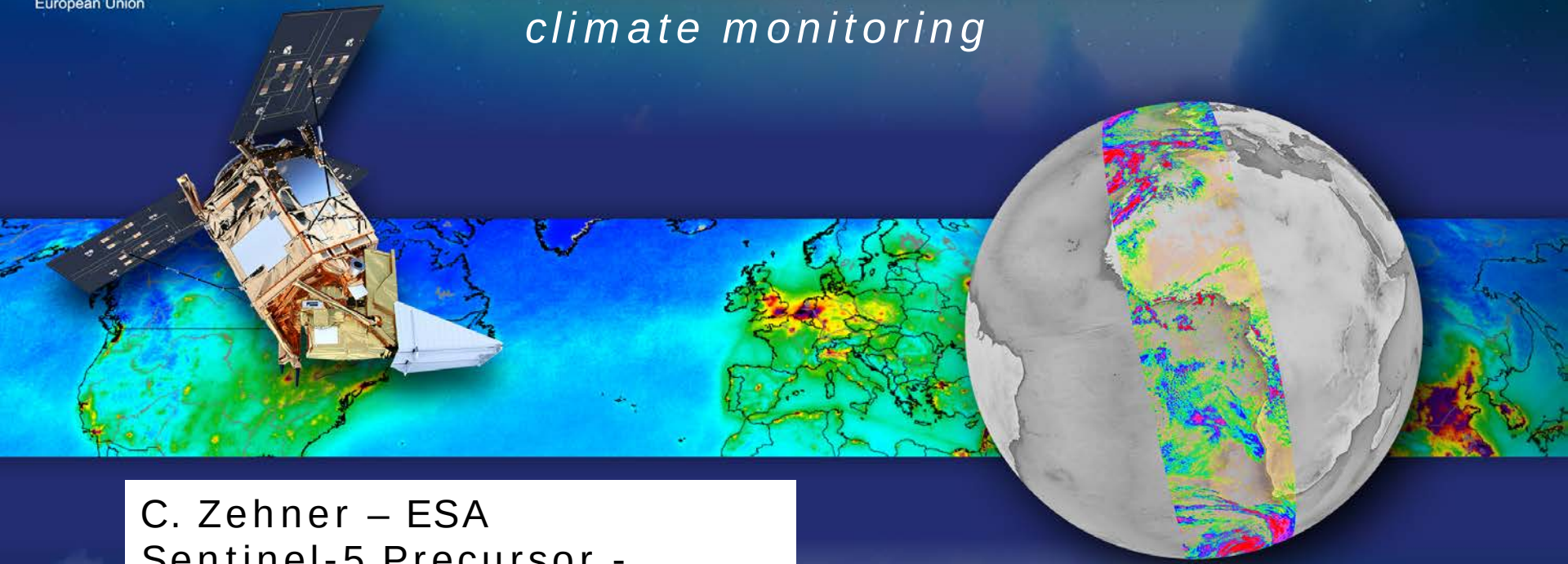
Latest results of the Copernicus Sentinel-5 Precursor satellite on air pollution, ozone and climate monitoring

European Union

esa



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

Copernicus
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Copernicus – continue global leadership in EO

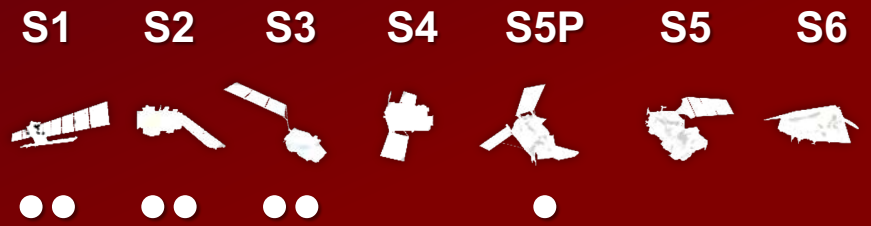
> 350.000
registered users
= tip of the iceberg

6 operational services

250 TB satellite data distributed per day

full, free & open data policy

7 Sentinel satellites flying



preparing Copernicus 4.0

Sentinel-5 Precursor: first atmospheric Sentinel Mission

- Launched: 13 October 2017, Plesetks
- Launcher: Rockot
- 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 (original requirement was 7 x 7 km)
- COVID-19: no impact on nominal Sentinel-5 Precursor Mission Operations
- Design lifetime: 7 years

