

Sentinel-5p (S5p) Mission Status and First Results

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S5p, S4, and S5 Missions Manager – ESA***

***TROPOMI results provided by P.
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& co-workers***

May 03 2018 - NOAA

European response to global needs:

- to manage the environment,
- to mitigate the effects of climate change and
- to ensure civil security

European independence, contribution to global system (GEOSS)

Copernicus Space Component



Copernicus Services Component

Sentinel Launches



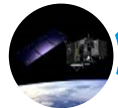
S1A/B: Radar Mission

3 Apr 2014/25 Apr 2016



S2A/B: High Resolution Optical Mission

23 June 2015/6 March 2017



S3A/B: Medium Resolution Imaging and Altimetry Mission
2018



S4A/B: Geostationary Atmospheric Chemistry Mission

2022



S5P: Low Earth Orbit Atmospheric Chemistry Mission

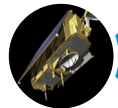


Oct. 2018



S5A/B/C: Low Earth Orbit Atmospheric Chemistry Mission

2021



S6A/B: Altimetry Mission

2020

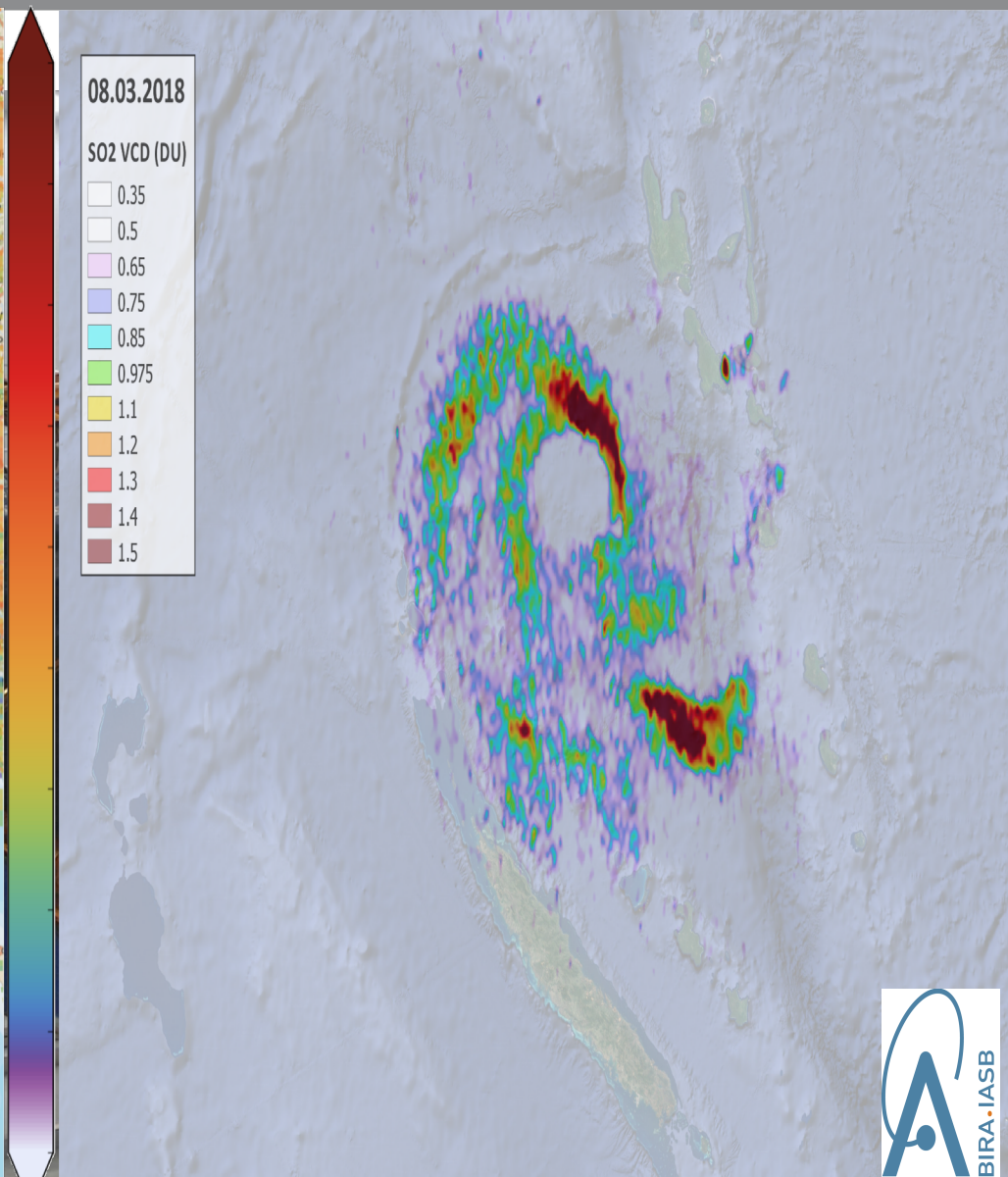


Sentinel-5 Precursor 'PR Slogan'



08.03.2018

SO2 VCD (DU)



Sentinel-5 Precursor

COPERNICUS ATMOSPHERE MISSION IN POLAR ORBIT



The Sentinel-5 Precursor (S-5P) is the first **atmospheric Sentinel** mission focusing on global observations of the atmospheric composition for **air quality** and **climate**.

The TROPOspheric Monitoring Instrument (**TROPOMI**) is the payload of the S-5P mission and was jointly developed by **The Netherlands and ESA**.

S-5P provides **enhanced radiometric sensitivity & spatial resolution** enabling sampling of small-scale variabilities specifically in the lower troposphere.

Launched on **Oct. 13 2017** with a **7 years** design lifetime.

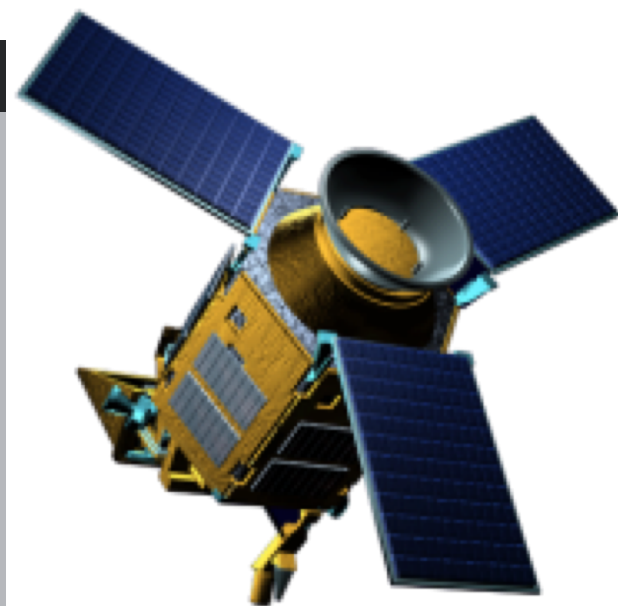
Commissioning Phase

finalised successfully on
24 April 2018.

Ramp-up Phase started on
April 25.

