2. ESA EO Data Access and resources, including Third Party missions, applications of Copernicus Earth Observation data

ESA EO Data Access and resources

ESA Earth Observation Data Policy

- To stimulate a <u>balanced development</u> of Science, Public Utility and Commercial Applications

- To maximize the use of data from ESA EO satellites

ERS and Envisat

Earth Explorers

ESA Third Party Missions

- *Free datasets*

  (Free of charge; User registration and acceptance of ESA Terms & Conditions are required → Open access)

- *Restrained datasets*

  (Free of charge; User registration, submission of a "Project (Full) Proposal" and acceptance of the ESA Terms & Conditions are required, after its evaluation a quota will be assigned)
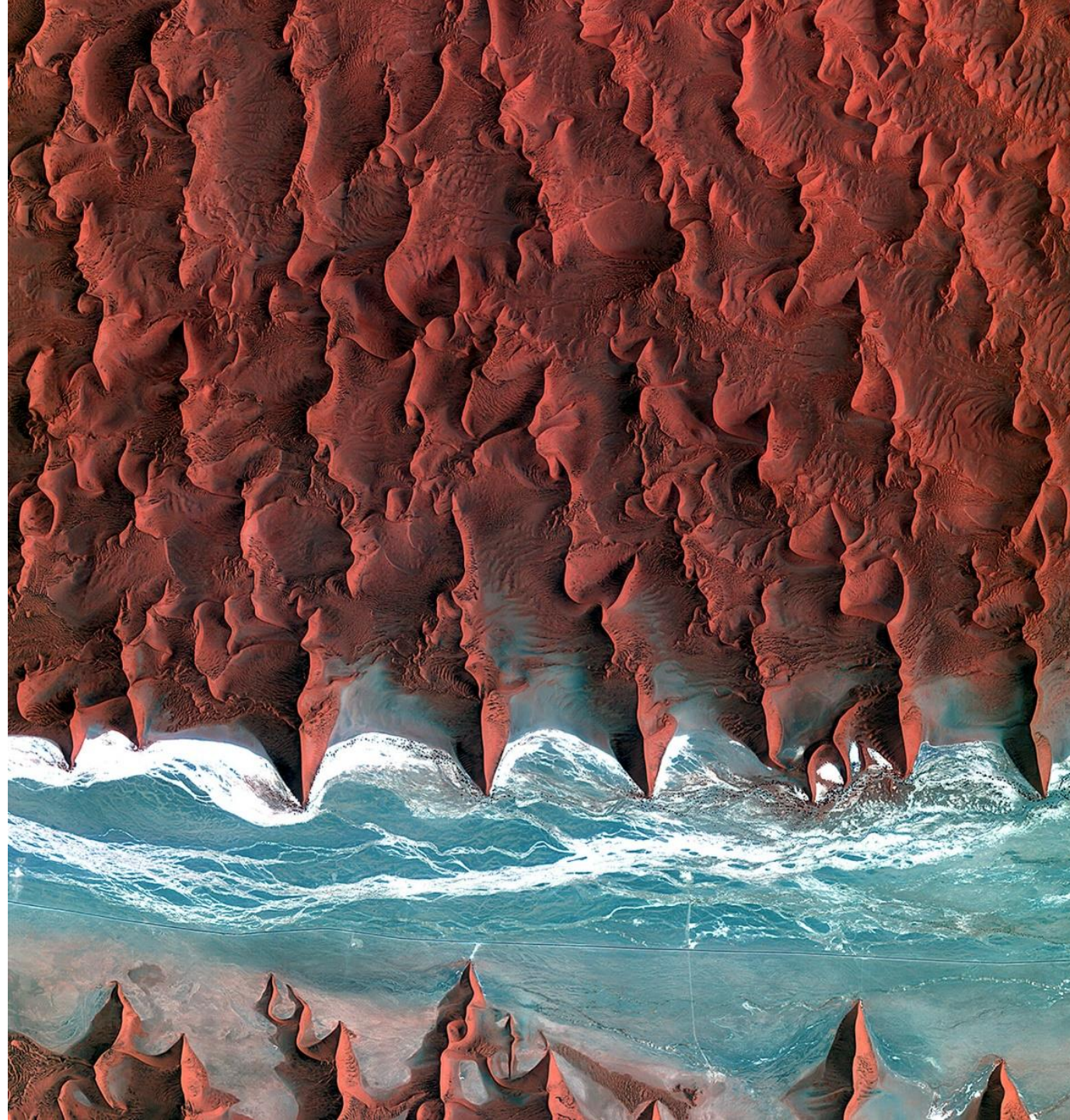
- <u>Data Policy of individual data providers</u>

  In some case, a reproduction cost (e.g. ALOS) or Specific Restrictions (limitations of quota, geographical restrictions, etc.) to the use of data may be applied for TPM

EO data access
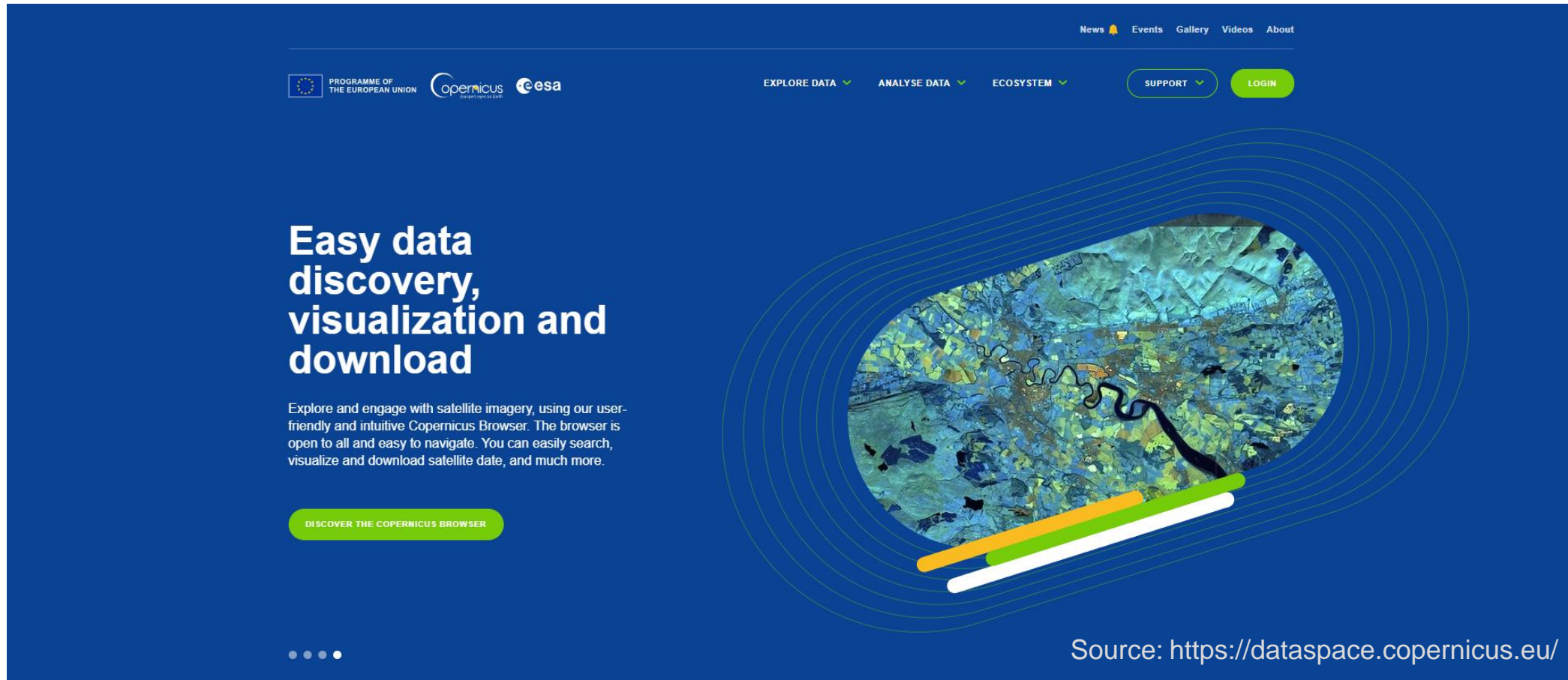
Free open source platforms

- **Copernicus Open Access Hub**
- Earth System Lab
- ESA Thematic Exploitation Platforms
- Alaska Satellite Facility
- Copernicus Global Land Service
- **Copernicus Data Space Ecosystem**
- **Sentinel Data Access Service**
- USGS Earth Explorer
- Sentinel Application Platform software
- Open Data Cube

Copernicus Data Space Ecosystem

https://dataspace.copernicus.eu/

Source: https://dataspace.copernicus.eu/

- Since 24 January 2023 a new Copernicus Data Space Ecosystem has been launched to provide free and open access to EO data from all Sentinel satellites with new features for visualisation and data processing.

Copernicus Open Access Hub

https://scihub.copernicus.eu/

- The previous Copernicus Open Access Hub provided complete, free and open access to Sentinel-1, Sentinel-2, Sentinel-3 and Sentinel-5P user products

SNAP (Sentinel Application Platform) software

http://step.esa.int/main/download/snap-download/
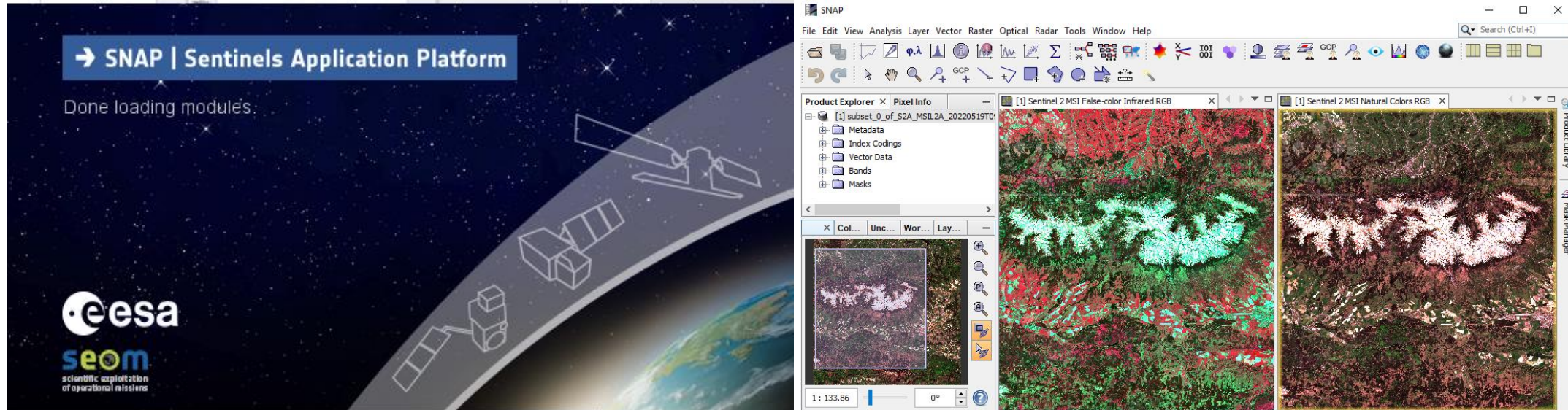
- ESA Sentinel Application Platform (SNAP) is a software toolkit developed by the ESA for processing and analyzing Earth observation data, particularly data from the Sentinel satellites. SNAP is part of the Sentinel Toolbox and is freely available to the public. It provides a user-friendly interface and a comprehensive set of tools also for working with a variety of other remote sensing data.

