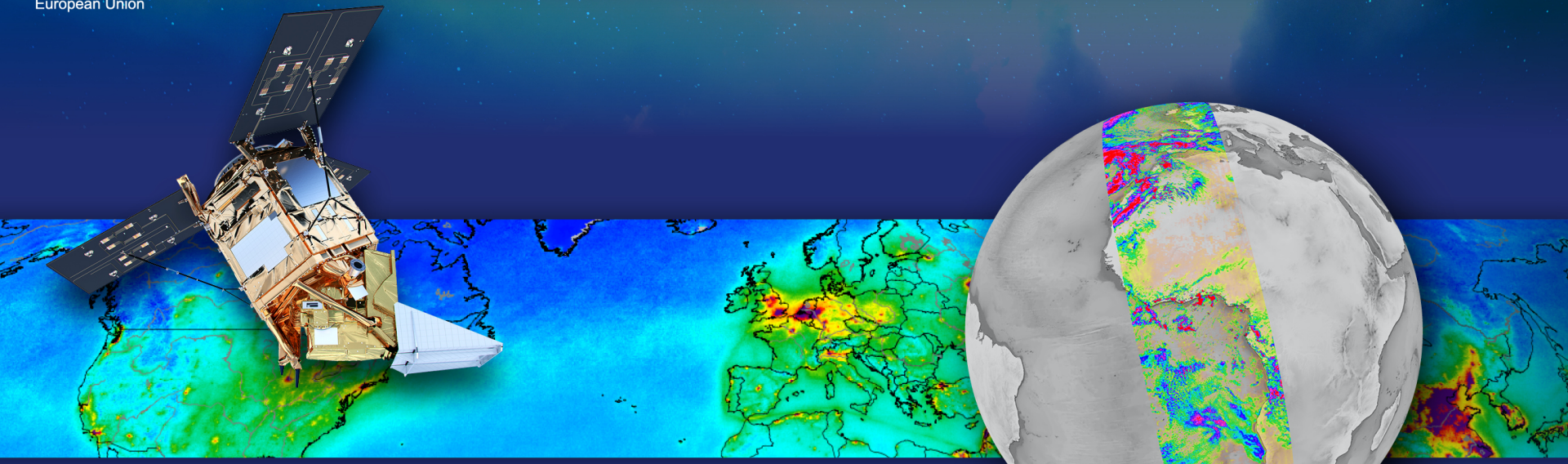




European Union

# Sentinel-5P Products and Applications



**User Workshop on Satellite Atmospheric Composition:  
raising awareness and expert consultation, 23-25 June**

**C. Zehner – ESA – Sentinel-5 Precursor Mission Manager**

# Sentinel-5 Precursor: first atmospheric Sentinel Mission



- **Launched:** 13 October 2017, Plesetsk
- **Launcher:** Rocket
- **Main Payload:** TROPOMI (co-funded by The Netherlands and ESA) - Hyper-spectral push-broom imaging spectrometer, 4 spectrometers with 2D detectors with 4000 spectral channels
- **Orbit:** Altitude of 820 km, 227 orbit repeat cycle
- **Daily Global Coverage:** 13:30 ascending node crossing time
- **Spatial Sampling:** in nadir 5.5 x 3.5 km, 24 million ground pixels per day
- **Mission Control:** ESOC
- **TROPOMI Mission Planning:** KNMI
- **Ground Stations:** Svalbard (NOR) and Inuvik (Canada)
- **Operational Data Processing:** DLR (on behalf of ESA)
- **Mission Design Life Time:** ~7 years
- **Mission Objective:** provide measurements for Ozone, Air Quality, and Climate Monitoring and Forecasting

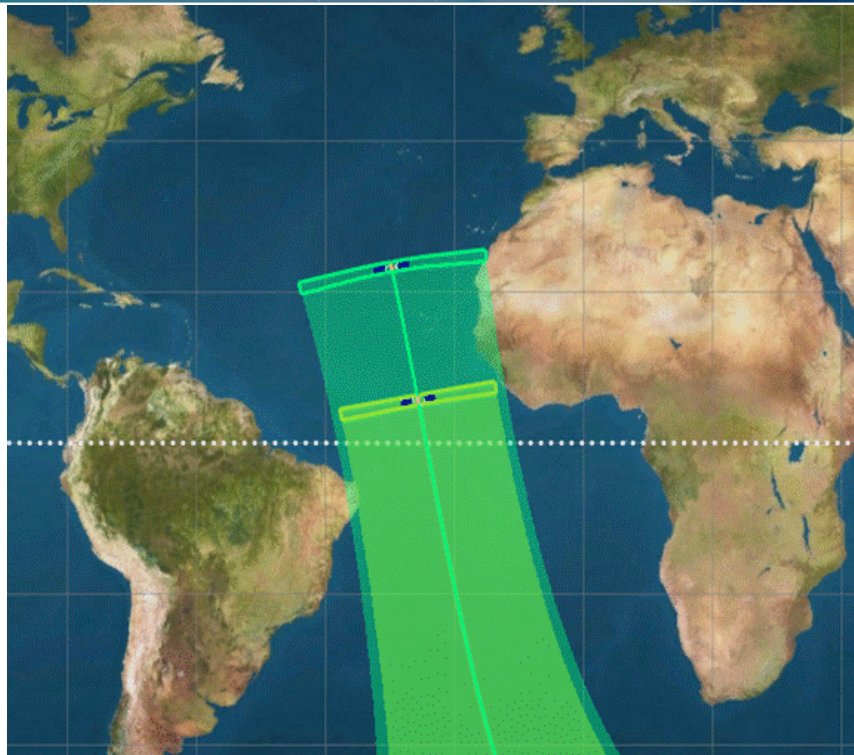




# Loose Formation flying of Sentinel-5P with Suomi-NPP



- improved Sentinel-5P/TROPOMI Methane retrieval
- intercomparison/validation of the products from both satellites
- future synergistic data exploitation