TROPOMI

- ▶ UV-VIS-NIR-SWIR nadir view grating spectrometer.
- ▶ Spectral range: 270-500, 675-775, 2305-2385 nm
- ▶ Spectral Resolution: 0.25-1.1 nm
- ▶ Spatial Resolution: 3.5x7km²
- ▶ Global daily coverage at 13:30 local solar time.



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Copernicus

Sentinel-5 Precursor Budget



STATUS - GRAND TOTAL : 240 M€

ESA contribution (Space + G/S specific): **~133 M€**

The Netherlands Contribution: **~80 M€**

EC Contribution: **~27 M€**

Launcher: ~27 M

Operations : ~11 M/year (starting now)

+ National Contributions from Germany and Belgium

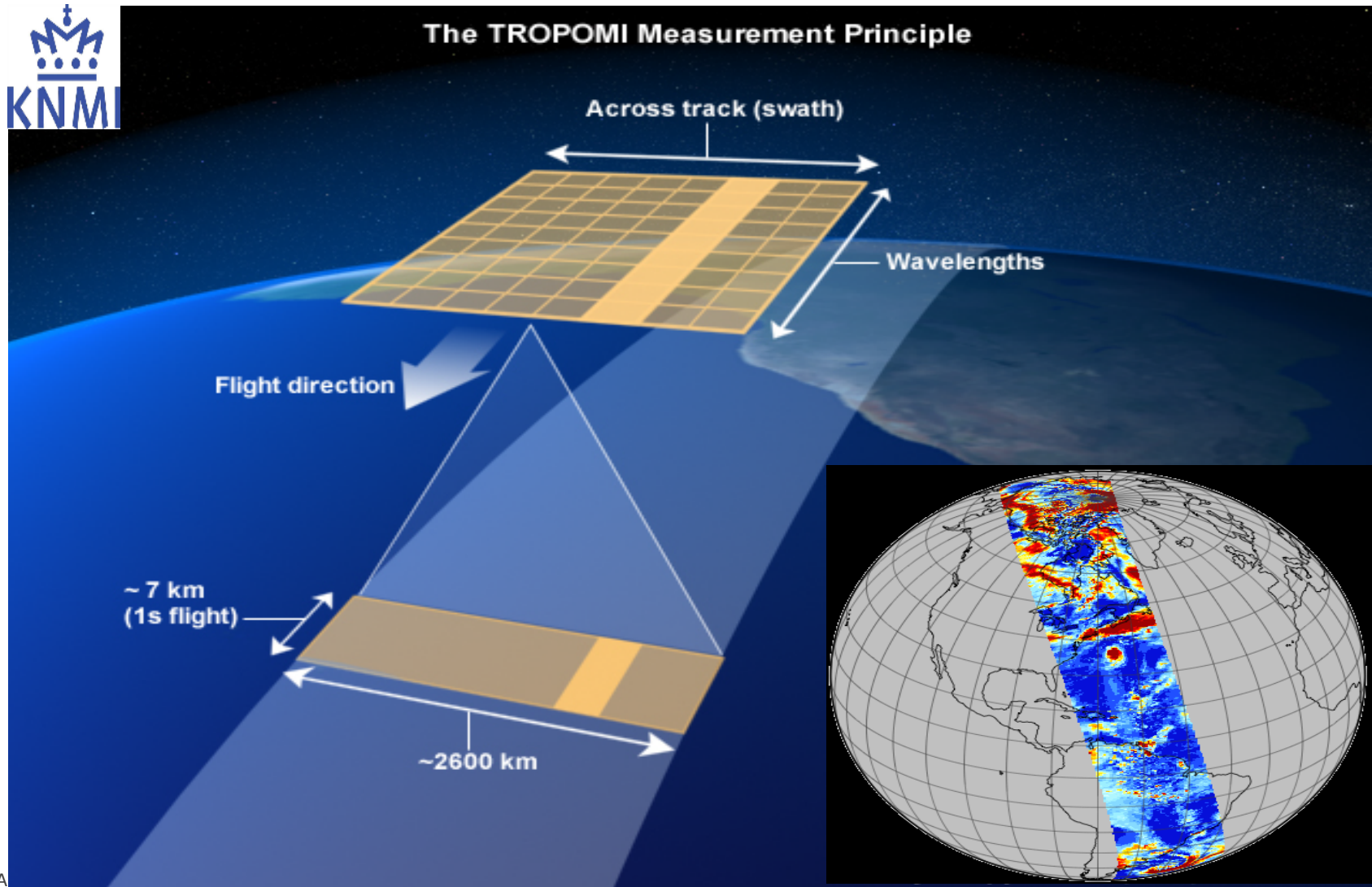
S5p is an operational Copernicus Mission and the owner of it is the EC



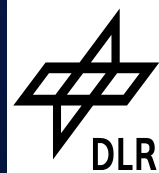
TROPOMI Measurement Principle



The TROPOMI Measurement Principle




ESA



Sentinel-5 Precursor Spectral Bands



	UV		UVIS		NIR		SWIR	
	1	2	3	4	5	6	7	8
Band								
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 [km ²]	7 x 28	7 x 3.5				7 x 3.5	7 x 7	



S5p Commissioning Phase Outcome Ramp-up Phase



Algorithm Investigations for product quality improvement:

- Band 2/3 radiometric inconsistency (impact on O3 profiles)
- Verify the NIR stray-light correction based on the dedicated phase E1 (limb) measurements, verify sun diffuser reflectance characterisation
- Methane retrieval: test the inclusion of the NIR band in the retrieval, reduce delivery time (within 2 days as requested by the **Copernicus Atmospheric Monitoring Service (CAMS)** rather than 2 weeks)

TROPOMI Operations: QWG/Experts to investigate possible impact of reduced along-track spatial resolution of 5.5 km on all Level 2 processors

Spacecraft Operations: QWG/Experts to investigate possible off-set S5p operations in order to fill the small gap over the equator on all processors

On-board fuel for additional 13 years of operations (in theory).

Ramp-up phase has started preparing a WS on the first S5p product release – **June 25/26 ESRIN** - Start full qualified operations after the Routine Operations Readiness Review (**RORR**) Meeting - **Dec. 2018**.

Sentinel-5 Precursor Product Releases

Product	Main Parameter
UV Aerosol Index	Aerosol index
Cloud Properties	Fraction, optical depth, top height
Nitrogen Dioxide (NO ₂)	Total and tropospheric columns
Total Ozone (O ₃)	NRT total column
Carbon Monoxide (CO)	NTC total column
NPP_CLOUD	Cloud mask from VIIRS
Sulphur Dioxide (SO ₂)	Total column
Formaldehyde (HCHO)	Total column
Tropospheric Ozone	Tropospheric column
Methane (CH ₄)	Total column
Carbon Monoxide (CO)	NRT total column
Total Ozone (O ₃)	NTC total column
Aerosol Layer Height	Mid-level pressure
Ozone Profiles	Total and tropospheric profiles
UV	UV dose

