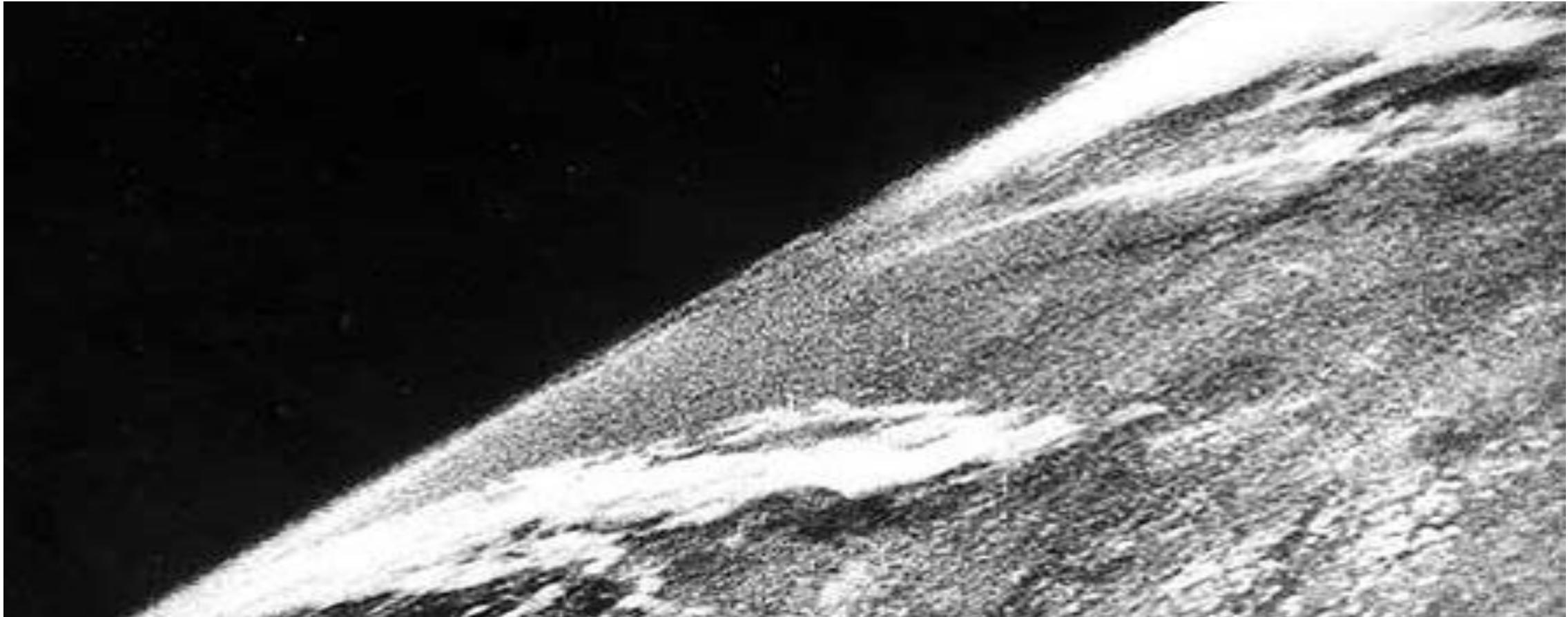


24 october 1946

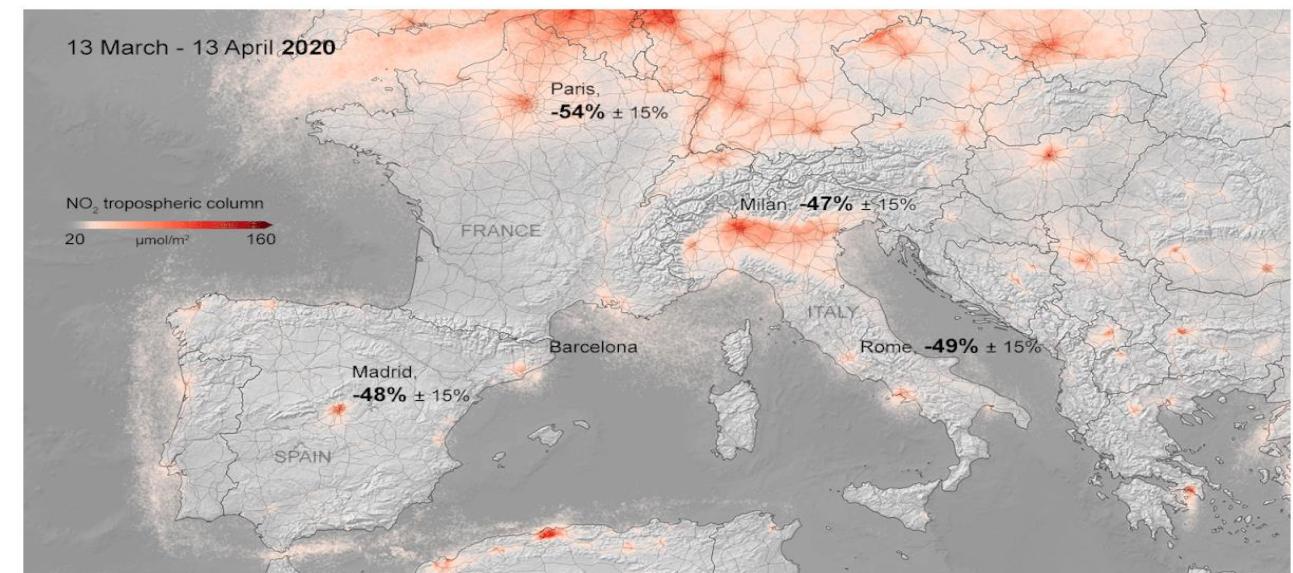
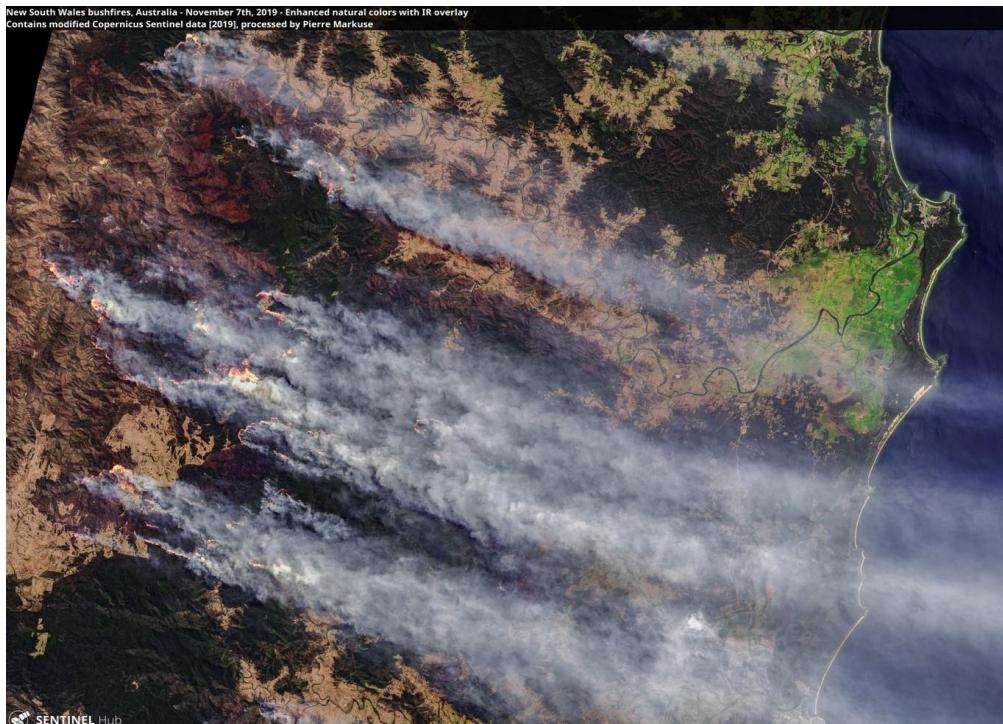