EO data access

Partially open-source EO platforms

- **EO Browser Sentinel Hub**

- DIAS - Copernicus Data & Information Access Services

- Google Earth Engine

- Earth on AWS

For more information, see the tutorial: 2. ESA EO Data Access and Selection, applications of Copernicus Earth Observation data

Source: https://www.esa.int/ESA_Multimedia/Images/2017/03/The_Karavasta_Lagoon_in_Albania_looks_spectacular/

EO Browser - SENTINEL Hub

https://apps.sentinel-hub.com/eo-browser/
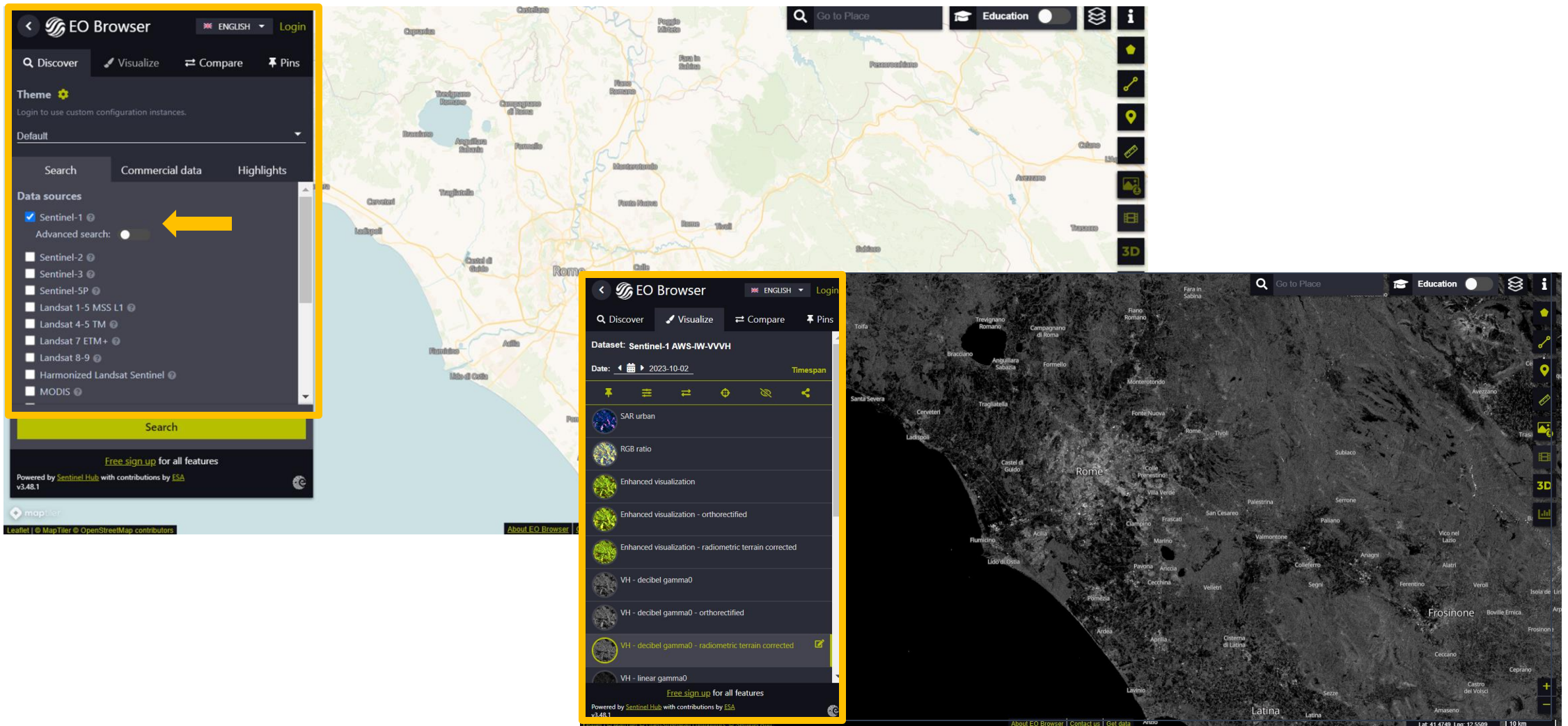
EO data access
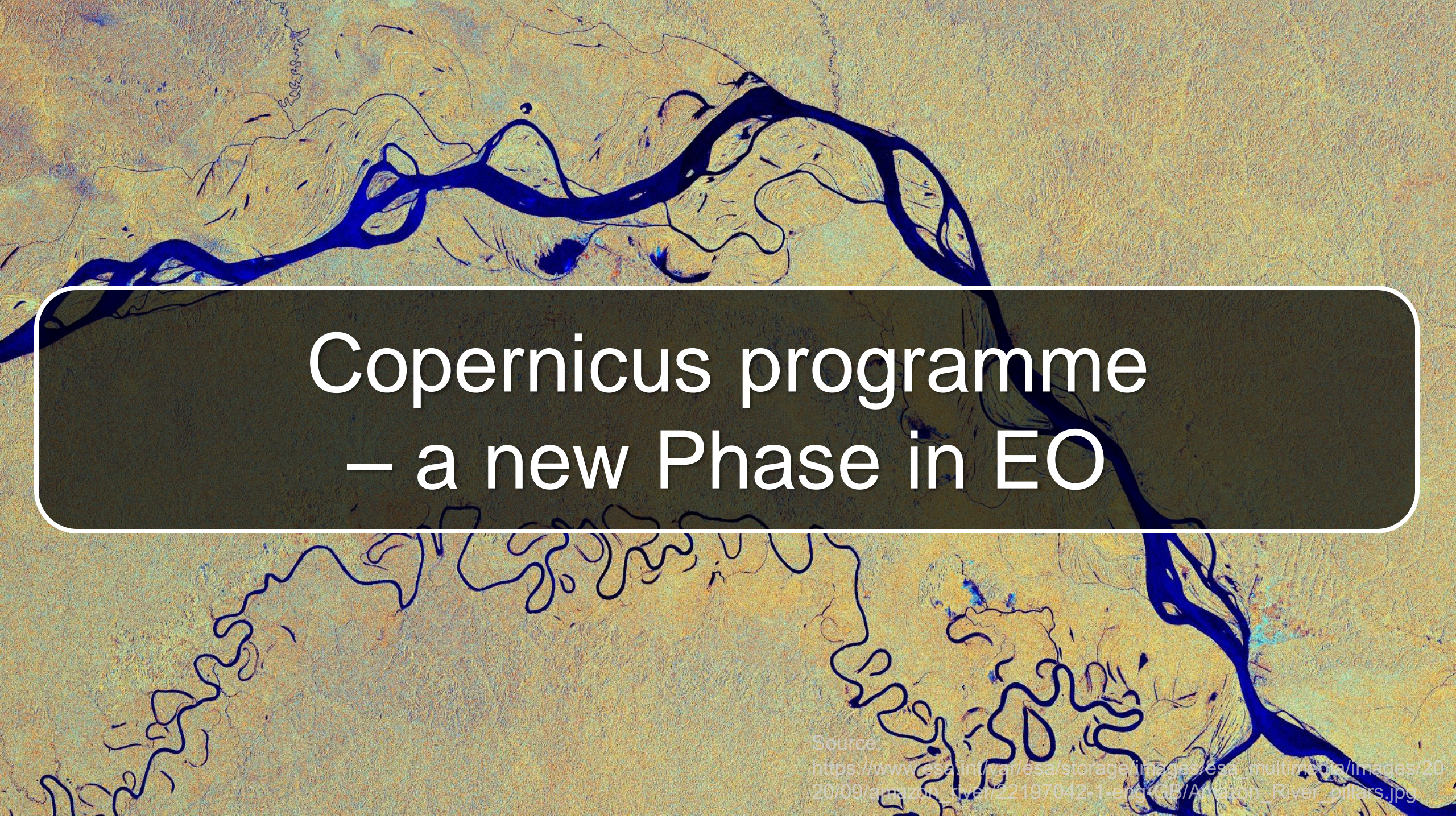
Commercial EO platforms

- DigitalGlobe / Maxar

- OneAtlas

- Planet platform

- e-Geos

- Decartes Labs

Copernicus programme – a new Phase in EO

Copernicus purpose and architecture

→ **European response to global needs:**

- to manage the environment
- to mitigate the effects of climate
- to ensure civil security
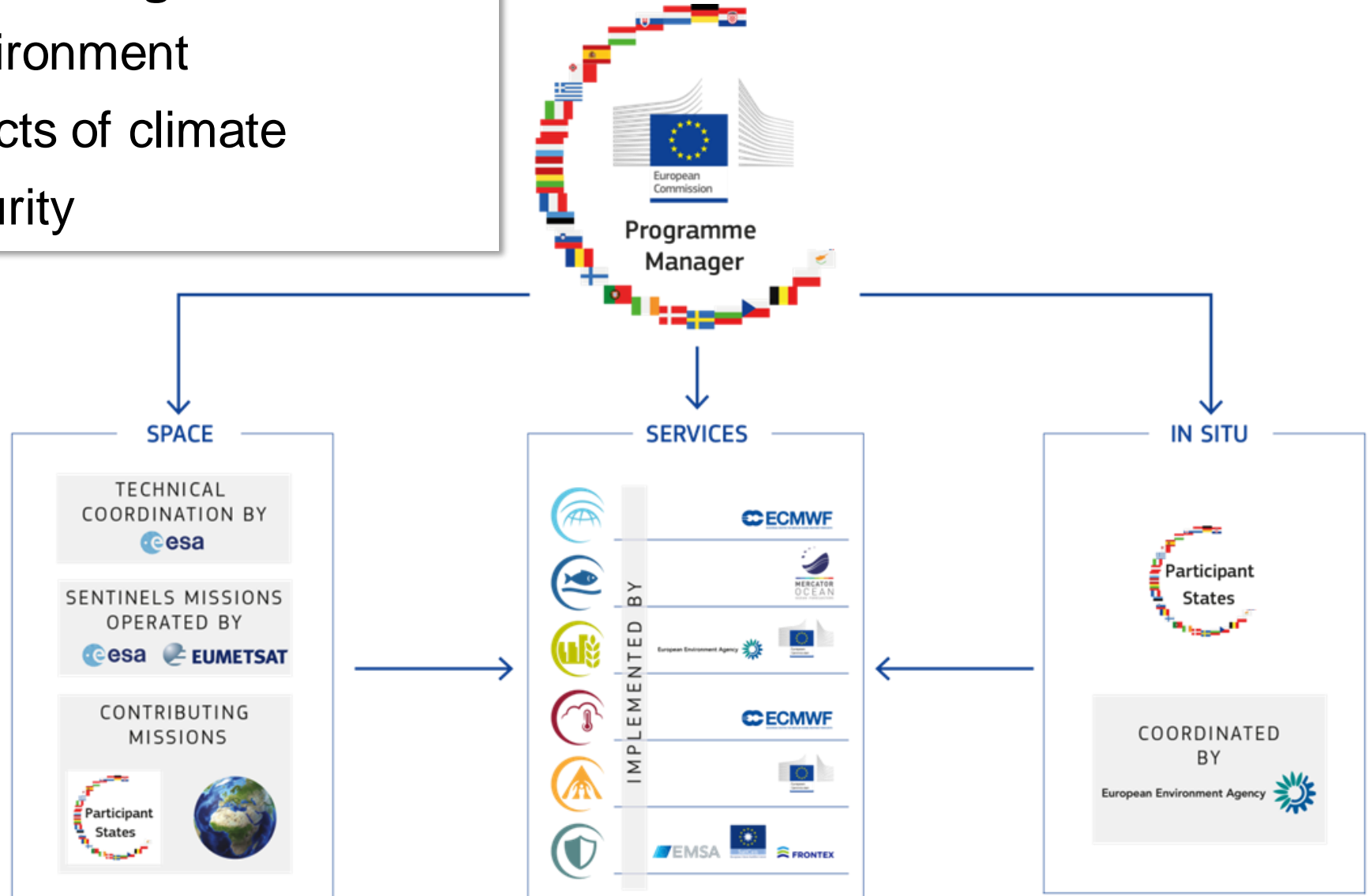
Space component

The Earth observation satellites which provide the data exploited by the Copernicus services are split into two groups of missions:

- Sentinels - developed for the specific needs of the Copernicus programme
  - Sentinel-1, -2, -3, -5P, -6, - Sentinel-4, -5
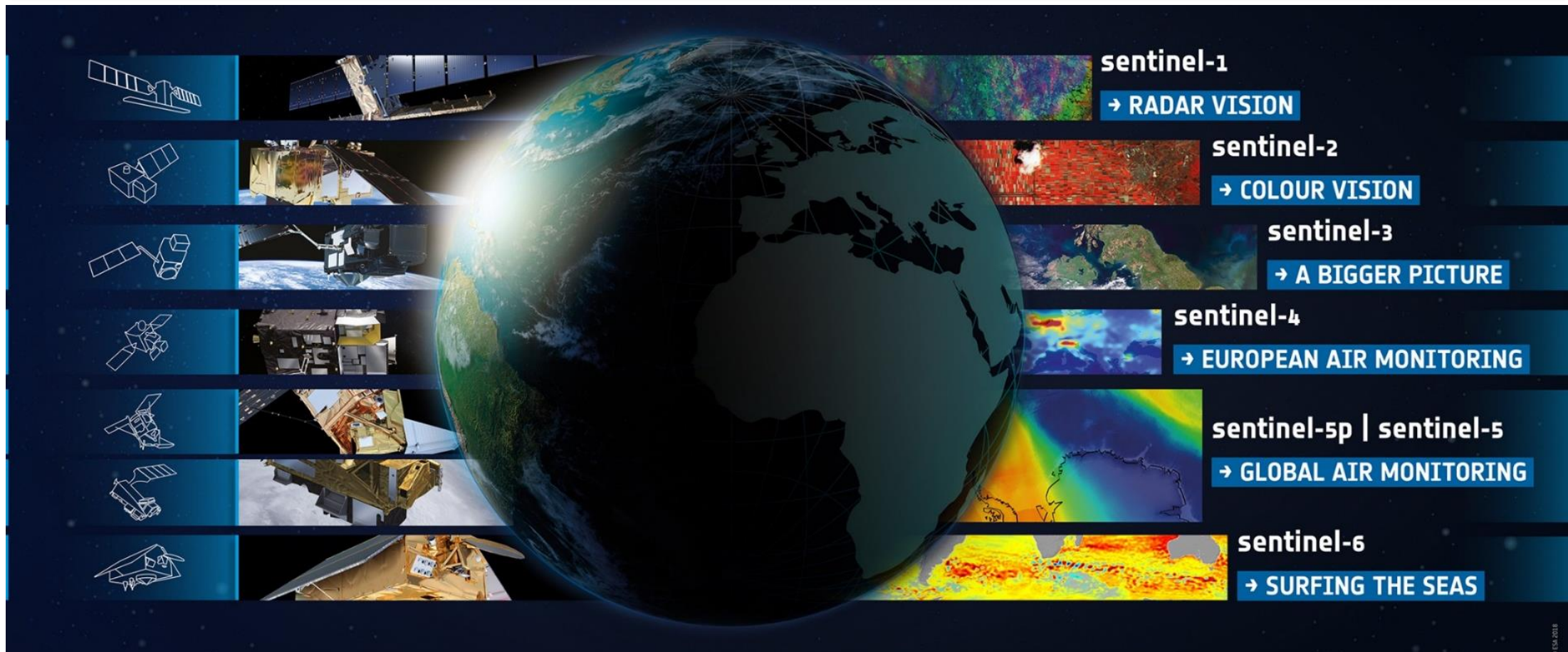
Space component