Staggered Product Releases to the Public

June 2018

August 2018

October 2018

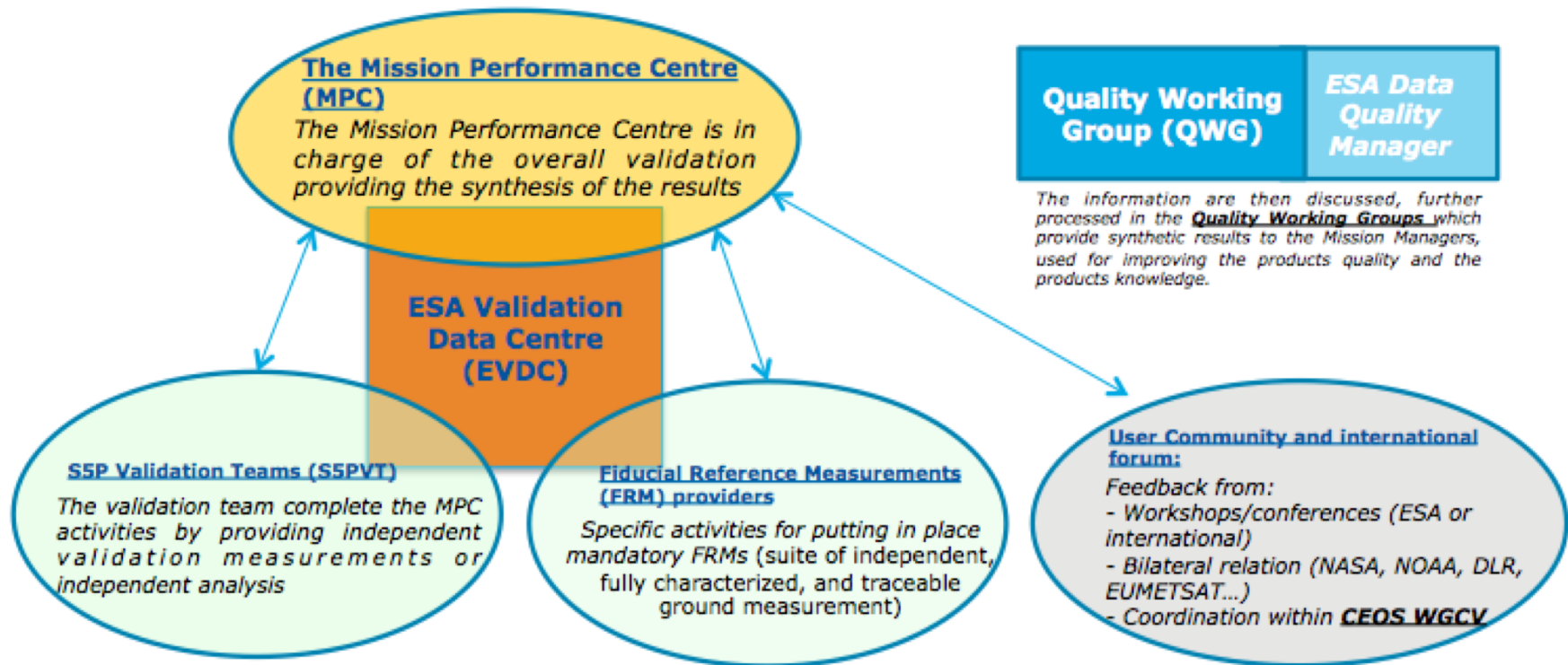
December 2018



S5p Cal/Val Plan – First Product Release Workshop at ESRIN



<https://sentinel.esa.int/documents/247904/2474724/Sentinel-5P-Calibration-and-Validation-Plan.pdf>



Workshop on the first release of S5p products – 25/26 June at ESRIN:
<https://nikal.eventsair.com/sentinel-5p-first-product-release-workshop/sentinel-5p>

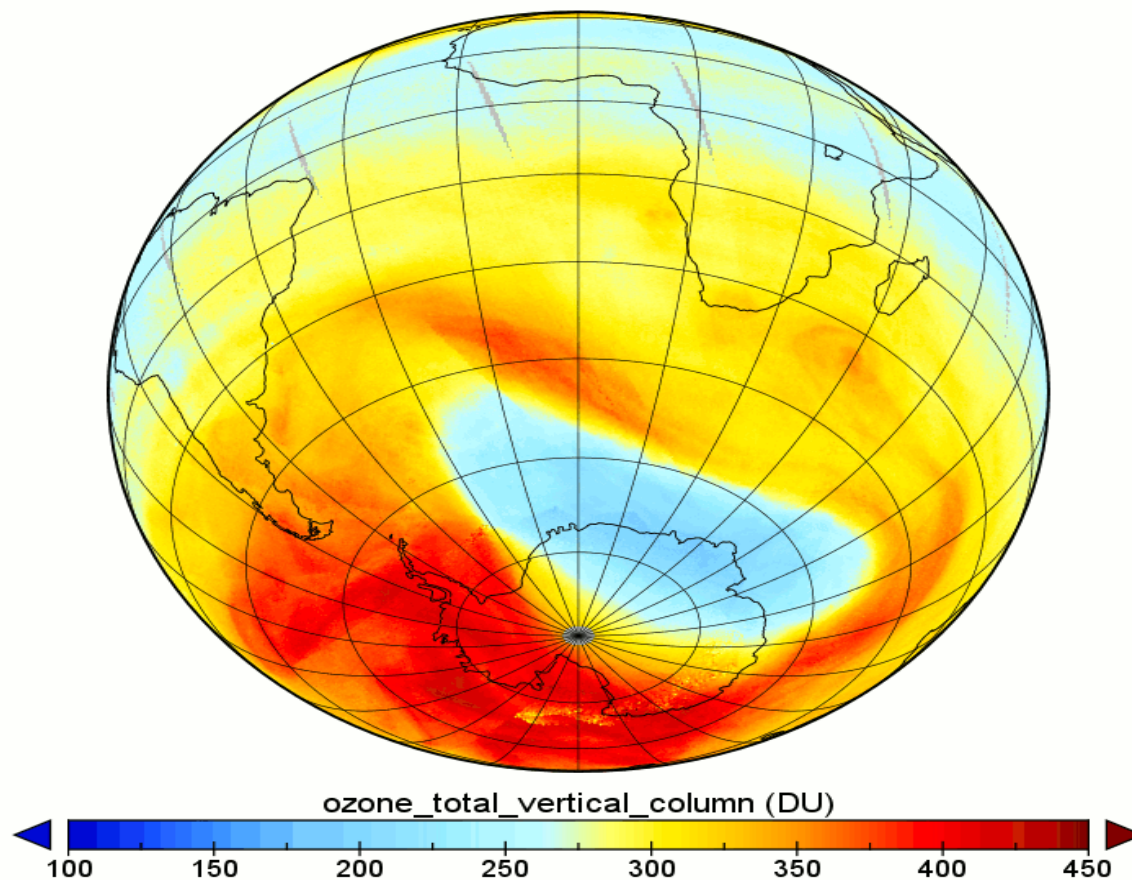
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Sentinel-5 Precursor Results



