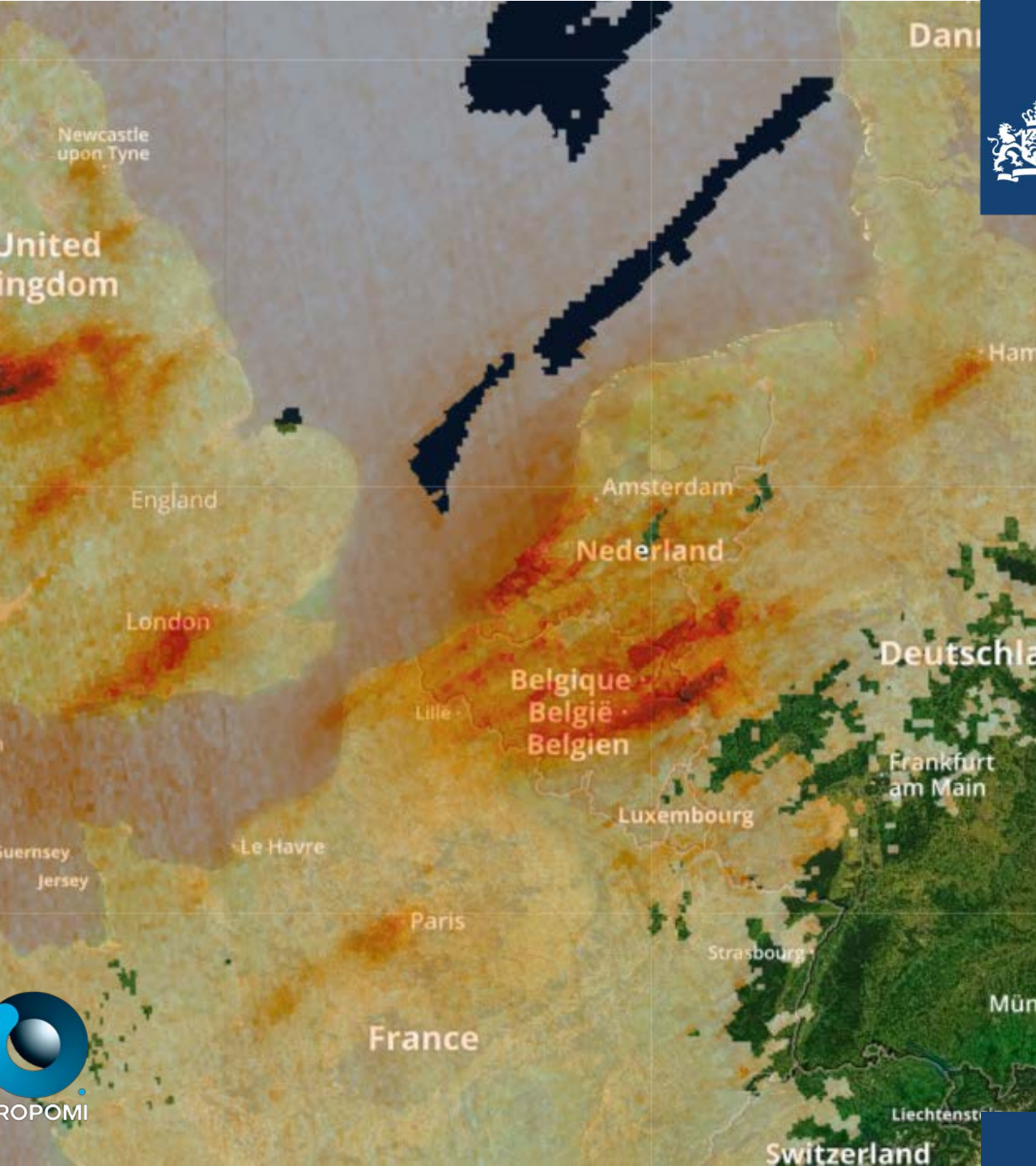




Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure
and Water Management*

S5P / TROPOMI: First Results

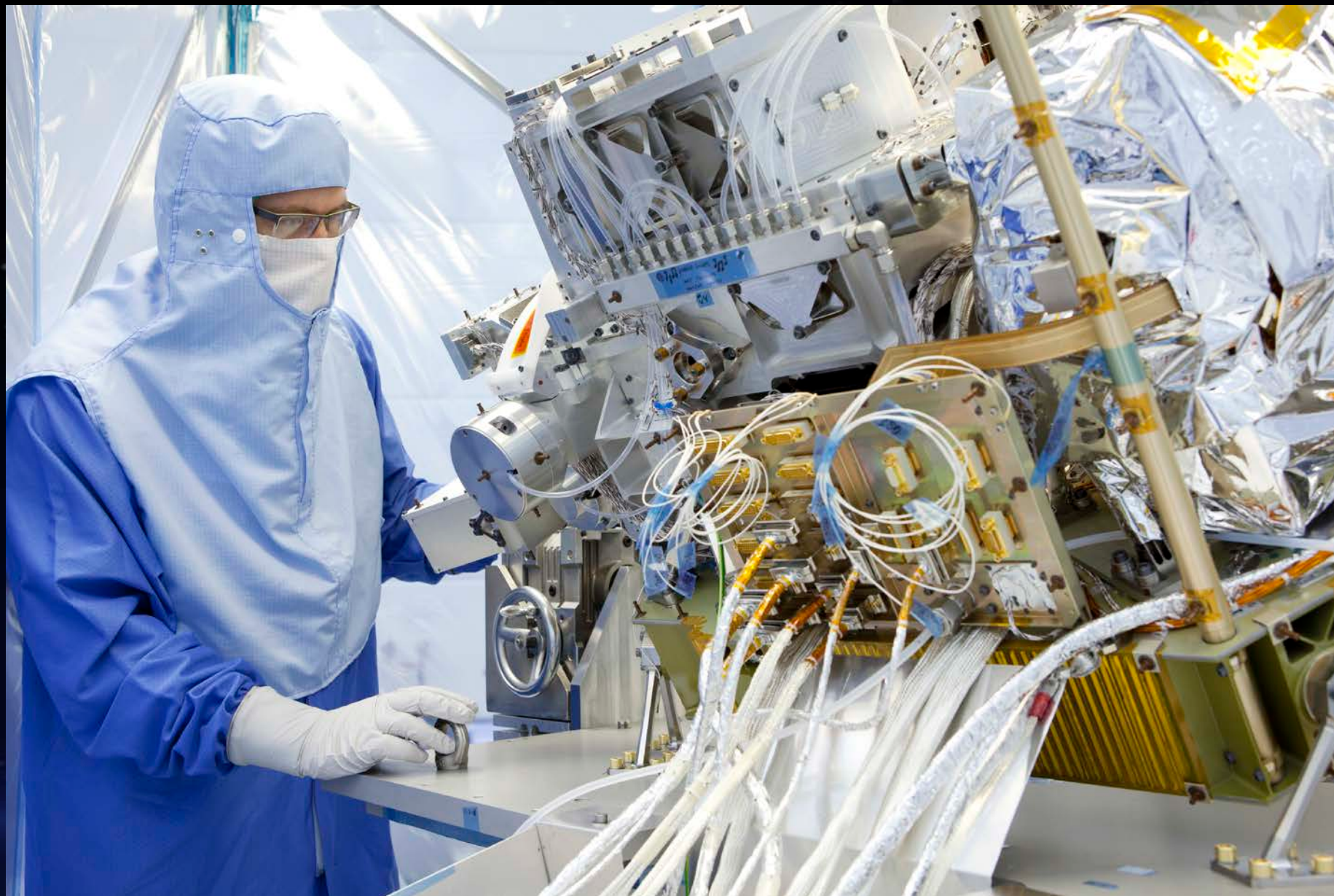
Pepijn Veeffkind KNMI and TU-Delft,
veeffkind@knmi.nl