# Sentinel-5P Products



European Union



**Sentinel-5 Precursor mission operations → in operations since April 2018 and in routine operations since March 2019**

**Sentinel-5P TROPOMI  
NO<sub>2</sub> tropospheric column  
April 2018 - March 2019**

**Aerosol Layer Height - September 30 2019**

**Methane (CH<sub>4</sub>)**

**Tropospheric Ozone Column (trop. O<sub>3</sub>) - March 2019**

**Sulfur Dioxide (SO<sub>2</sub>)**

**Formaldehyde (OCHO) - October 2018**

**Total Columns of Ozone (O<sub>3</sub>)**

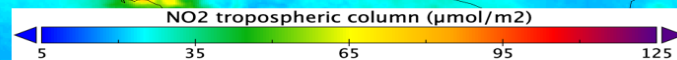
**Nitrogen Dioxide (NO<sub>2</sub>)**

**Carbon Monoxide (CO)**

**Cloud information**

**Aerosol information**

**Radiances/Irradiances – July 2018**











*Copyright: Contains modified Copernicus Sentinel data (2018-2019) / processed by KNMI*



# Sentinel-5P – L2 Product Portfolio



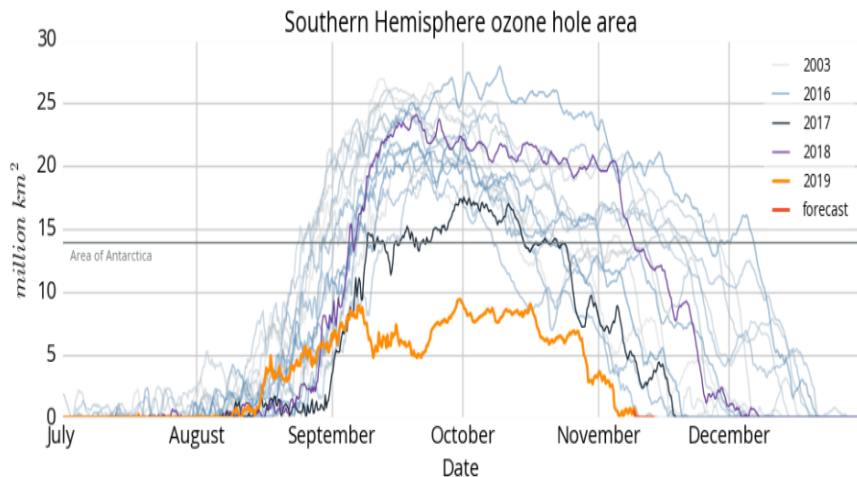
Parameter	Data Product	Vertical Resolution	Bias	Random
Ozone 	<b>Ozone Profile</b>	<b>6 km</b>	<b>10-30%</b>	<b>10%</b>
	Total Ozone	total column	3.5-5%	1.6-2.5%
	Tropospheric Ozone	trop column	25%	25%
NO <sub>2</sub> 	Stratospheric NO <sub>2</sub>	strat column	<10%	0.5e15
	Tropospheric NO <sub>2</sub>	trop column	25-50%	0.7e15
SO <sub>2</sub> 	SO <sub>2</sub> enhanced	total column	30%	0.15-0.3 (0.06-0.12) DU
	Total SO <sub>2</sub>	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 <sub>4</sub>	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			

# Sentinel-5P Ozone Hole Monitoring



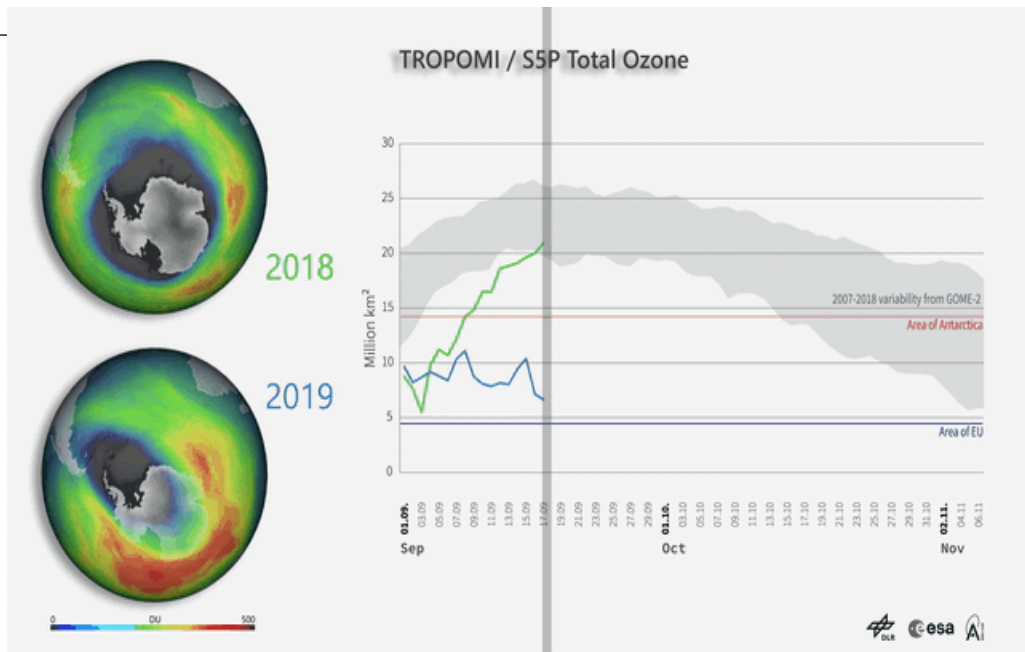
[http://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-5P/Ozone\\_hole\\_set\\_to\\_close](http://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Ozone_hole_set_to_close)