ozone_total_vertical_column
TROPOMI, S5P, Nov 2017, DLR



09

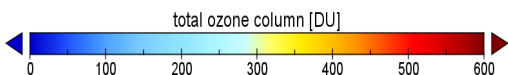
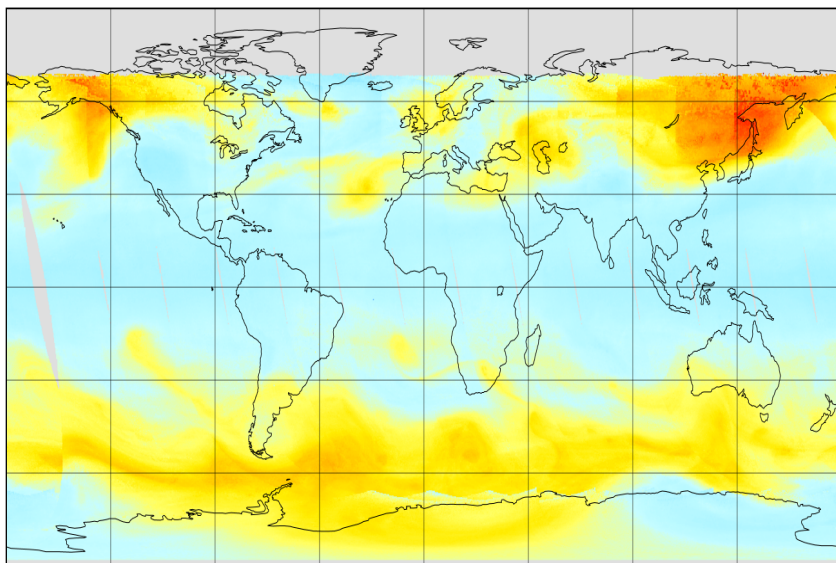
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Sentinel-5 Precursor Results: NRT 03

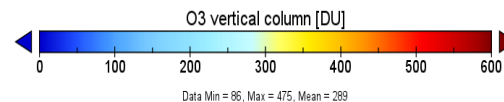
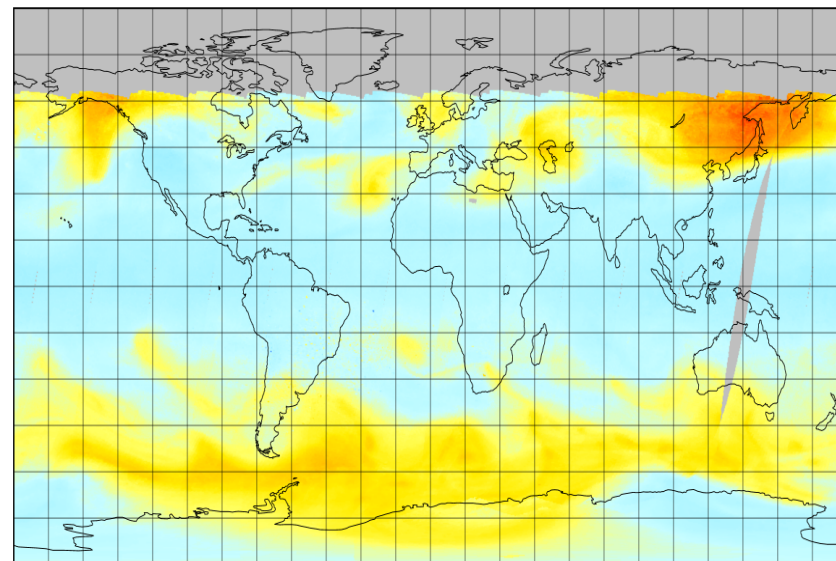


ozone_total_vertical_column
S5P TROPOMI, 2017-11-25, DLR



DLR/BIRA/ESA

ozone_total_vertical_column
MetOp A and MetOp B, GOME-2, 2017-11-25, DLR



AC-SAF/EUMETSAT

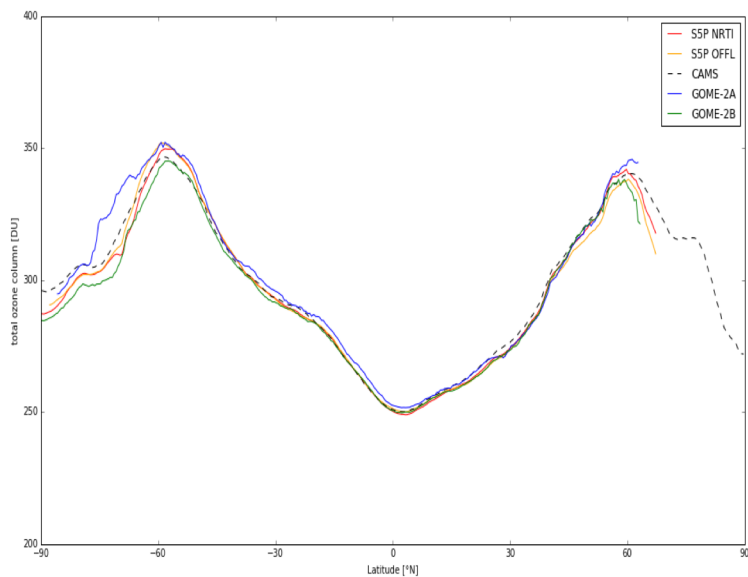
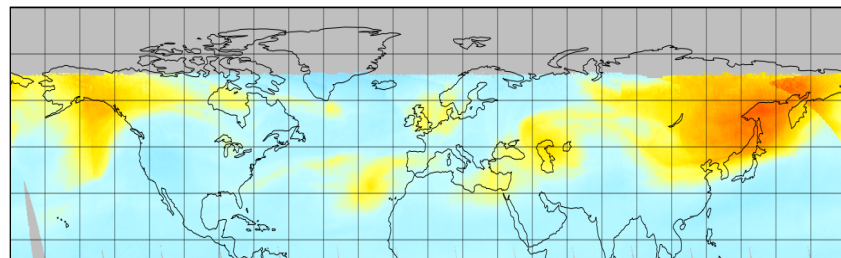
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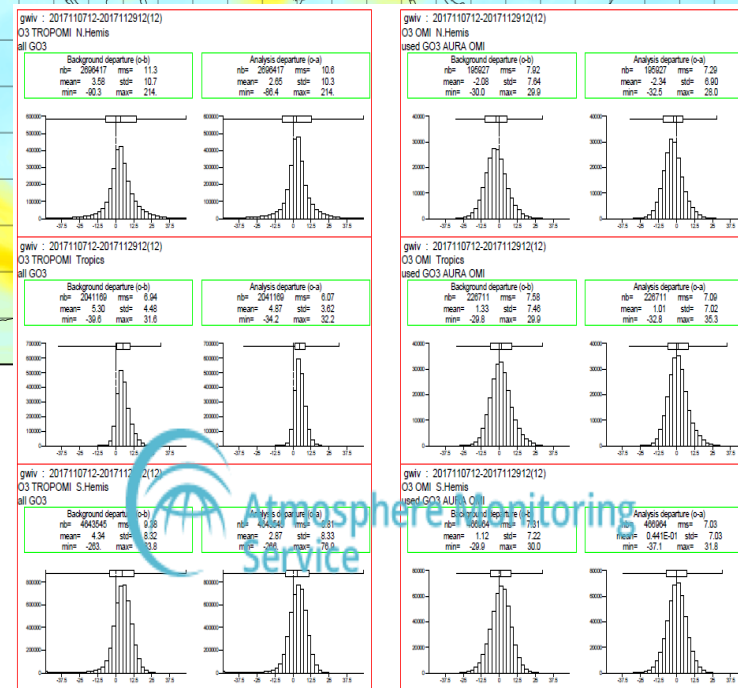
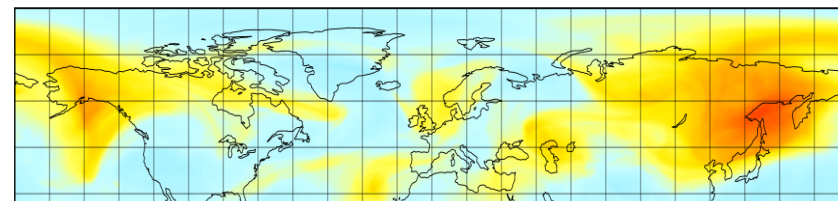
Sentinel-5 Precursor Results: NTC 03



ozone_total_vertical_column
SSP TROPOMI, 2017-11-25



CAMS Total column ozone
2017-11-25



BIRA/DLR/ESA

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CAMS/ECMWF
Courtesy Antje Inness