S5P/TROPOMI teams at KNMI, SRON, DLR,
BIRA-IASB, MPIC, IUP-Bremen, RAL and FMI

SENTINEL 5 PRECURSOR

Launch	13 October 2017
Launcher	Rockot from Plesetsk Russia
Orbit	Polar Sun synchronous, altitude 824 km
Overpass time	13:30 local time
Mission duration	7 year
Satellite	Airbus Astrobuss-M, height 3,55 m, 5,63 m diameter, mass 820 kg
Payload	Tropospheric Monitoring Instrument (TROPOMI)
Ground stations	Svalbard (Norway), Inuvik (Canada) and Kiruna (Sweden)
Data processing	DLR Oberpfaffenhofen (Germany) KNMI De Bilt, The Netherlands
Agencies	European Space Agency ESA Netherlands Space Office





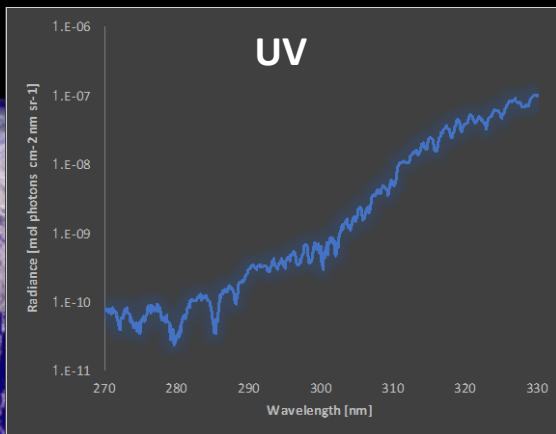




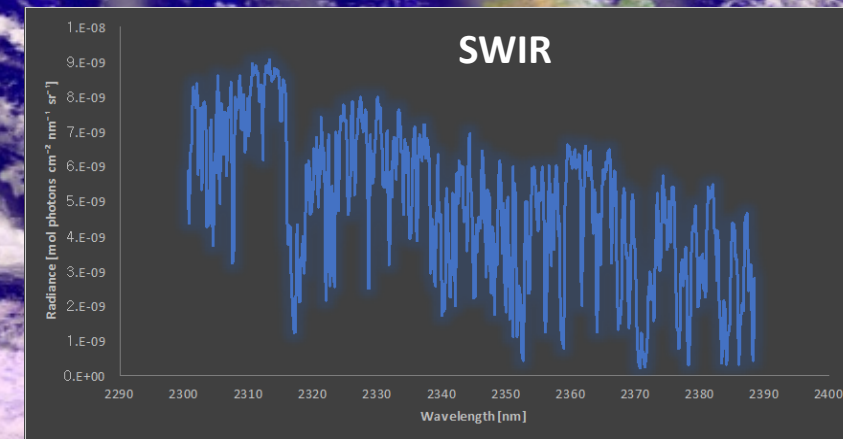
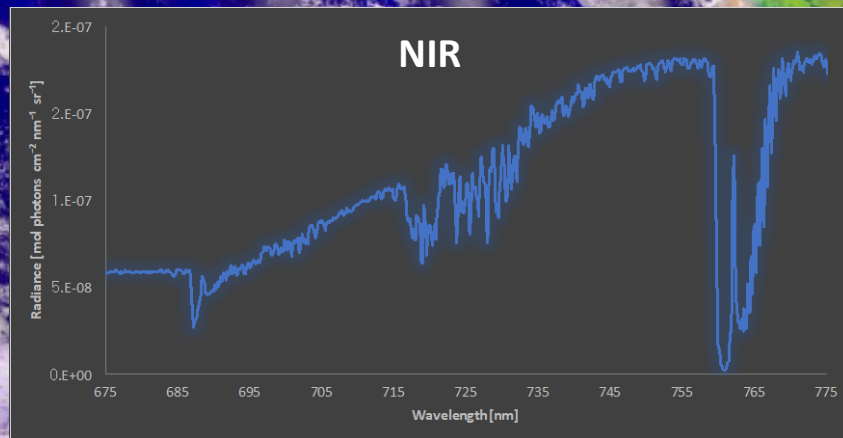
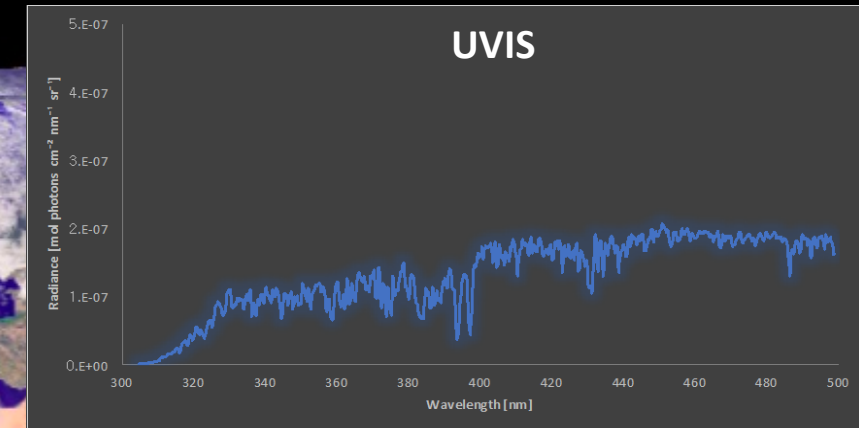
	UV		UVIS		NIR		SWIR	
Band	1	2	3	4	5	6	7	8
Spectral coverage [nm]	270 – 320		320 – 495		675 - 775		2305 – 2385	
Full spectral coverage [nm]	267 - 332		303 - 499		660 - 784		2299 - 2390	
Spectral resolution [nm]	0.49		0.54		0.38		0.25	
Spectral sampling ratio	6.7		2.5		2.8		2.5	
Spatial sampling [km²]	7 x 28	7 x 3.5				7 x 3.5	7 x 7	

TROPOMI is developed by The Netherlands in cooperation with ESA





- 1 scanline per second
- 440 spectra per scanline
- 3000 scanlines per orbit
- 15 orbits per day
- 20 million groundpixels per day
- 225 Gbyte raw data per day
- 1 Tbyte L1b data per day