Ozone hole area



Last update: 2019-11-10T10:15Z

@CopernicusECMWF

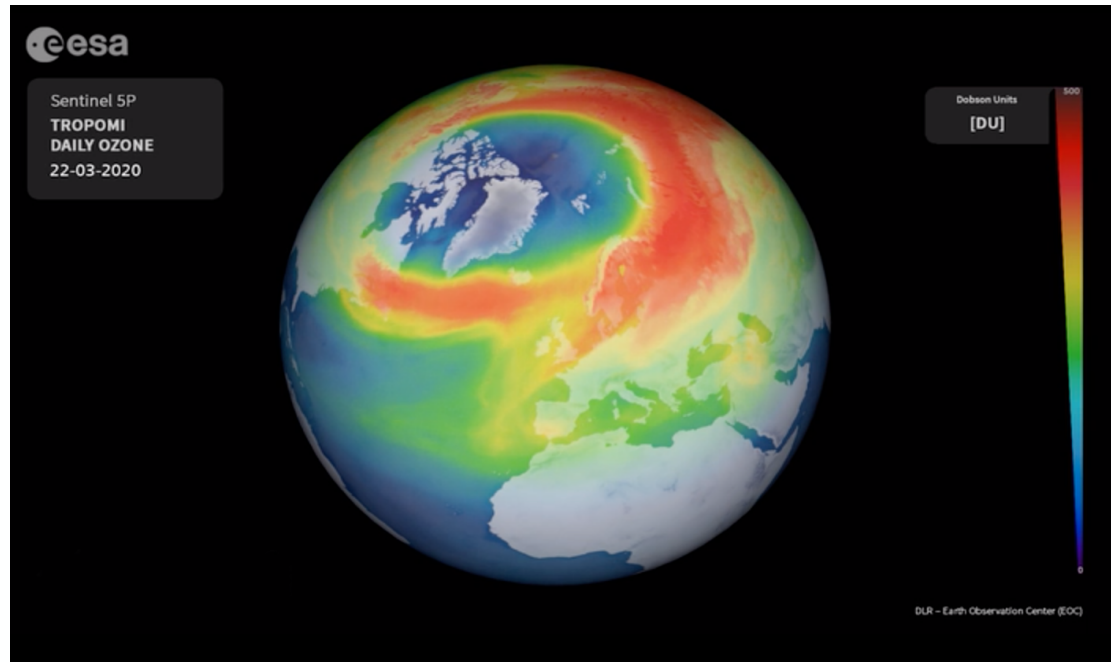




# Sentinel-5P Ozone Hole Monitoring



[https://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-5P/Unusual\\_ozone\\_hole\\_opens\\_over\\_the\\_Arctic](https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Unusual_ozone_hole_opens_over_the_Arctic)



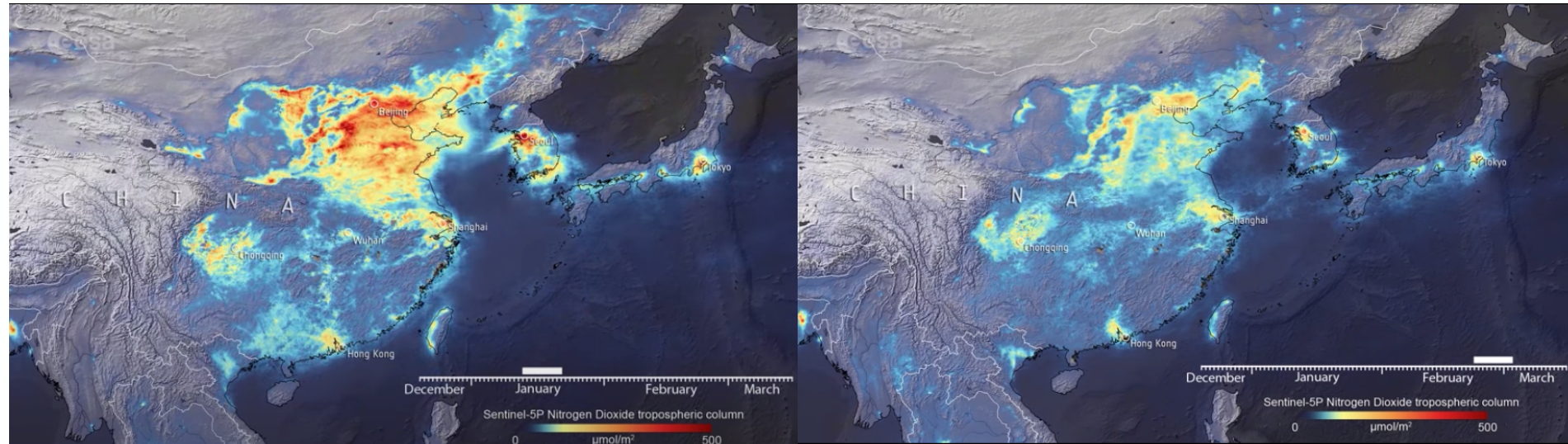
Copyright: Contains modified Copernicus Sentinel data (2020) / processed by DLR