# Visualize atmospheric composition from Satellite

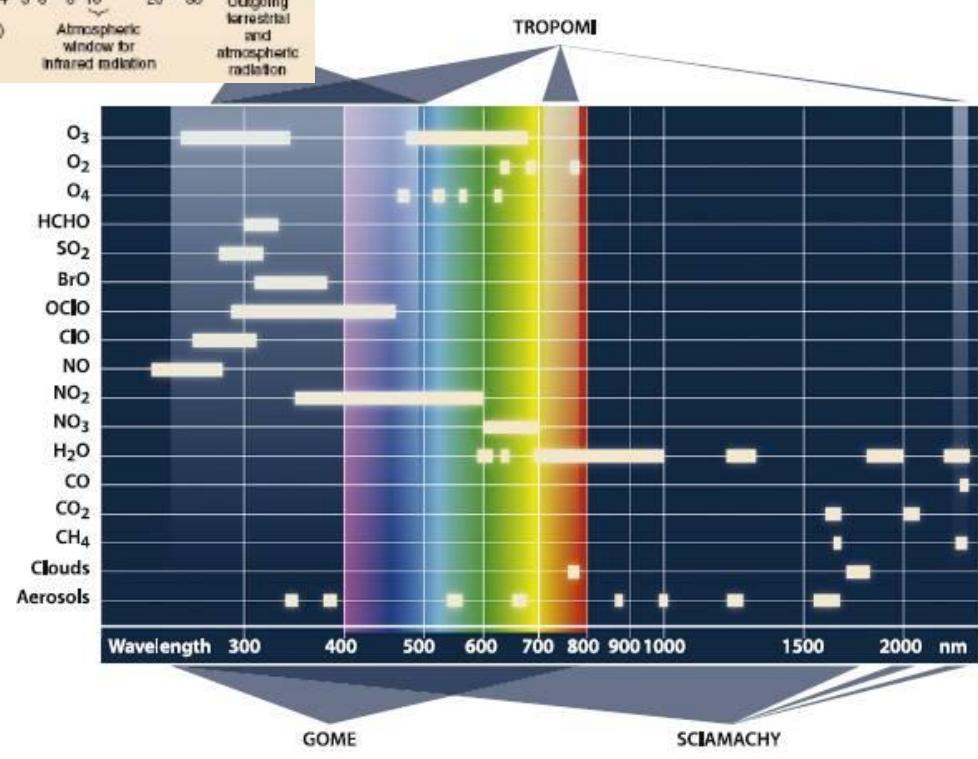
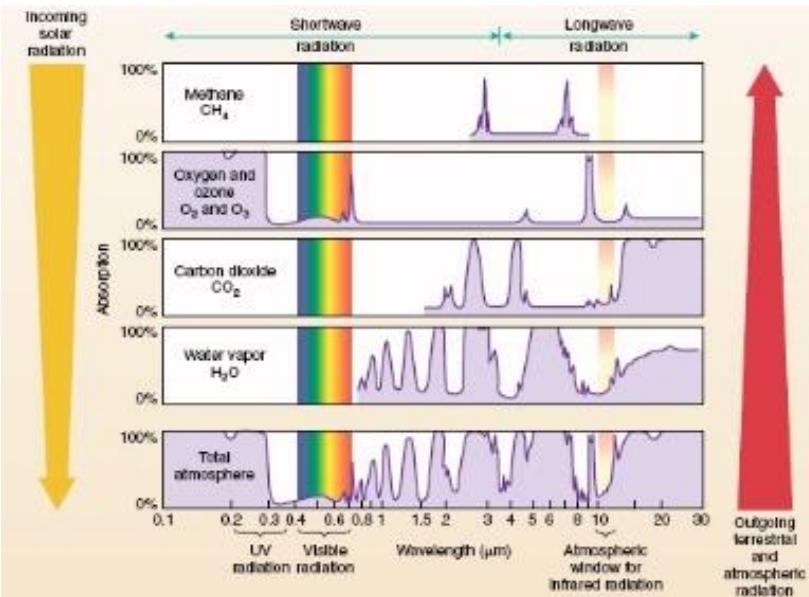
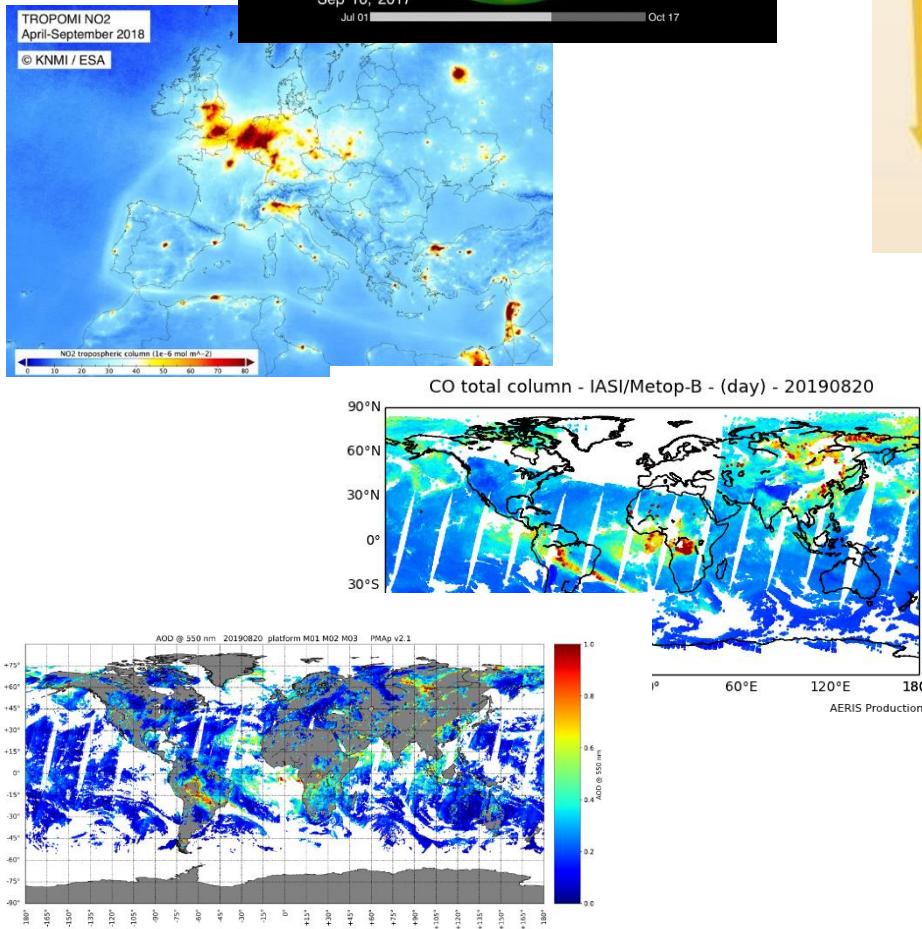
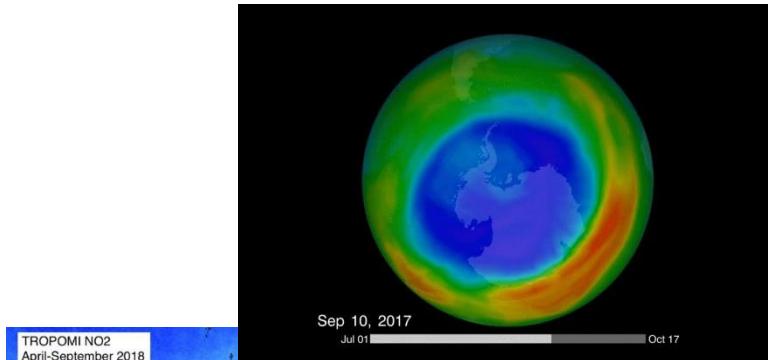
www.eumetsat.int

Visualize the visible and the invisible ...



<https://maps.s5p-pal.com/>

# We walk the line ... chemistry – air quality climate



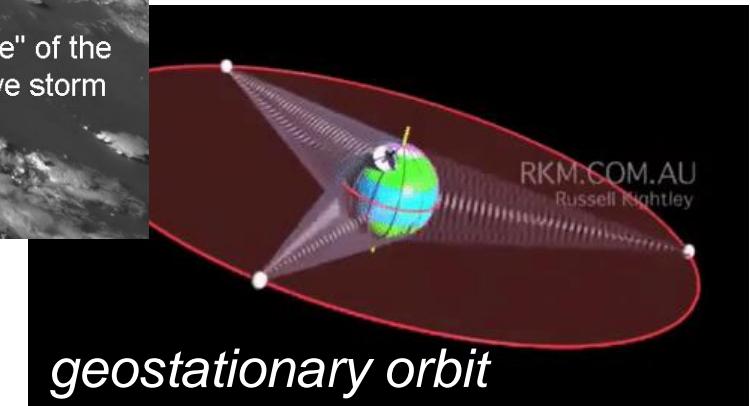
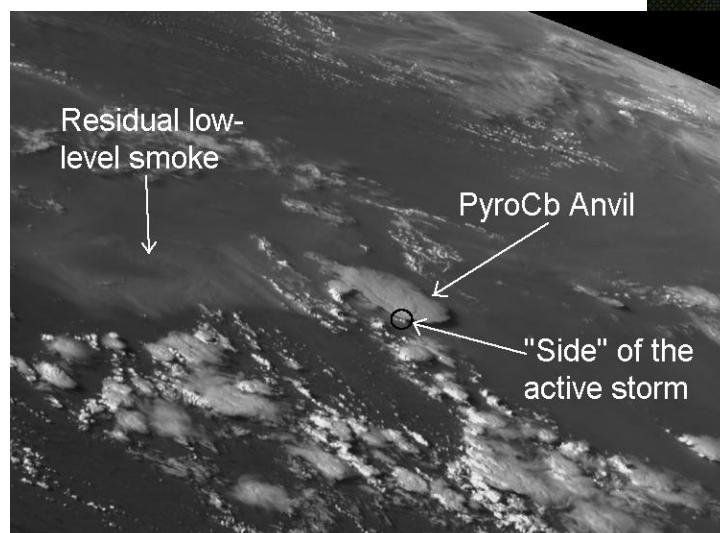
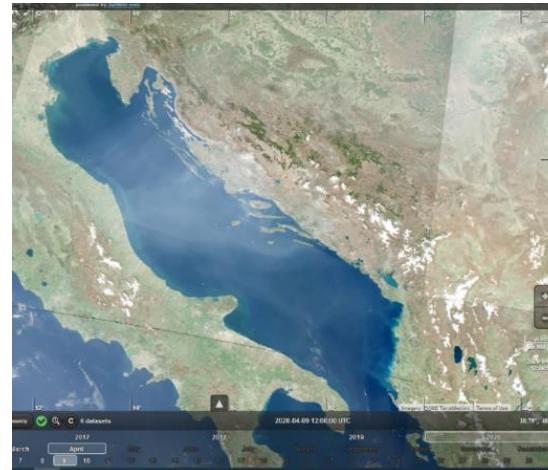


# Monitoring from space

[www.eumetsat.int](http://www.eumetsat.int)

## Why monitoring from space?

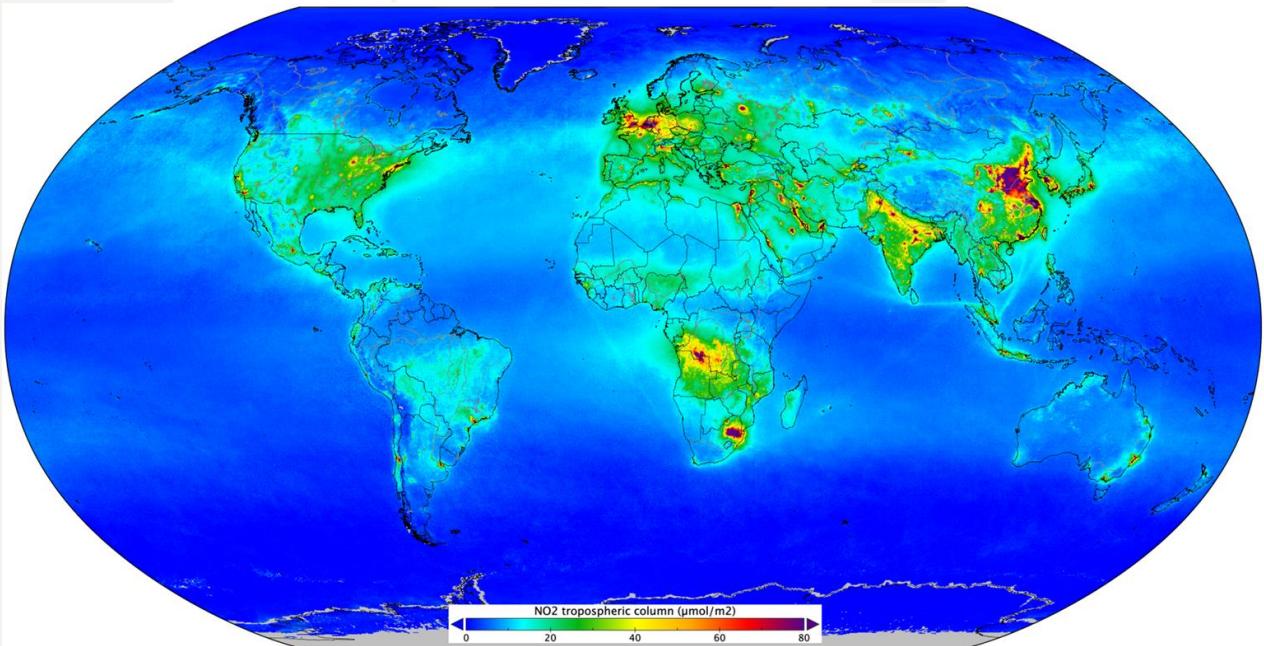
- Use data and algorithms instead of eyes
- Observe and measure from a distance without modifying the target
- Access to spatial and temporal scales impossible without the contribution of satellites
- Consistency of measurements worldwide
- *Low earth orbits (circling the earth)*
- *Geostationary (fixed position above earth)*