- Contributing Missions
  - operated by National, European or International organisations
  - already provide a wealth of data for Copernicus services

Sentinel-1 – Radar vision

Mission objectives:

- Marime and land monitoring
- Emergency management

Mission profile:

- C-Band SAR mission at 5.4 GHz
- Multi-polarisation
- Sun synchronous orbit at 693 km mean alt.
- 6 days repeat cycle at Equator with 2 satellites
- 4 operation modes

https://sentinels.copernicus.eu
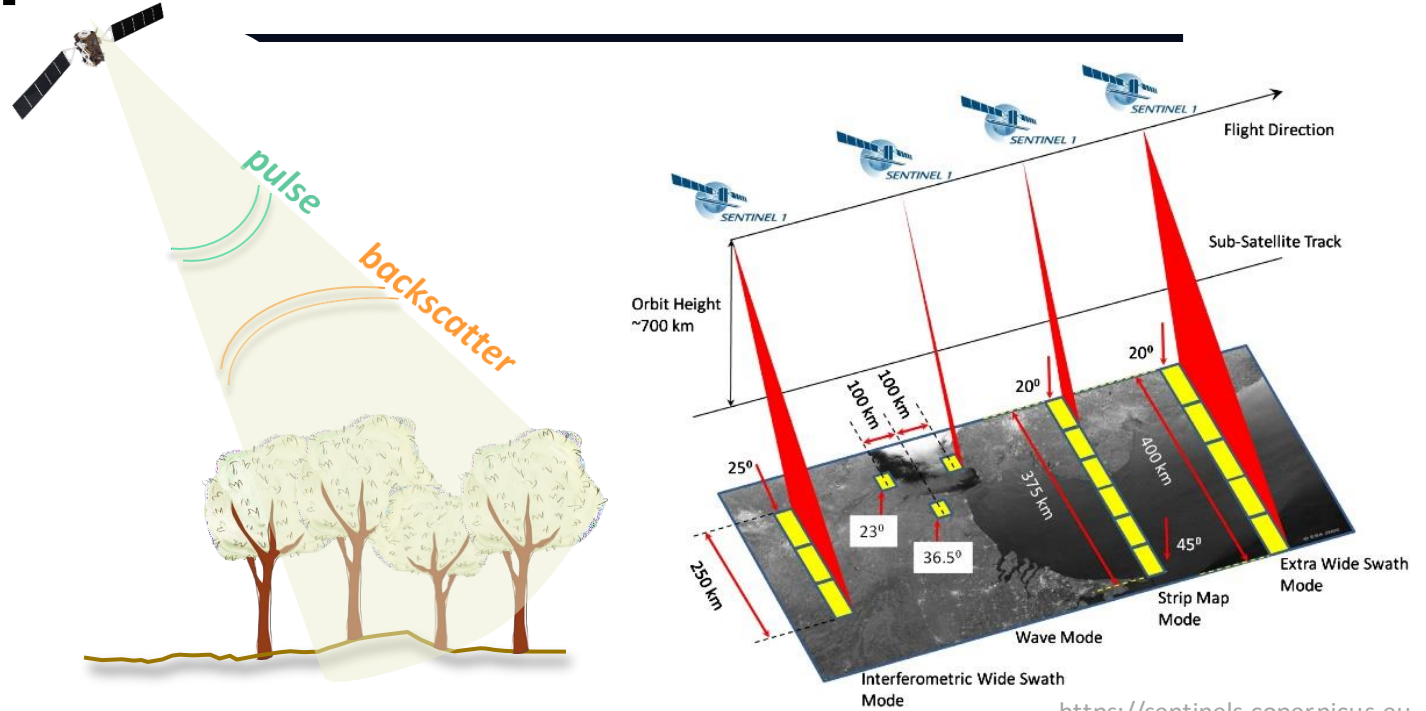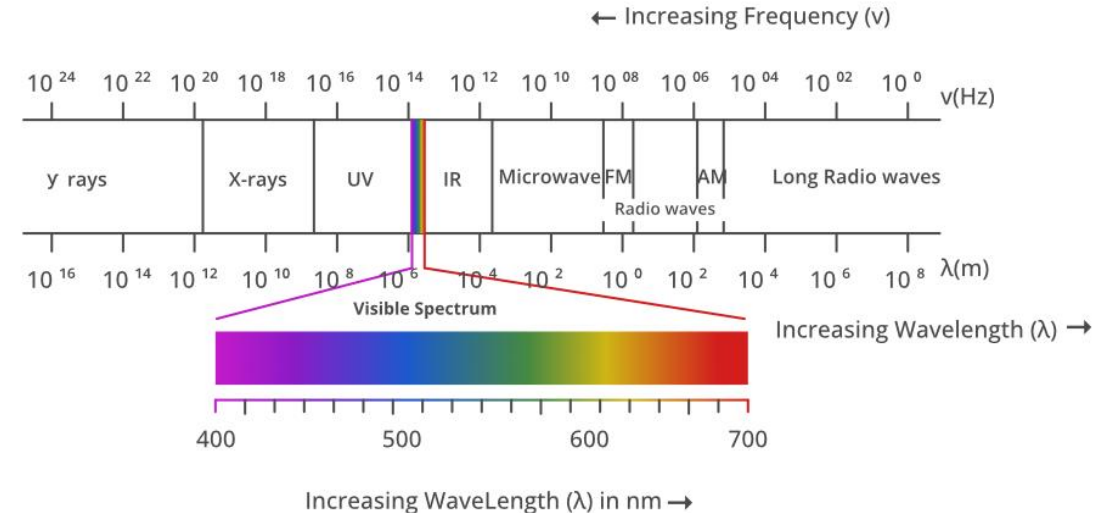
Sentinel-1 – Applications

Maritime surveillance:

- Ice Monitoring
- Oil Spill Monitoring
- Ship Detection
- Marine Winds, Etc.

Antarctic Peninsula glacier flow

Grande America oil spill imaged

Towing the Costa Concordia
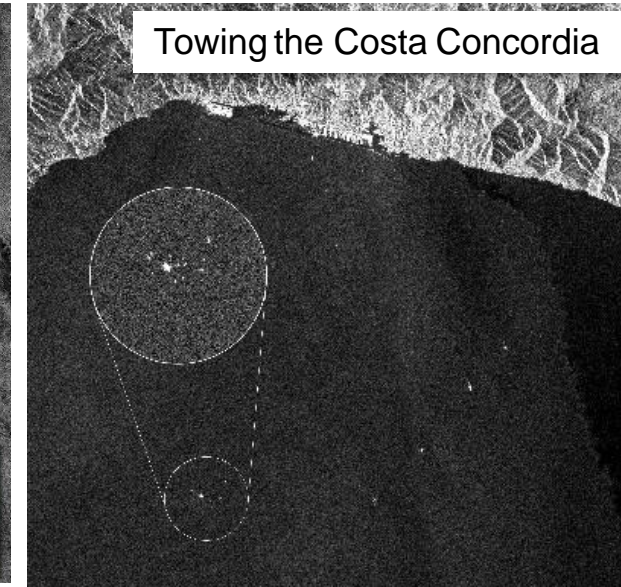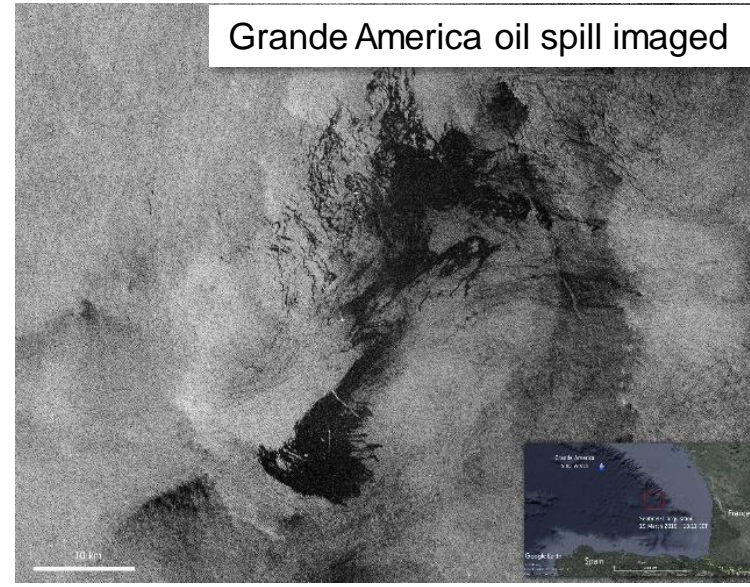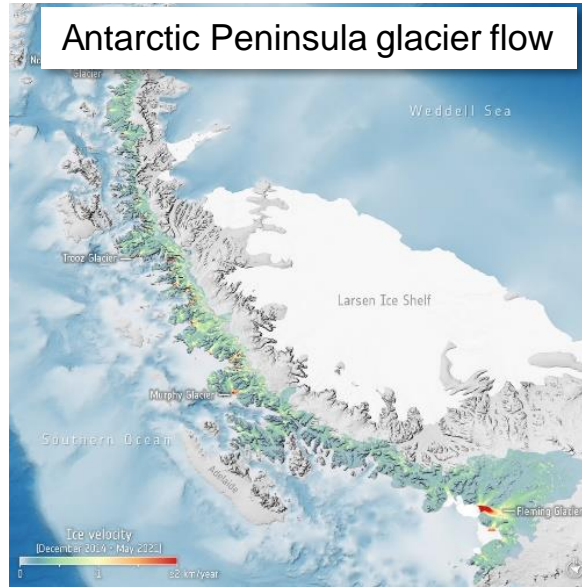
Land monitoring

- Forestry
- Agriculture
- Ground deformation
- Urban planning
- Soil Moisture, Etc.

Subsidence Mexico City
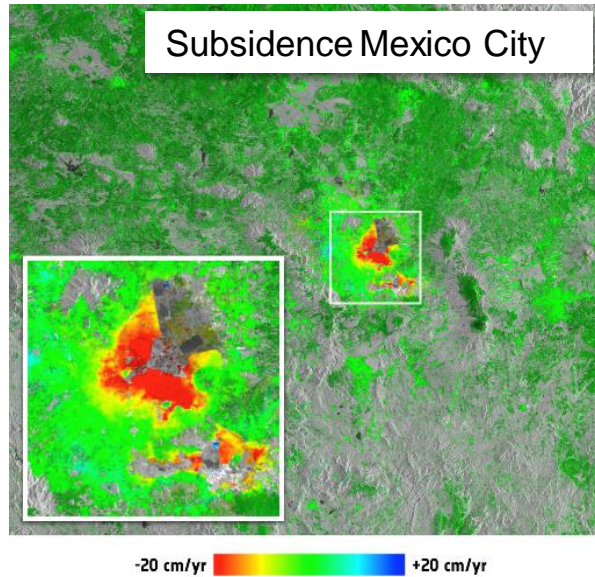
Rice-cropping systems in Vietnam's Red River Delta

Wetland map of Uganda
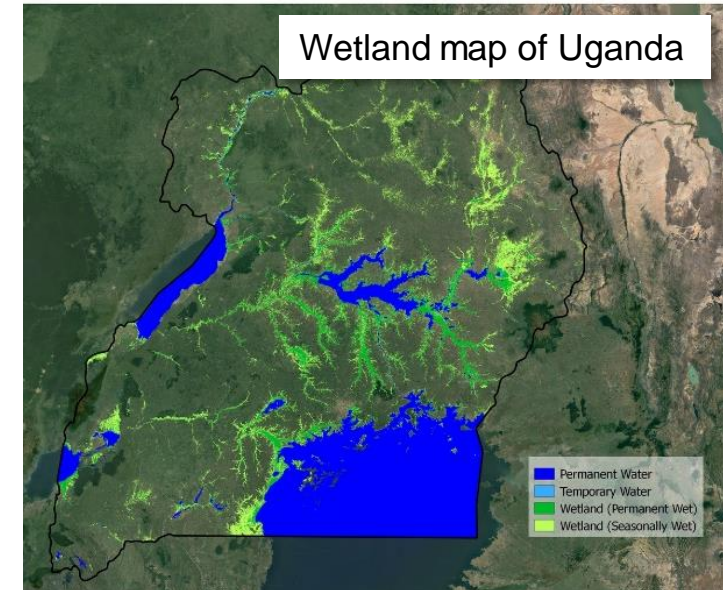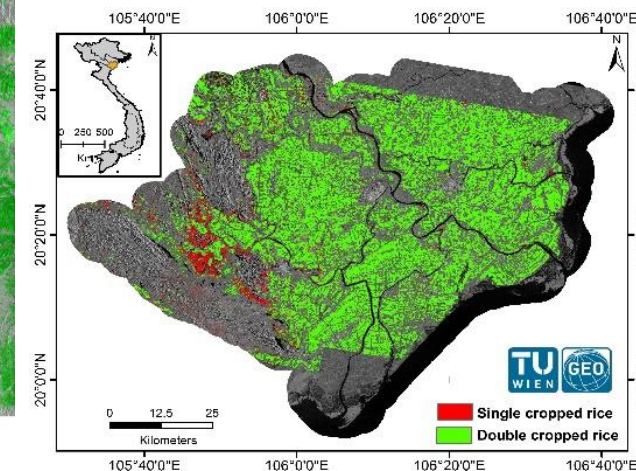
Sentinel-1 – Applications

Emergency management:

- Flood Monitoring
- Earthquake Analysis
- Landslide and volcano monitoring, etc.