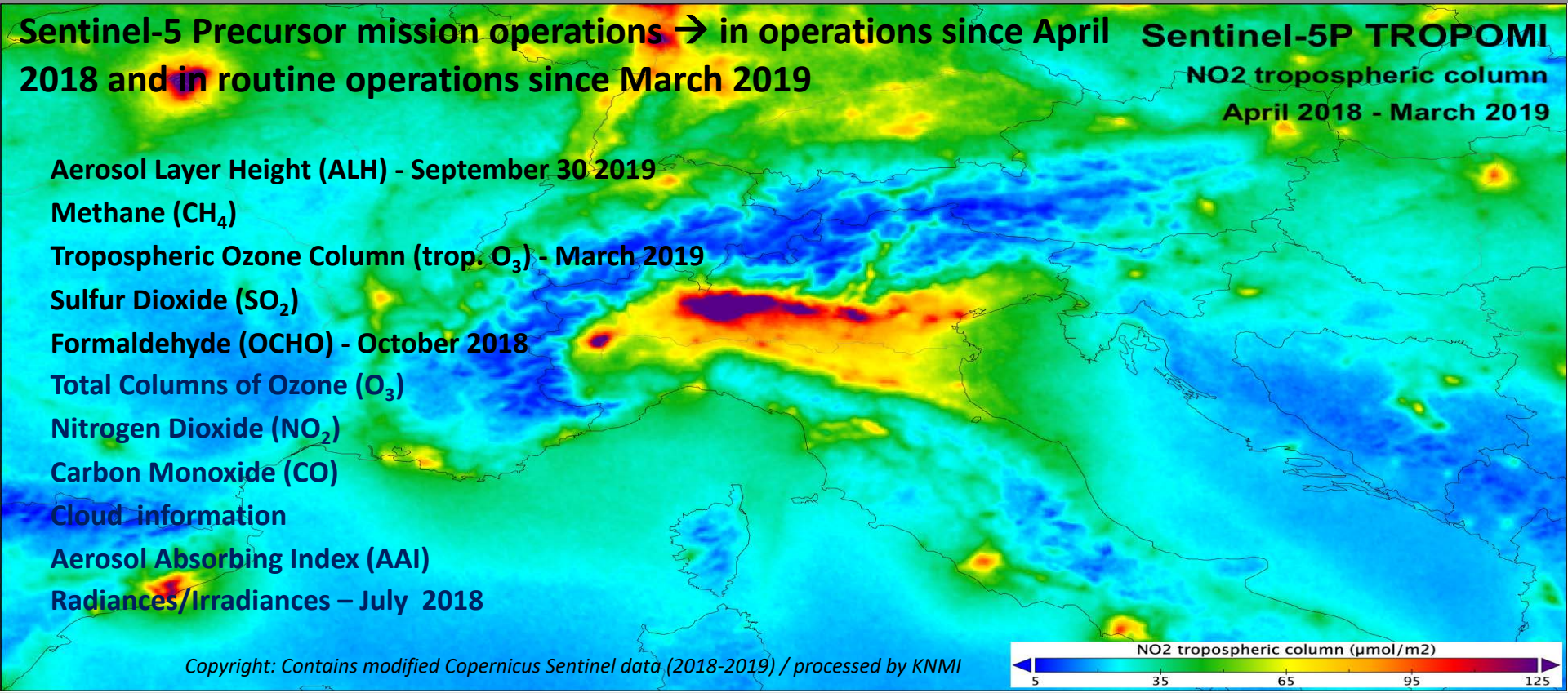
Sentinel-5 Precursor

Mission Objectives

1. Ozone, Air Quality, and Climate Monitoring and Forecasting
2. Extending the time series of GOME, SCIAMACHY, OMI, GOME2 measurements
3. Precursor of the Copernicus Sentinel-4 and Sentinel-5 missions

Sentinel-5 Precursor Products

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



- Aerosol Layer Height (ALH) - September 30 2019
- Methane (CH_4)
- Tropospheric Ozone Column (trop. O_3) - March 2019
- Sulfur Dioxide (SO_2)
- Formaldehyde (OCHO) - October 2018
- Total Columns of Ozone (O_3)
- Nitrogen Dioxide (NO_2)
- Carbon Monoxide (CO)
- Cloud information
- Aerosol Absorbing Index (AAI)
- Radiances/Irradiances – July 2018

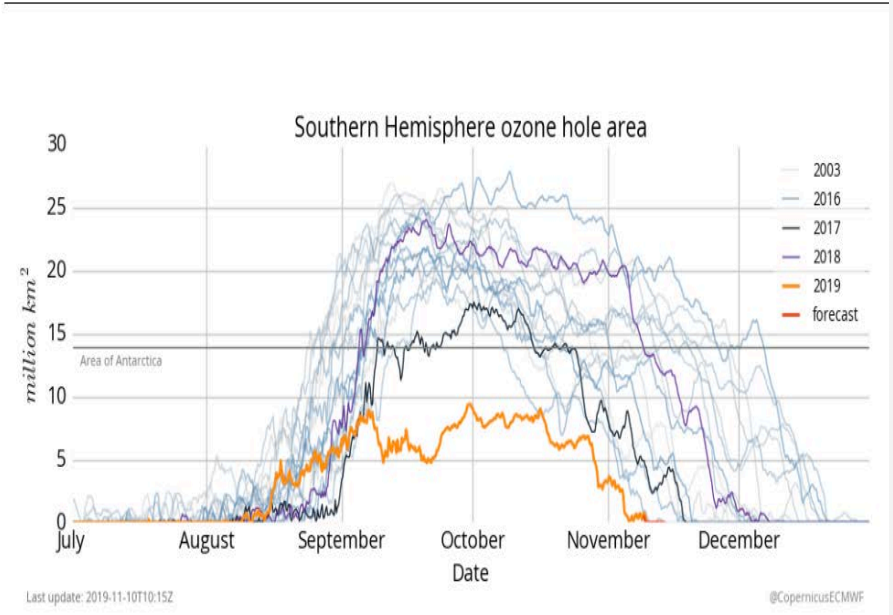
Sentinel-5P Ozone Hole Monitoring

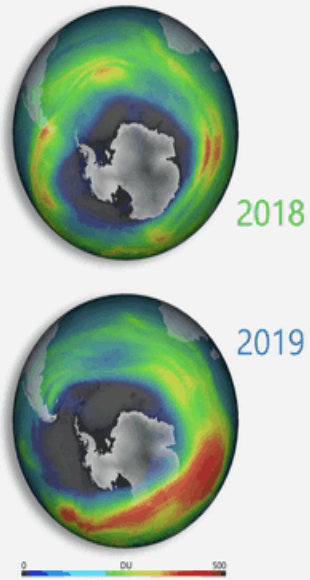
European Union

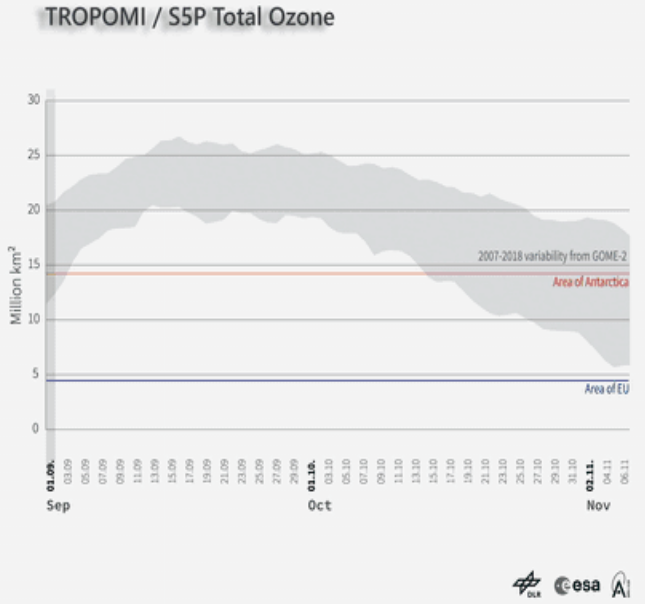
esa

http://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Ozone_hole_set_to_close