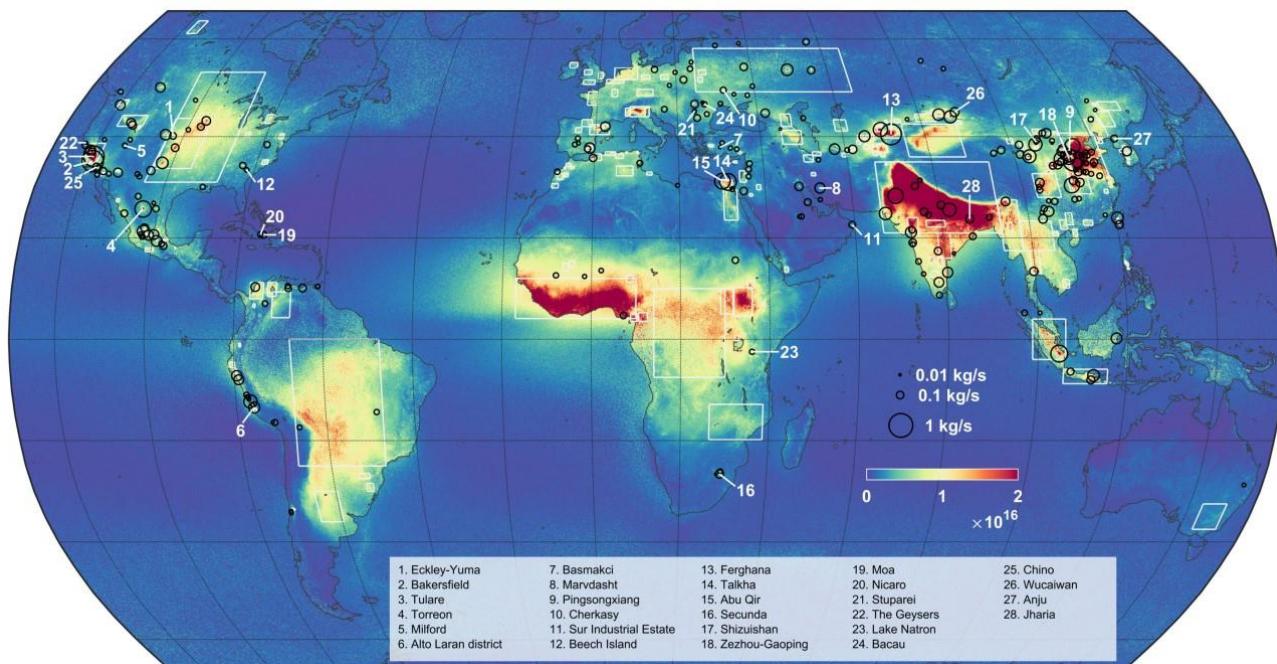


# Satellite monitor pollutants and support observational effort

[www.eumetsat.int](http://www.eumetsat.int)



Nitrogen Dioxide from 1 month TROPOMI data  
© Copernicus program



Ammonia fluxes based on 9 years of IASI data  
© Martin Van Damme and Lieven Clarisse / IJLB



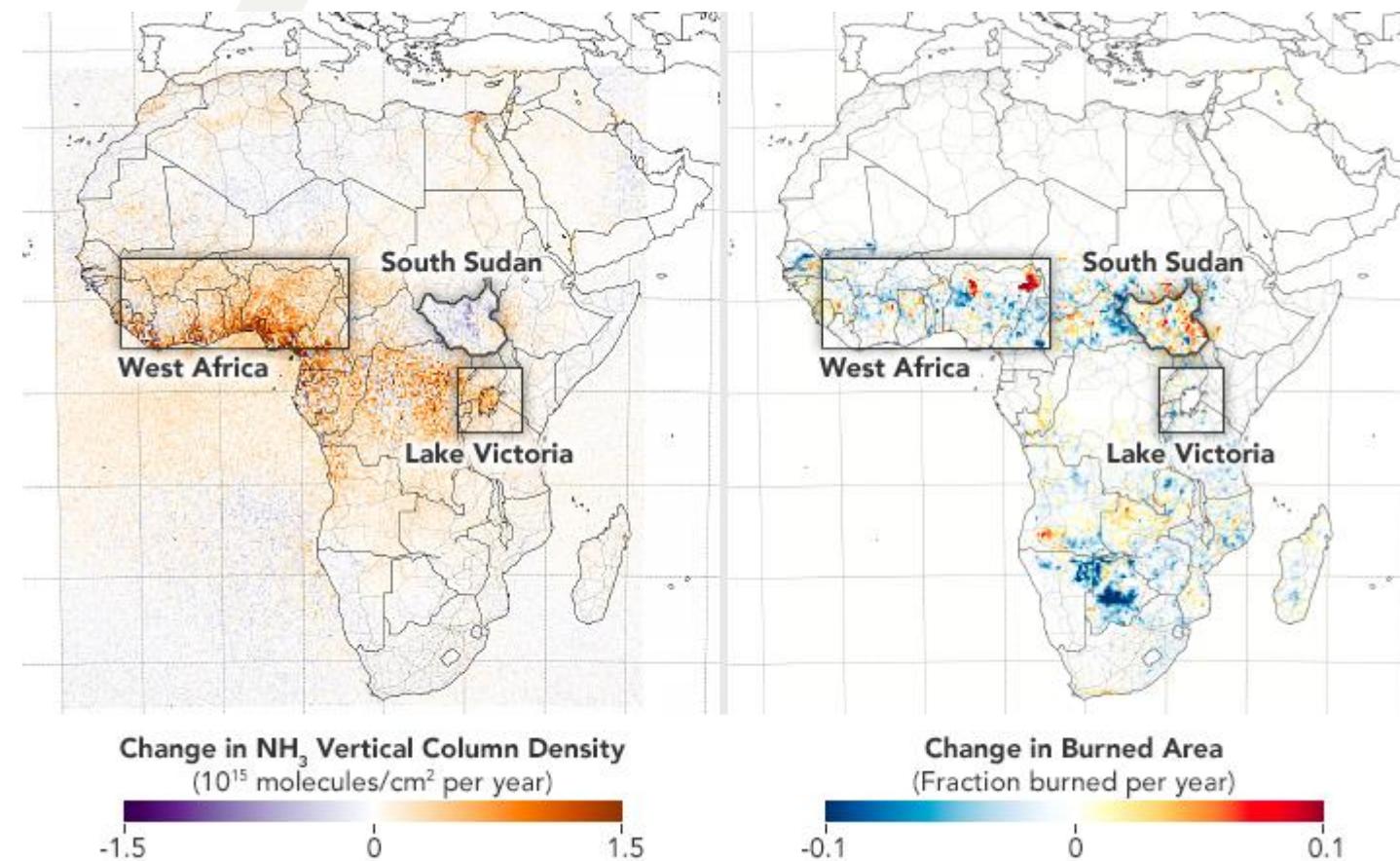


# Example: Changes in ammonia concentrations

www.eumetsat.int

What does it means – support air quality monitoring

Analysis of 7 years of IASI data from <https://acp.copernicus.org/articles/21/16277/2021/>

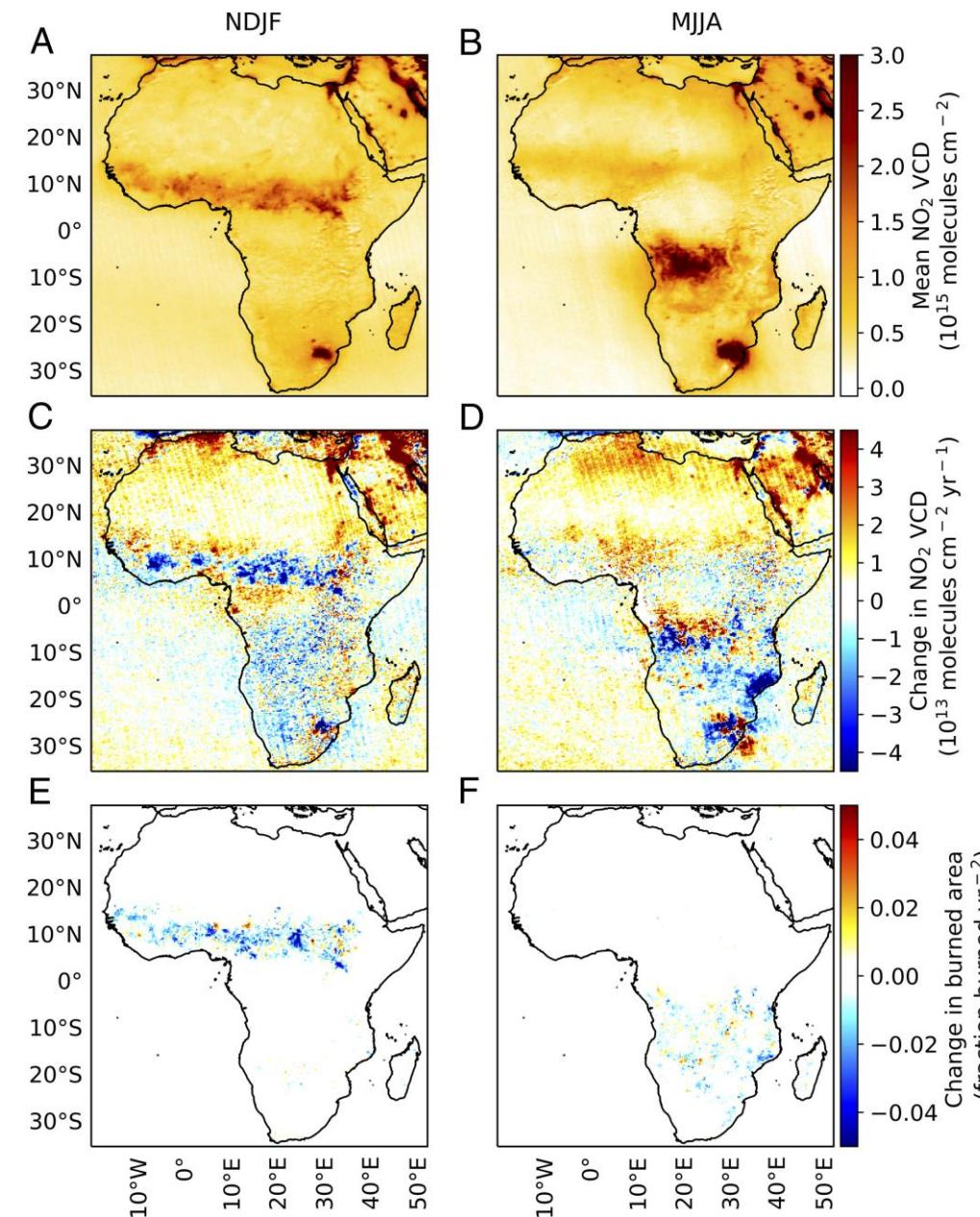




# Example: Changes in nitrogen dioxide concentrations

www.eumetsat.int

What does it means – support air quality monitoring  
Analysis of 12 years of OMI, Sentinel-5P data from  
<https://www.pnas.org/doi/10.1073/pnas.2002579118>





# Discussion ...

[www.eumetsat.int](http://www.eumetsat.int)





# Monitoring from space

www.eumetsat.int

*satellites play a key role in fire monitoring*

*what can we already do and where are we heading?*

The image shows a Google search results page with the query "monitoring fires satellites esa". The results are arranged in a grid of cards, each containing a thumbnail image, a title, and a link to esa.int.