Türkiye–Syria interferogram

Record floods in Australia
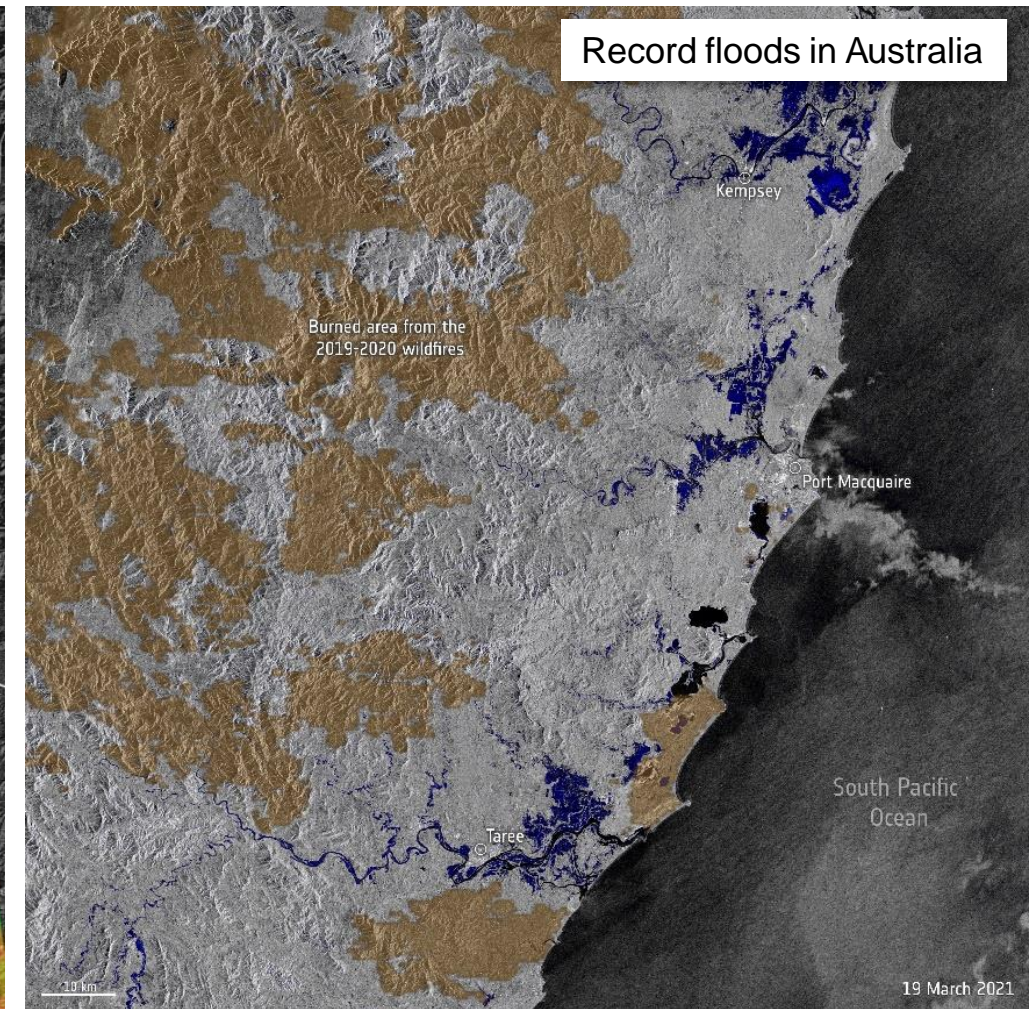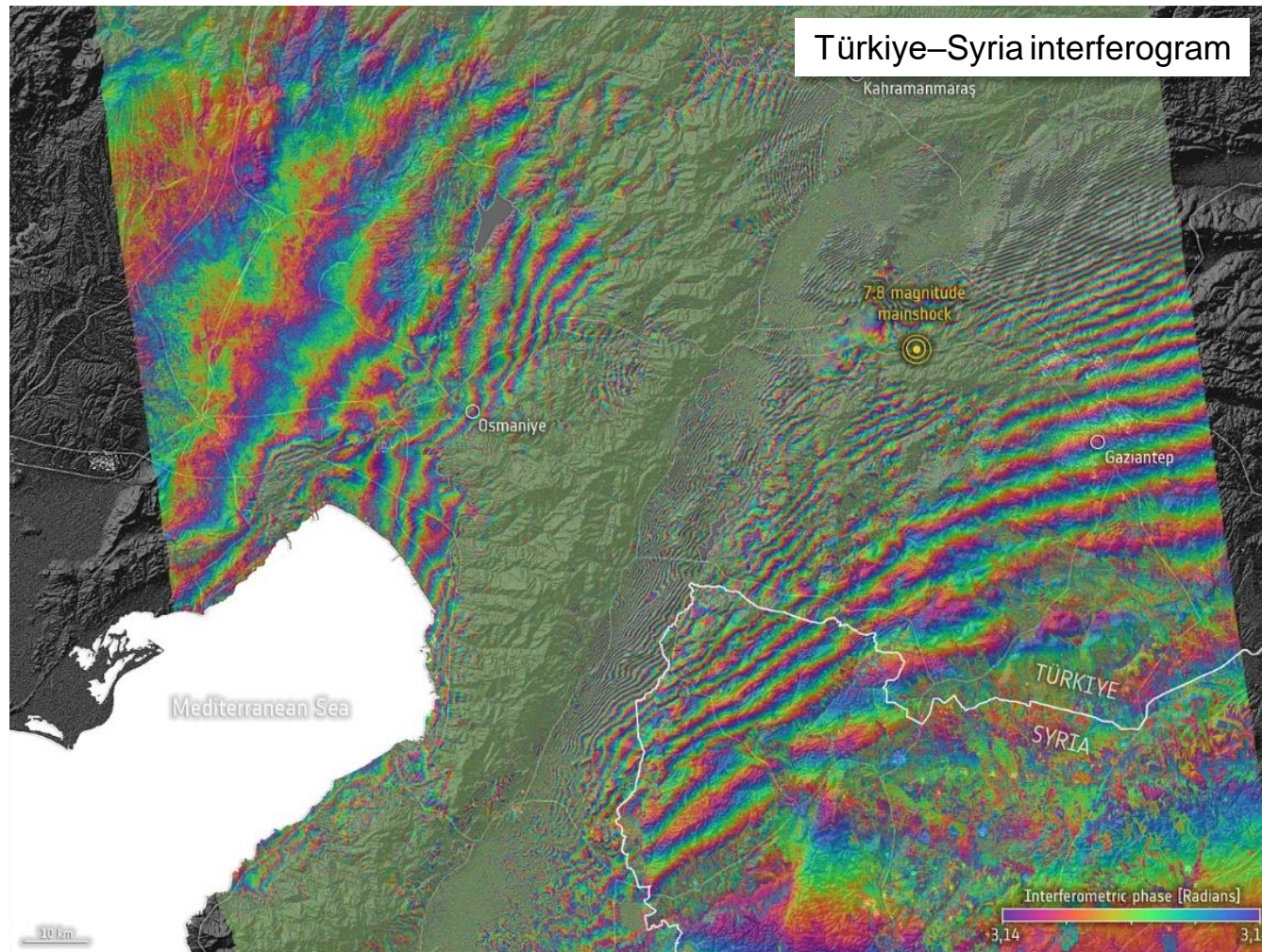
Sentinel-2 – Color vision

Mission objectives:

- Land management
- Agriculture
- Forestry
- Humanitarian relief operations
- Risk mapping and security concerns

Mission profile:

- Multi-Spectral imaging mission
- Sun-synchronous orbit 786 km,
- 290 km swath with 13 spectral bands (VIS, NIR & SWIR), at 10, 20 and 60 m spatial resolution
- 5 day revisit at Equator with 2 satellites
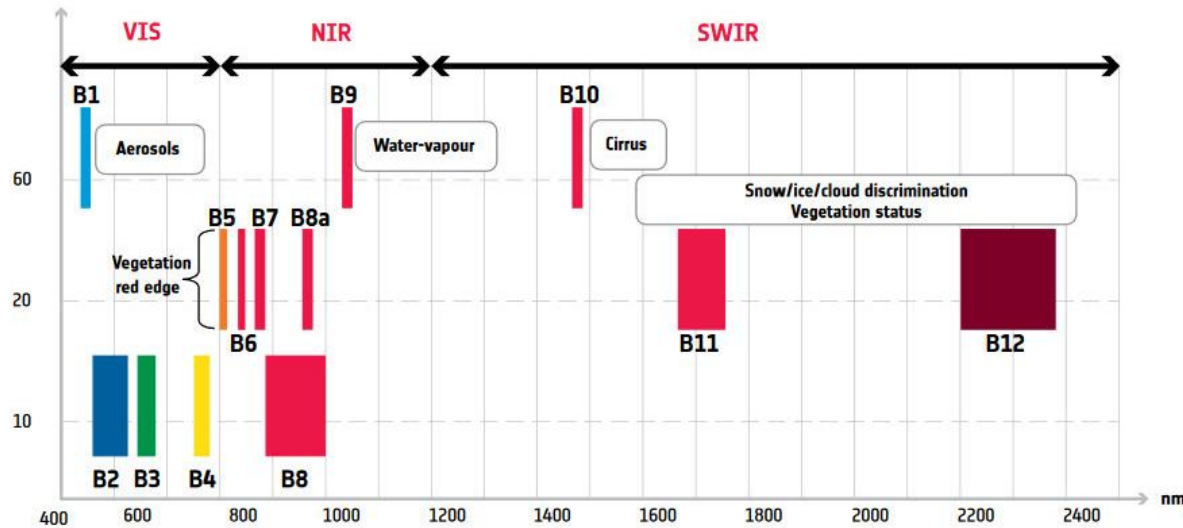
13 MSI bands are optimized for accurate atmospheric correction and vegetation monitoring

Source: http://esamultimedia.esa.int/docs/EarthObservation/Sentinel-2_ESA_Bulletin161.pdf

https://sentinels.copernicus.eu
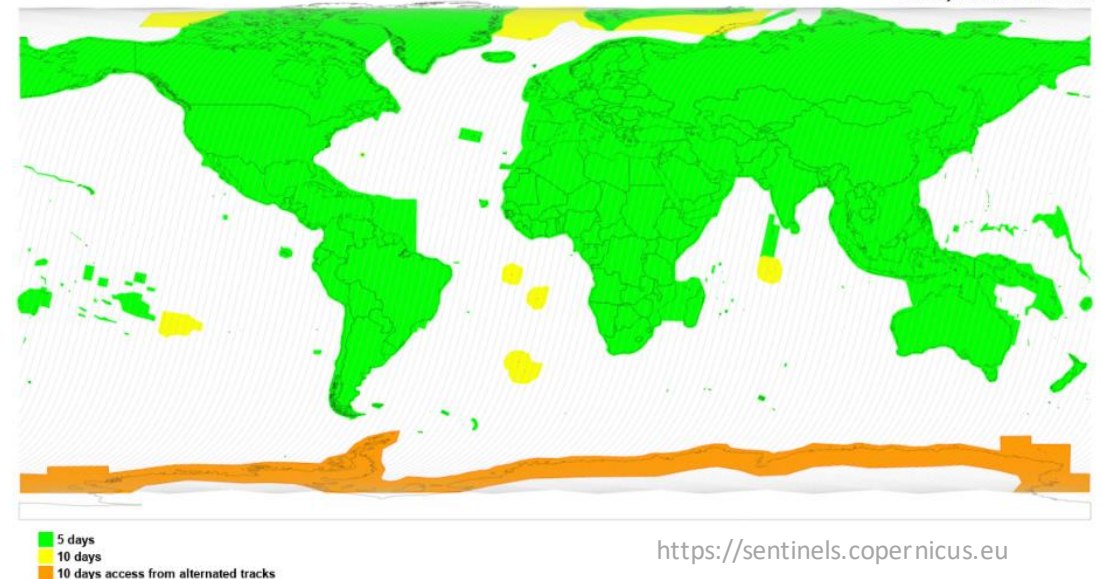
Sentinel-2 – Applications