# COVID-19 impact as 'seen' by Sentinel-5P



[https://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-5P/COVID-19\\_nitrogen\\_dioxide\\_over\\_China](https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/COVID-19_nitrogen_dioxide_over_China)

Nitrogen Dioxide concentrations over China – ESA Webportal story issued during March 2020



Copyright: Contains modified Copernicus Sentinel data (2019/20) / processed by ESA

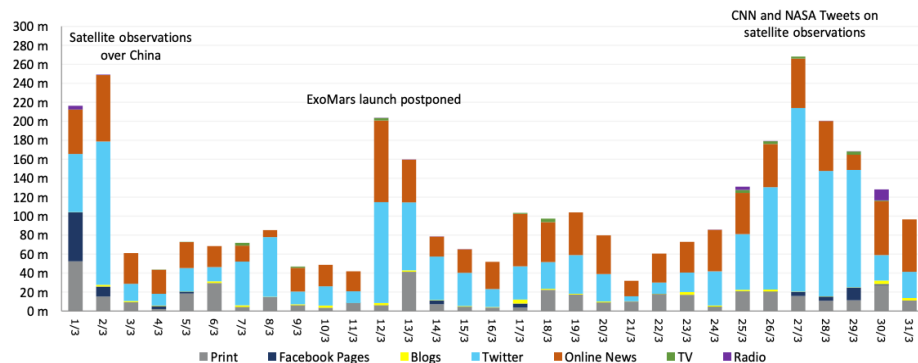


# COVID-19 impact as 'seen' by Sentinel-5P (March 2020 - ESA internal Statistics)



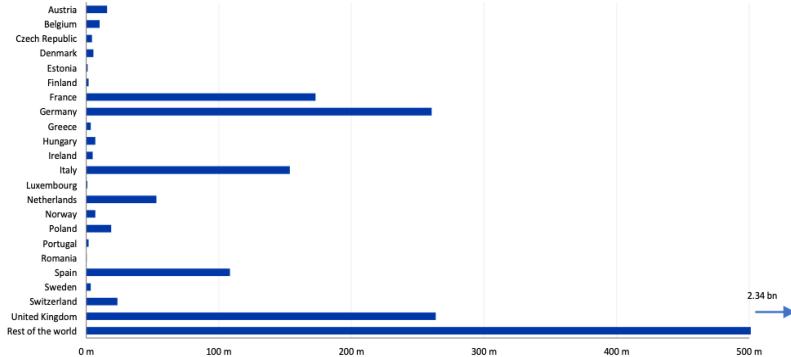
## ExoMars and Sentinel-5P drive the media visibility

Visibility by date and by channel (Gross Reach)



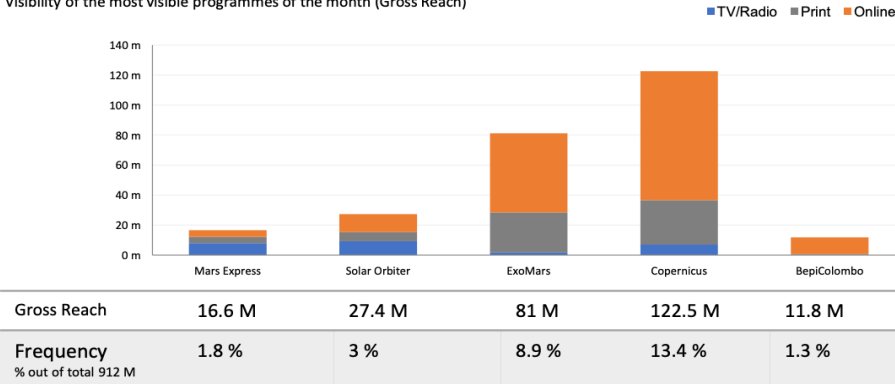
## 32 % of the visibility generated by ESA member states media

Visibility by country (Gross Reach)



## Programmes

Visibility of the most visible programmes of the month (Gross Reach)



## Key messages

### Italy

- Italy was overwhelmingly the story which gained most traction in March. 53% of all Facebook posts were focused on NO2 drops in Northern Italy.