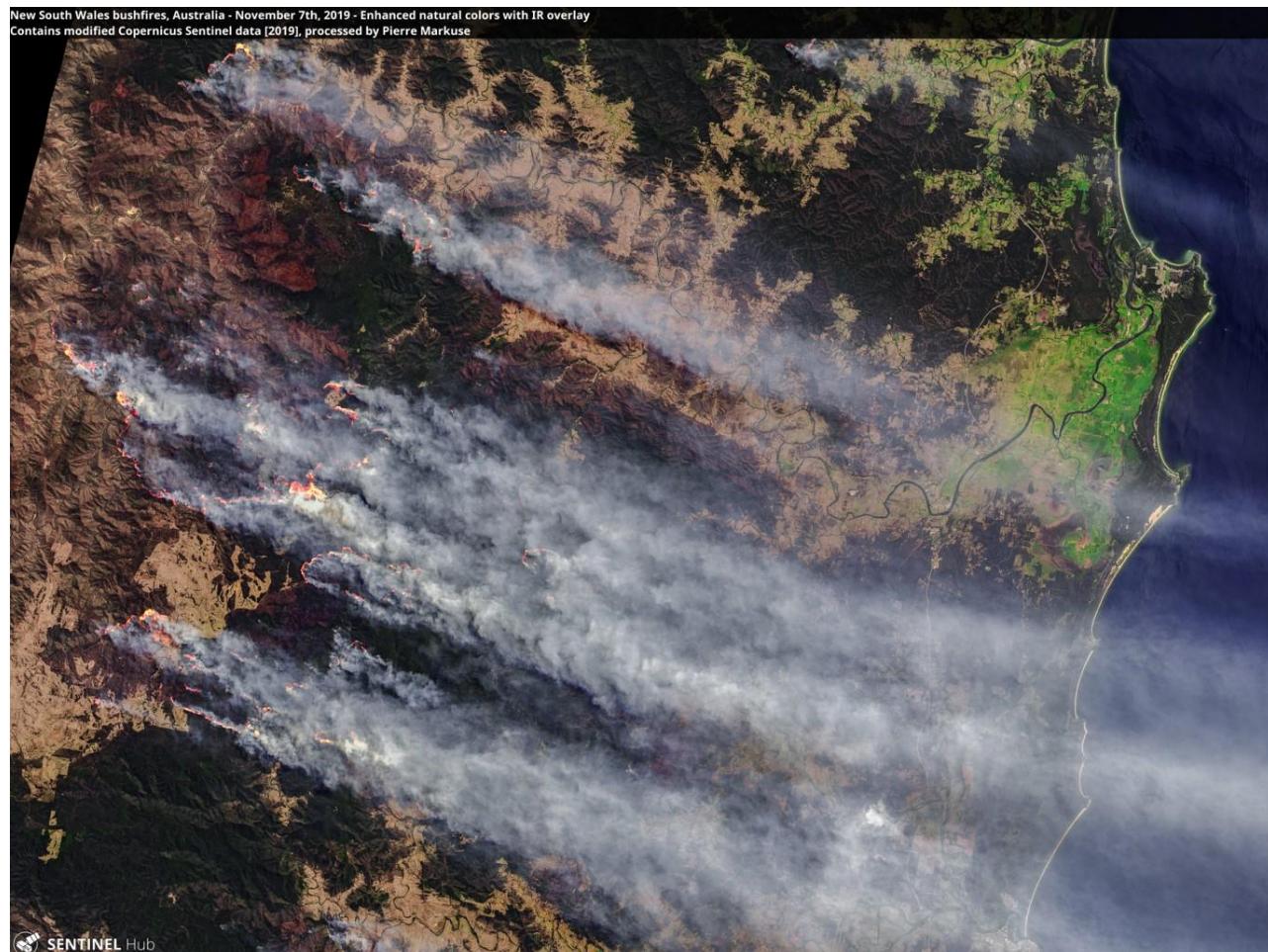
- Row 1:
  - Thumbnail: World map showing air pollution. Title: "ESA - Monitoring air pollution from fires". Link: esa.int
  - Thumbnail: Satellite images of land cover. Title: "Artificial intelligence for Earth ...". Link: eo4society.esa.int
  - Thumbnail: World map showing air pollution. Title: "ESA - Monitoring air poll...". Link: esa.int
  - Thumbnail: Satellite image of Earth. Title: "real-time detection of potential fires ...". Link: earth.esa.int
  - Thumbnail: World map showing fire detections. Title: "dataset to analyse global fire trends". Link: esa.int
  - Thumbnail: Satellite image of South America. Title: "ESA - Monitoring air pollution from fires". Link: esa.int
- Row 2:
  - Thumbnail: Satellite images of land cover. Title: "Artificial intelligence for Earth ...". Link: eo4society.esa.int
  - Thumbnail: Satellite image of Earth. Title: "dataset to analyse global fir...". Link: esa.int
  - Thumbnail: Satellite image of Earth with climate change icons. Title: "ESA - Monitoring climate change from space". Link: esa.int
  - Thumbnail: Satellite image of a forest fire. Title: "TITLE OF PRESENTATION". Link: eo4society.esa.int
  - Thumbnail: Satellite image of a forest fire. Title: "ESA - Is Earth on fire?". Link: esa.int
  - Thumbnail: Satellite image of a forest fire. Title: "ESA - Fire mapping". Link: esa.int
  - Thumbnail: Satellite image of Europe. Title: "ESA - Monitoring air pollution from fires". Link: esa.int
- Row 3:
  - Thumbnail: Satellite image of a forest fire. Title: "ESA - Is Earth on fire?". Link: esa.int
  - Thumbnail: Satellite image of a forest fire. Title: "forest fire scars". Link: esa.int
  - Thumbnail: Satellite image of a forest fire. Title: "forest fire scars". Link: esa.int
  - Thumbnail: Satellite image of a coastal area. Title: "ESA - Is Earth on fire?". Link: esa.int
  - Thumbnail: Satellite image of Europe. Title: "ESA - Is Earth on fire?". Link: esa.int
  - Thumbnail: Satellite image of Europe. Title: "ESA - European hot spots and fires ...". Link: esa.int
  - Thumbnail: Satellite images of air pollutants. Title: "Copernicus Sentinel-5P Mapping Portal". Link: maps.s5p-pal.com
- Row 4:
  - Thumbnail: Satellite image of Europe. Title: "fire gif". Link: esa.int
  - Thumbnail: Satellite image of a satellite. Title: "climate change pictures". Link: esa.int
  - Thumbnail: Satellite image of Earth. Title: "2nd of January 2016". Link: esa.int
  - Thumbnail: Satellite image of Earth. Title: "22nd of January 2016". Link: esa.int
  - Thumbnail: Satellite image of Earth. Title: "1st of February 2016". Link: esa.int

**394 to 519 million hectares burned per year**

**19000 fires in July 2019 spotted by Sentinel-2**

**Indonesia in 1997 → 0.81 and 2.57 gigatons of CO<sub>2</sub> into the atmosphere, (13%–40% of the annual global carbon dioxide emissions from burning fossil fuels)**

**In June and July of 2019, fires in the Arctic emitted more than 140 megatons of carbon dioxide, according to**





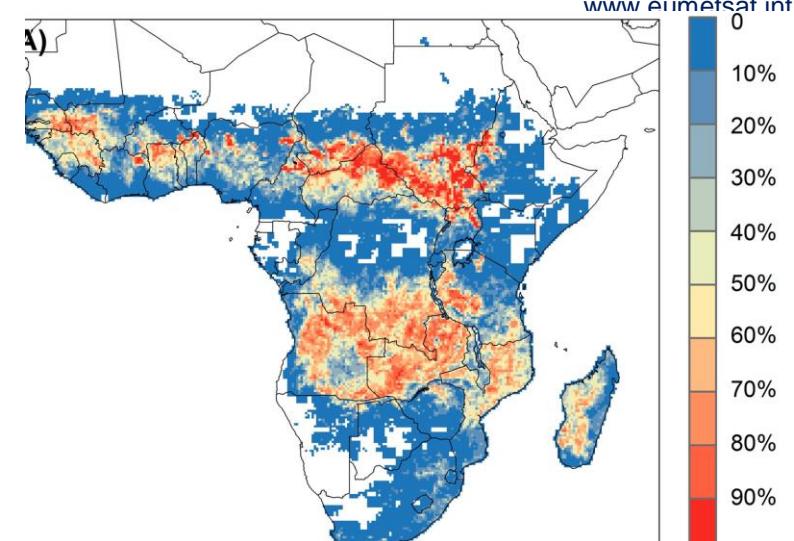
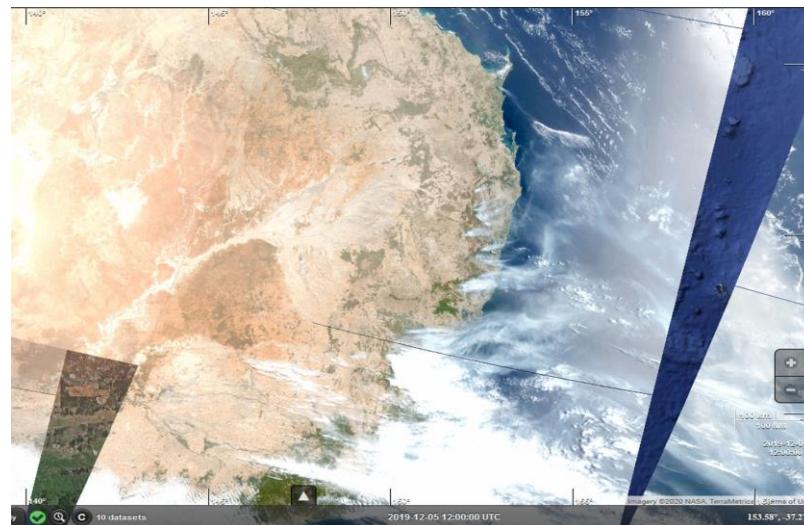
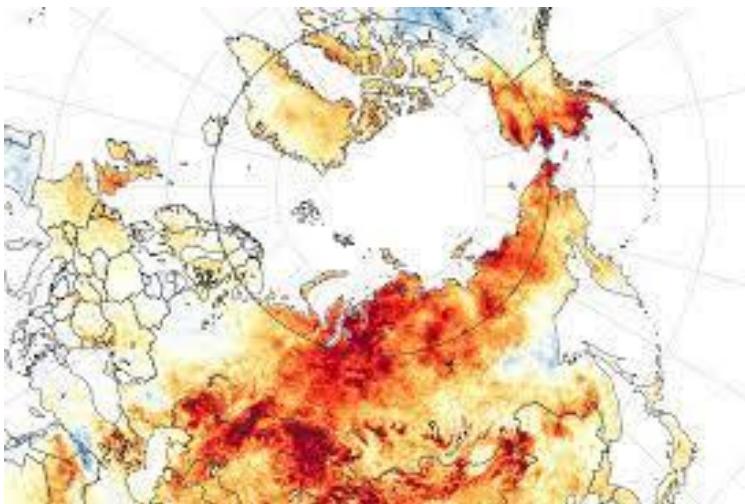
# View from the space - wildfires in Greece - Turkey 2021

[www.eumetsat.int](http://www.eumetsat.int)





# Wildfires at the global scale



**IPCC 2019**

Climate change is crucial for the current and future fire regime

Risk will increase including tropical forests

Prolonged fire seasons

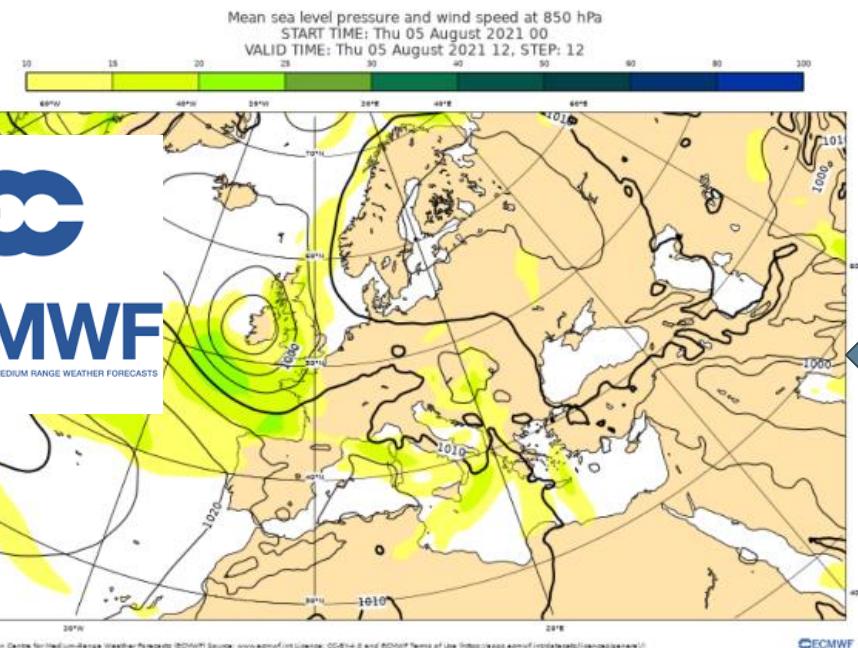
However - burnt area decreased in 1979-2018 - possible bias in resolution