Europe land-cover mapped in 10 m resolution

Etna erupts

Sentinel-2 – Applications

Above ground biomass in Italy
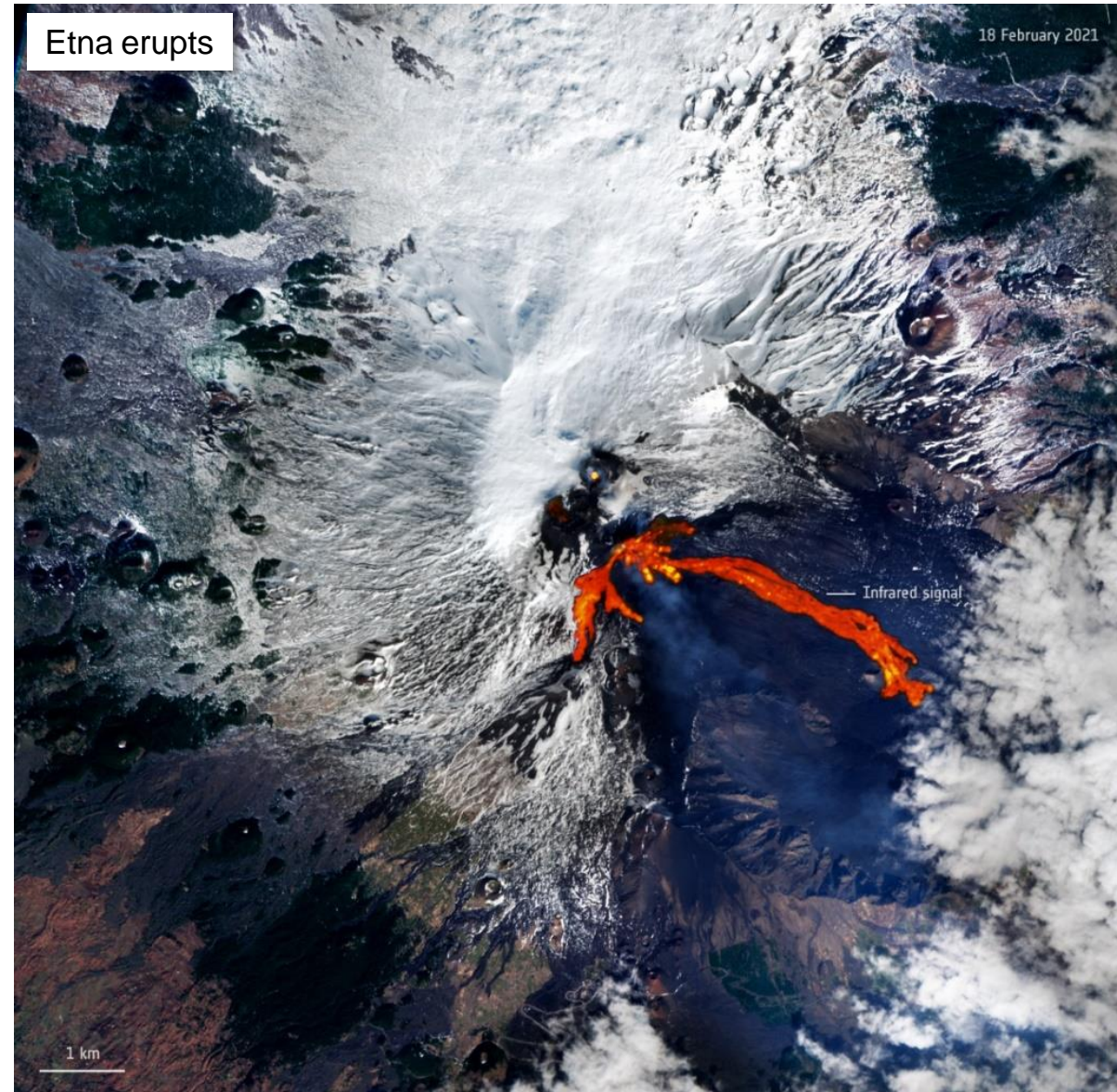
Sentinel-2 – Applications

Rhodes wildfire forces thousands to flee

23 July 2023

Glacier avalanches in the Sedongpu region, China

Sedongpu (6812m)

Gyala Peri (7294m)

Tiba Kangri (6846m)

2017 avalanche

2018 avalanche

Sedongpu Basin

Rock-ice debris flows

Landslide dam

5 km
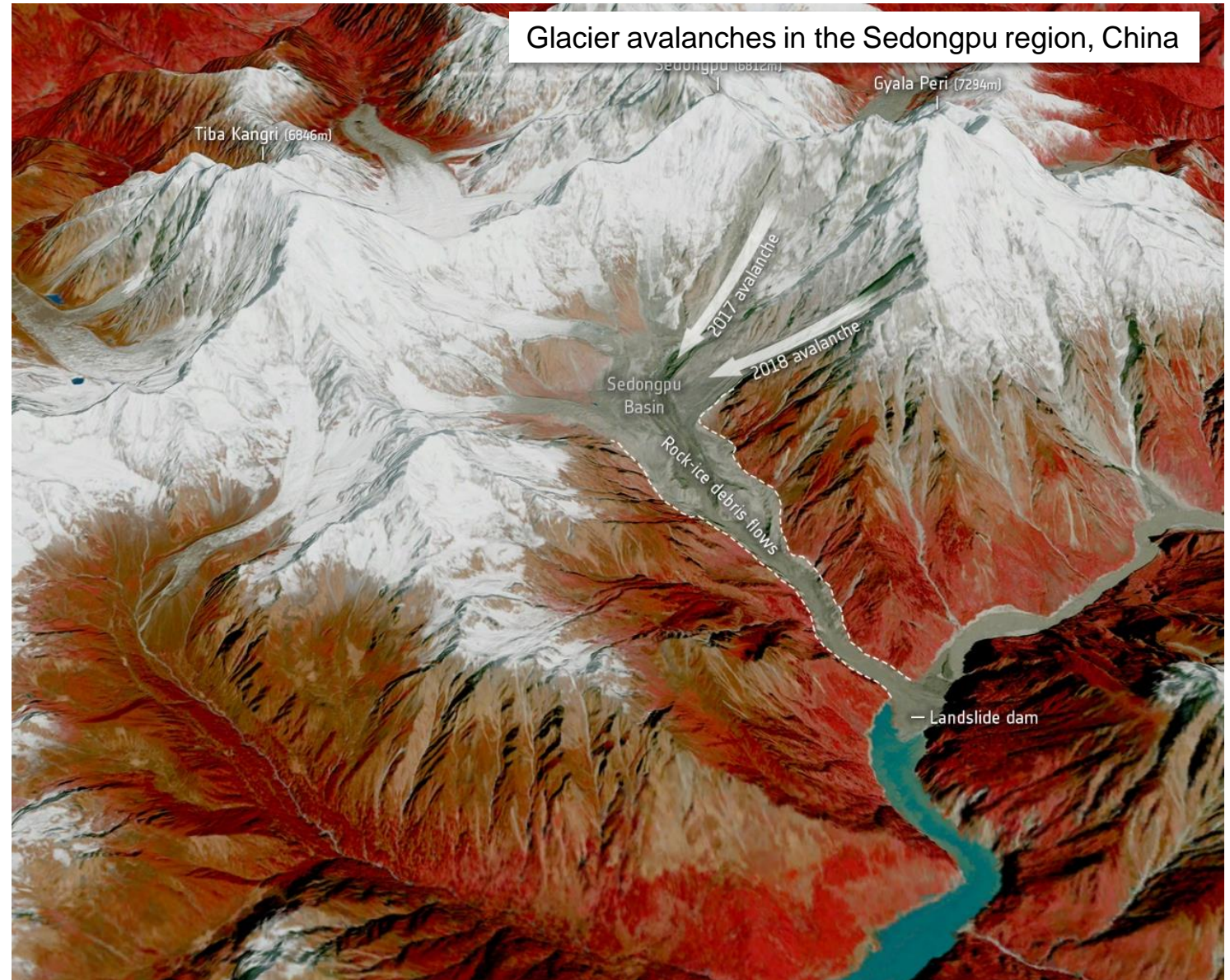
Sentinel-3 – A bigger picture

Mission objectives:

- Ocean, inland sea, coastal zone colour measurements
- Sea surface temperature measurements
- Sea surface topography measurements

Mission profile:

- Operational mission in high-inclination, low Earth orbit
- Orbital cycle is 27 days
- Ocean and Land Colour Instrument (OLCI),
  Sea and Land Surface Temperature Radiometer (SLSTR),
  SAR Radar Altimeter (SRAL),
  MicroWave Radiometer (MWR)
  and Precise Orbit Determination (POD) instruments
- Full performance achieved with 2 satellites in orbit

SRAL (>2 km) and MWR (20 km) nadir track
1400 km SLSTR (nadir)
740 km SLSTR (oblique)
1270 km OLCI
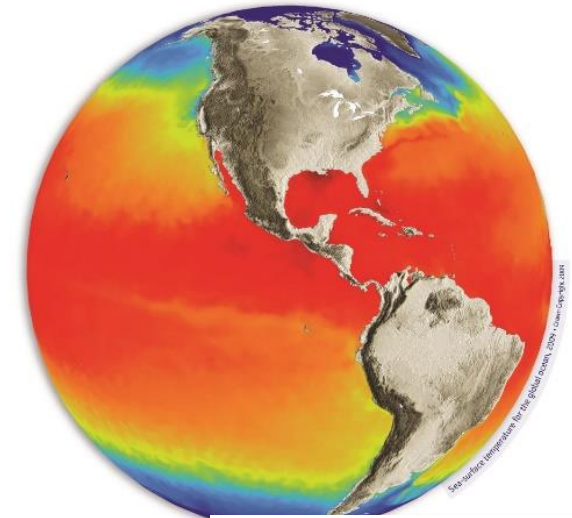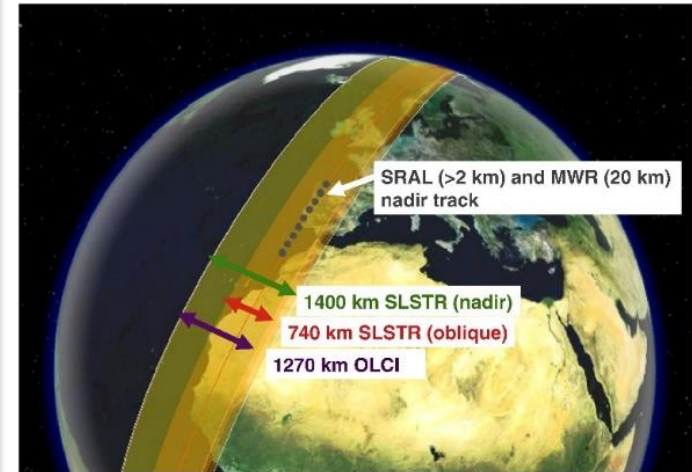
Sea-surface temperature