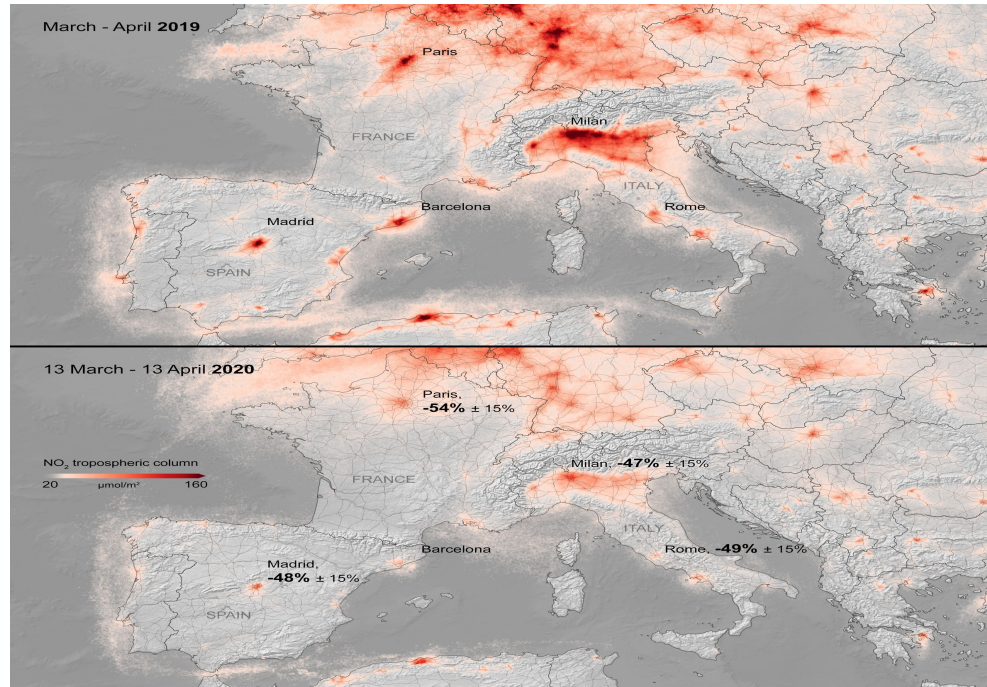
### China

- China also featured prominently, though the posts looked at increasing emissions after the lockdown was relaxed. 12% of all Facebook posts focused on China.

# COVID-19 impact as 'seen' by Sentinel-5P



[http://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-5P/Air\\_pollution\\_remains\\_low\\_as\\_Europeans\\_stay\\_at\\_home](http://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Air_pollution_remains_low_as_Europeans_stay_at_home)



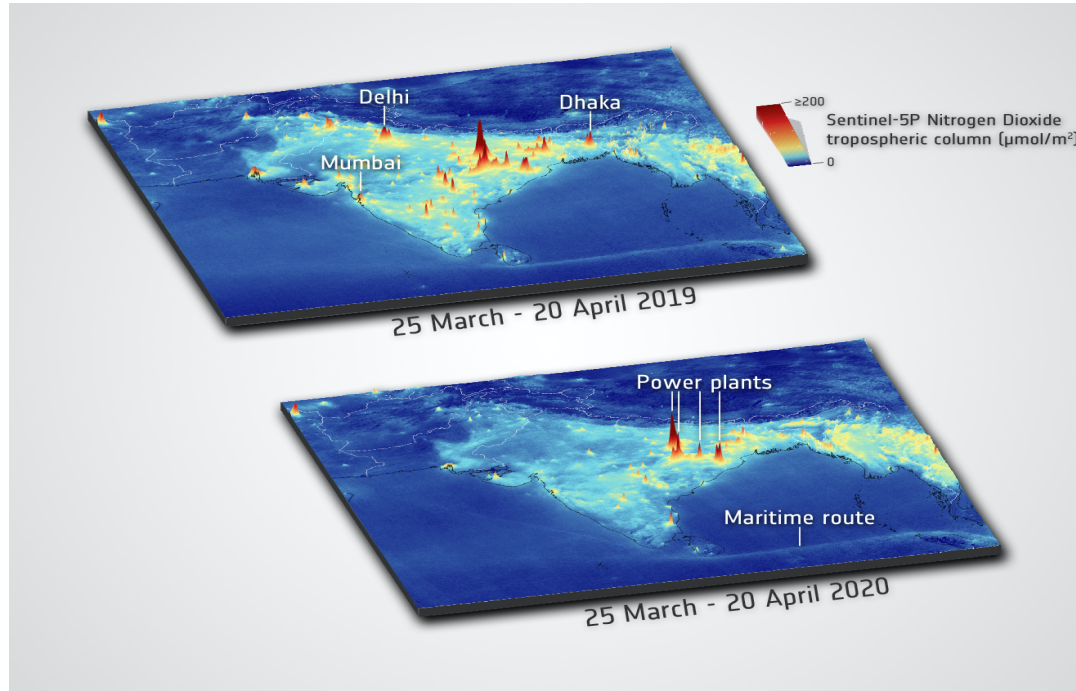
Copyright: Contains modified Copernicus Sentinel data (2019/20) / processed by ESA/KNMI



# COVID-19 impact as 'seen' by Sentinel-5P



[http://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-5P/Air\\_pollution\\_drops\\_in\\_India\\_following\\_lockdown](http://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Air_pollution_drops_in_India_following_lockdown)