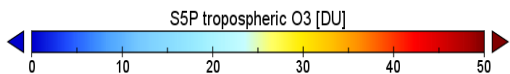
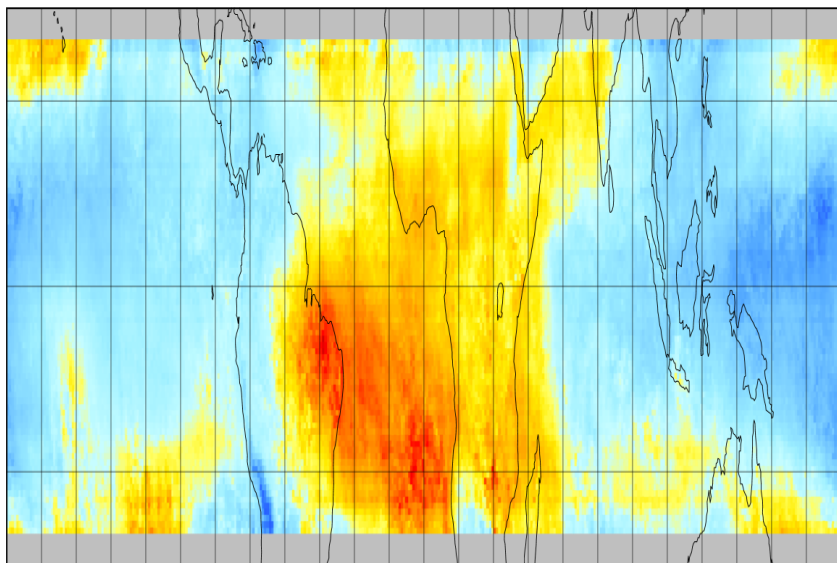


Sentinel-5 Precursor Results: Trop. O3 esa



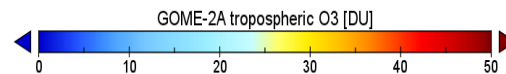
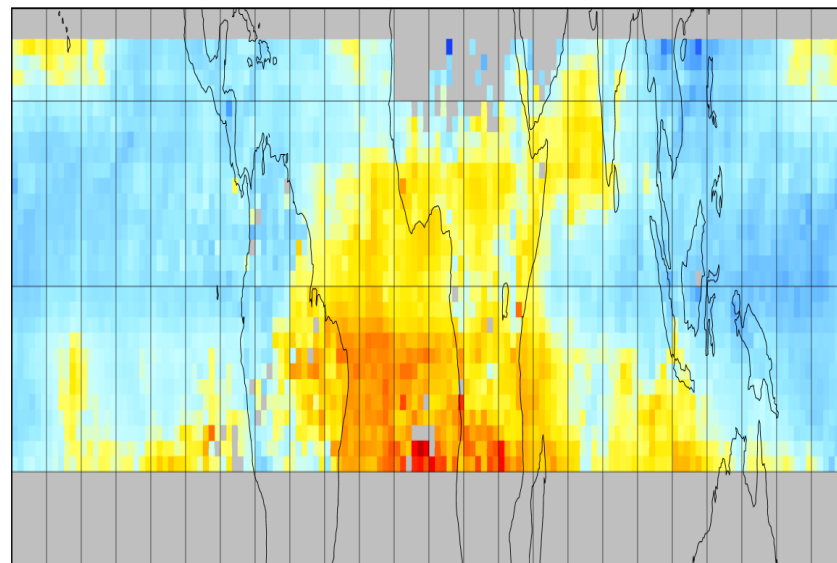
DLR

ozone_tropospheric_vertical_column
S5P TROPOM, 2017-11, DLR



DLR/ESA

ozone_tropospheric_vertical_column
GOME-2 MetOp-A, 2017-11, DLR

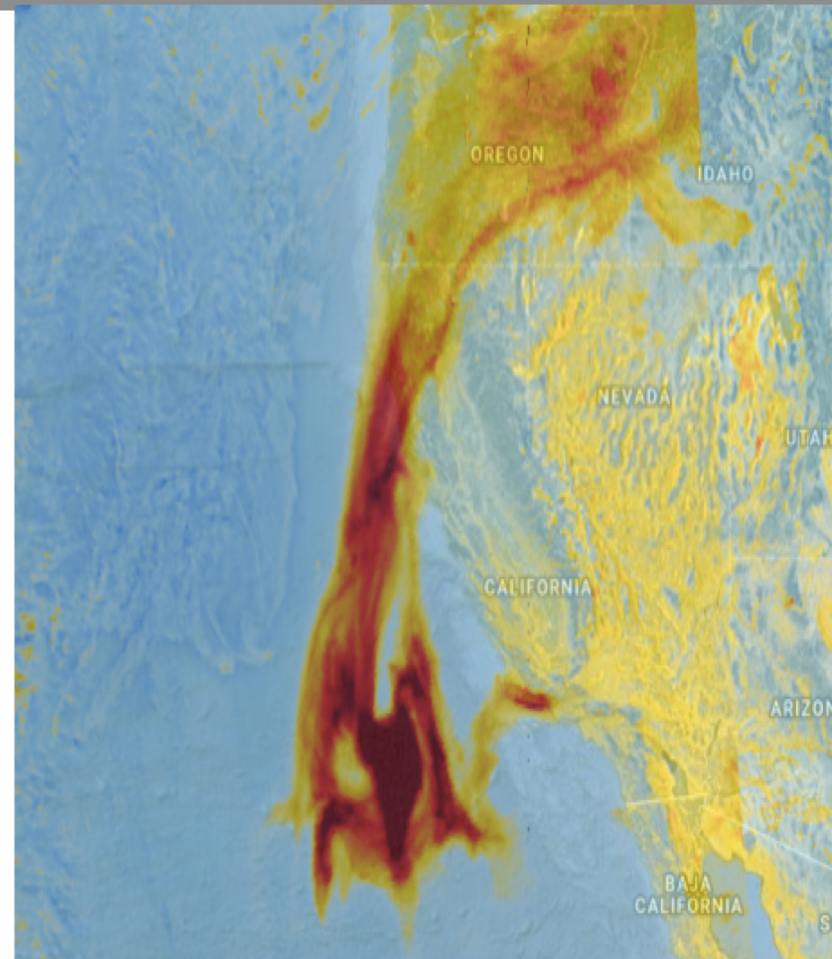


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Sentinel-5 Precursor Results: AAI