Sentinel-3 – Applications

Land-surface temperature in Italy

Land surface temperature
09 July 2023

≤20   32.5   ≥45°C

Fire-burned area 2019

August 2019

0   200   400 km²/cell

Fire Burned Area
from ESA's Climate Change Initiative
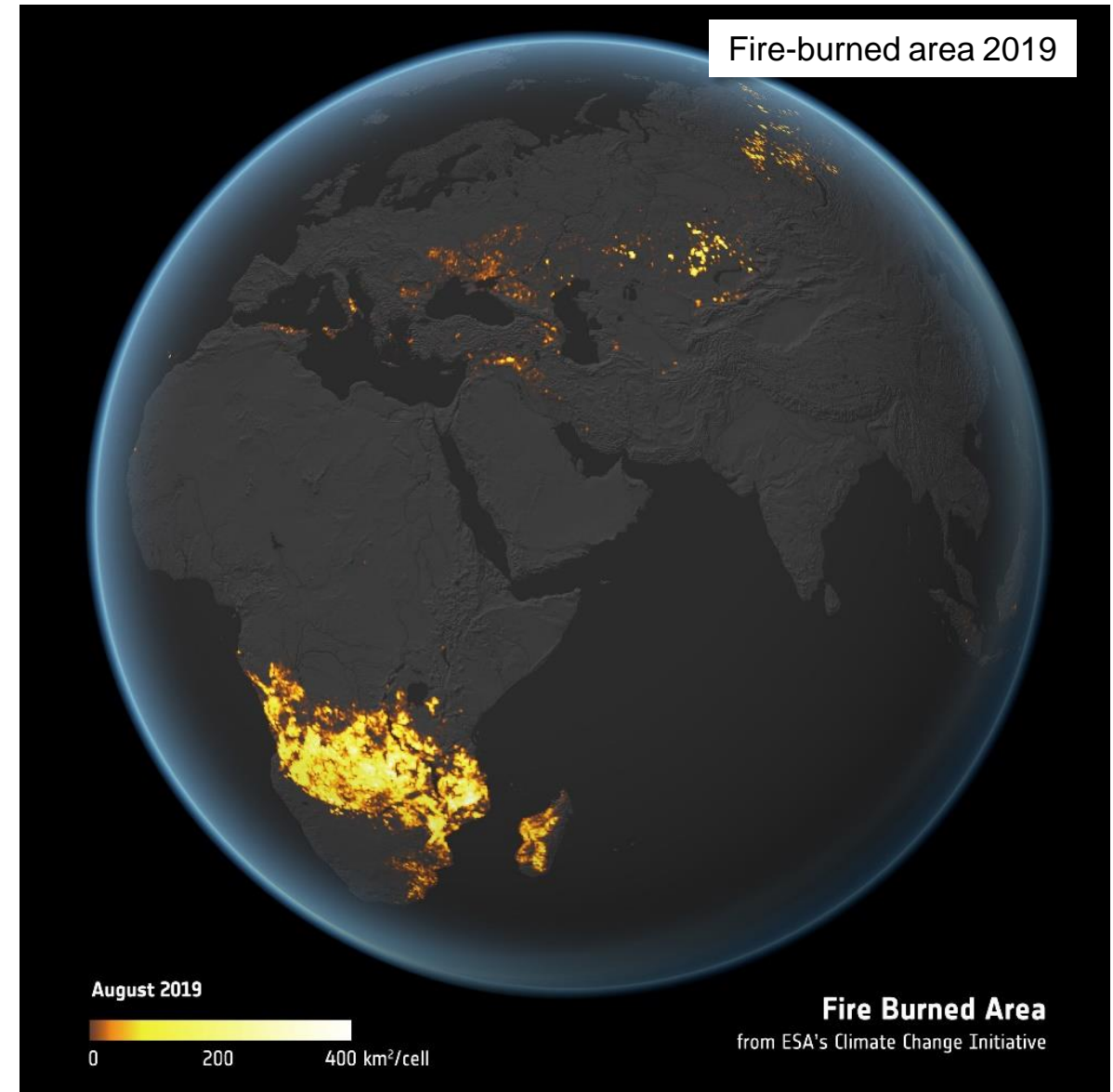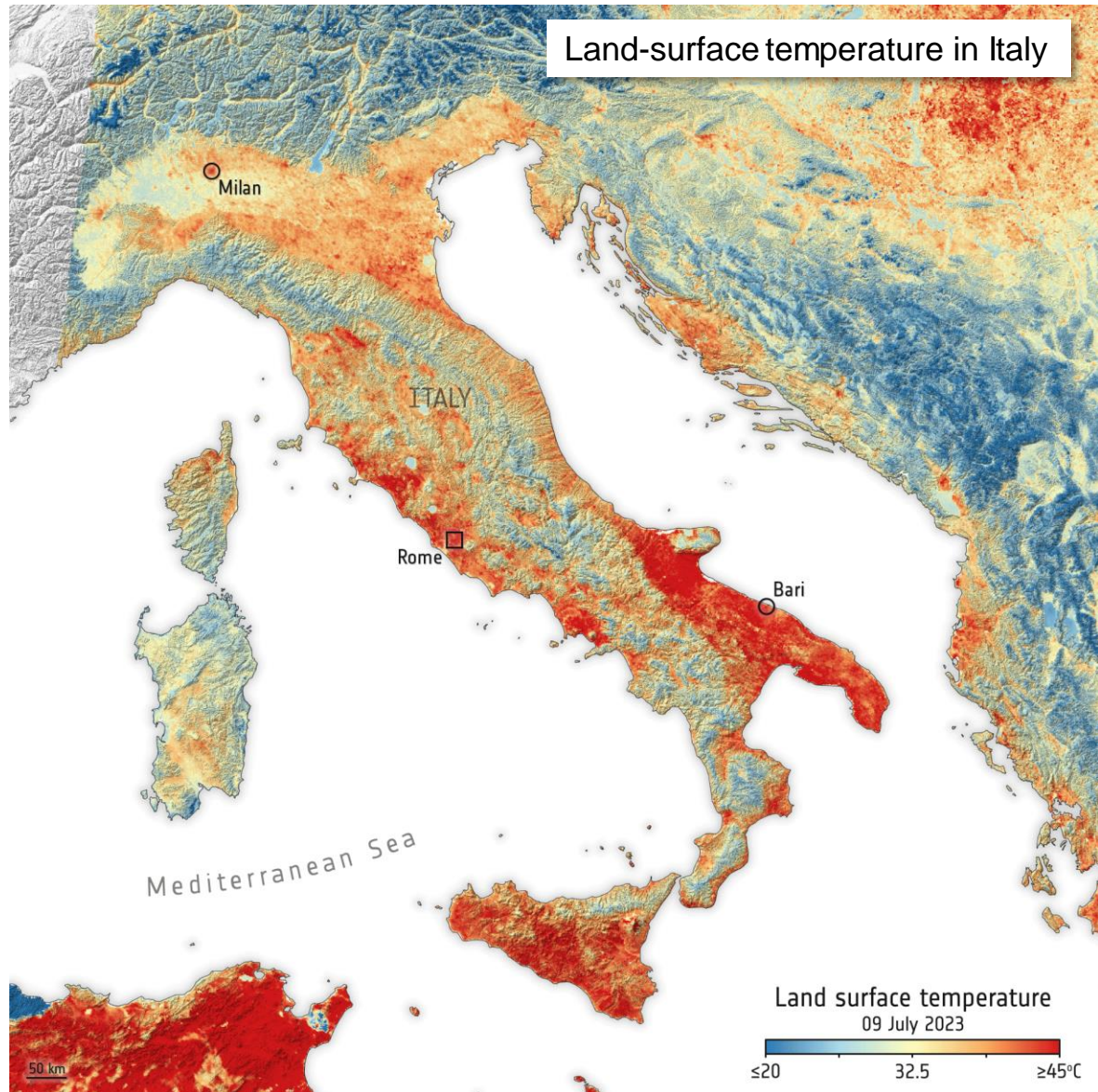
Sentinel-3 – Applications

Greenland snow grain diameter and snow/ice albedo
Copernicus Sentinel-3 Ocean and Land Colour Instrument

25 July
2017

Snow grain
diameter

mm
- 2.0
- 1.5
- 1.0
- 0.5

clouds or no retrieval

Albedo

- 0.8
- 0.7
- 0.6
- 0.5
- 0.4

retrieval after
Kokhanovsky et al., 2018

SICE, snow.geus.dk
@Climate_Ice
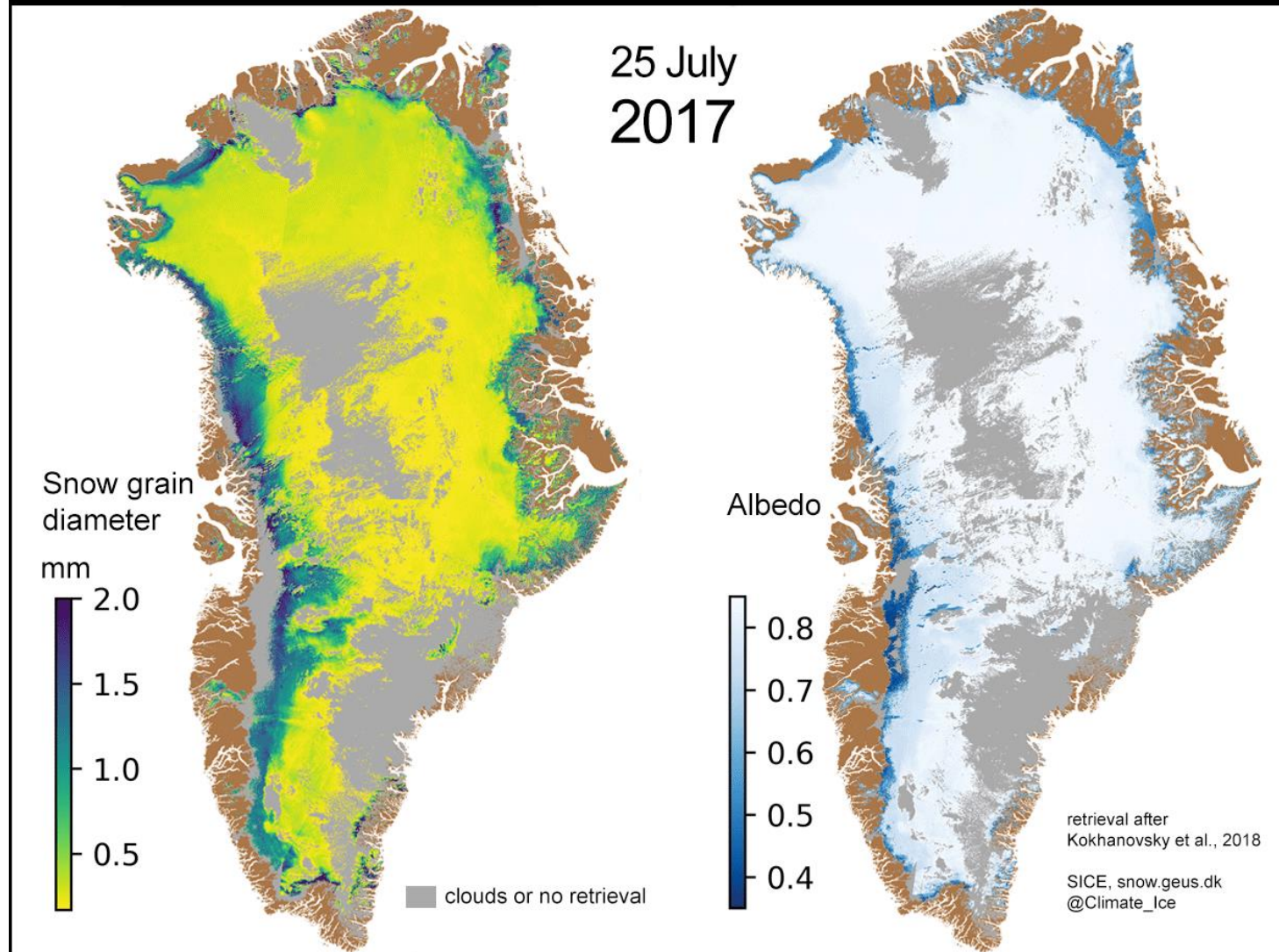
Greenland snow grain and albedo

Sentinel-4 – European air monitoring

Mission objectives:

- Observing the diurnal cycle of the tropospheric composition over Europe and North Africa
- Monitoring in particular key air quality trace gases like O_3, NO_2, SO_2, HCHO, CHOCHO, as well as aerosol and cloud properties

Mission profile:

- Passive imaging spectrometer
- Three spectrometric bands: UV (305-400 nm), VIS (400-500 nm) and NIR (750-775 nm)
- Push-broom scanning (scan - E/W direction)
- Spatial resolution: 8x8 km^2
- Revisit time: about 60 min

Sentinel-4.
Credits: ESA

Spectral coverage of the UVN Sounder. Credits: ESA

A pioneering new constellation of three space-based instruments has started to take shape to advance global air quality science and monitoring. Credits: NASA
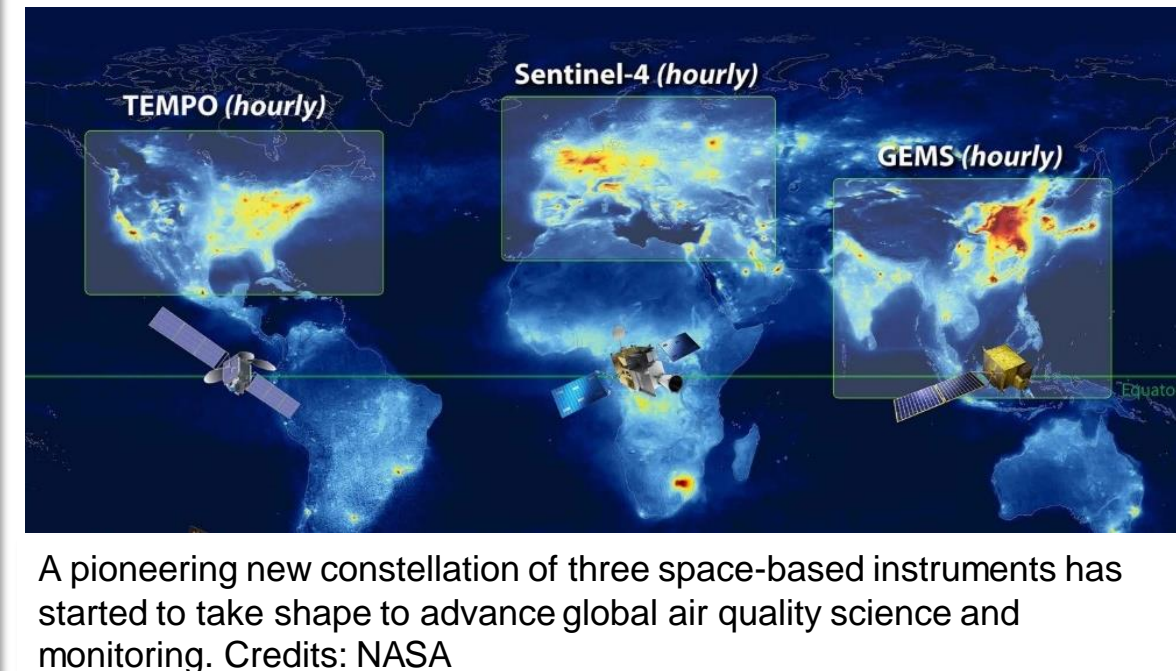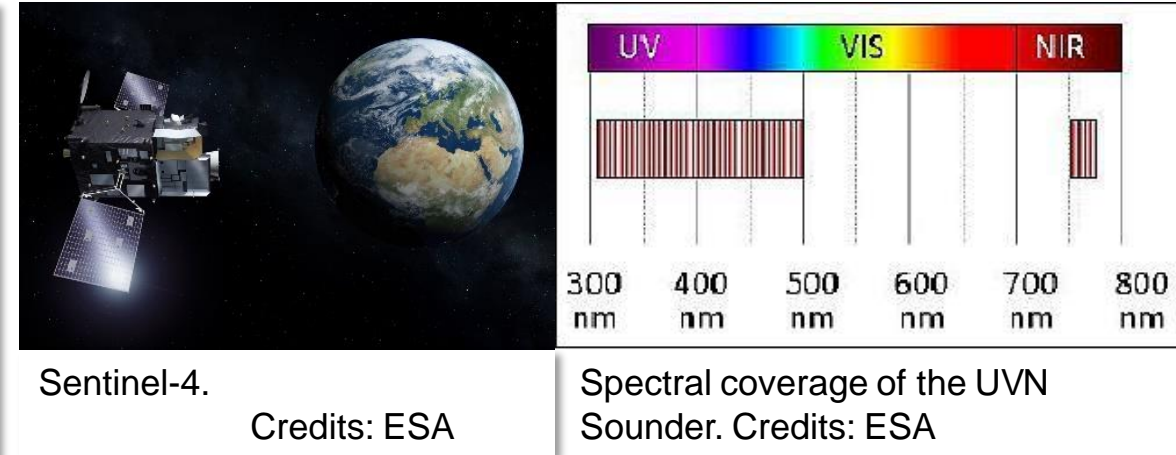
Sentinel-5P - Sentinel-5 – Global air monitoring