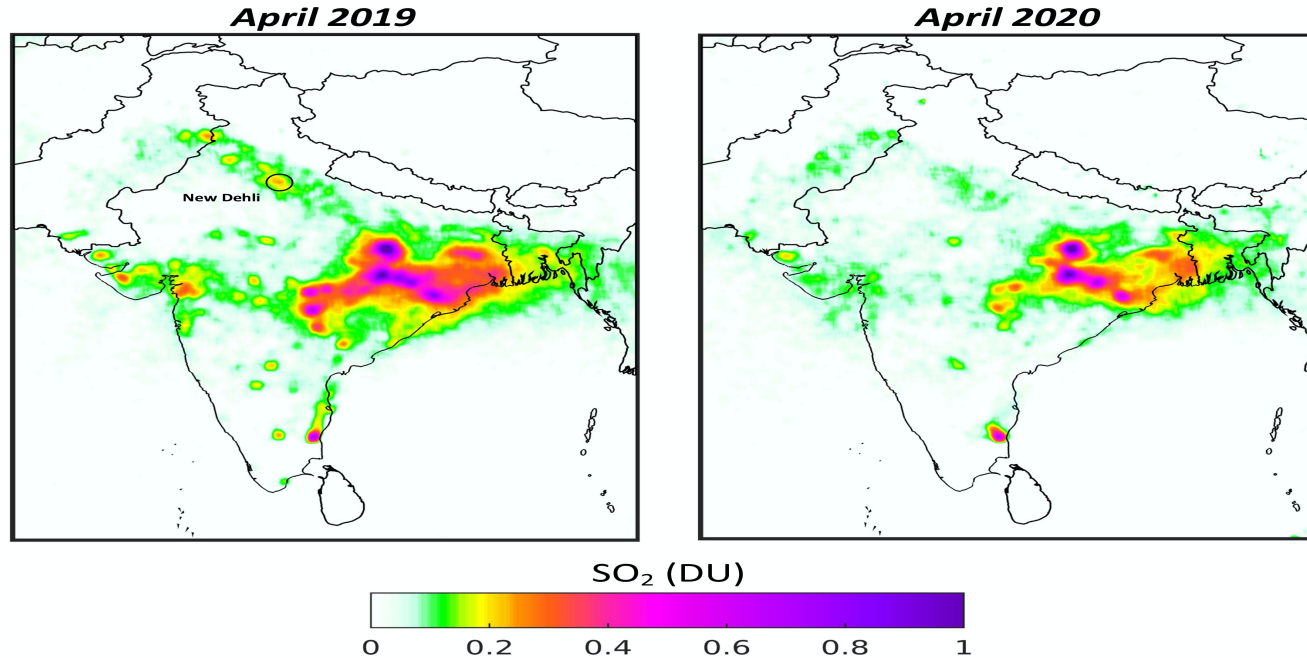


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# COVID-19 impact as 'seen' by Sentinel-5P



## Sentinel-5P Sulphur Dioxide Measurements over India



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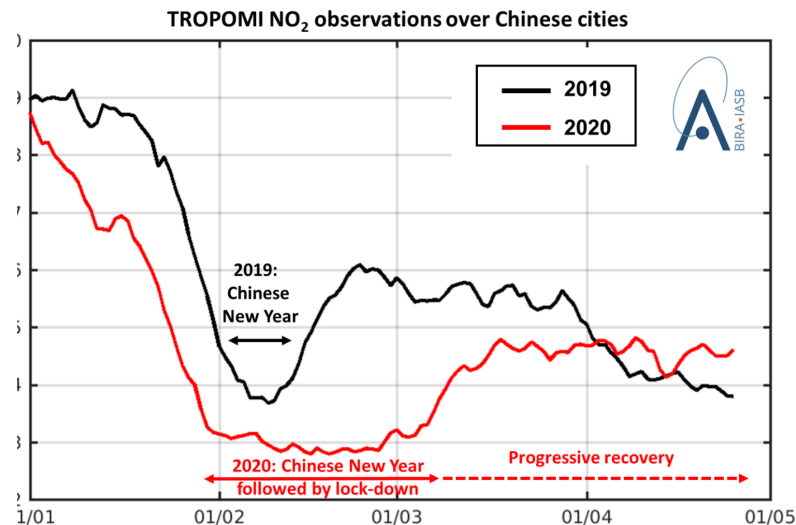
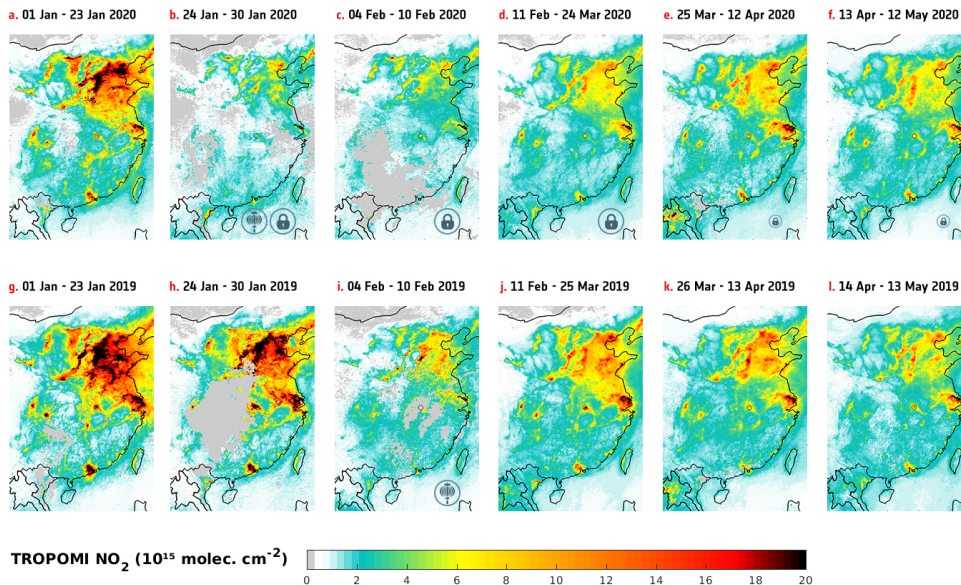


# COVID-19 impact as 'seen' by Sentinel-5P



European Union

<https://eo4society.esa.int/2020/05/14/is-the-global-covid-19-related-drop-in-no2-pollution-coming-to-an-end/>