Californian wildfires, 12-12-2017

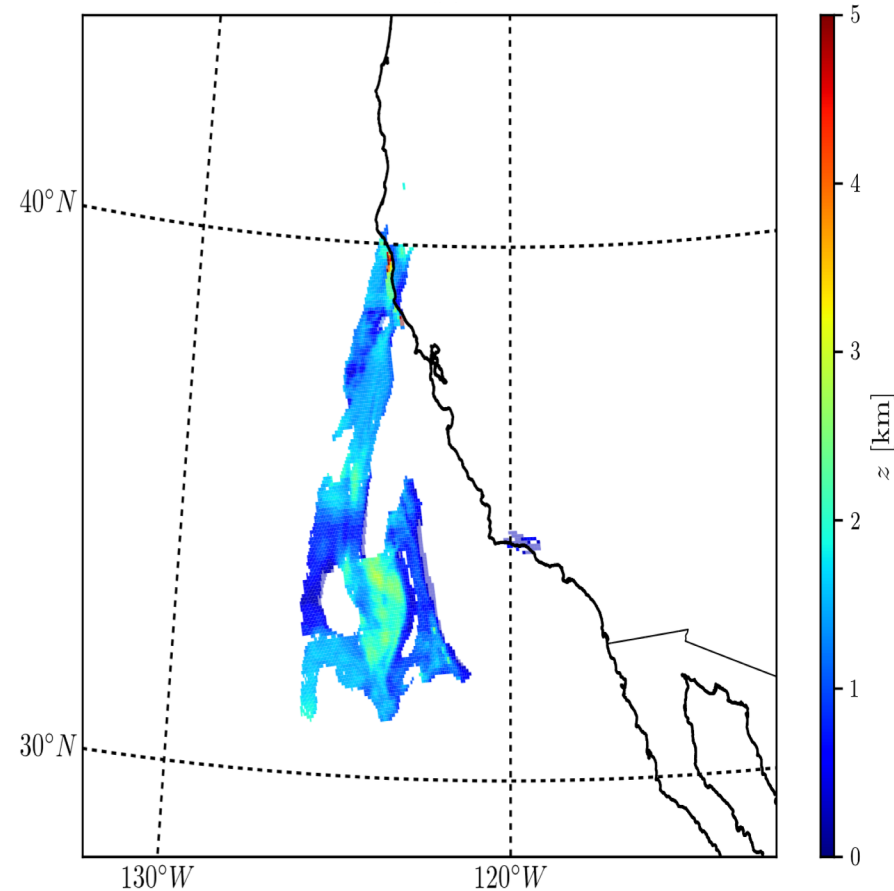
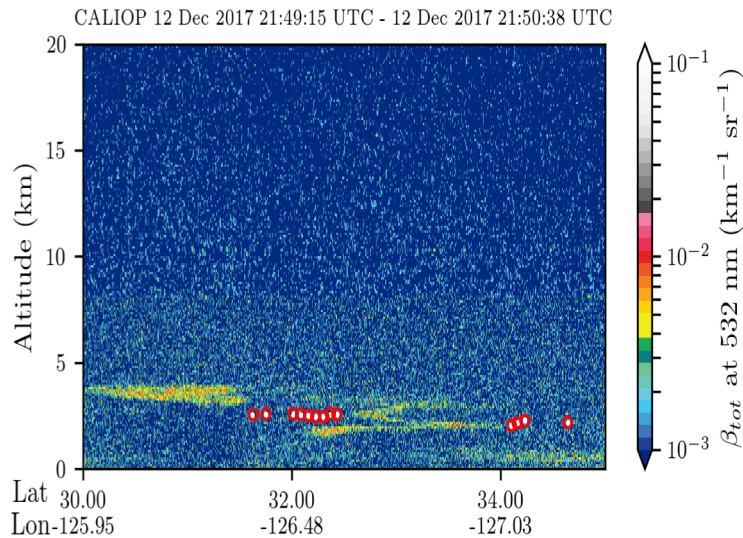
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Sentinel-5 Precursor Results: Aerosol Layer Height



Aerosol Layer Height retrieval of
the 12 Dec 2017 California fires
Good comparison with CALIPSO.



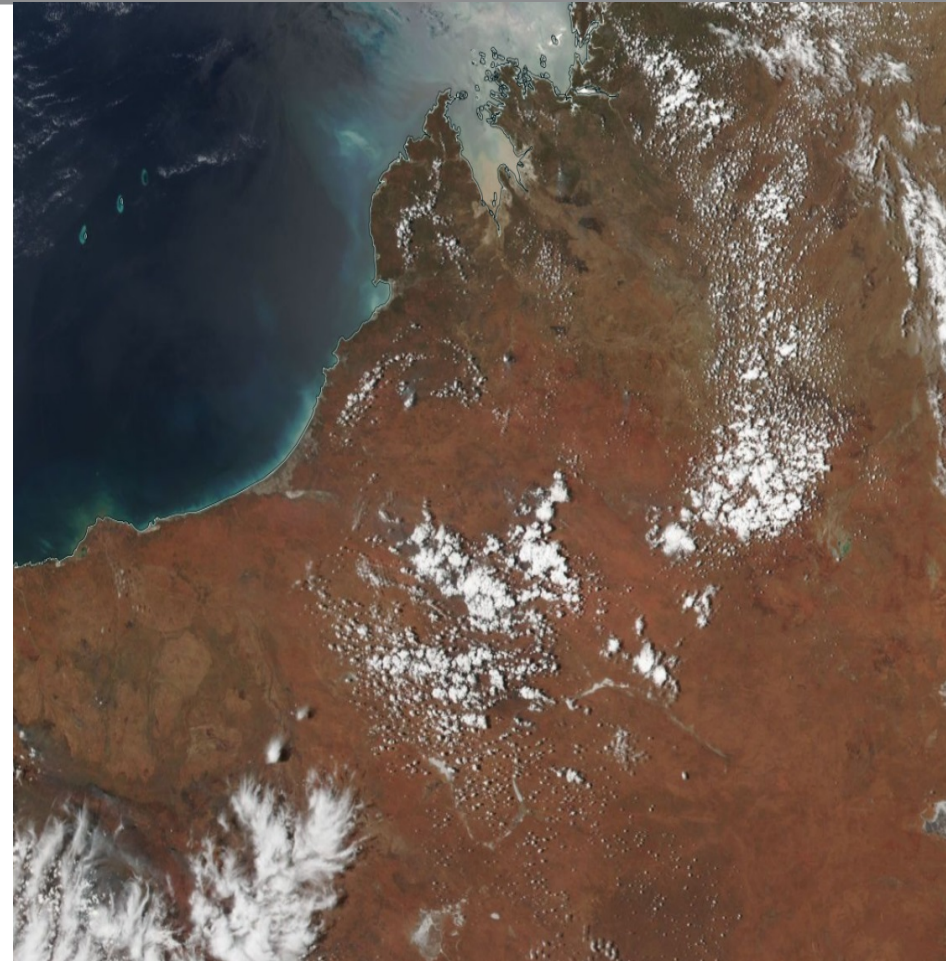
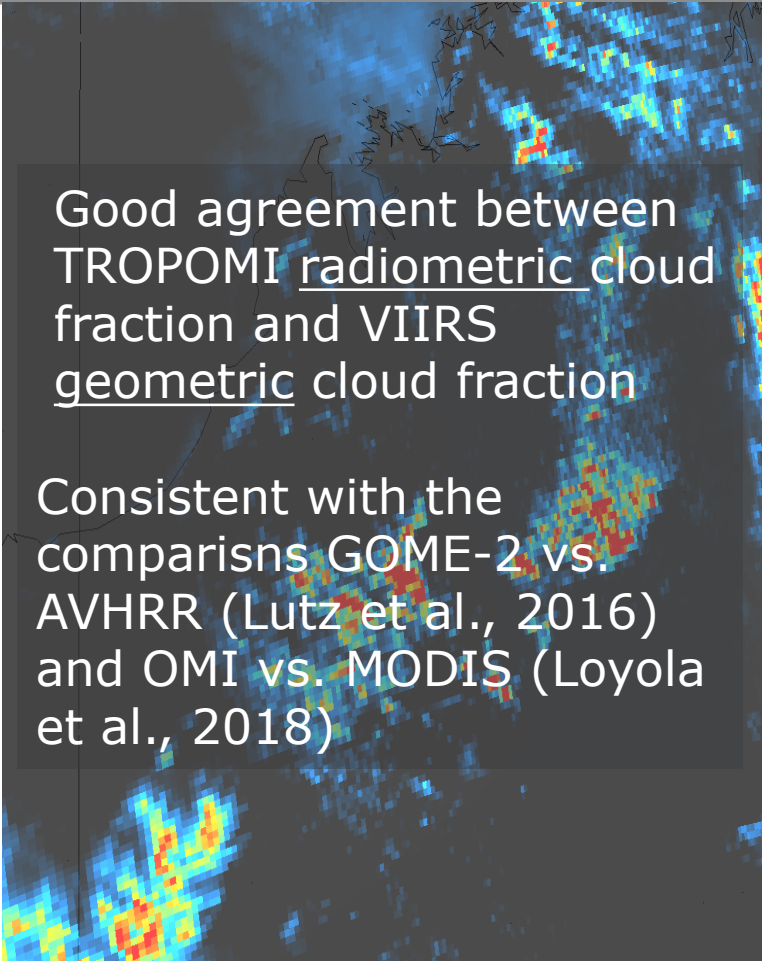
Californian wildfires, 12-12-2017