Mission objectives:

- Measuring, at the Top Of Atmosphere (TOA), the solar radiation reflected by and radiated from the earth
- Monitoring air quality, stratospheric ozone layer and climate change monitoring + forecasting

Mission profile:

- TROPOMI - space-borne, nadir-viewing, imaging spectrometer covering UV and SWIR bands
- Push-broom configuration (non-scanning), with a swath width of ~2600 km on the Earth's surface
- The typical pixel size (near nadir) will be 7x3.5 km^2 for all spectral bands, with the exception of the UV1 band (7x28 km^2) and SWIR bands (7x7 km^2).
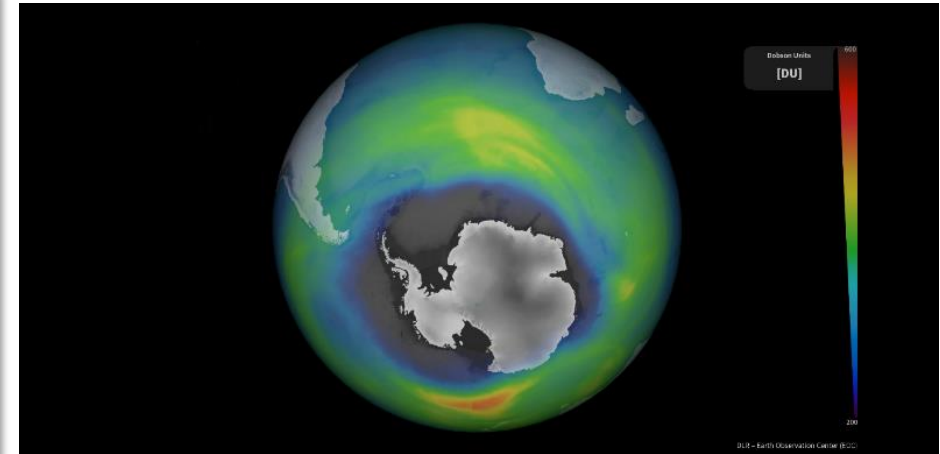
Ozone hole extension 2022. Credits: ESA
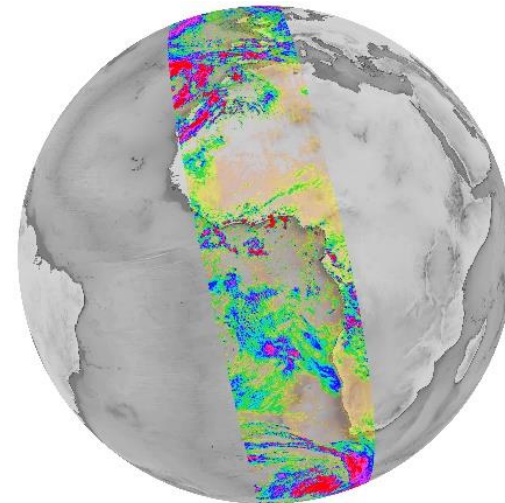
Cloud coverage seen in high resolution with Sentinel-5P. Credits: ESA

Sentinel-5P - Sentinel-5 – Applications

Methane enhancement over Libya
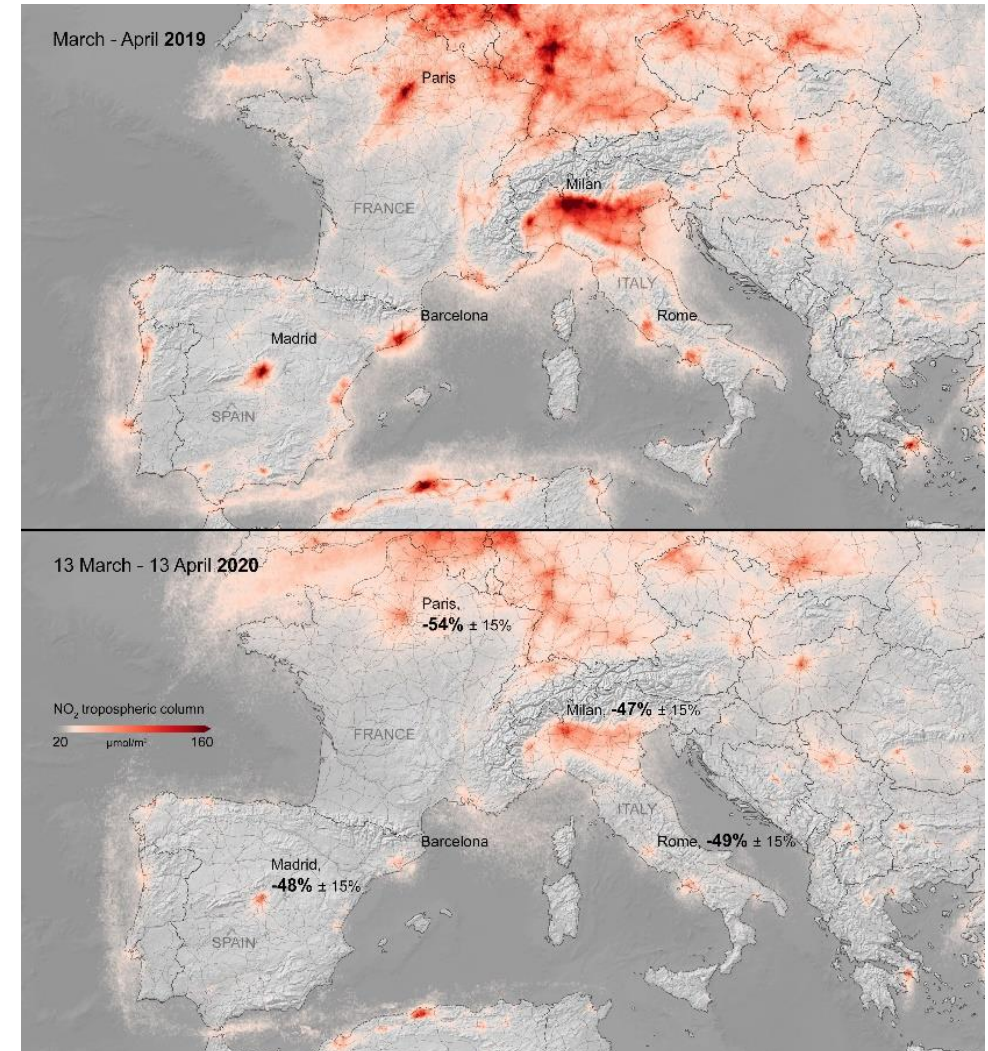
Nitrogen dioxide concentrations over Europe

Sentinel-5P - Sentinel-5 – Applications

Nitrogen dioxide concentrations over China
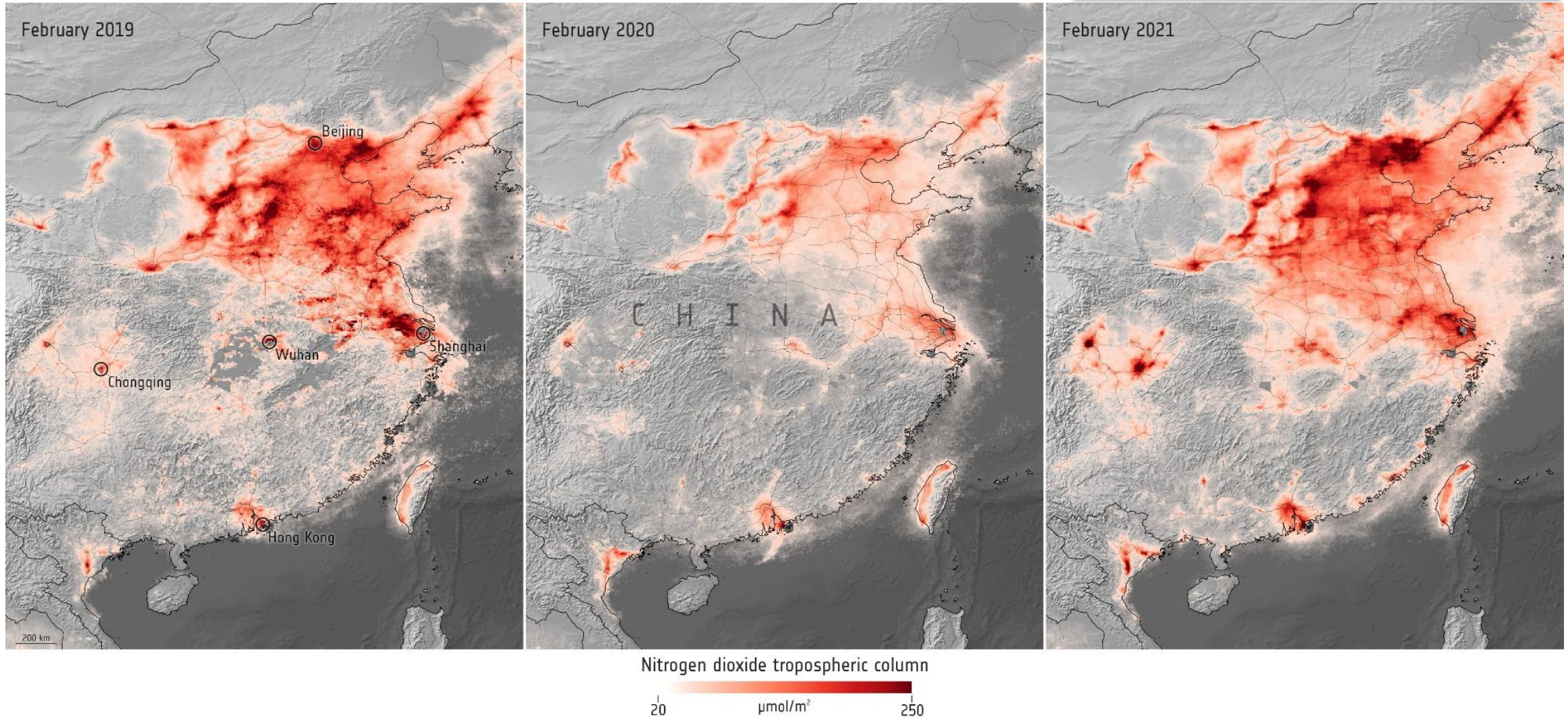
Sentinel-6/Jason-CS – Surfing the seas

Mission objectives:

- Provide continuity of satellite altimetry measurements
- The mission will extend this measurement time series to ~2030+
- Reference mission in the CEOS-coordinated virtual constellation of ocean surface topography missions

Copernicus Sentinel-6 radar altimeter.   Credits: ESA

Mission profile:

- High Resolution altimetry based on unfocused SAR (Synthetic Aperture Radar) processing combined with the conventional Low Resolution Mode (LRM) altimetry;

sea level anomaly (cm)
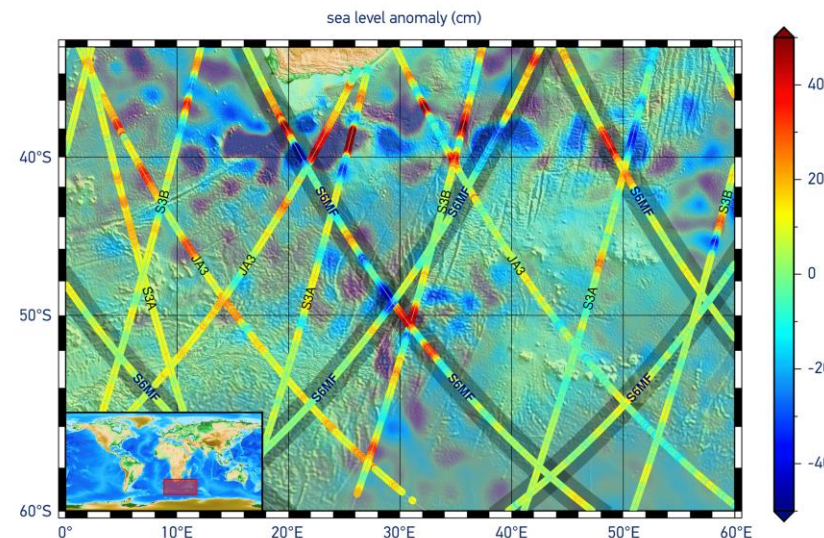
First sea-level height results from Copernicus Sentinel-6. Credits: ESA