Ozone hole area







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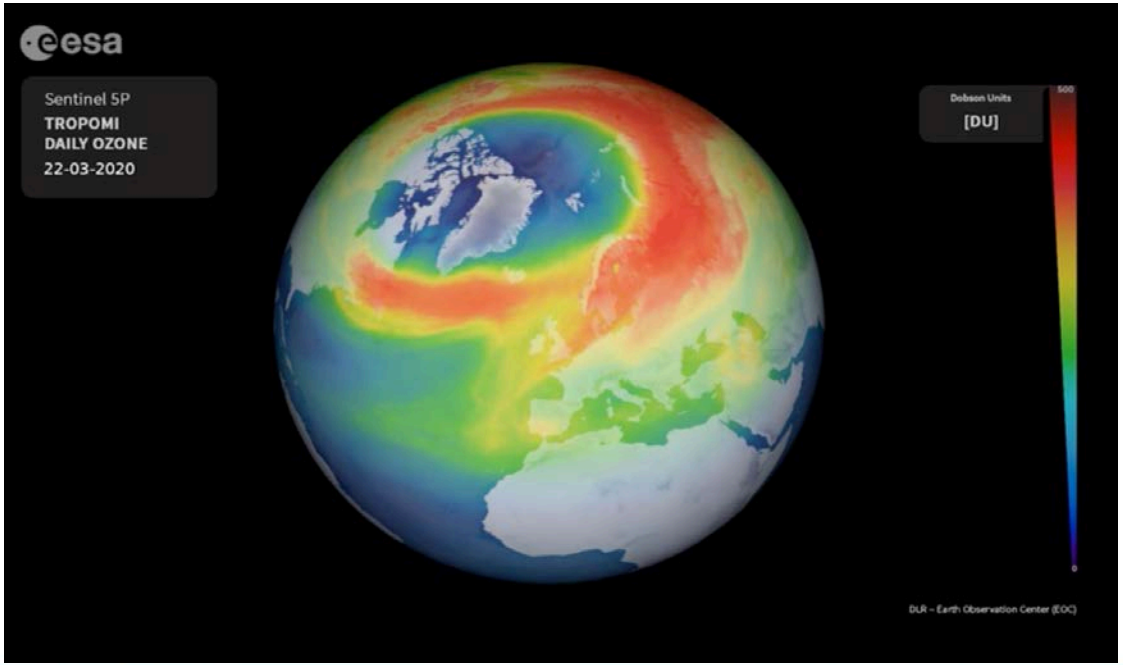
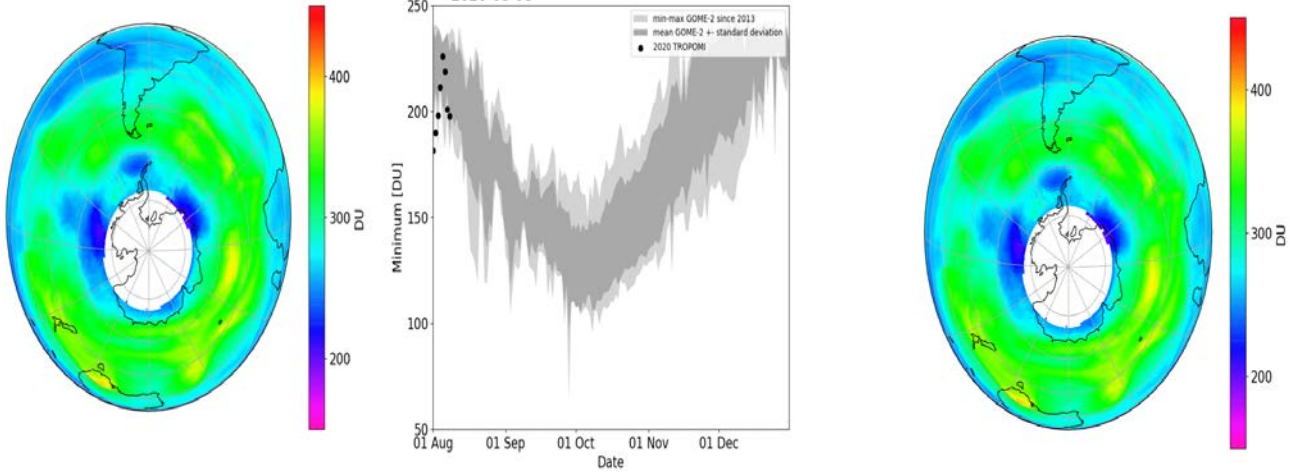
Sentinel-5P Ozone Hole Monitoring

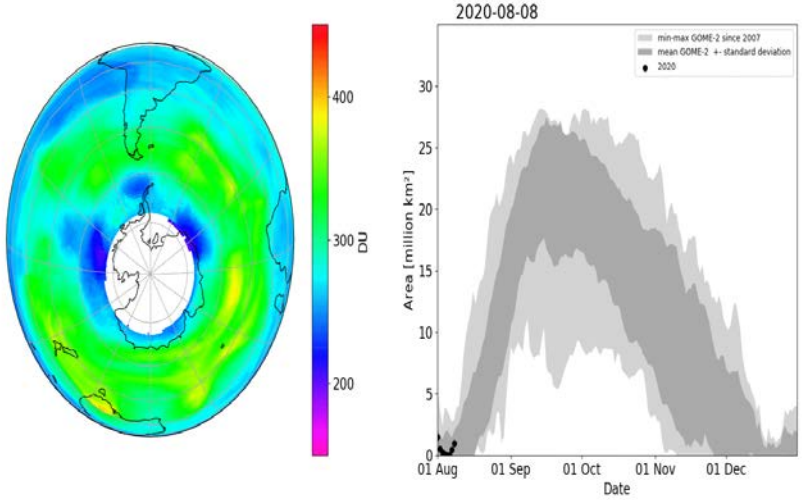
https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Unusual_ozone_hole_opens_over_the_Arctic



Sentinel-5P Ozone Hole Monitoring

https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Antarctic_ozone_hole_is_one_of_the_largest_and_deepest_in_recent_years

