 times better than OMI.


TROPOMI Feb. 2018
OMI Feb. 2018
OMI Feb. 2005
DLR
aeronomie.be
QA4ECV
HCHO VCD 10^{15} molec.cm^{-2}
0
2
4
6
8
10
12
14
16
18
20
TROPOMI
esa

First validation results: NID4VAL UV-VIS and FTIR stations



MAX-DOAS Xianghe



FTIR network

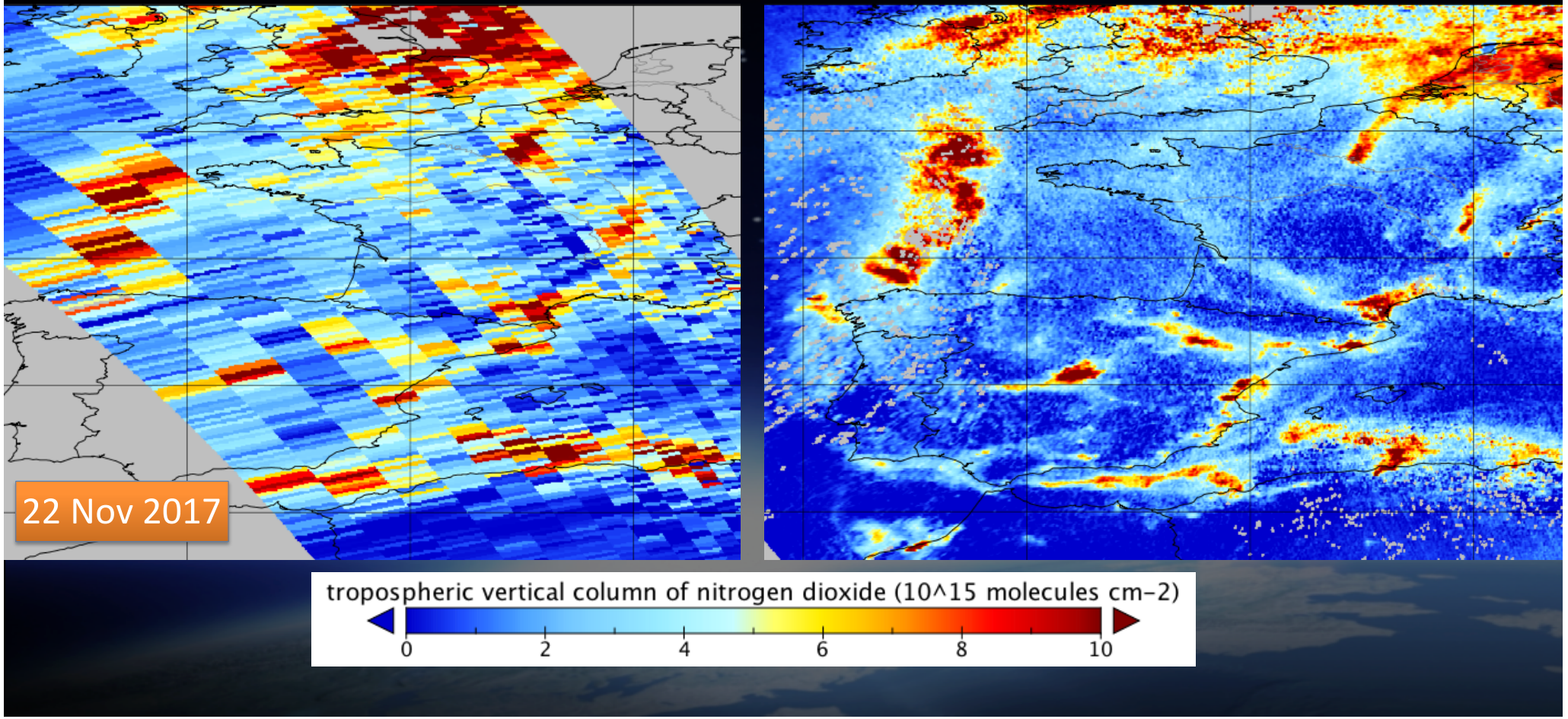
	Daily means ALL sites			Monthly means ALL sites		
	Bias	Stand. Dev. (% and molec/cm²)	Corr.	Bias	Stand. Dev. (% and molec/cm²)	Corr.
UPAS-2 v12	-46%	75%	0.85	43%	74%	0.86
BIRA PROTO v1.2	-15%	57% ; 3.4x10^{15}	0.92	-3%	63%; 2.7x10^{15}	0.89