Sentinel-5 Precursor Results: Cloud Properties



DLR



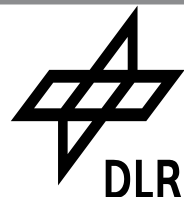
DLR/ESA OCRA Cloud Fraction

**VIIRS/NASA
11 Nov 2017**

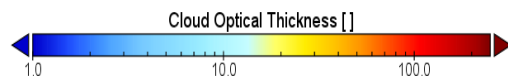
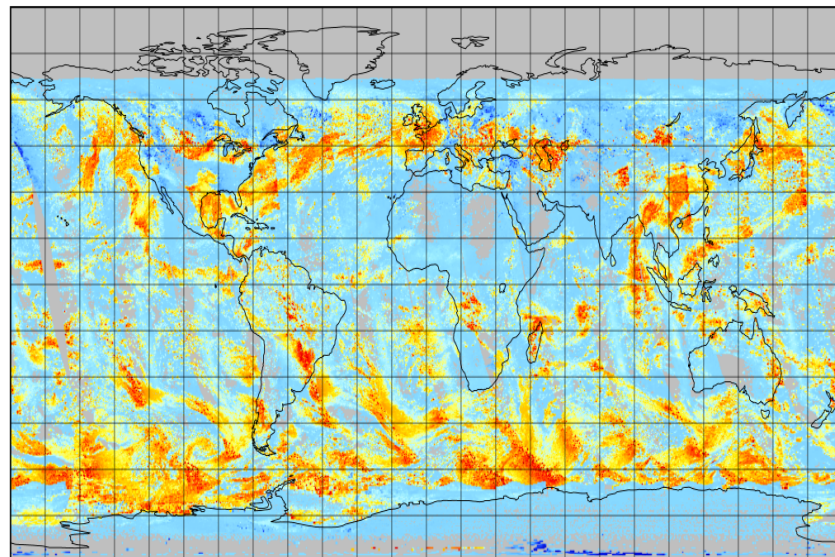
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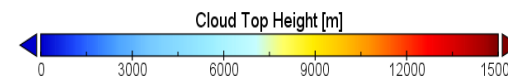
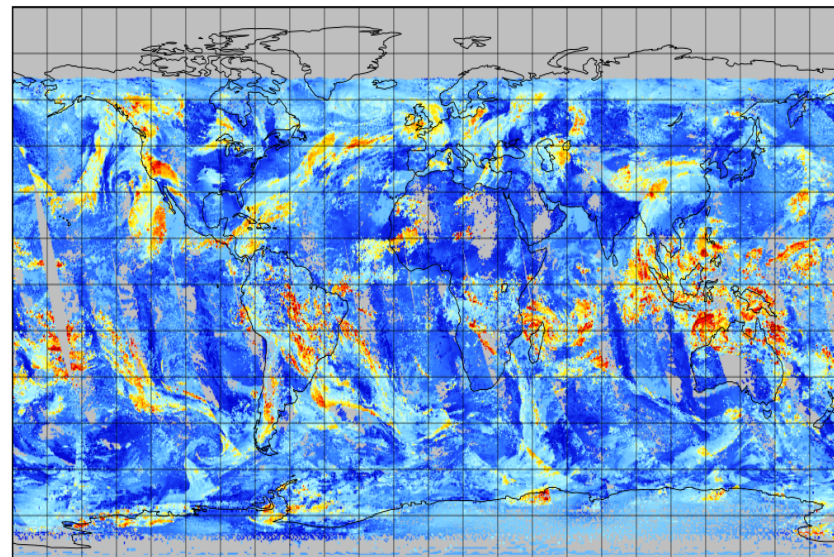
Sentinel-5 Precursor Results: Cloud Properties



ROCINN_CAL algorithm



ROCINN_CAL algorithm



Two set of cloud products provided:

ROCINN Clouds As Layers (CAL), physically more realistic model

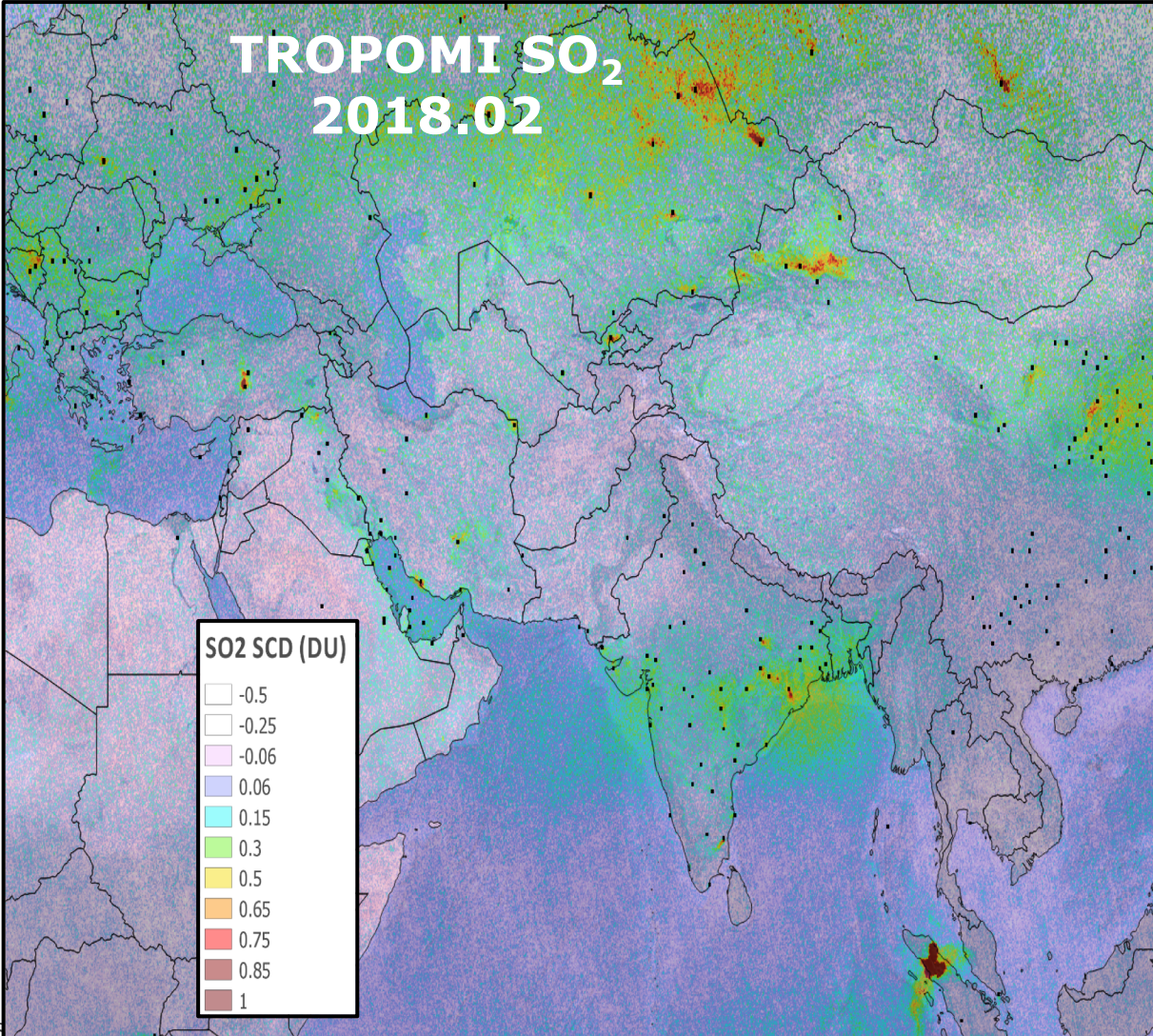
ROCINN Clouds as Reflecting Boundaries (CRB), simplified Lambertian model

Good agreement with VIIRS cloud products from NASA

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Sentinel-5 Precursor Results: SO₂



OMI SO₂
sources catalogue
(Fioletov et al.,
2016)

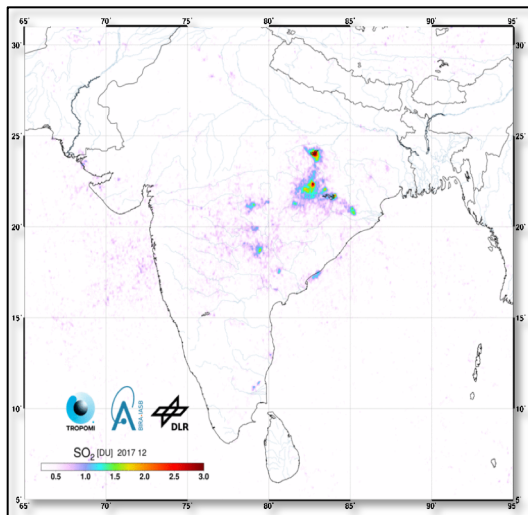
ESA UNCLASS



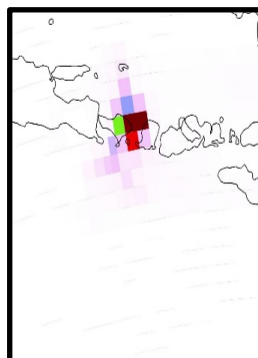
Sentinel-5 Precursor Results: SO₂



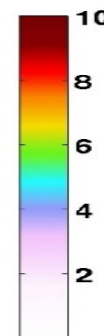
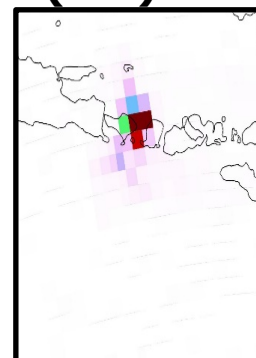
TROPOMI



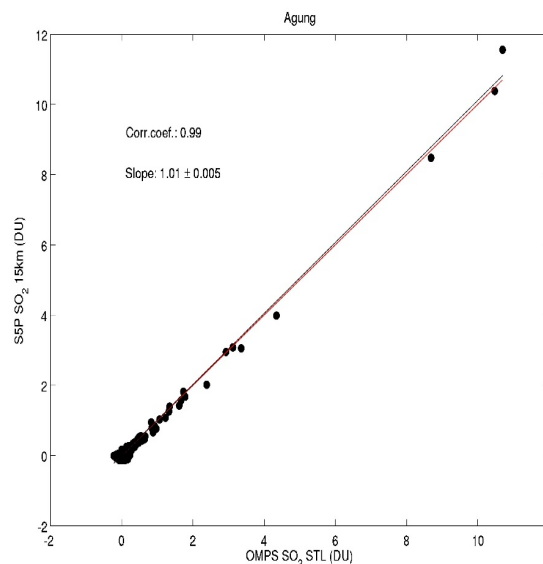
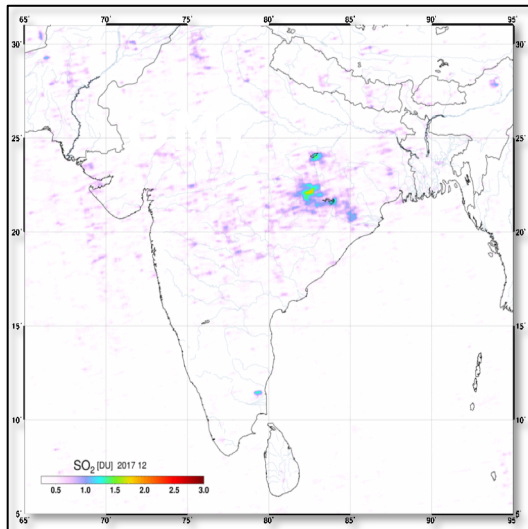
S5P SO₂
(DU) 15 km



OMPS SO₂
(DU) STL



OMI



Courtesy
C. Li & N. Krotkov
(NASA)

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