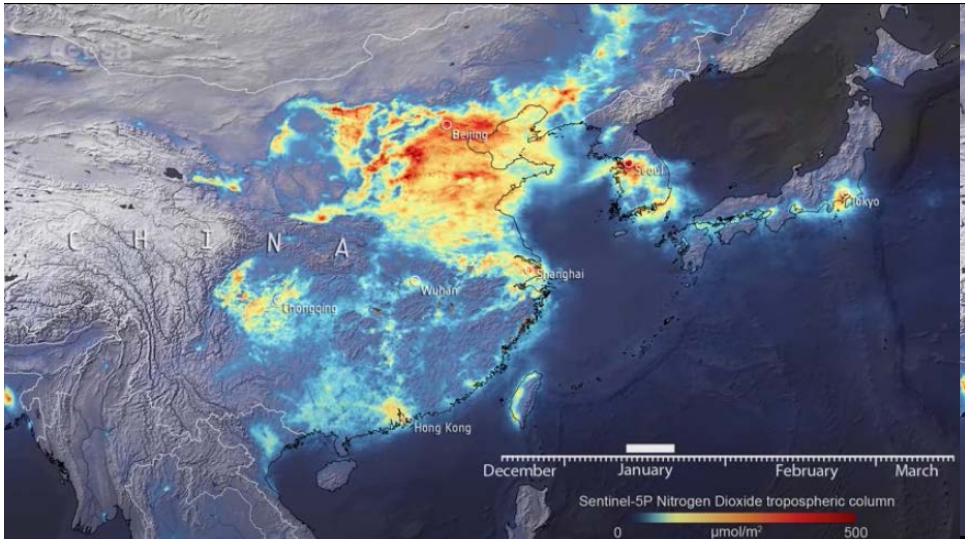


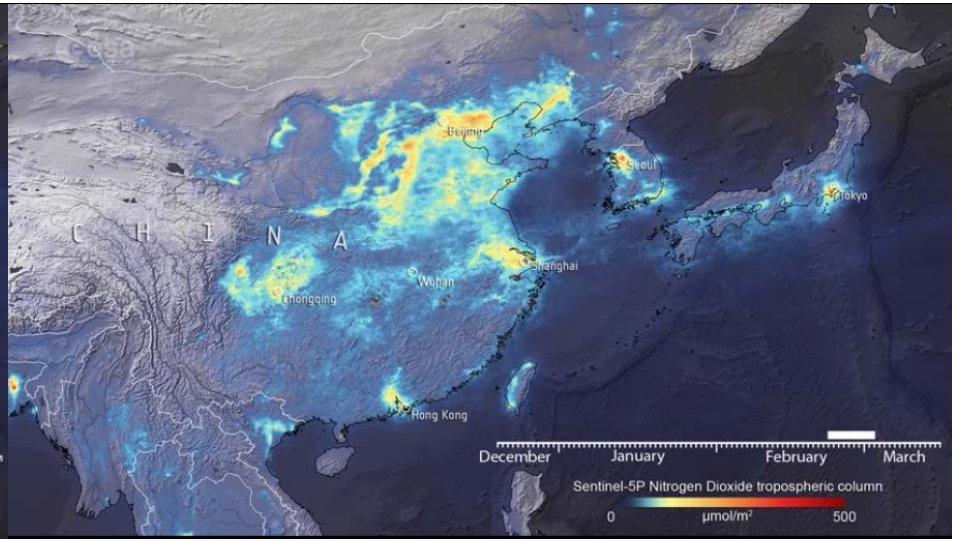


COVID-19 impact as 'seen' by Sentinel-5P

https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/COVID-19_nitrogen_dioxide_over_China

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





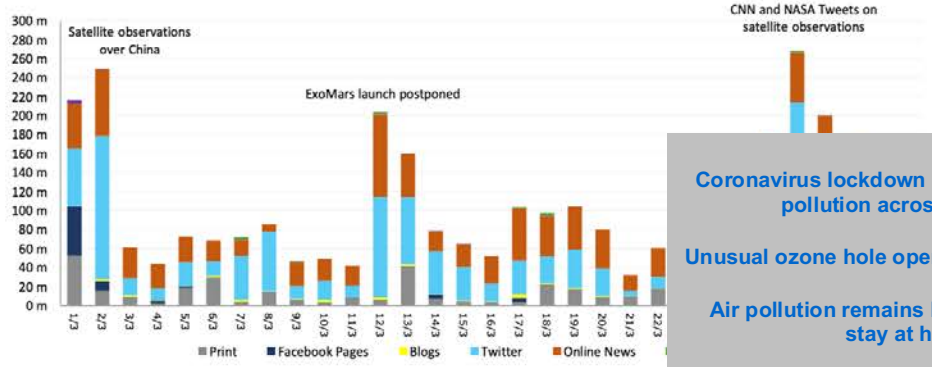
COVID-19 impact as 'seen' by Sentinel-5P (March 2020 - ESA internal Statistics)

European Union

esa

ExoMars and Sentinel-5P drive the media visibility

Visibility by date and by channel (Gross Reach)