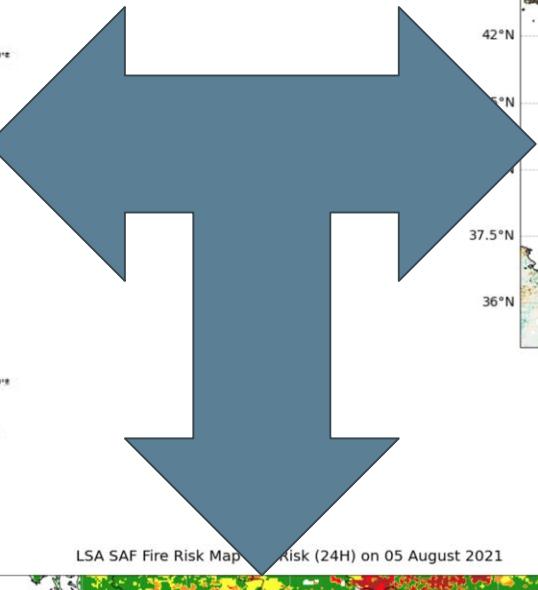
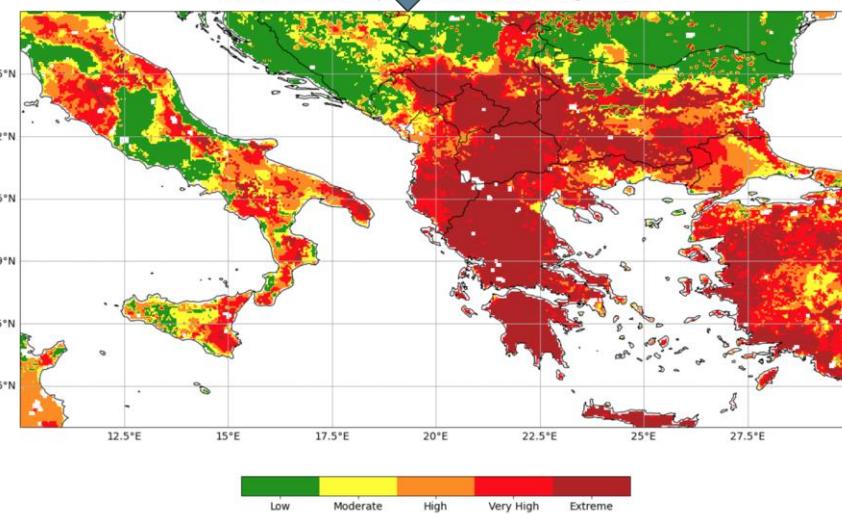


# Anticipating Events: Fire Risk Assessment

Greece 2021

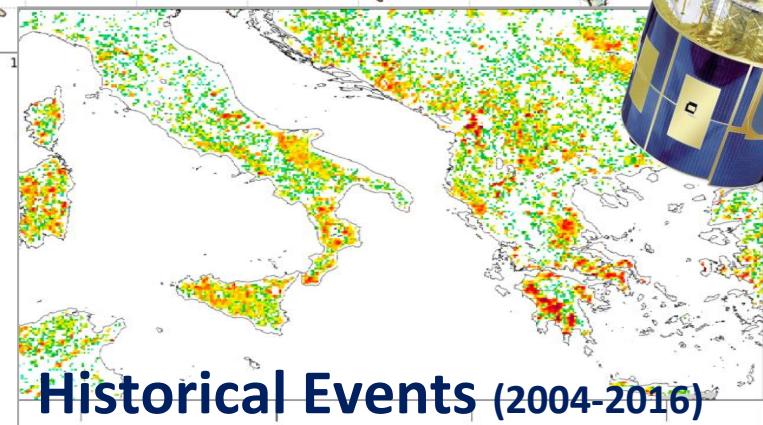
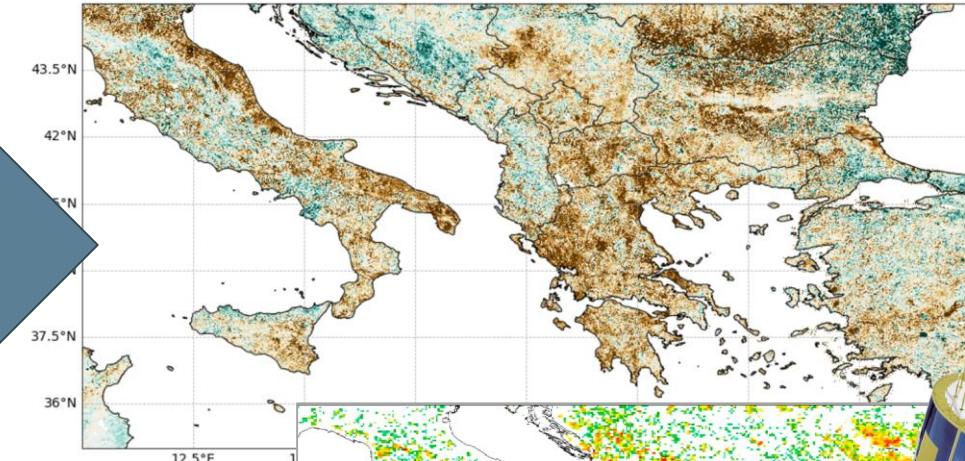


Fire Risk



## Vegetation State

Normalized Difference Vegetation Index (ENDVI10) Anomaly - Dekad 3 - 2021-07

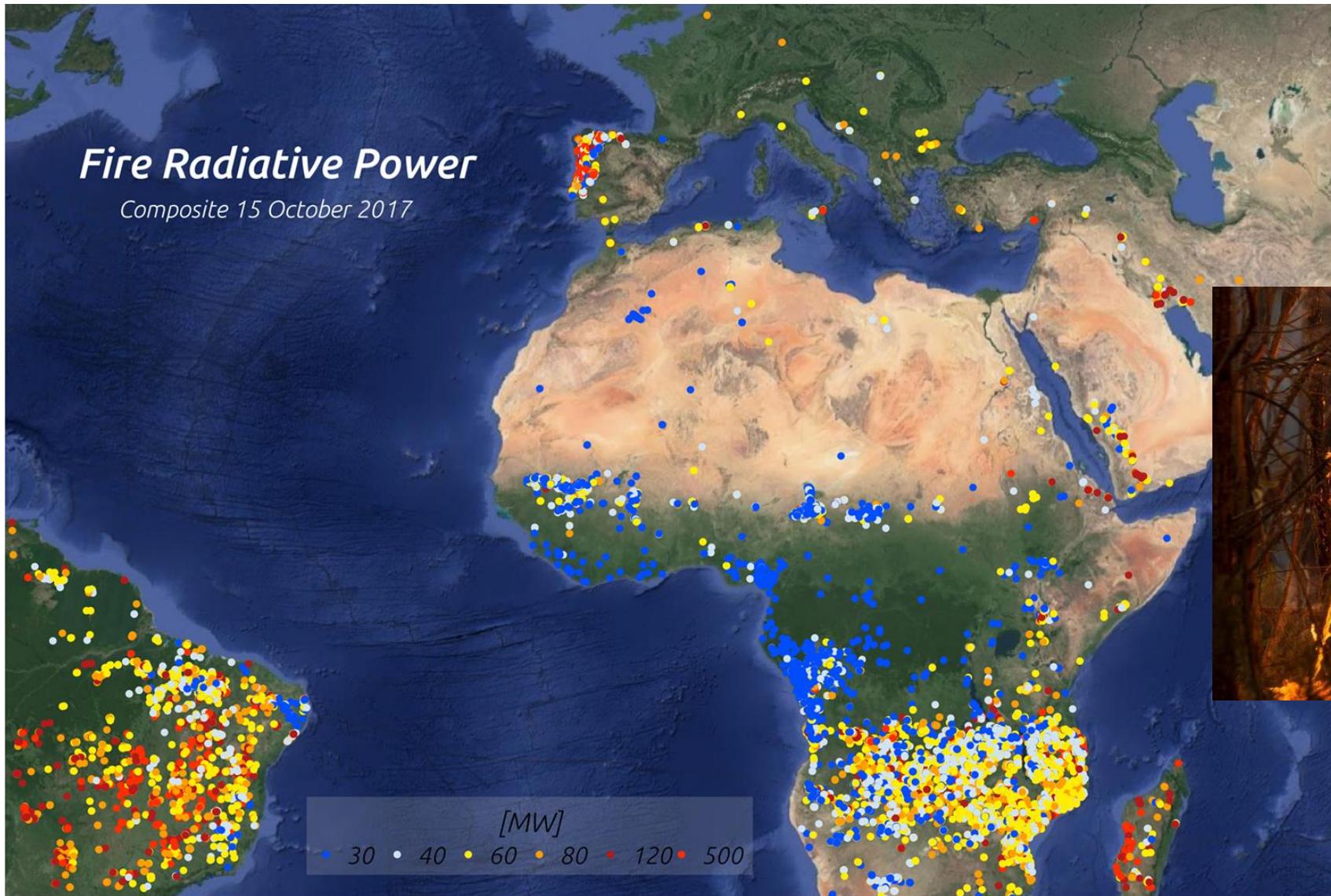


EUMETSAT  
**LSA SAF**  
LAND SURFACE ANALYSIS



# Anticipating Events: Fire Risk Assessment

[www.eumetsat.int](http://www.eumetsat.int)



October 2017

Central Portugal – 15 Oct 2017



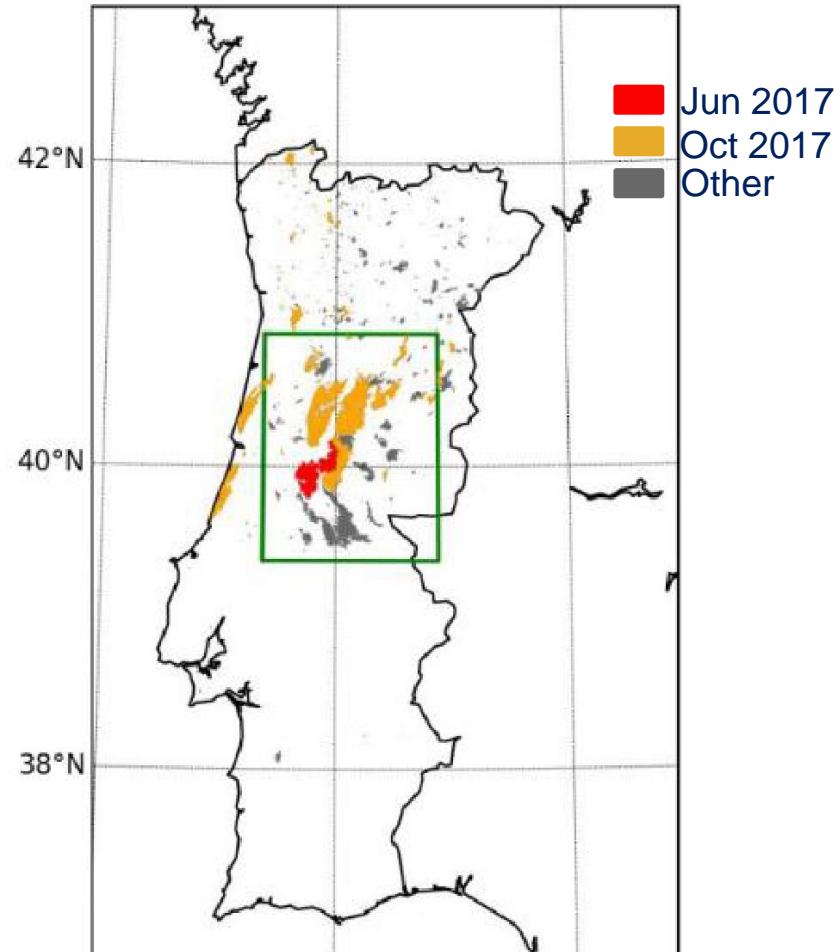
© Fernando Fontes / Global Imagens



# Impacts: Burned Area

[www.eumetsat.int](http://www.eumetsat.int)

## Burned Area in 2017



Deep Learning approach to detect changes in VIIRS Spectral Signature (Pinto et al., 2022).