## Back to 'normal' Air Pollution in China

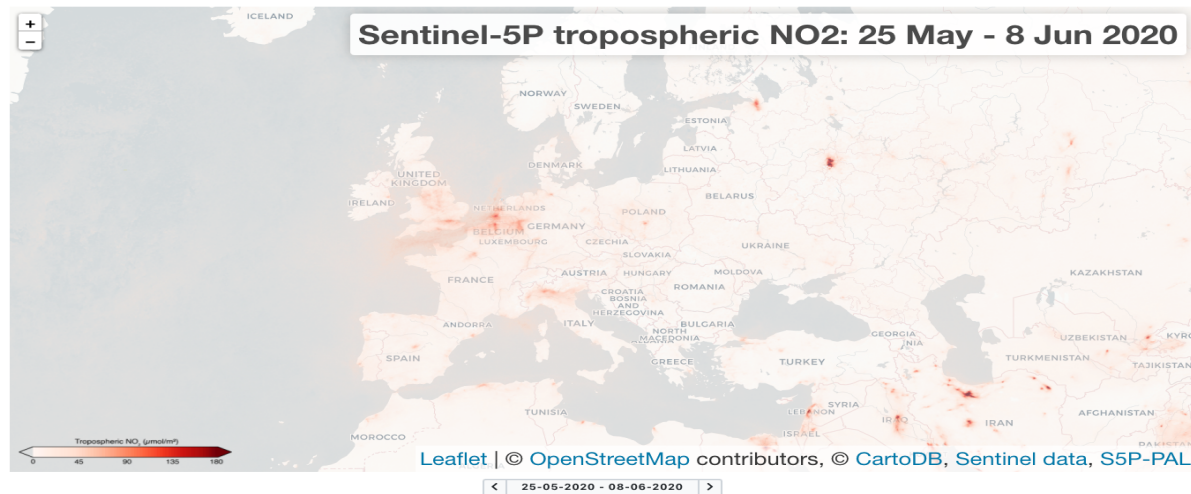
Copyright: Contains modified Copernicus Sentinel data (2019/20) / processed by BIRA/IASB

# New S5p Products – pre-operational delivery to the User Community



<https://maps.s5p-pal.com/> as part of the S5p Product Algorithm Laboratory

Copernicus Sentinel-5P Tropospheric Nitrogen Dioxide  
maps of tropospheric NO<sub>2</sub> concentrations averaged over 14 days



The maps show 14 days averages of tropospheric Copernicus Sentinel-5 Precursor Nitrogen Dioxide measurements. Concentrations of short-lived pollutants, such as Nitrogen Dioxide, are indicators of changes in economic slowdowns and are comparable to changes in emissions. Using a 14 day average eliminates some effects which are caused by short term weather changes and clouds cover. The average gives a view over the whole time period and therefore reflects trends better than shorter time periods. ⓘ

This service is provided as part of the Sentinel-5P Product Algorithm Laboratory (S5P-PAL) and contains modified Copernicus Sentinel data processed by S&T.

Questions regarding this service can be sent to the [ESA EO Support Helpdesk](#).

Used in:  
<https://race.esa.int/>



Copyright: Contains modified Copernicus Sentinel data processed by S&T

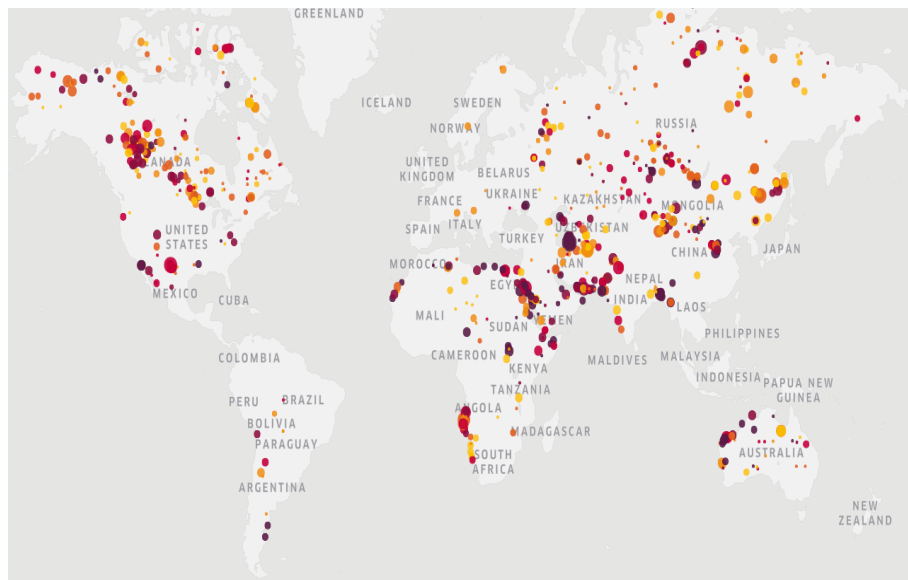
[http://www.esa.int/ESA\\_Multimedia/Images/2020/06/Global air pollution maps now available](http://www.esa.int/ESA_Multimedia/Images/2020/06/Global_air_pollution_maps_now_available)