Sentinel-6/Jason-CS – Applications
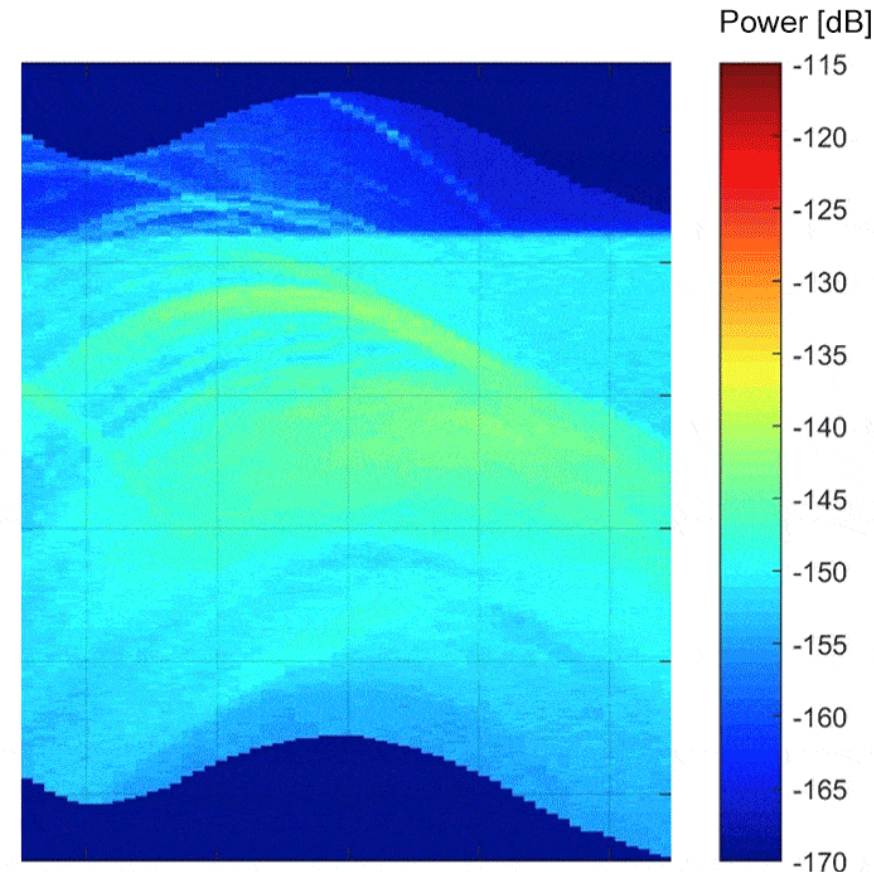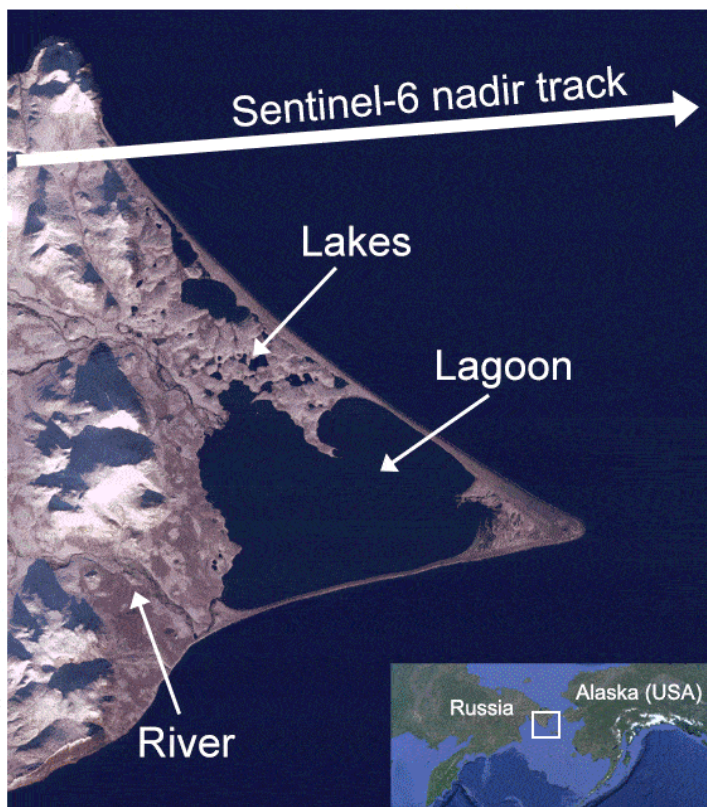
The images of Russia's Ozero Nayval Lagoon and surrounding rivers show multiple views from Copernicus satellites. The first is a 10-m resolution 'camera-like' image captured on 29 October 2020 by Copernicus Sentinel-2. The image is marked with the ground track of Copernicus Sentinel-6 as it crosses the region. The second is a radar image captured on 29 November 2020 by Copernicus Sentinel-1 in interferometric wide swath mode and processed to 10 m resolution. The lagoon has frozen over and numerous cracks are visible in the ice. Ocean swell and wind sea roughness are also seen in the ocean with some wave reflection and refraction on the southern coastal areas. The next image uses Copernicus Sentinel-6 pulse-limited low-resolution mode data for the same area. In this mode, similar to Jason-3, the strongest radar reflections appear as overlapping parabola features, but no discrimination of the ground can be made. Overlying the third image, the Copernicus Sentinel-6 Poseidon-4 fully-focused synthetic aperture radar image reveals features of the Ozero Nayvak Peninsular in fine detail. Credits: ESA

Service component

Copernicus services – provided free of charge for users:

Atmosphere

Marine

Land

Climate Change

Security

Emergency

# Service component - Atmosphere

We provide consistent and quality-controlled information related to air pollution and health, solar energy, greenhouse gases and climate forcing, everywhere in the world.

The service focuses on five main areas:

- Air quality and atmospheric composition;
- Ozone layer and ultra-violet radiation;
- Emissions and surface fluxes;
- Solar radiation;
- Climate forcing.:

Service component - Atmosphere
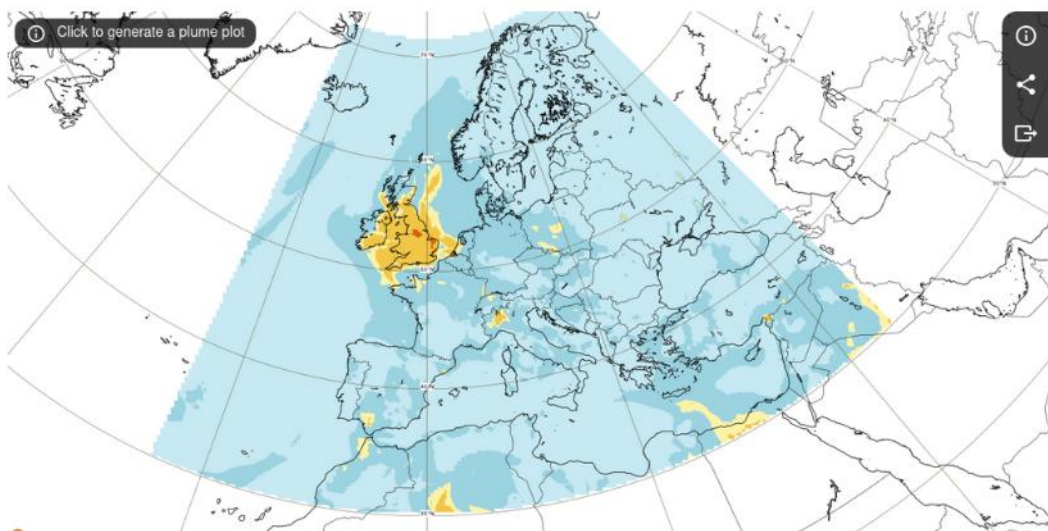
Regulated pollutants

Forecasts of the five main air pollutants regulated by the European Union and the World Health Organization air quality standards: nitrogen dioxide (NO_2), ozone (O_3), coarse particulate matter (PM10), fine particulate matter (PM2.5) and sulphur dioxide (SO_2).

Access the charts >
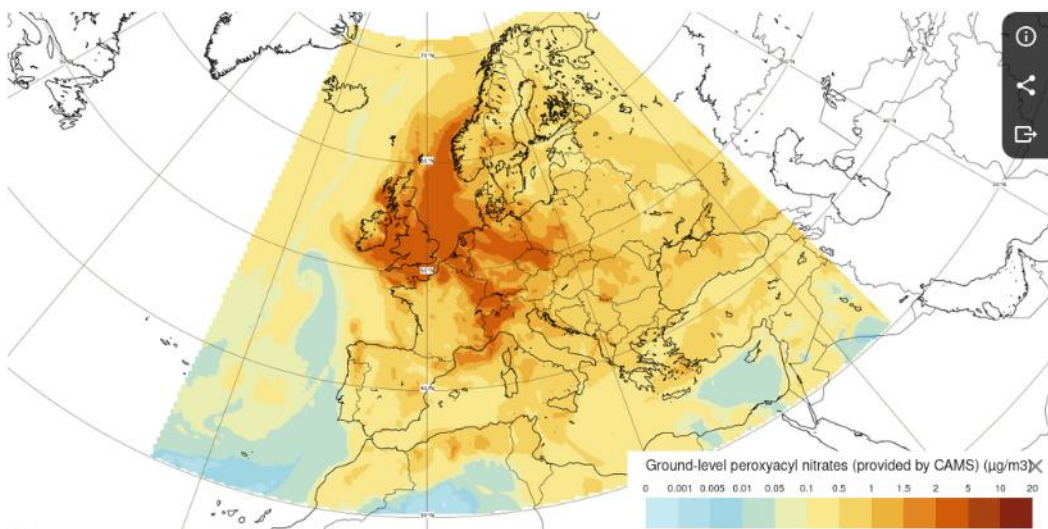
Other air quality pollutants

European forecasts for other air quality pollutants: ammonia, carbon monoxide, formaldehyde, glyoxal, nitrogen monoxide, non-methane VOCs, peroxyacyl nitrates.

Access the charts >

European air quality forecast plots. Credits: ESA

Service component - Marine

Provides free, regular and systematic authoritative information on the state of the Blue (physical), White (sea ice) and Green (biogeochemical) ocean, on a global and regional scale.

- combating pollution

- marine protection

- maritime safety and routing

- sustainable use of ocean resources

- developing renew. marine energy resources

- supporting blue growth
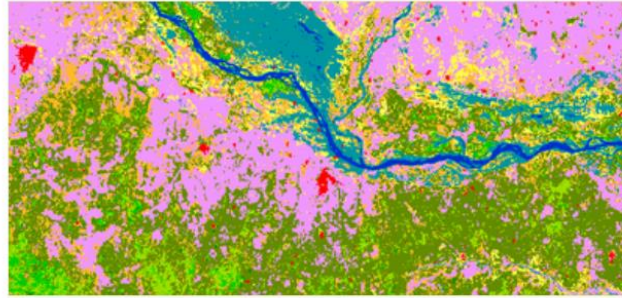
- climate monitoring, forecasting, etc.

Support to coral reef protection: Coral Guardian.

Rheticus Marine for Water and Food Security Planning and Investments in Indonesia

Service component - Land

- The systematic monitoring of biophysical parameters

- Land cover and land use mapping

- Thematic hot-spot mapping

- Imagery and reference data

- Ground motion

Dynamic Land Cover

The Dynamic Land Cover product provides a primary land cover scheme at three classification levels with class definitions according to the Land Cover Classification System (LCCS) scheme. The product is produced annually, and the actual version of the product (V3.0) is available for the 2015-2019 reference years.
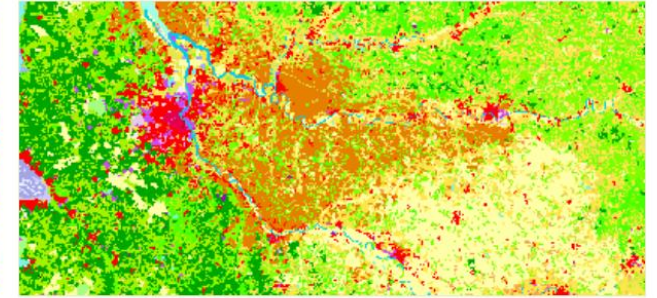
CORINE Land Cover

CORINE Land Cover is a pan-European land cover inventory with 44 thematic classes. Initiated in 1985 (the 1990 reference year) the inventory is available for the 1990, 2000, 2006, 2012 and 2018 reference years including change layers 1990-2000, 2006-2012 and 2012-2018.
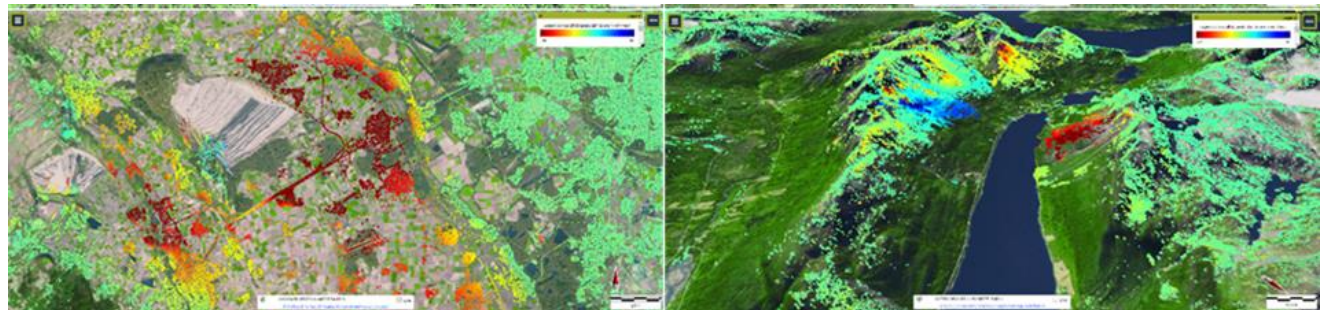
Lower left, ground motion in the surroundings of the Hambach surface mine in Germany; lower right, landslides in the slopes of a fjord near Tromsø (Norway).

Thank you for the attention