© Joana Bourgard/RR

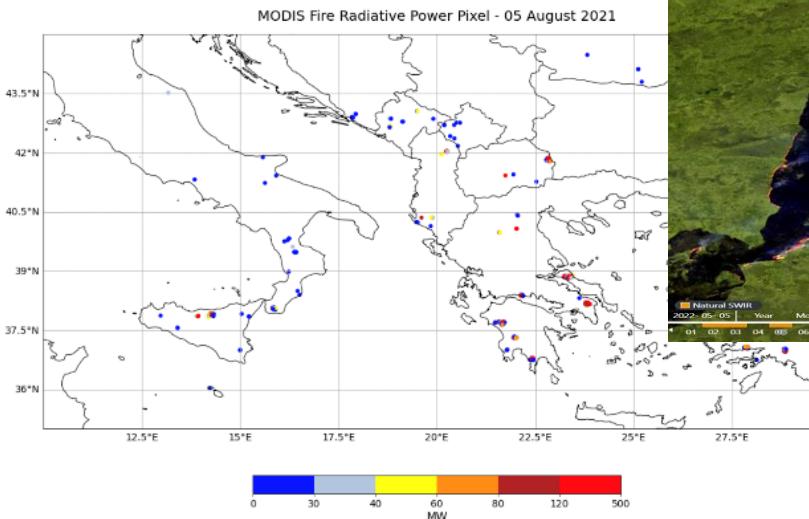


© Pedro Martins / Global  
Imagens

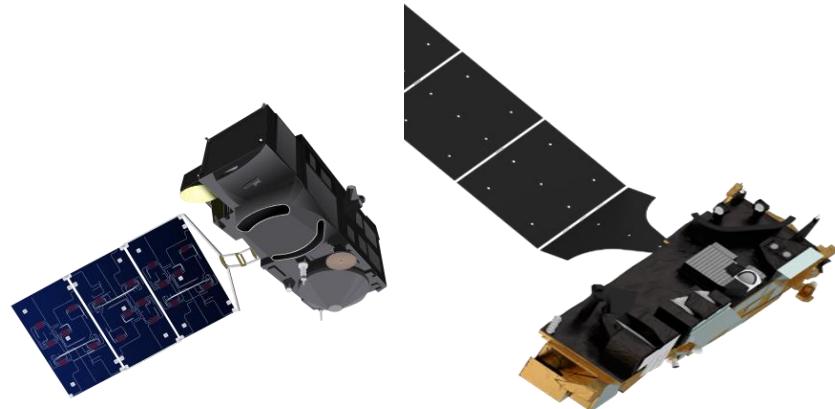


# Monitoring from space

[www.eumetsat.int](http://www.eumetsat.int)



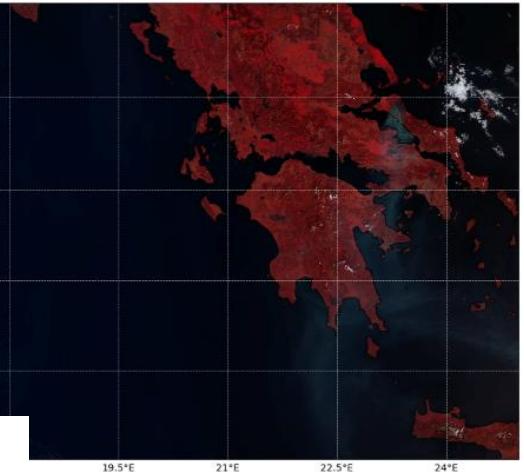
active fires



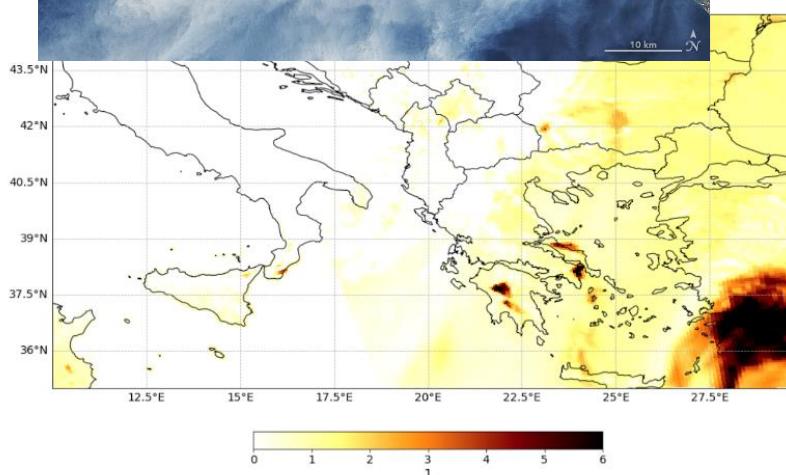
smoke plumes



Sentinel-3 OLCI Level-1 False Color RGB - "07 August 2021"



reflected sunlight  
thermal heat radiation



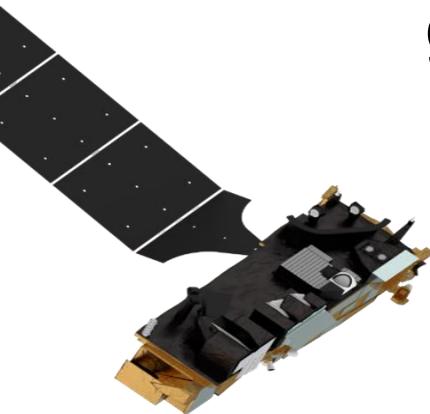
atmospheric particles



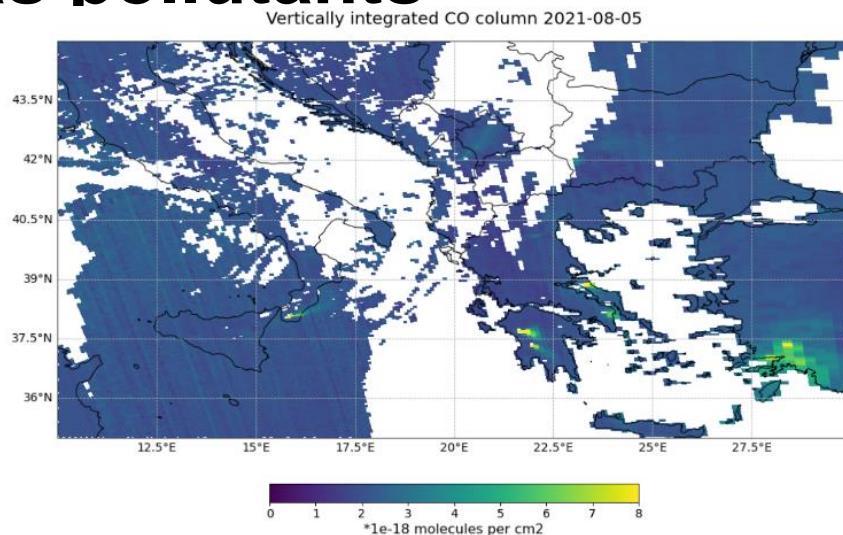
# Monitoring from space



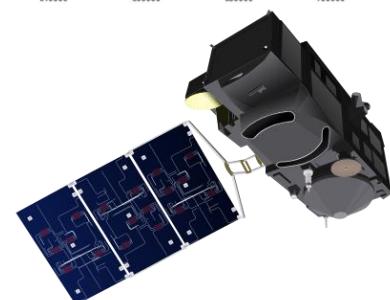
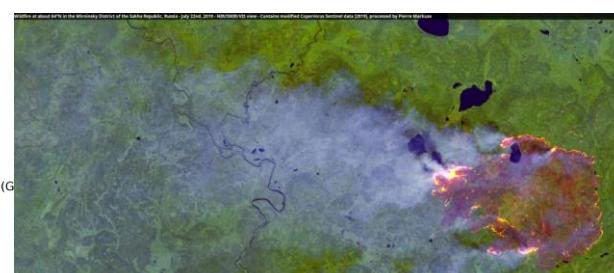
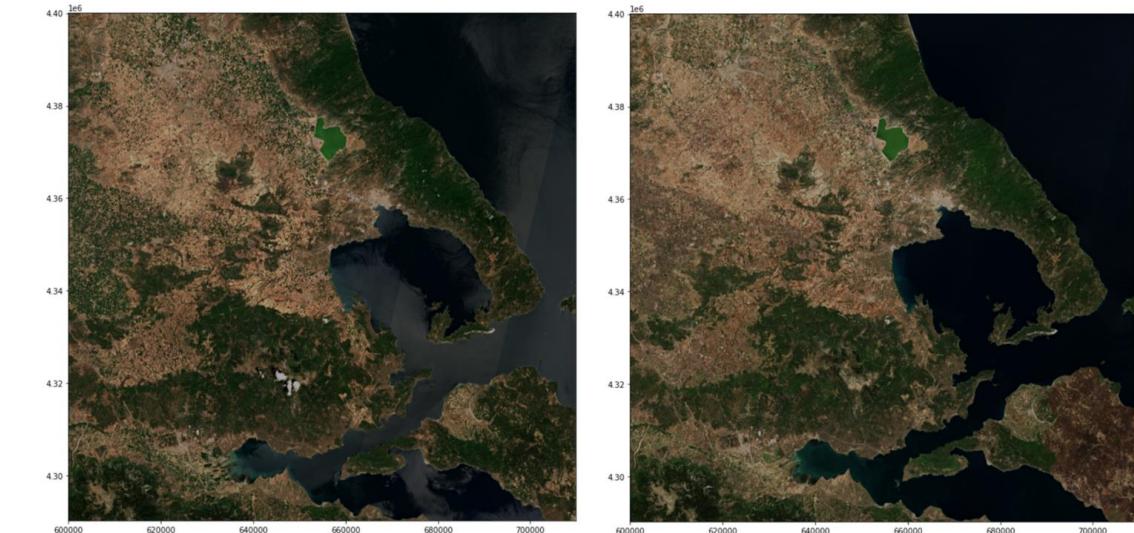
[www.eumetsat.int](http://www.eumetsat.int)