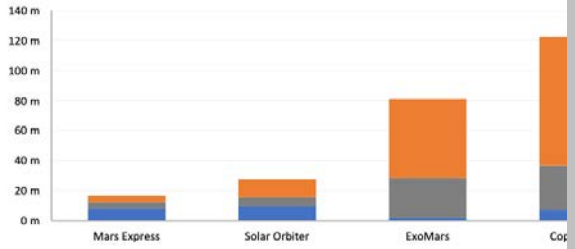


32 % of the visibility generated by ESA member states media

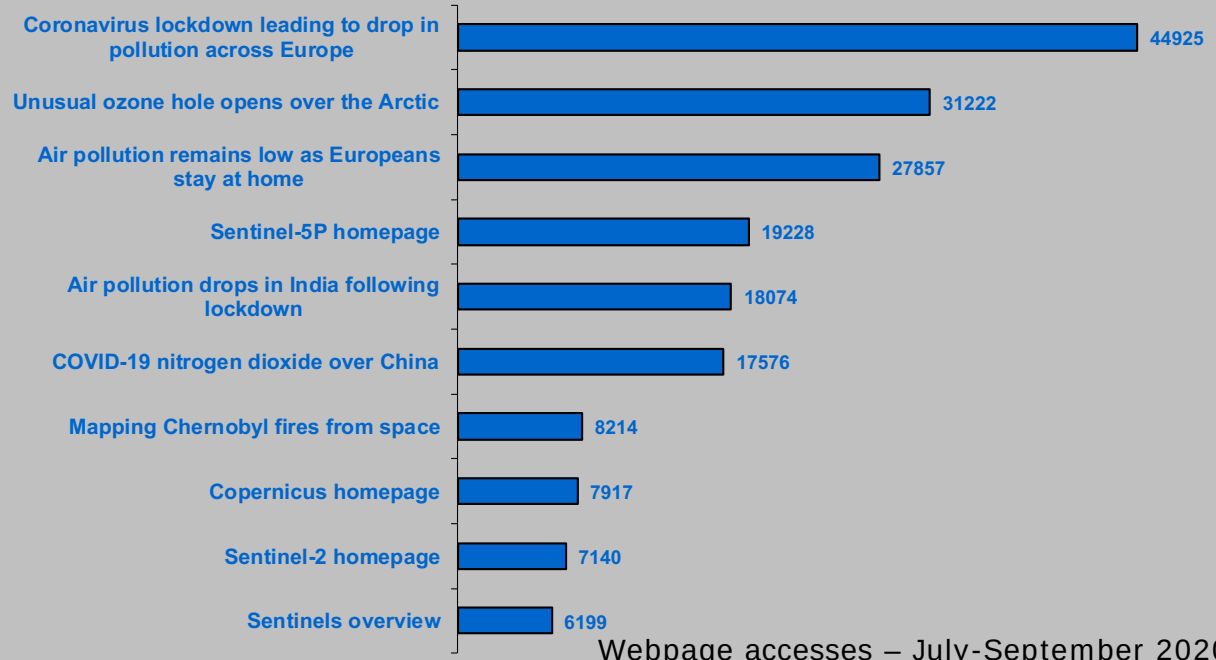
Visibility by country (Gross Reach)

Programmes

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



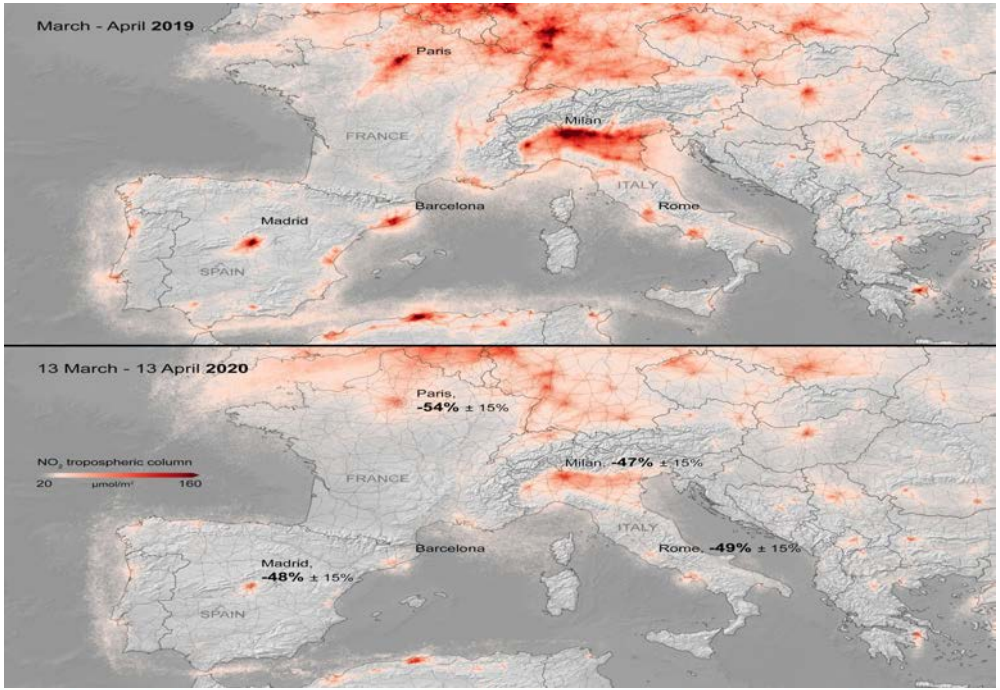
	Mars Express	Solar Orbiter	ExoMars	
Gross Reach	16.6 M	27.4 M	81 M	12
Frequency % out of total 912 M	1.8 %	3 %	8.9 %	13



Webpage accesses – July-September 2020

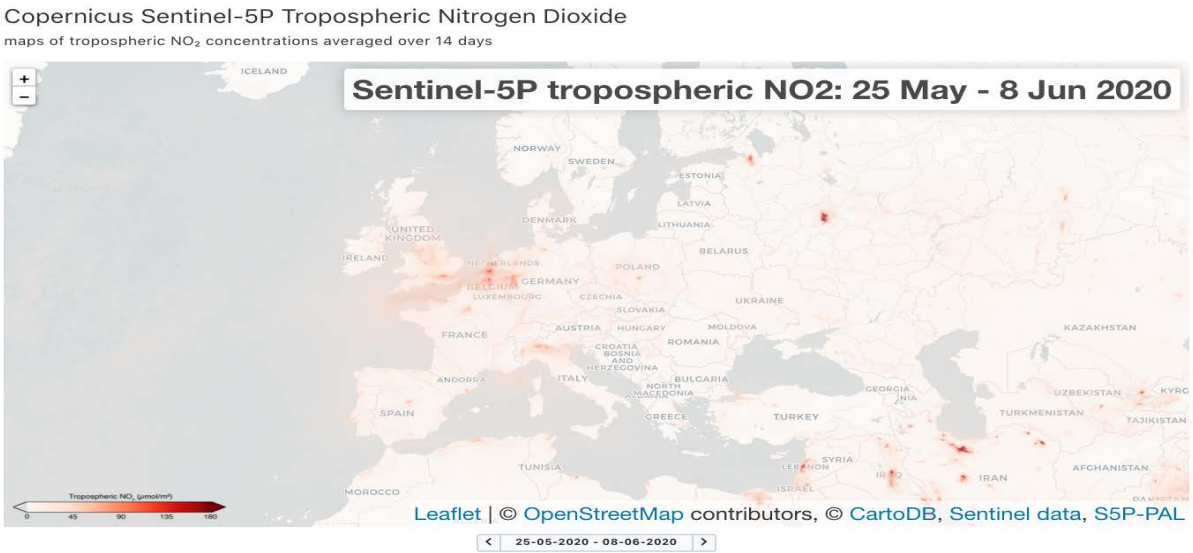
COVID-19 impact as 'seen' by Sentinel-5P

http://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Air_pollution_remains_low_as_Europeans_stay_at_home