TROPOMI Level 2 Data Products

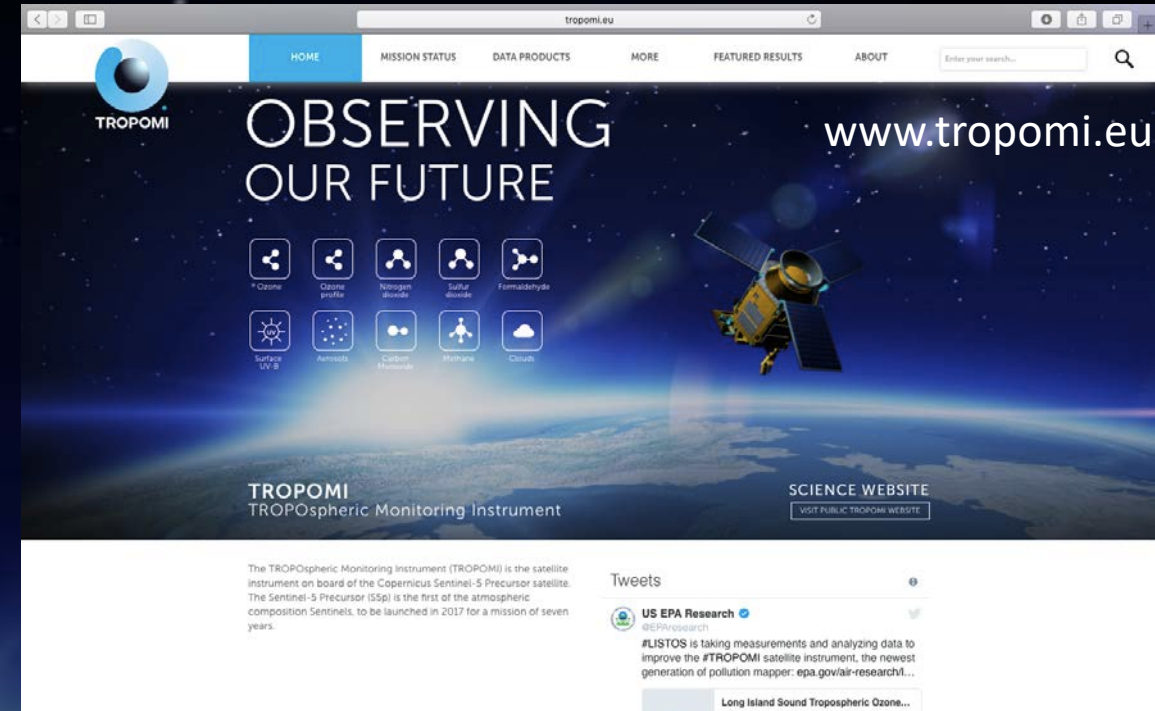


Parameter		Data Product	Vertical Resolution	Bias	Random
Ozone 		Ozone Profile	6 km	10-30%	10%
		Total Ozone	total column	3.5-5%	1.6-2.5%
		Tropospheric Ozone	trop column	25%	10%
NO ₂ 		Stratospheric NO ₂	strat column	<10%	0.5e15
		Tropospheric NO ₂	trop column	25-50%	0.7e15
SO ₂ 		SO ₂ enhanced	total column	30%	0.15-0.3 (0.06-0.12) DU
		Total SO ₂	total column	30-50%	1-3 (0.4-1.2) DU
Formaldehyde 		Total HCHO	total column	40-80%	1.2e16 (4e15)
CO 		Total CO	total column	15%	<10%
Methane 		Total CH ₄	total column	1.5%	1%
Cloud 		Cloud Fraction	total column	<20%	0.05
		Albedo (Optical Thickness)	total column	<20%	0.05 (10)
		Cloud Height (Pressure)	total column	<20%	<0.5 km (<30hPa)
Aerosol 		Aerosol Layer Height	total column	<100hPa	<50hPa
		Aerosol Type	total column	~1 AAI	<0.1 AAI
Surface UV		Provided by FMI in frame of the Finnish Sentinel Collaborative Ground Segment			

KNMI | DLR | BIRA-IASB | SRON | RAL | IUP-Bremen | MPIC | FMI

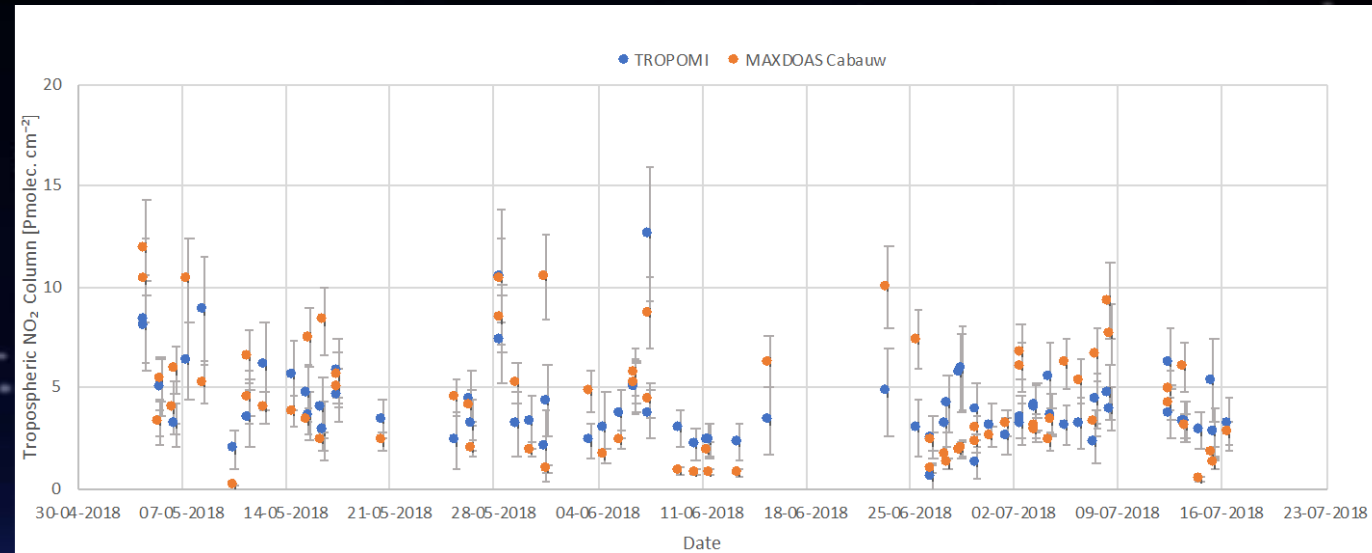
Data and Information

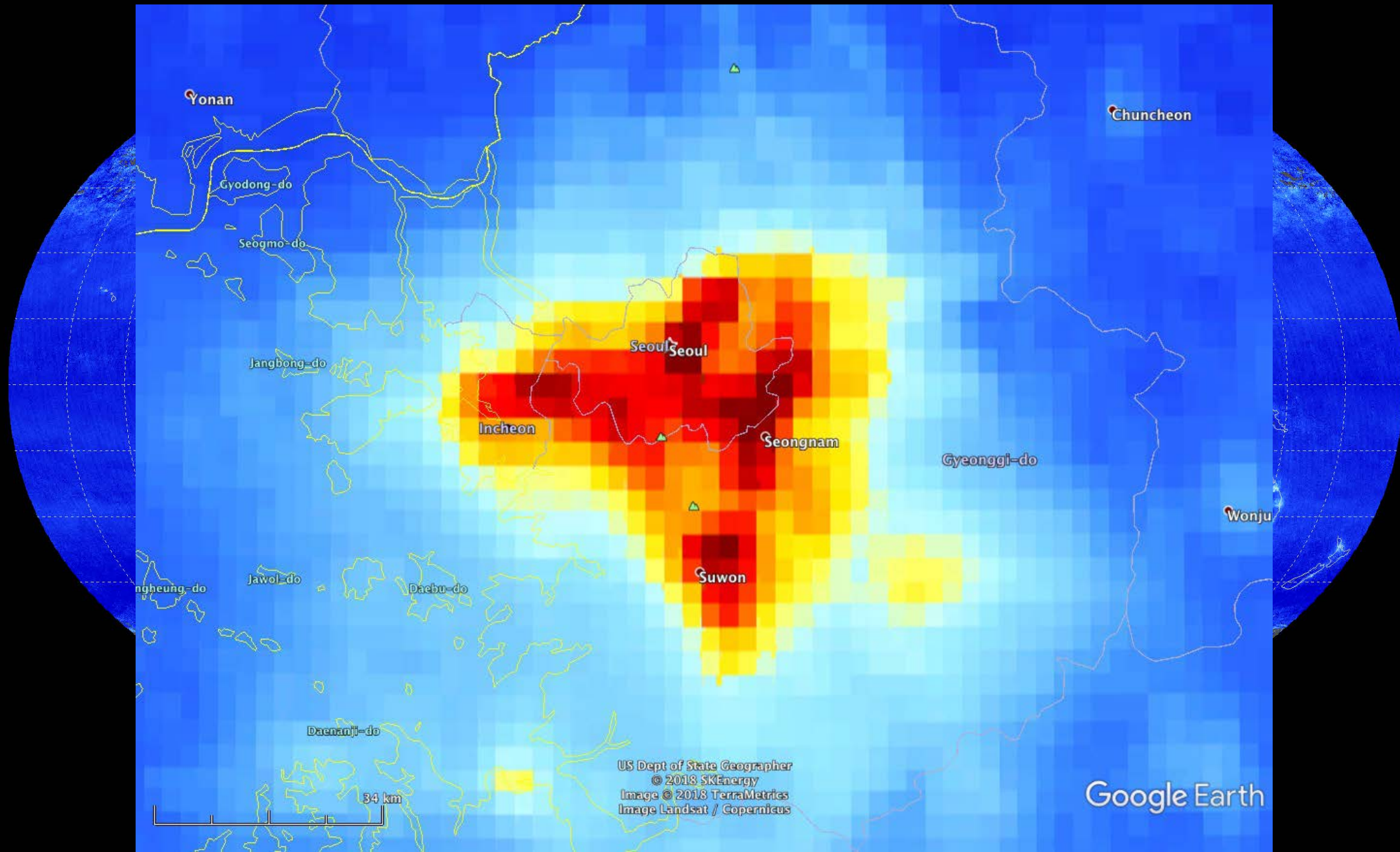
- S5P/TROPOMI data is disseminated through ESA (<https://scihub.copernicus.eu>) and NASA (<https://disc.gsfc.nasa.gov>).
- Online information on data quality and validation: www.tropomi.eu.
- New users are encouraged to read the documentation, e.g. the README files and Product User Manual.