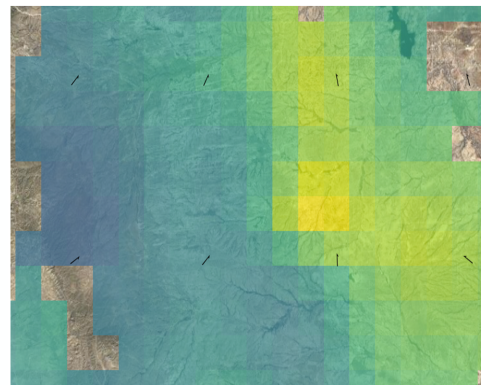
# Methane Emission Source Detection by Sentinel-5P



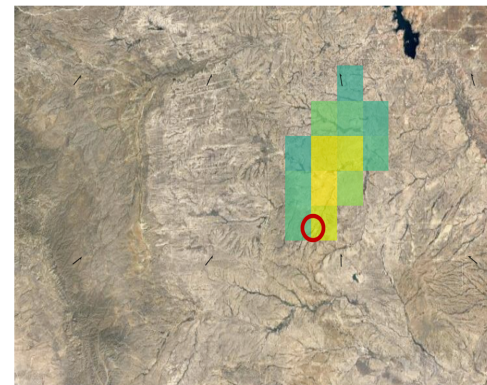
[https://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-5P/Mapping\\_methane\\_emissions\\_on\\_a\\_global\\_scale](https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Mapping_methane_emissions_on_a_global_scale)



100 high volume-emitting methane sources as detected by Sentinel-5P during 2019



Observed concentrations from satellite



Dispersion simulation - 33 tons per hour

○ Most probable source location

↘ Wind direction

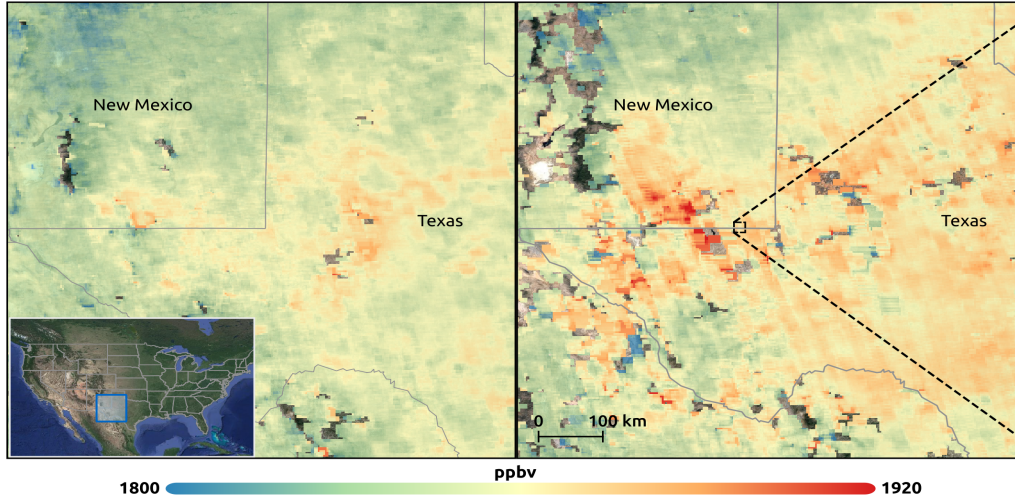
Methane Emission Source in the Permian Basin

# Methane Emission Source Detection by Sentinel-5P/GHGSat

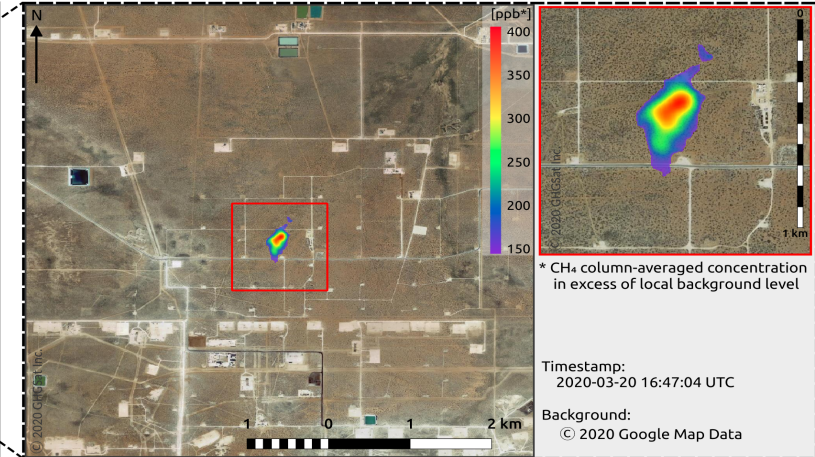


*Copyright: Contains modified Copernicus Sentinel data (2019) processed by GHGSat*

Monthly averages derived from TROPOMI  
March - April 2019



GHGSat-D Satellite Observation  
March 20<sup>th</sup>, 2020



Methane Emission Source in the Permian Basin as measured by Sentinel-5P/TROPOMI and GHGSat

**Open GHGSAT AO Call: [earth.esa.int/aos](http://earth.esa.int/aos) – click on 'GHGSat'**

[http://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-5P/Detecting\\_methane\\_emissions\\_during\\_COVID-19](http://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Detecting_methane_emissions_during_COVID-19)



# Sentinel-5 Precursor Planning



✧ **2020 July : Release** of upgraded O<sub>3</sub>, HCHO, SO<sub>2</sub> and Cloud products

✧ **2020 Autumn/end of Year: Release** of the new **Level 1 product** and an **upgraded L2 products**