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

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



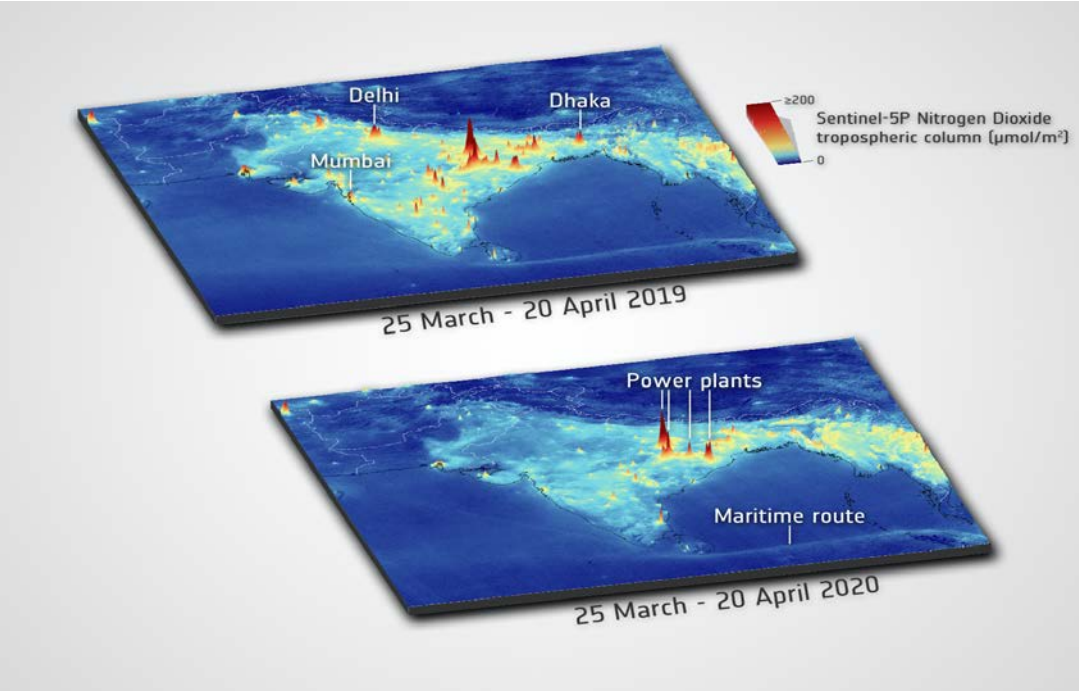
Used operationally in:

https://race.esa.int/

http://www.esa.int/ESA_Multimedia/Images/2020/06/Global_air_pollution_maps_now_available