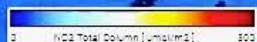
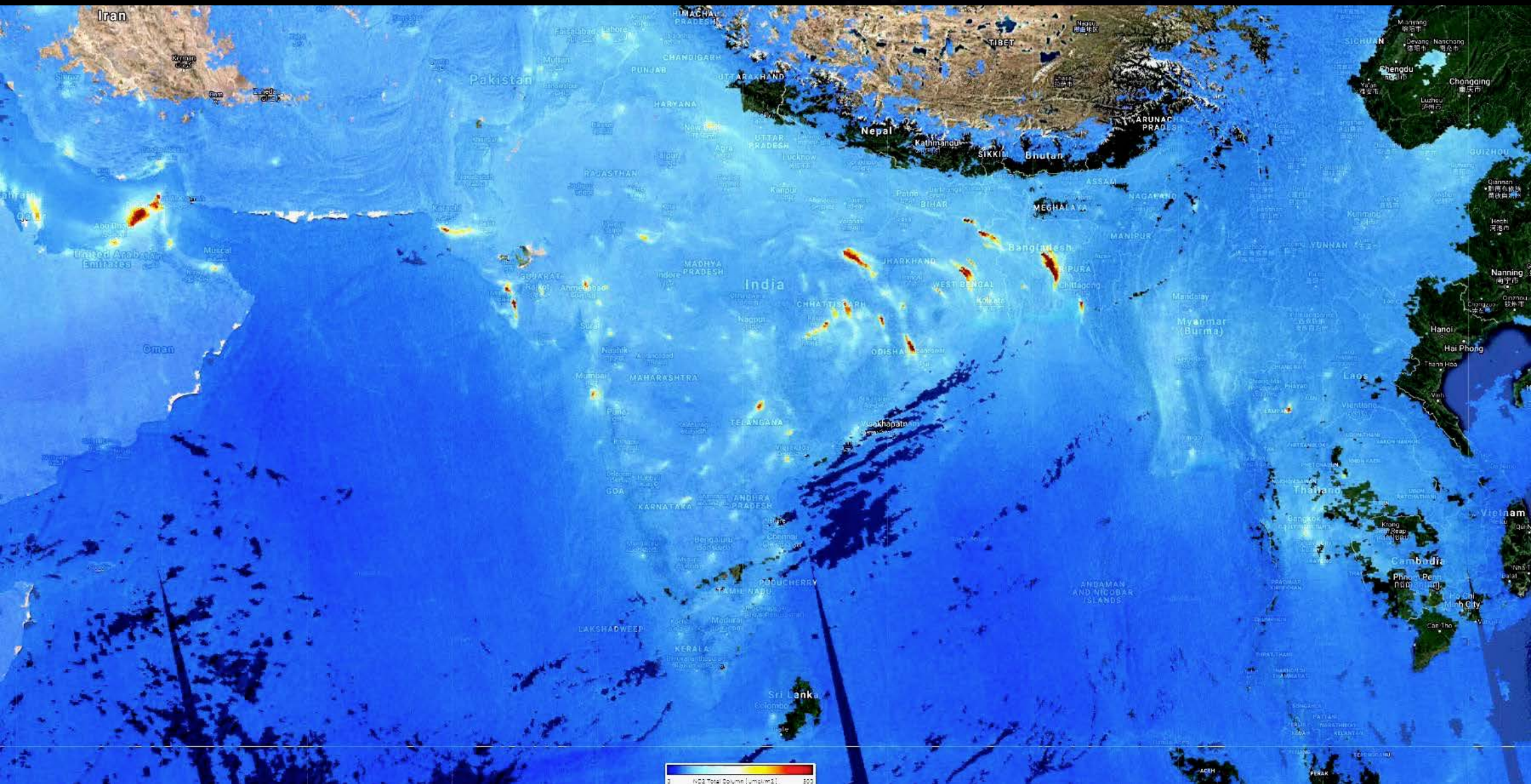