Pinardi et al.: Sentinel-5 Precursor NO2 and HCHO validation using NDACC and complementary UV-Vis DOAS systems

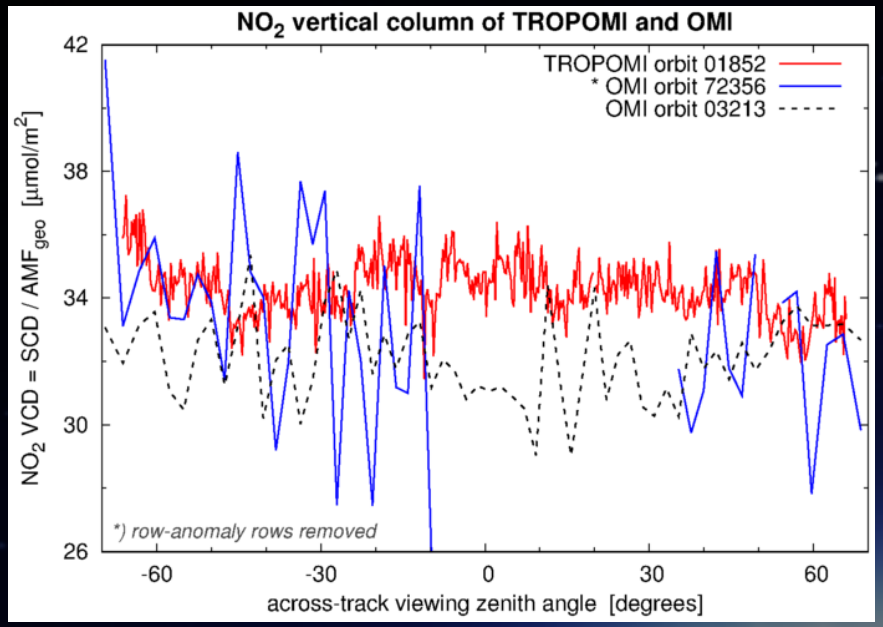
Vigouroux et al.: First HCHO TROPOMI validation using NDACC harmonized total columns within the FTIR network