## gas pollutants

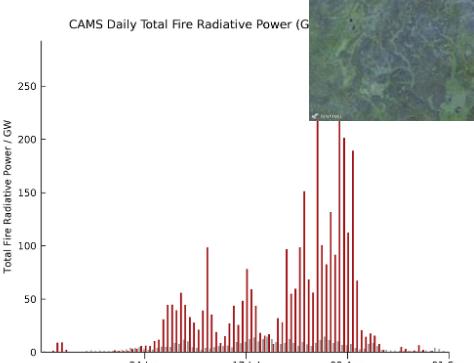
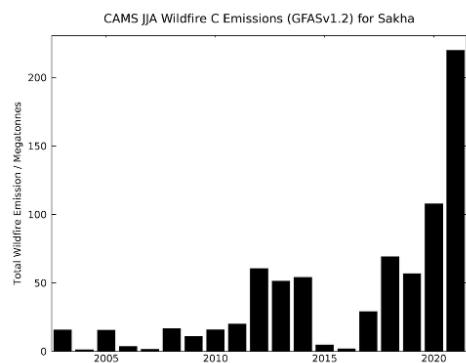


## burned area & scars



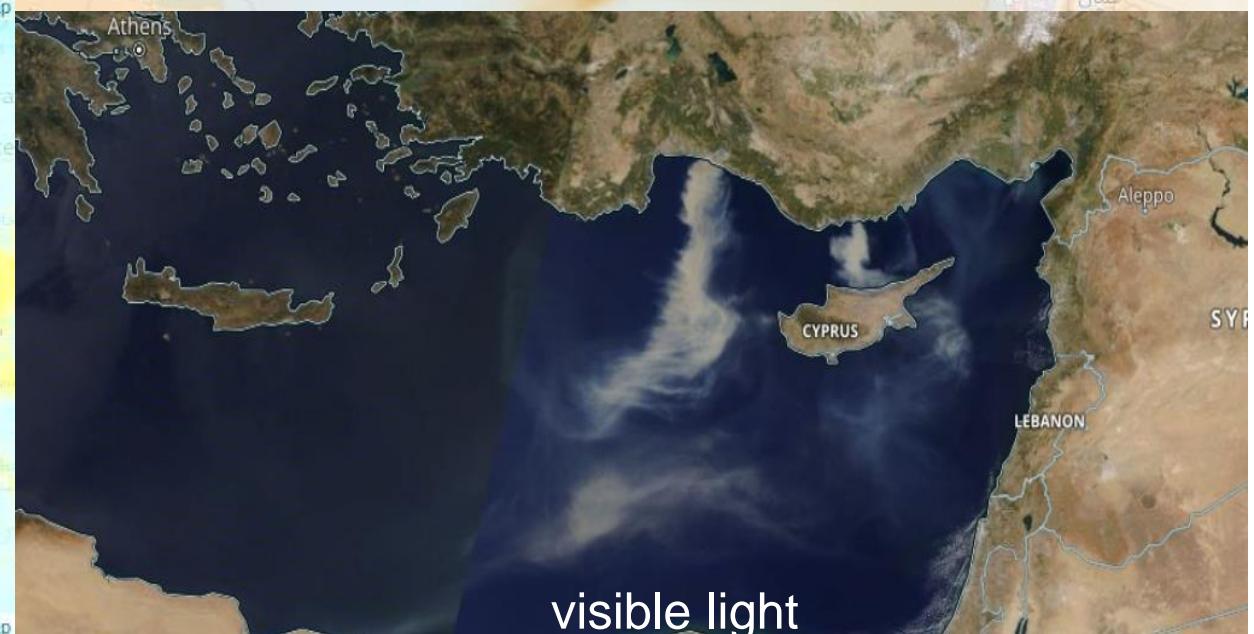
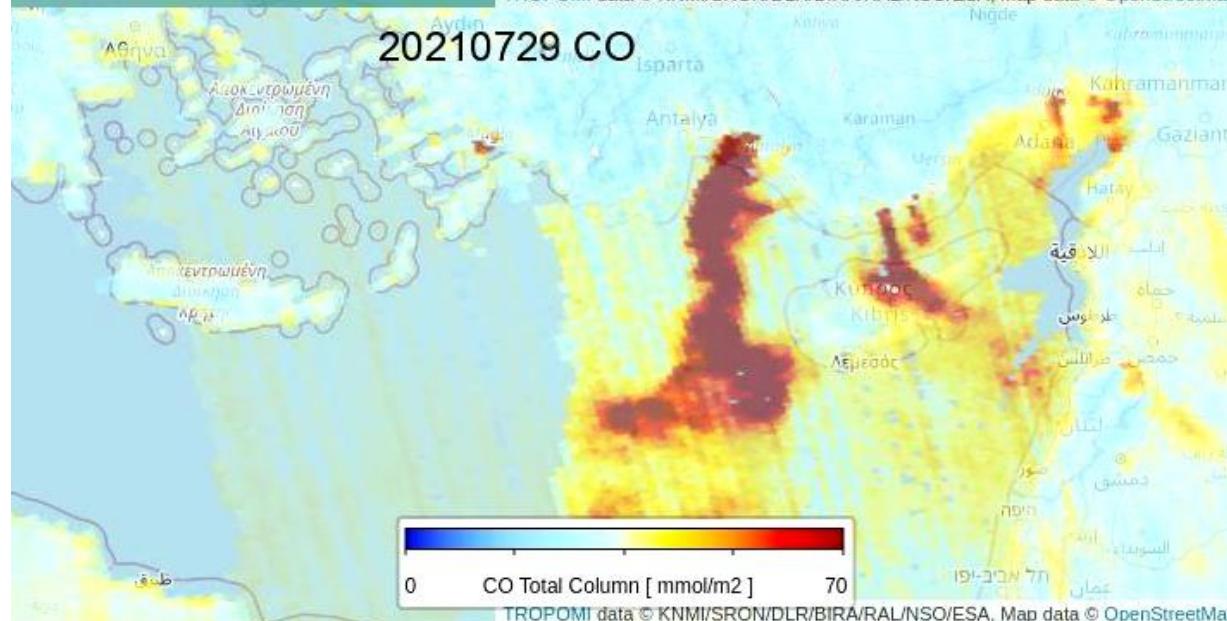
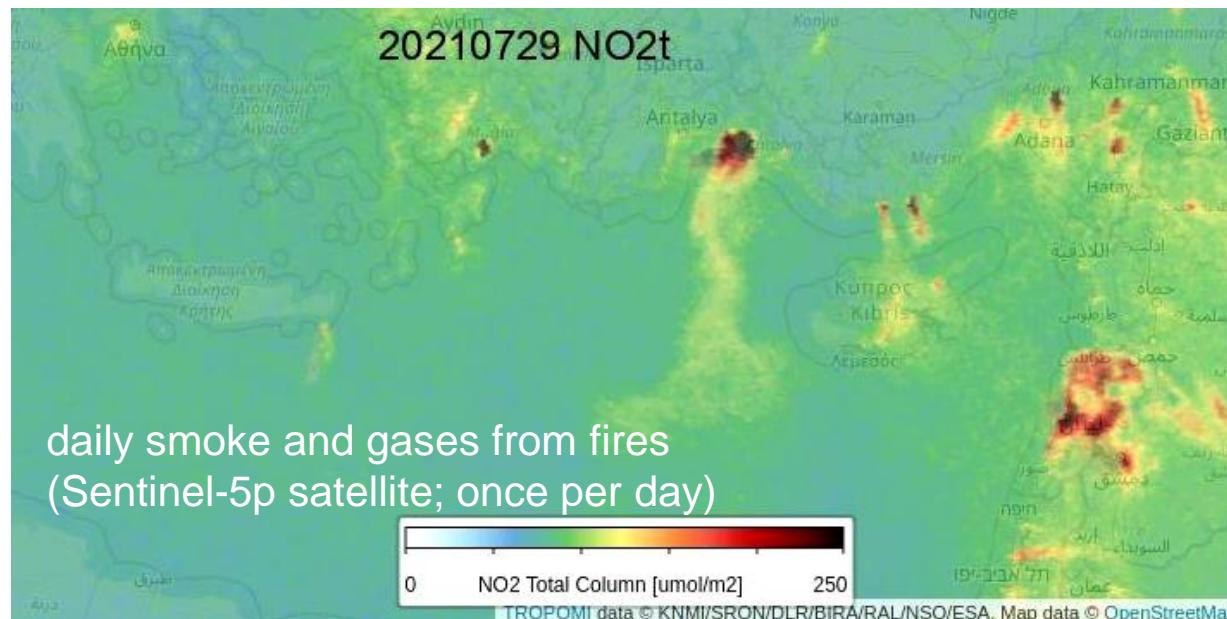
**ECMWF**  
EUROPEAN CENTRE FOR MEDIUM RANGE WEATHER FORECASTS