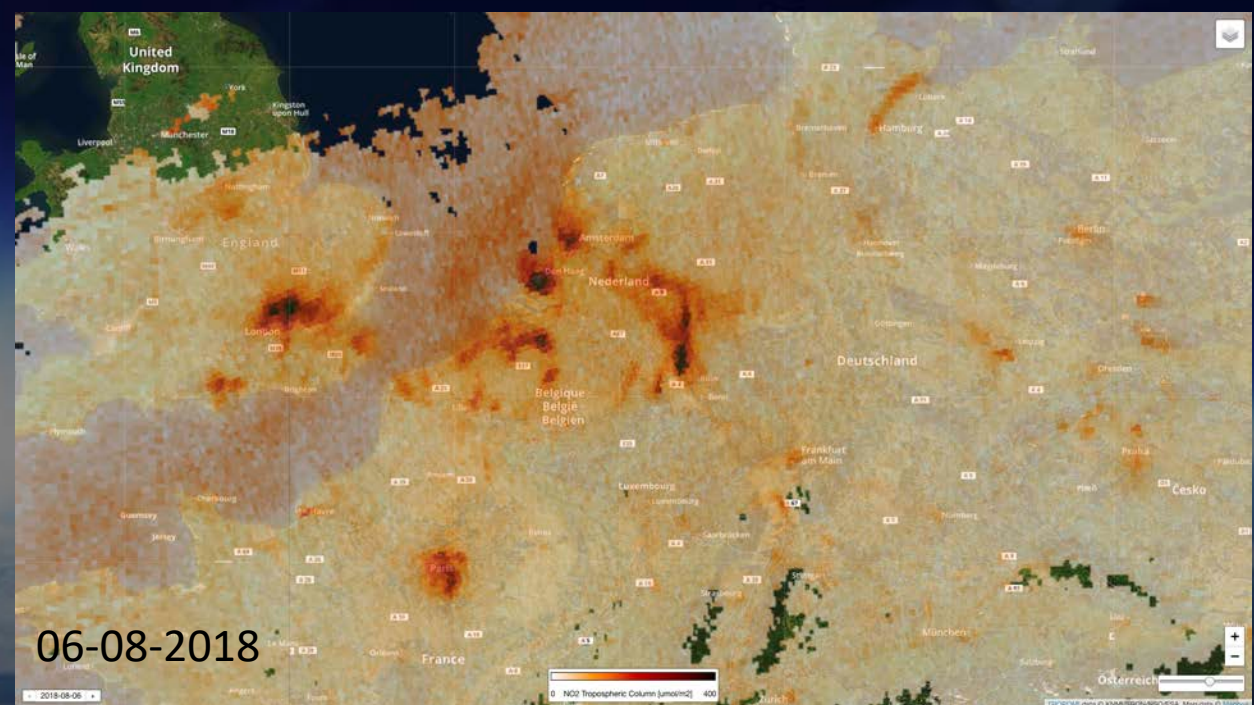
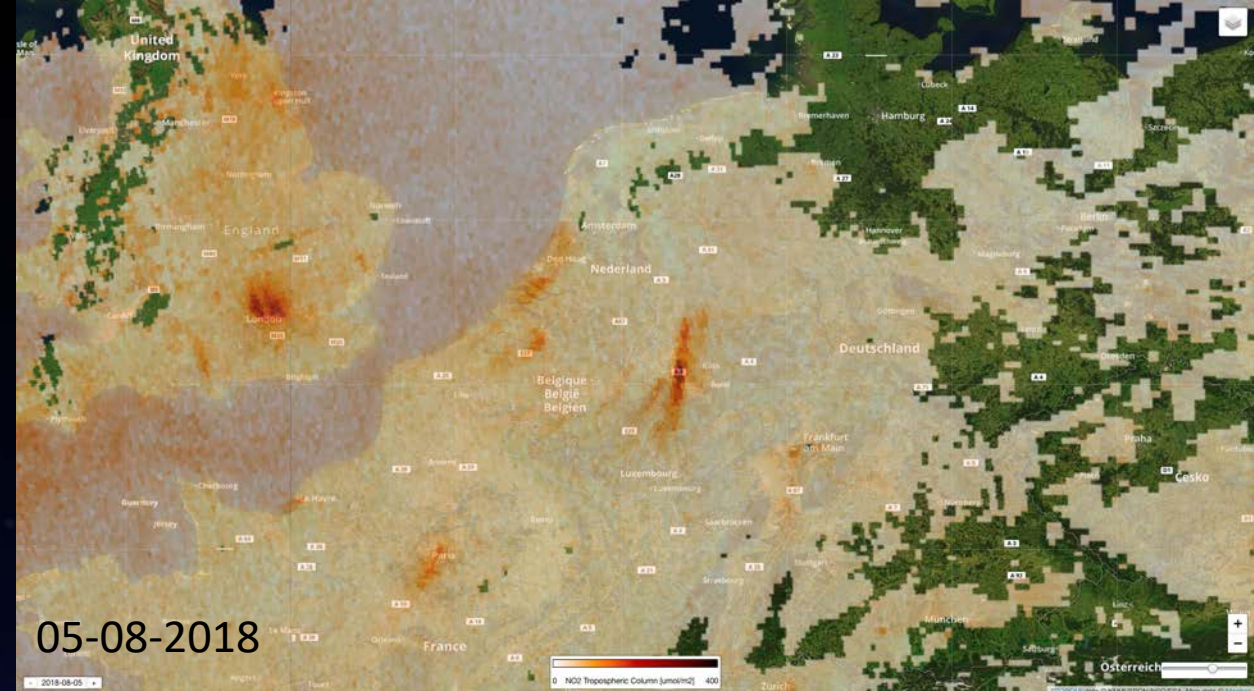
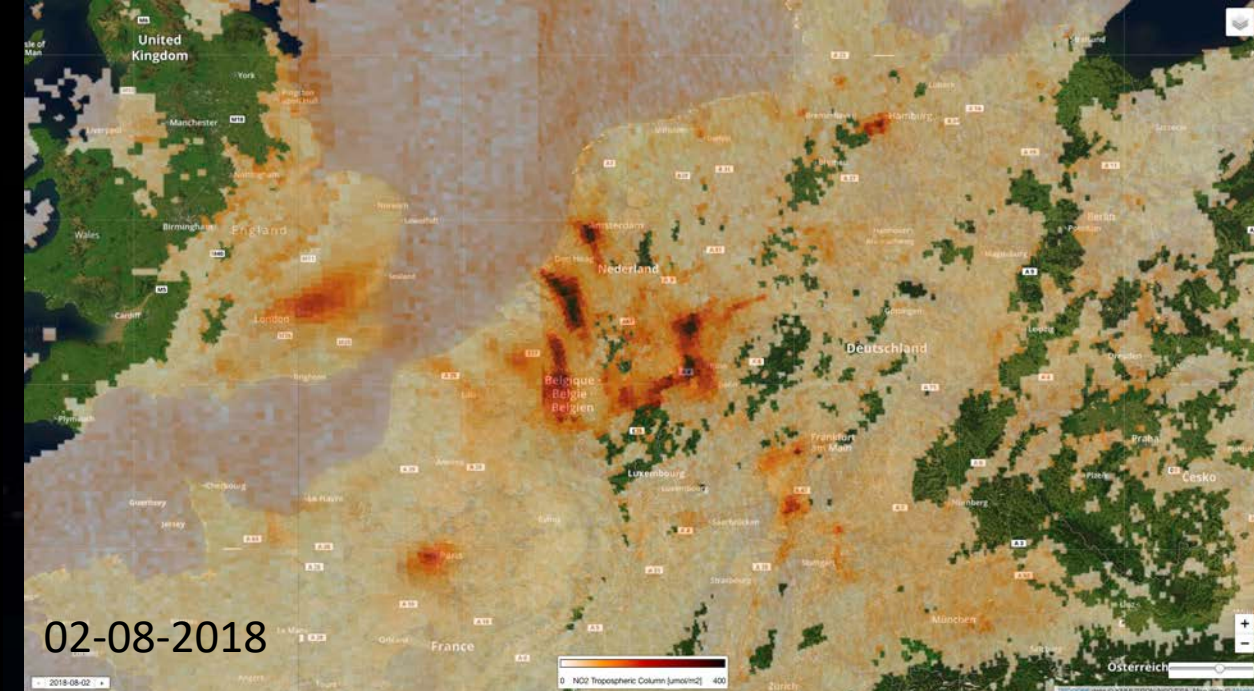
Validation

- The data quality of TROPOMI is continuously monitored.
- For validation an automated system is being implemented.
- Need for long-term measurements of column concentrations in urban areas.
- In 2019 dedicated measurement campaigns will be organised, including activities in Cabauw.