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

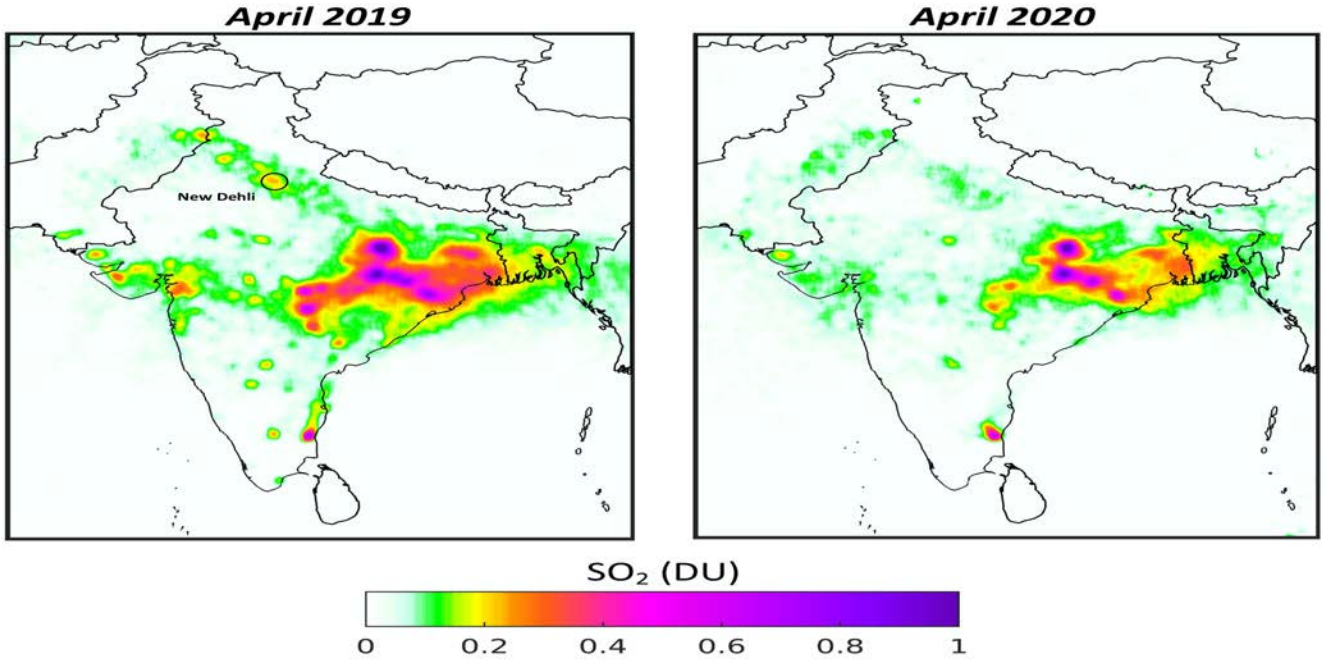


COVID-19 impact as 'seen' by Sentinel-5P

European Union

esa

Sentinel-5P Sulphur Dioxide Measurements over India



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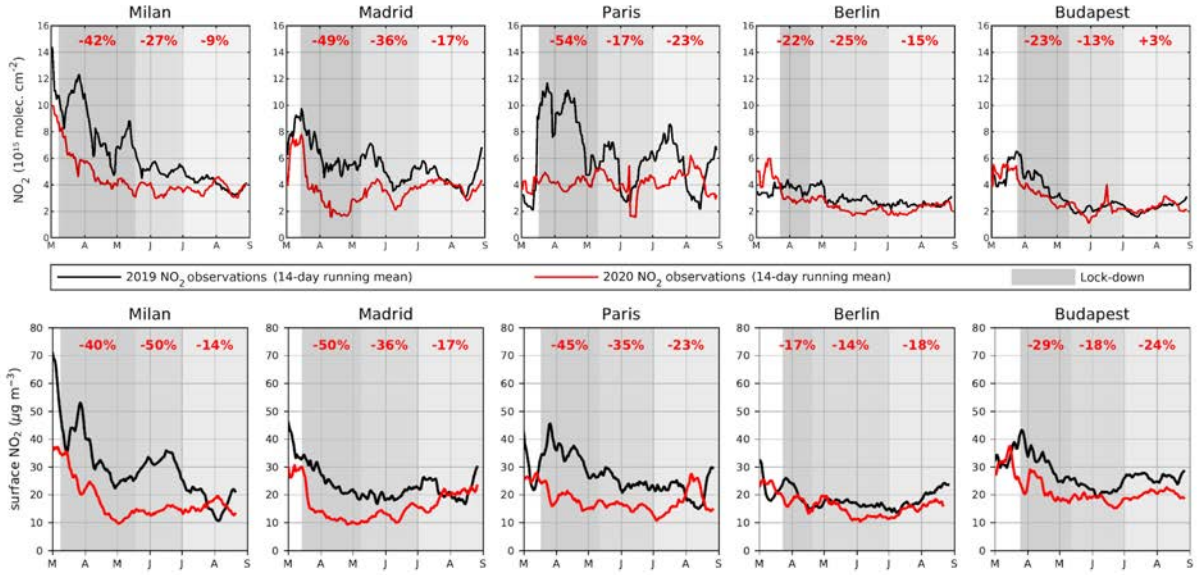
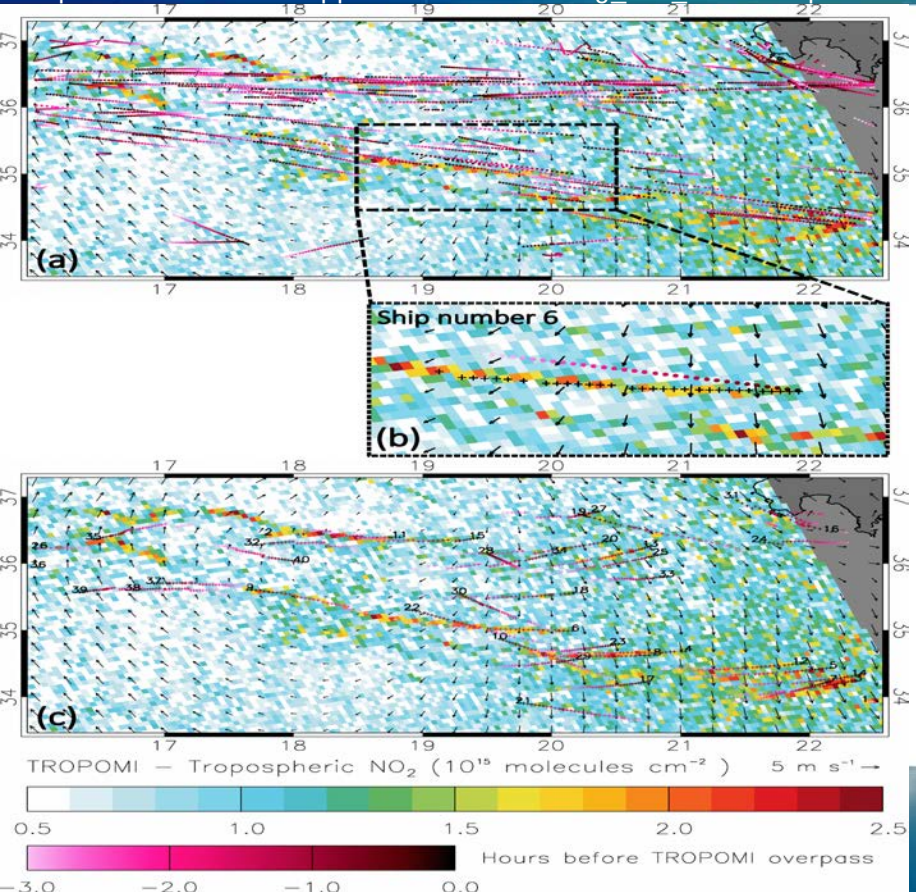
COVID-19 impact as 'seen' by Sentinel-5P



This graph shows the averaged nitrogen dioxide concentrations over five major European cities. The upper panel shows concentrations (using a 14-day moving average) in 2019 compared to 2020 using data from the Copernicus Sentinel-5P satellite, while the lower panel shows *in situ* observations. The shades of grey denote the lockdown periods in 2020, moving progressively from strict (dark grey) to loose (light grey) measures. The percentages shown in red represent the column reduction in 2020 compared to 2019 over the same period.