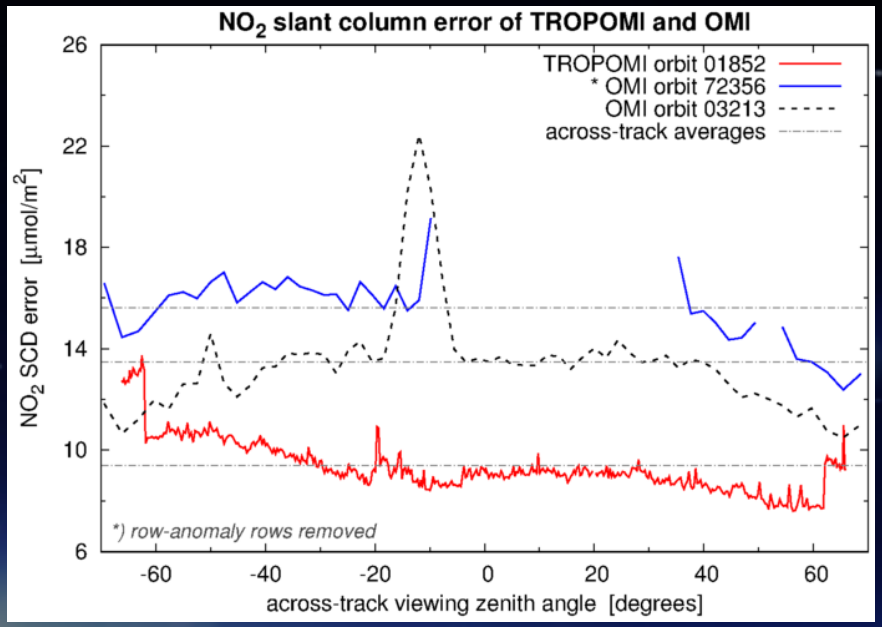
Nitrogen dioxide

OMI vs TROPOMI NO2



TROPOMI vs OMI NO2

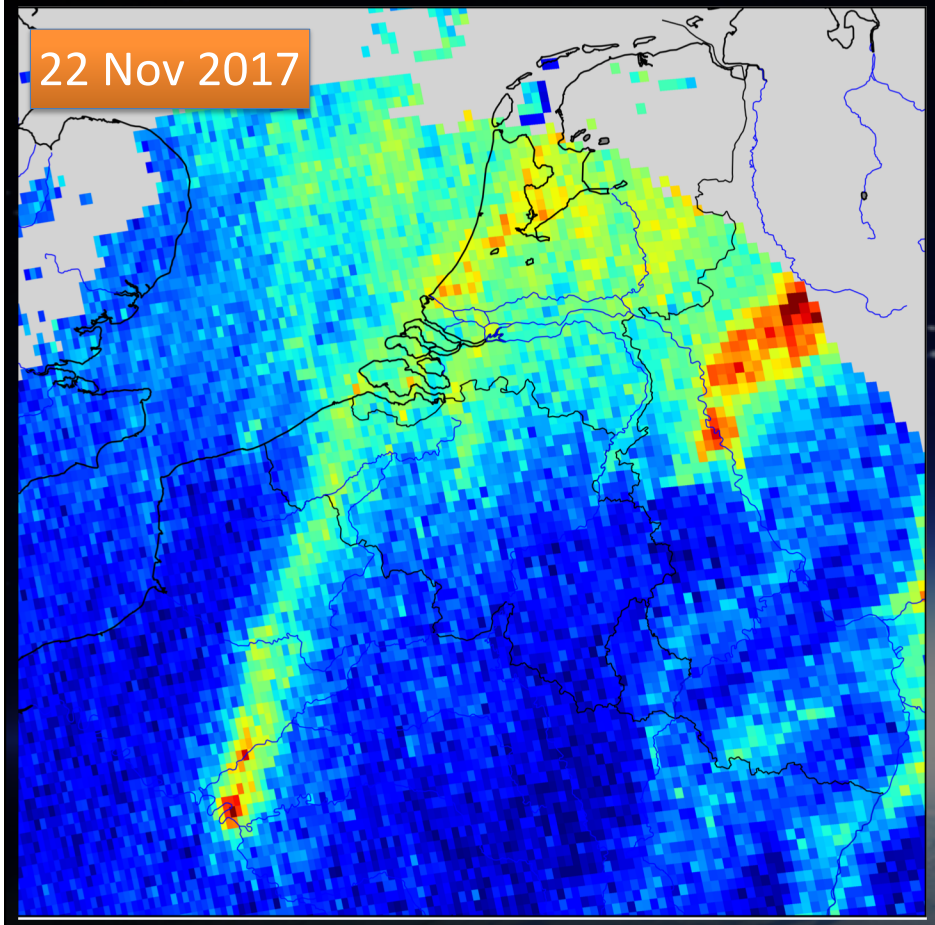




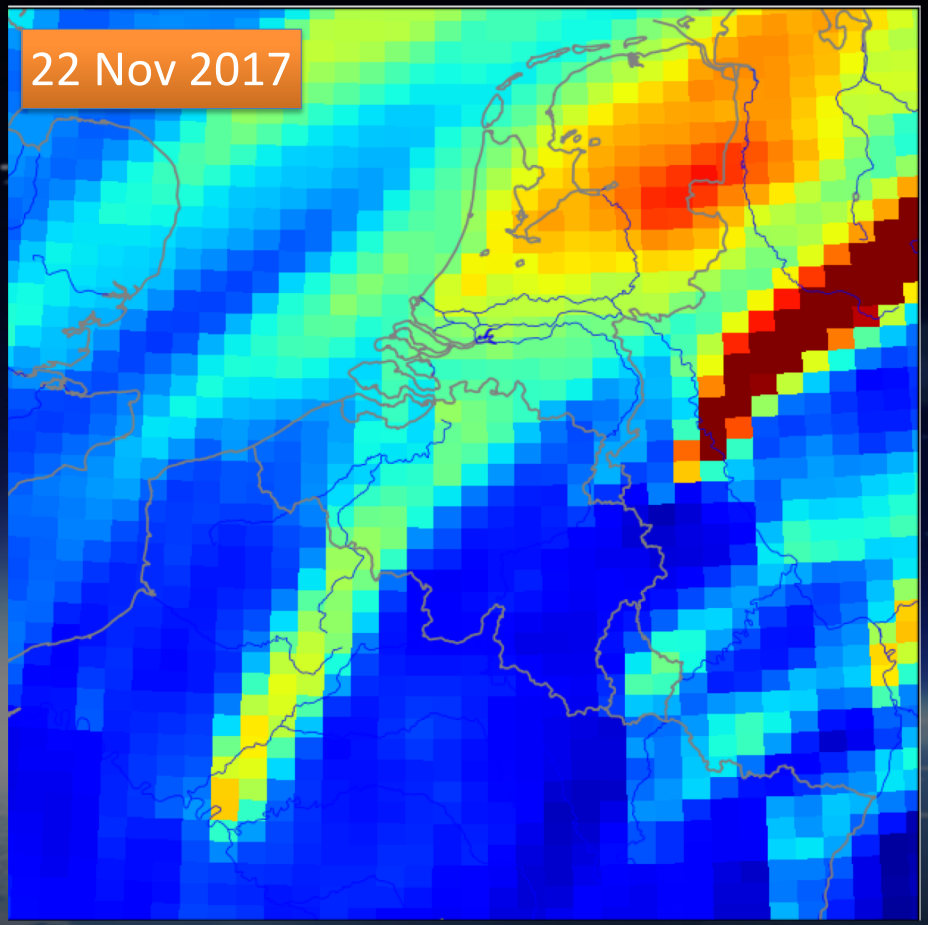
Pacific, tropics:

- Within uncertainty range of OMI, there is agreement
- Across-track variability TROPOMI much smaller
- TROPOMI noise on individual observations up to factor 2 smaller than OMI

TROPOMI



LOTOS-EUROS MODEL



TROPOMI

TROPOMI measurements of CO, HCHO and NO2

- A resolution and noise level “game changer” performing better than expected
- Data release, including CO, HCHO, NO2, is planned for June 2018 (on schedule)
- “v1” code installed at DLR, reprocessing started NO2 test data available in few weeks
- We are looking forward to work with the validation teams …
- … and users / modellers (e.g. emission estimates)

www.tropomi.eu

www.temis.nl

www.knmi.nl/omi

sentinels.copernicus.eu

#tropomi

- **Disclaimer:** The presented work has been performed in the frame of the Sentinel-5 Precursor Validation Team (S5PVT) or Level 1/Level 2 Product Working Group activities. Results are based on preliminary (not fully calibrated/validated) Sentinel-5 Precursor data that will still change.

- **Acknowledgement:** Sentinel-5 Precursor is a European Space Agency (ESA) mission on behalf of the European Commission (EC). The TROPOMI payload is a joint development by ESA and the Netherlands Space Office (NSO). The Sentinel-5 Precursor ground-segment development has been funded by ESA and with national contributions from The Netherlands, Germany, and Belgium.

TROPOMI

opernicus
Europe's eyes on Earth