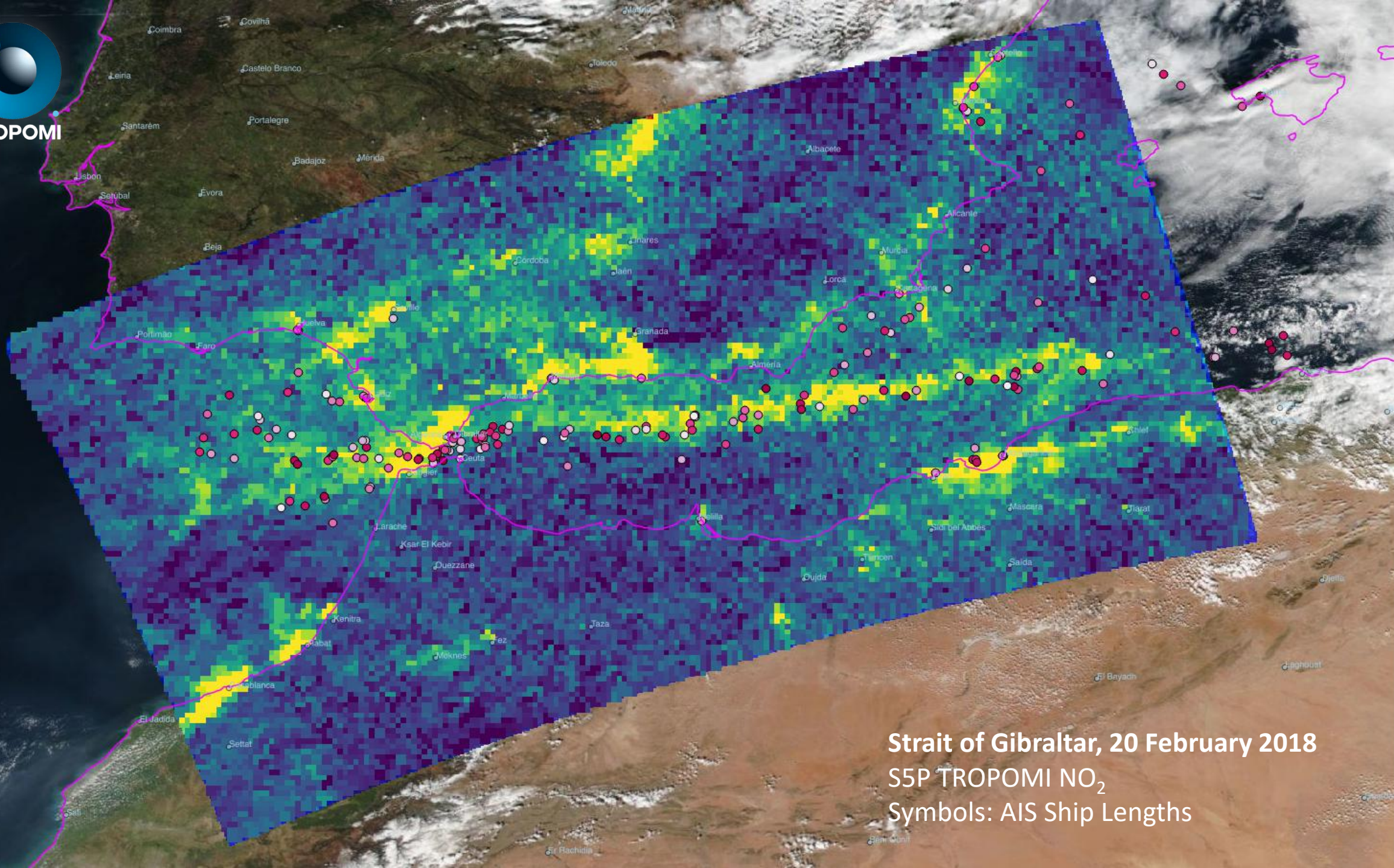
Shipping Lanes



Sentinel 2, Strait of Gibraltar, 22 February 2018



TROPOMI



Strait of Gibraltar, 20 February 2018

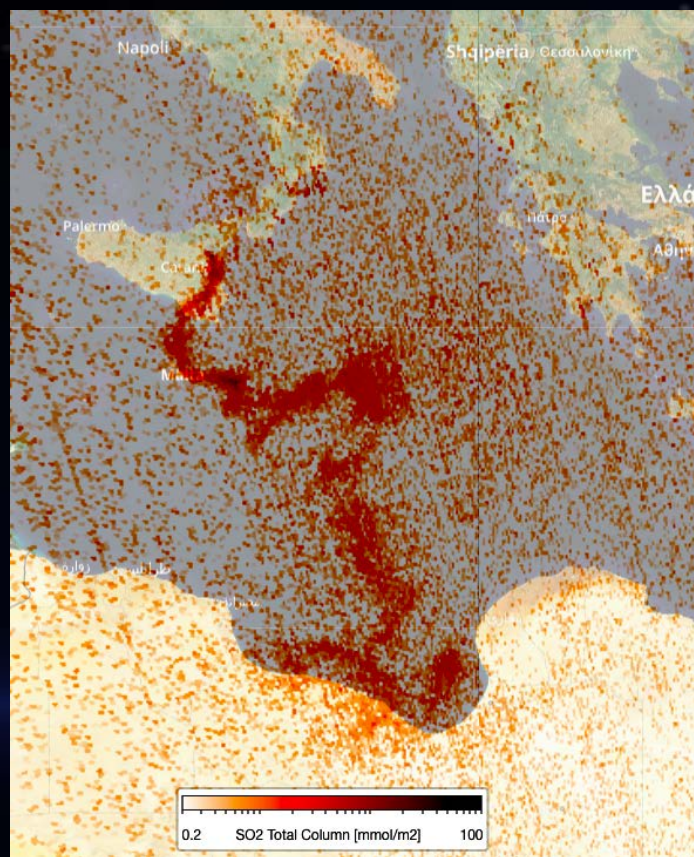
S5P TROPOMI NO₂