## emissions & trends





# Monitoring from space

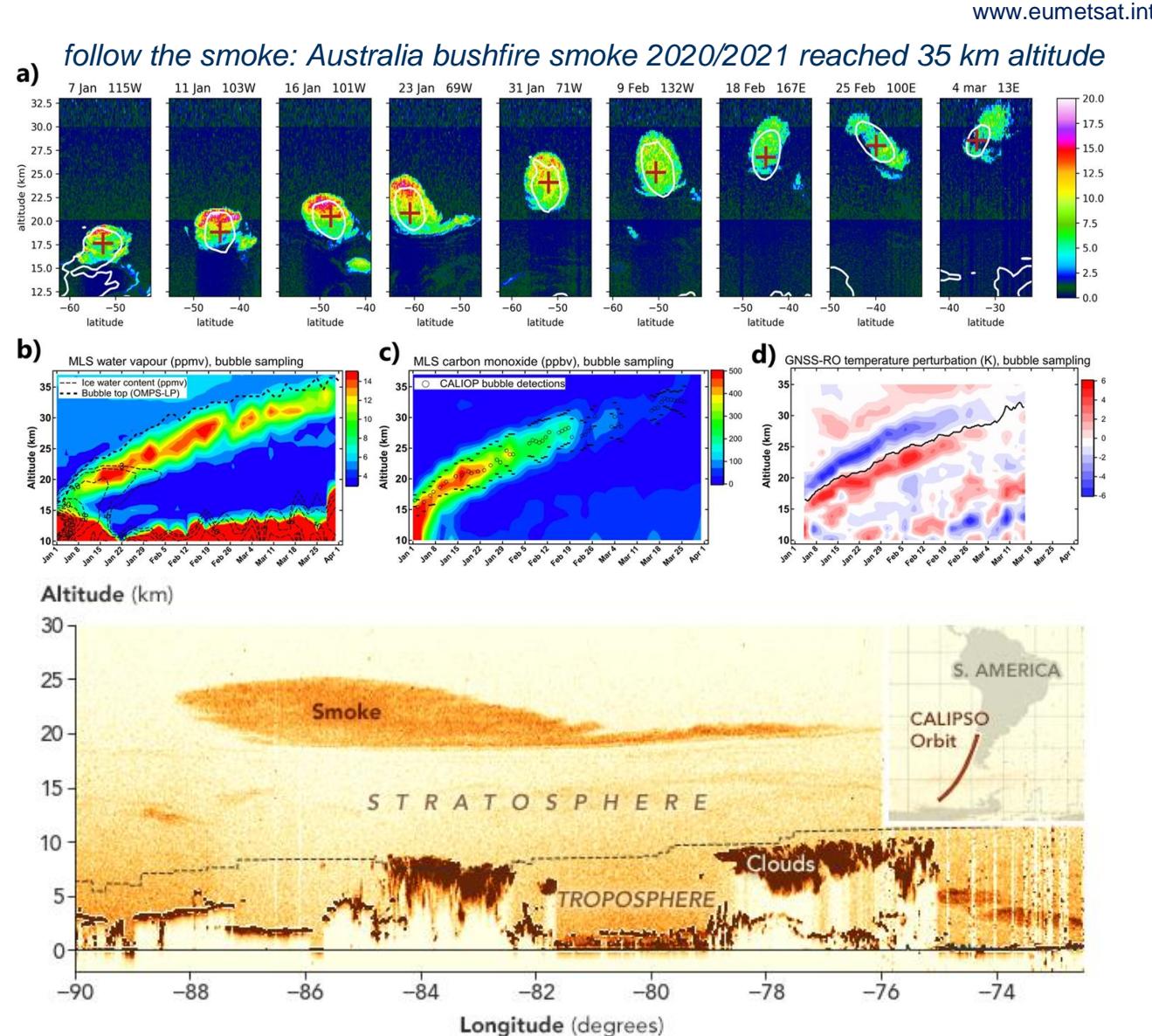
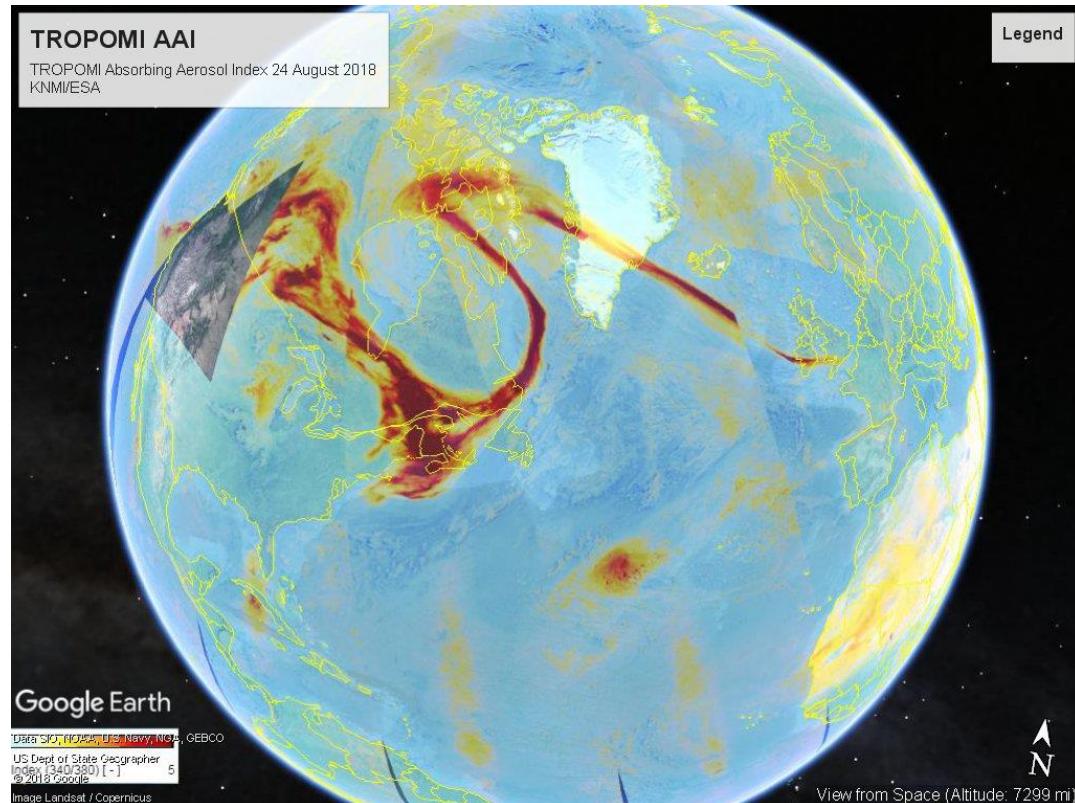




# Monitoring from space

worldwide monitoring of wildfire  
smoke and air pollution

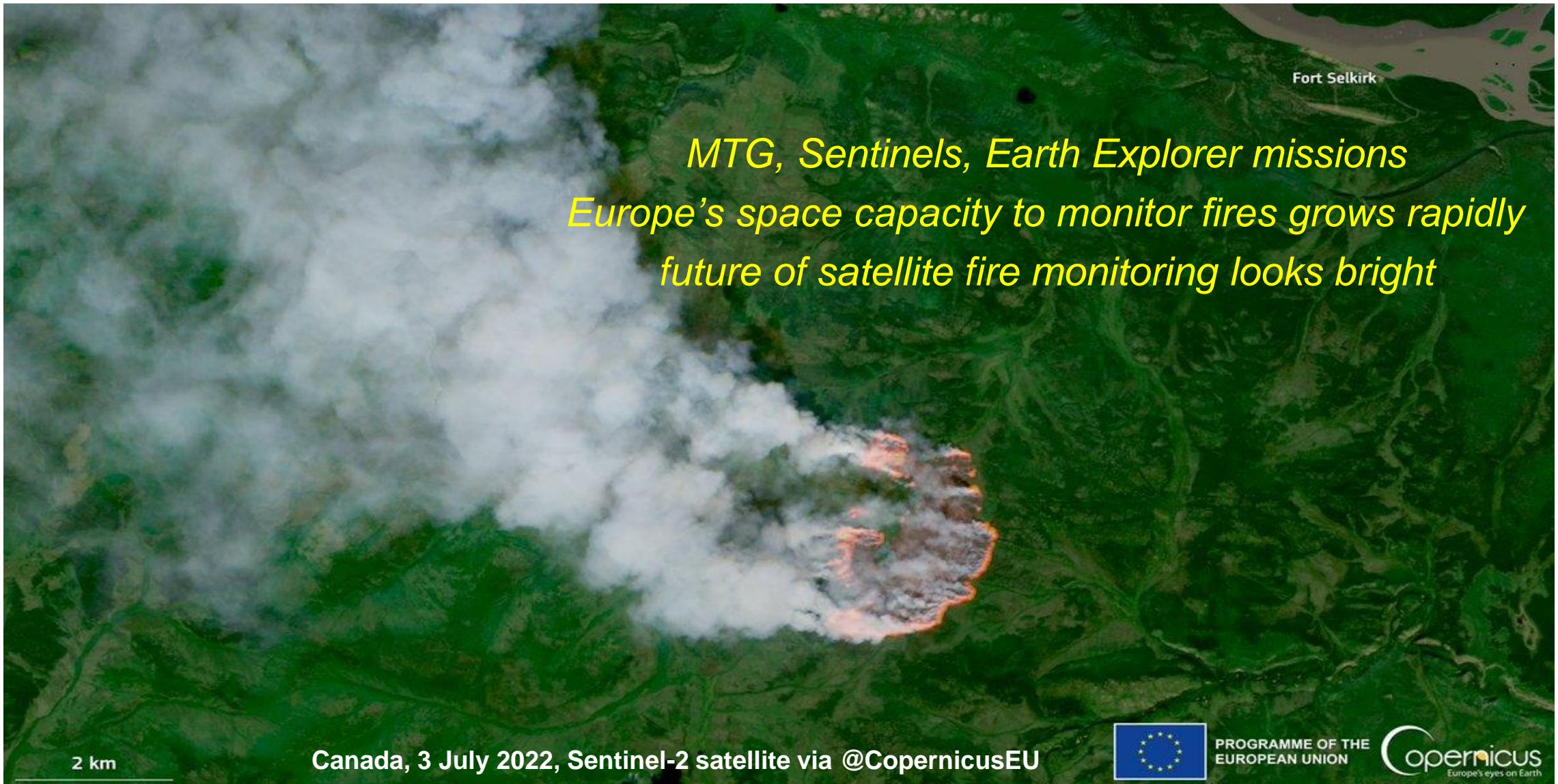
*follow the smoke: smoke from Canada fires 2018 reached Europe*





# Monitoring from space

[www.eumetsat.int](http://www.eumetsat.int)



Canada, 3 July 2022, Sentinel-2 satellite via @CopernicusEU



PROGRAMME OF THE  
EUROPEAN UNION

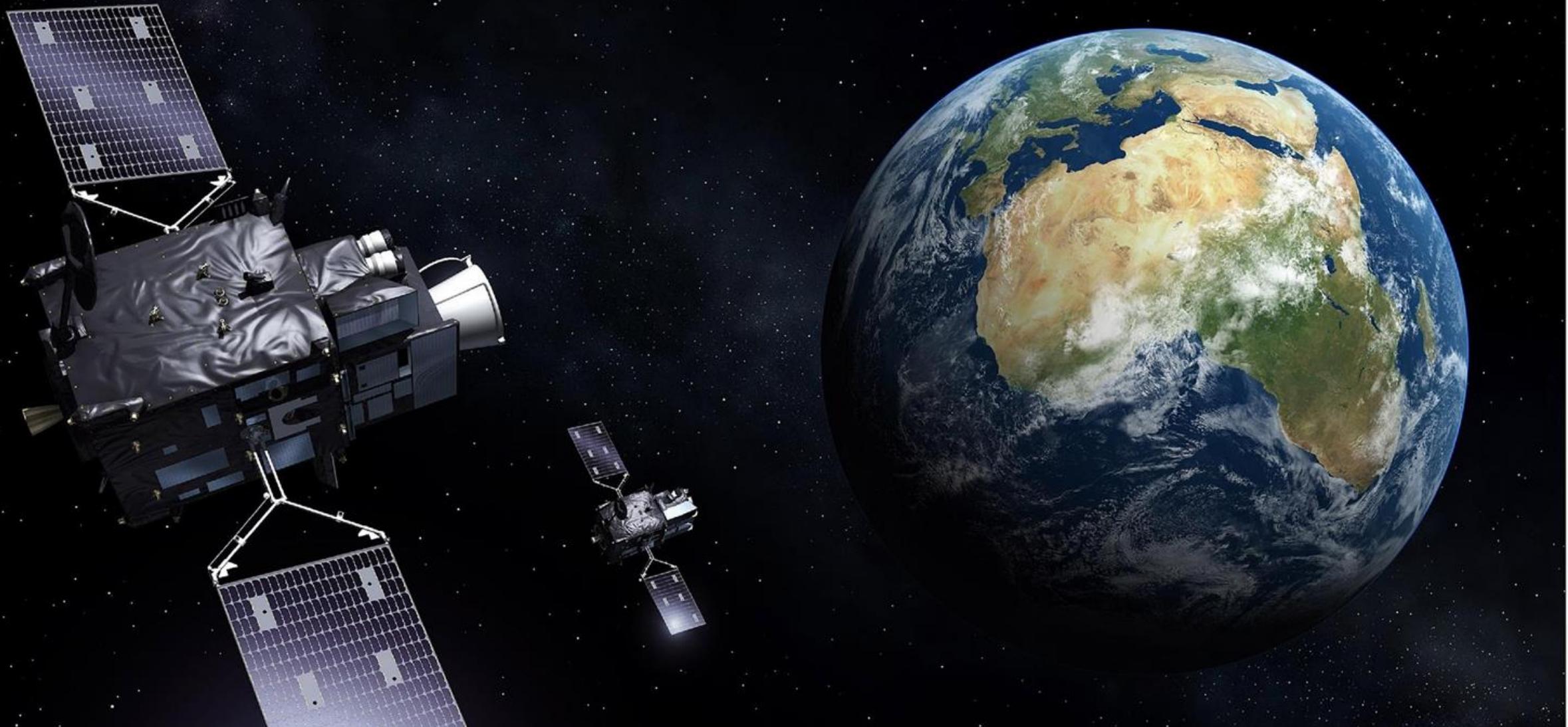




# Monitoring from space

*The future is now: METEOSAT Third Generation (2023 onwards)*

[www.eumetsat.int](http://www.eumetsat.int)





# Monitoring from space

[www.eumetsat.int](http://www.eumetsat.int)



a whole new dimension will  
be explored by Sentinel-4:

daytime hourly air quality data  
over Europe