Air pollution emission detection from single ships by Sentinel-5P

https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Detecting_pollution_from_individual_ships_from_space



Sunglint

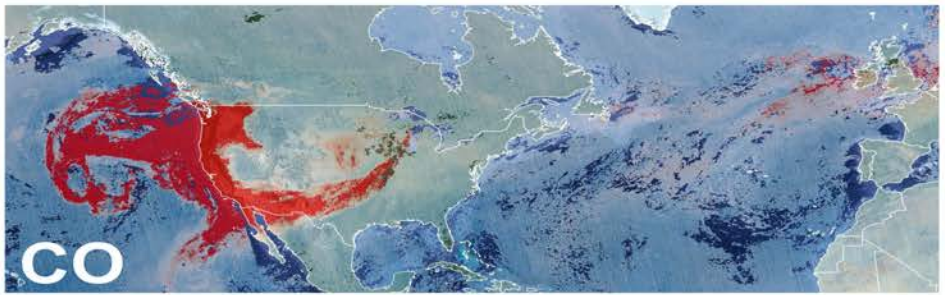
Copyright: Joseph A. Shaw and Michael Vollmer

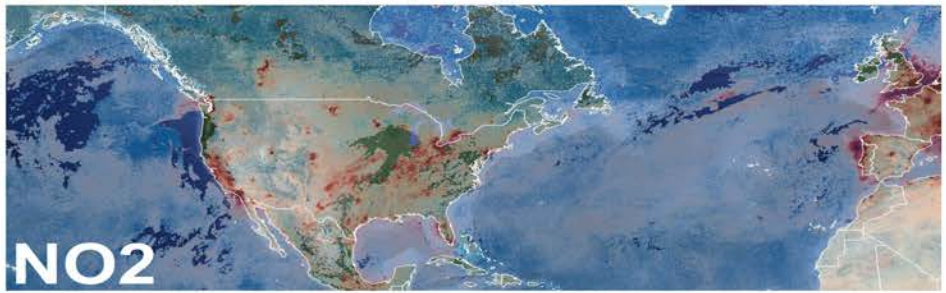
Copyright: Contains modified Copernicus Sentinel data (July 2018) / processed by KNMI

2020 Californian Fire Emissions measured by Sentinel-5P

European Union

https://sentinels.copernicus.eu/web/sentinel/news/-/article/copernicus-sentinels-work-together-to-monitor-air-pollution-in-recent-us-wildfires

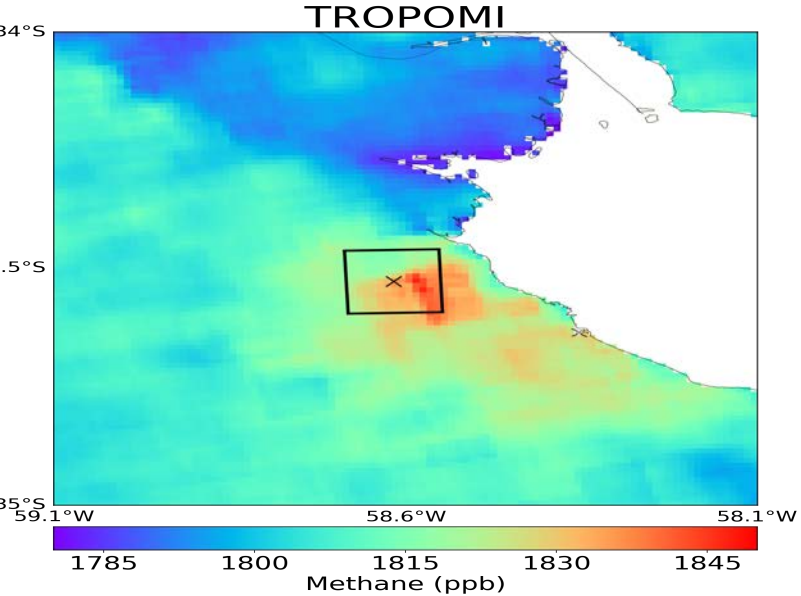


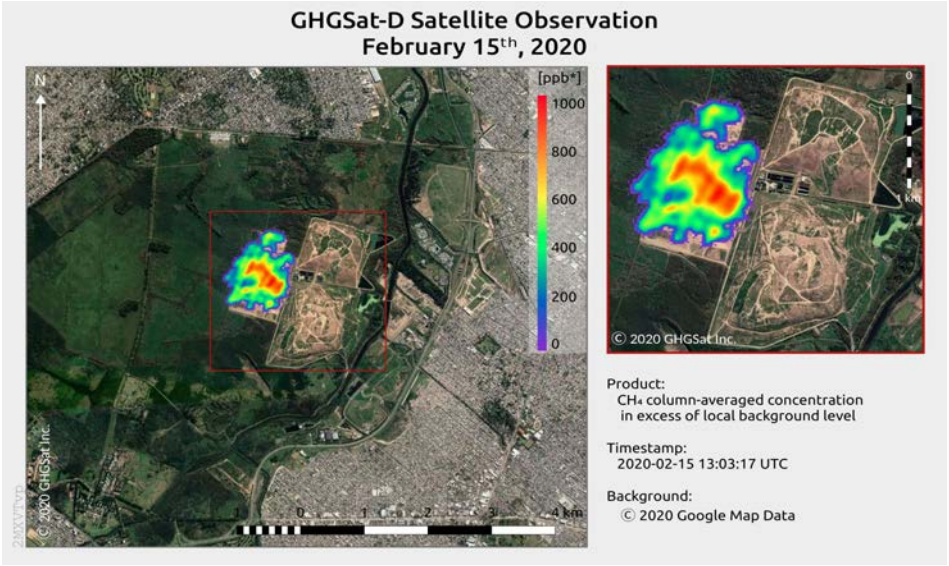


10-11-12 September 2020

Methane Emission Source Detection by Sentinel-5P/GHGSat

European Union





Methane Emission Source close to Buenos Aires as measured by Sentinel-5P/TROPOMI and GHGSat

Open GHGSAT AO Call: earth.esa.int/aos – click on 'GHGSat'

Copernicus Europe's eyes on Earth

https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/High-resolution_methane_emissions_data_for_waste_management

Conclusions

- Ozone : Sentinel-5P Total Ozone columns are used within the ESA CCI Programme to extend ECVs and by ECMWF/CAMS for forecasting

- Air Quality:
  - Sentinel-5P trop. NO_2 concentration measurements can be used to monitor the impact of COVID-19 restrictions on traffic and industrial activities worldwide
  - Sentinel-5P NO_2 images were used by News organisations (e.g. BBC) to provide simple messages to the public about COVID-19 impact on air quality
  - Sentinel-5P trop. NO_2 concentration measurements showing COVID-19 impact on air quality agree very well with ground-based measurements
  - COVID-19 is an excellent show case how changes in human behaviour are impacting the environment (improved air quality/human health)

- Climate: Sentinel-5P Methane measurements are being used now for the detection of Methane emission hots spots and will certainly contribute to the implementation of the new EU Methane strategy (July 2020)