Symbols: AIS Ship Lengths

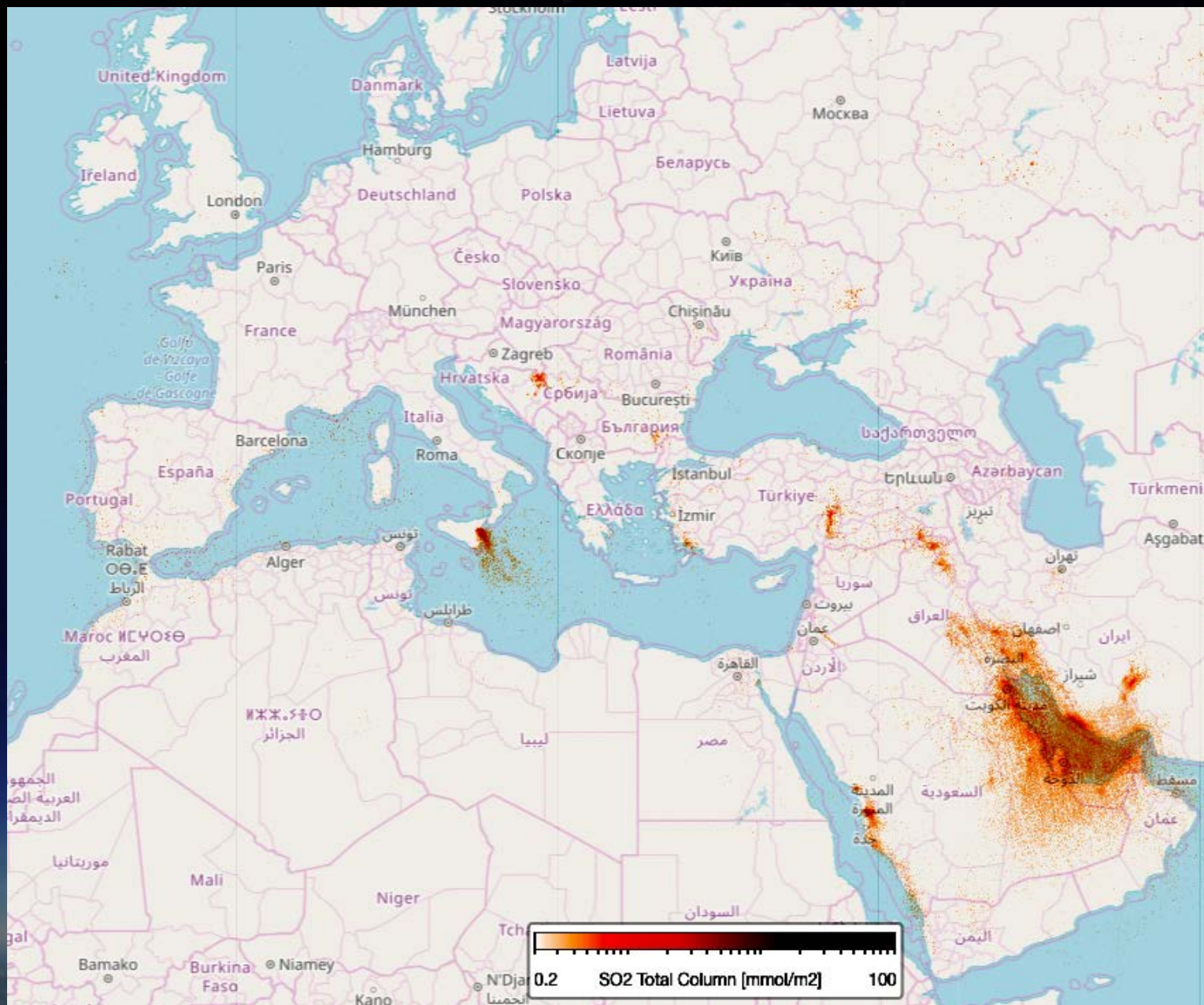
N



SO₂

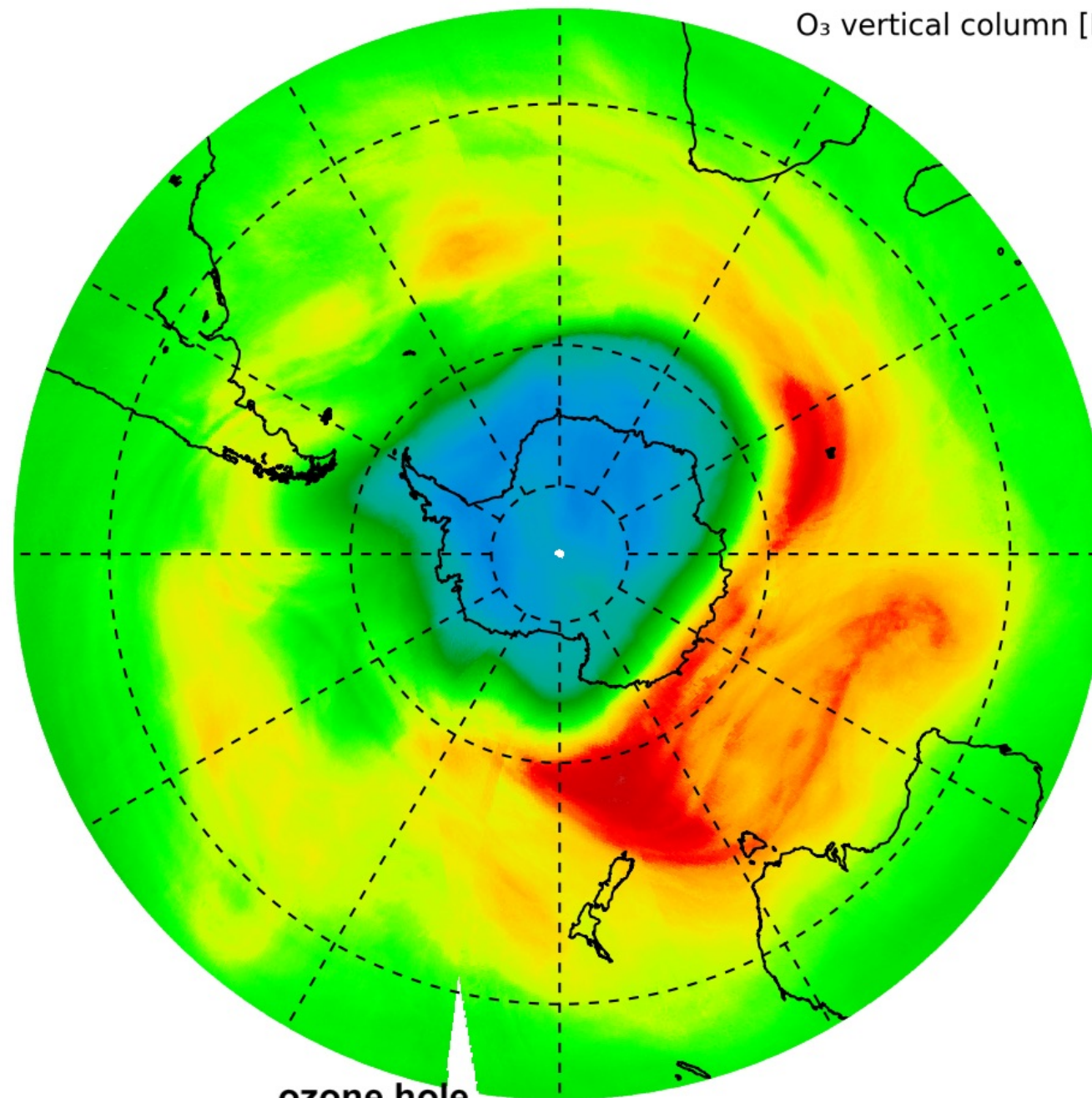


Etna, 03-08-2018

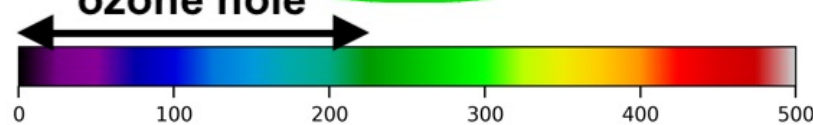


Monthly average, July 2018

O₃ vertical column [DU]

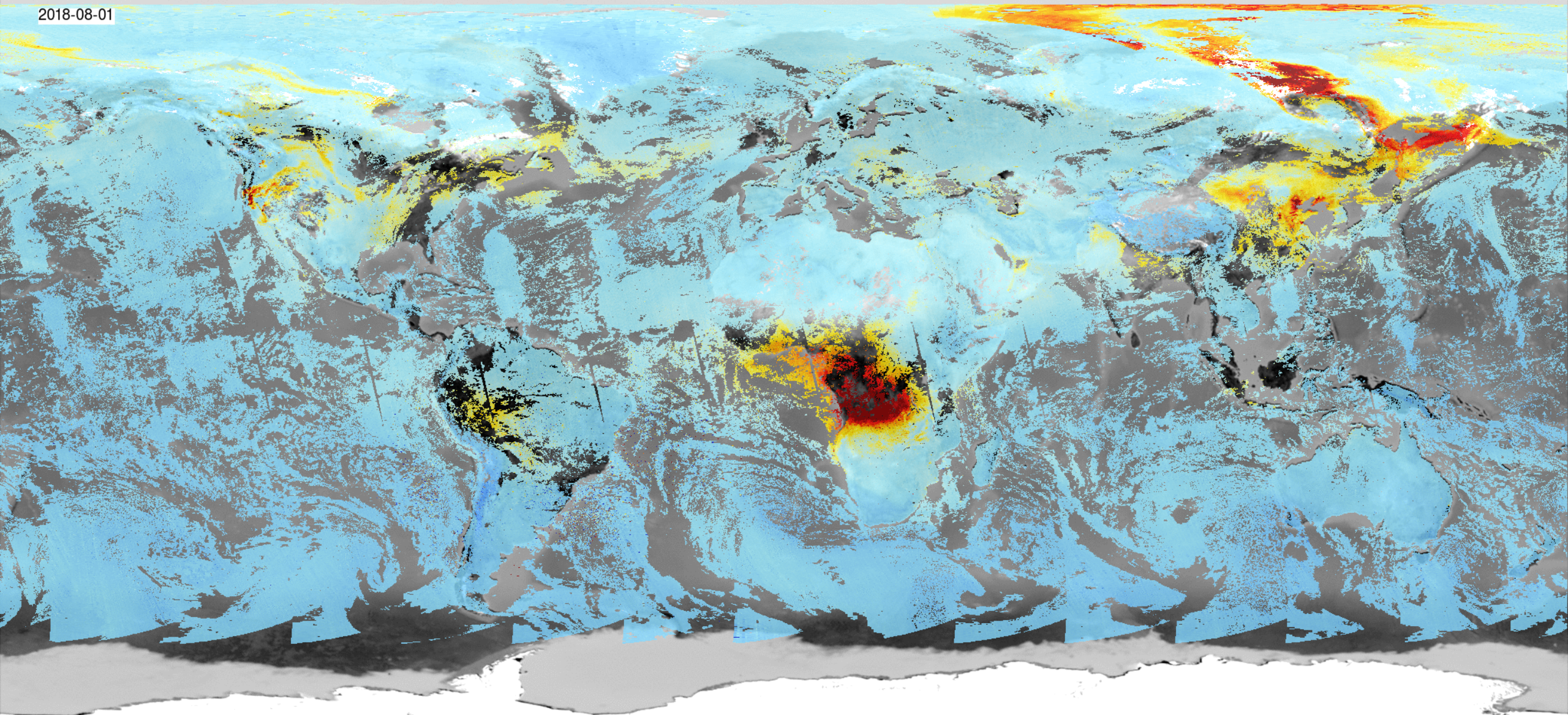


ozone hole



DLR/KNMI

2018-08-01



CO, August 2018

Summary



- S5P/TROPOMI is the first of the atmospheric composition Sentinels
- The TROPOMI performance is excellent
 - Level 1B and part of the L2 data is already released
 - CAMS has started to use L2 data products
- TROPOMI is the LEO part of the Air Quality Constellation.
 - Travelling standard between the geostationary instruments.
 - Spatial resolution is similar to the GEMS, TEMPO and Sentinel-4

veefkind@knmi.nl

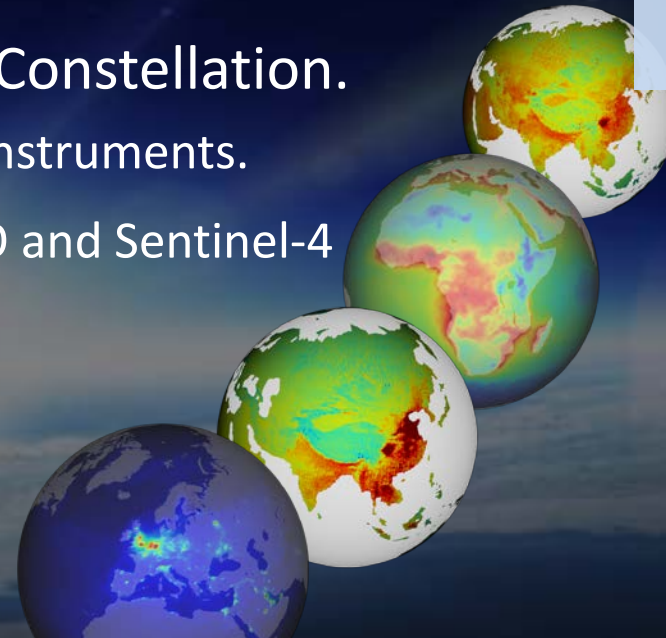
www.tropomi.eu

www.temis.nl

www.knmi.nl/omi

sentinels.copernicus.eu

[#tropomi](https://twitter.com/tropomi)



Copernicus Atmospheric Monitoring Service (CAMS)



- The CAMS global model assimilates several satellite datasets, including OMI, IASI and GOME-2.
- The CAMS data are used as boundary conditions for the nested regional models.
- CAMS system started to use the TROPOMI NO₂, O₃ and CO data.

The screenshot shows the Copernicus Atmospheric Monitoring Service (CAMS) website. The header includes the Copernicus logo, the title "Atmosphere Monitoring Service", social media icons, and a search bar. A navigation menu lists: ABOUT CAMS, NEWS & MEDIA, EVENTS, CATALOGUE, RESOURCES, TENDERS, and HELP & SUPPORT. The main headline reads: "CAMS poised to fully implement newly released Sentinel-5P data". Below this, a breadcrumb trail shows "Home » News & Media » News". The central feature is a map titled "Sentinel-5p NO2 observations" showing nitrogen dioxide concentrations over Europe and North Africa, with a color scale from blue (low) to red (high). To the right of the map is a sidebar with "SERVICE THEMES" (AIR QUALITY & ATMOSPHERIC COMPOSITION, CLIMATE FORCING, OZONE LAYER & UV, SOLAR RADIATION, EMISSIONS AND SURFACE FLUXES), "ANALYSES" (European Air Quality, Fire Monitoring, Reactive Gases, Aerosols), and "FORECASTS" (Reactive Gases, Aerosols, European Air Quality, Ozone Layer, CO2). Below the map, a paragraph explains that Sentinel-5P observations are used in the CAMS forecasting system, averaging data to match the 40 km model resolution. At the bottom, a paragraph states that data from the Sentinel-5P satellite, released by the European Space Agency (ESA), is being processed by CAMS for public use and forecasting.

Copernicus Europe's eyes on Earth

Atmosphere Monitoring Service

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CAMS poised to fully implement newly released Sentinel-5P data

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Sentinel-5p NO2 observations

Copernicus Atmosphere Monitoring Service 2018

Observations of Nitrogen Dioxide (NO₂) from Sentinel-5p as they are used in the CAMS forecasting system. To make maximum use of the many observations relative to the CAMS model spatial resolution of 40 km, neighbouring observations are averaged together. Some of the fine detail is lost, but the signal is improved resulting in improved forecasts (Credit: ECMWF, Copernicus Atmosphere Monitoring Service)

With the official release of data from the Sentinel-5P satellite by the European Space Agency (ESA), a wealth of information about air quality is now available for the public. Observations from Sentinel-5P are being processed and analysed by the Copernicus Atmosphere Monitoring Service (CAMS) and will be ready to forecast air quality and to help with related decision-making later this year.

SERVICE THEMES

- AIR QUALITY & ATMOSPHERIC COMPOSITION
- CLIMATE FORCING
- OZONE LAYER & UV
- SOLAR RADIATION
- EMISSIONS AND SURFACE FLUXES

ANALYSES

- European Air Quality
- Fire Monitoring
- Reactive Gases
- Aerosols

FORECASTS

- Reactive Gases
- Aerosols
- European Air Quality
- Ozone Layer
- CO₂

S5P MPC



S5P Mission Performance Centre

**In-flight
Calibration**

**Quality
Control**
L1B and L2

Communication

**Algorithm
Evolution**
L1B and L2

**Routine
Geophysical
Validation**

**Processor
Maintenance**

www.tropomi.eu

KNMI | BIRA-IASB | DLR | IUP-Bremen | MPI-C | NILU | S[&]T | SRON

S5P – NPP Formation

SENTINEL-5P

Orbit Number: 447
Time Since ANX: 227.240
Lat: 13°N 21' 26"
Lng: 109°W 04' 58"

Alt: 828.825 km

Daylight

Suomi-NPP

Orbit Number: 31333
Time Since ANX: 558.311
Lat: 96°N 53' 23"
Lng: 113°W 52' 44"

Alt: 830.531 km

Daylight

