Climate change monitoring and adaptation

2021	REGULATION (EU) 2021/1119	Regulation on establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')
2021	REGULATION (EU) 2021/2139	supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives
2020	COM(2020) 562 final	COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Stepping up Europe's 2030 climate ambition Investing in a climate-neutral future for the benefit of our people
2021	COM(2021) 82	Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change
2021	SWD(2021) 25 final	COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT REPORT Accompanying the document COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Forging a climate-resilient Europe - The new EU Strategy on Adaptation to Climate Change
2021	SWD(2021) 123 final	closing the climate protection gap - scoping policy and data gaps
2020	SWD(2020) 176 final	IMPACT ASSESSMENT Accompanying the document COM(2020) 562 final Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people

*** Darker background indicates policy documents mentioning Copernicus**

Highlights on key policy aspects supported by Copernicus

Adaptation Strategy (2021): EU launches ambitious and comprehensive strategy to promote climate adaptation on all governance levels.

Impact Assessment Report (SWD(2021)25 final) **proposes actions**, drivers, problems and objectives supported by **Copernicus** geospatial and modelling data

Copernicus as an endorsed source of information contributing to

- regularly assess progress on climate-neutrality objective and climate mitigation/adaptation
- close knowledge gaps on climate impacts and resilience

Key Copernicus supporting elements

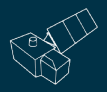
Climate Change Service
climate.copernicus.eu

Land Monitoring Service

Copernicus Marine Service

Emergency Management


SENTINEL-1


SENTINEL-2


SENTINEL-3


SENTINEL-5P


SENTINEL-5


SENTINEL-6


CRISTAL


CIMR

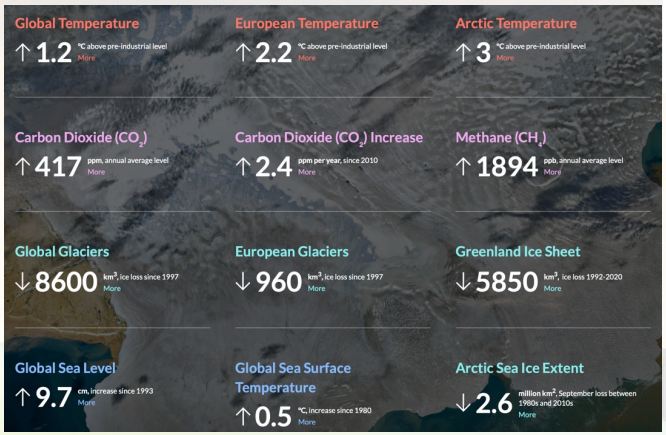

LSTM

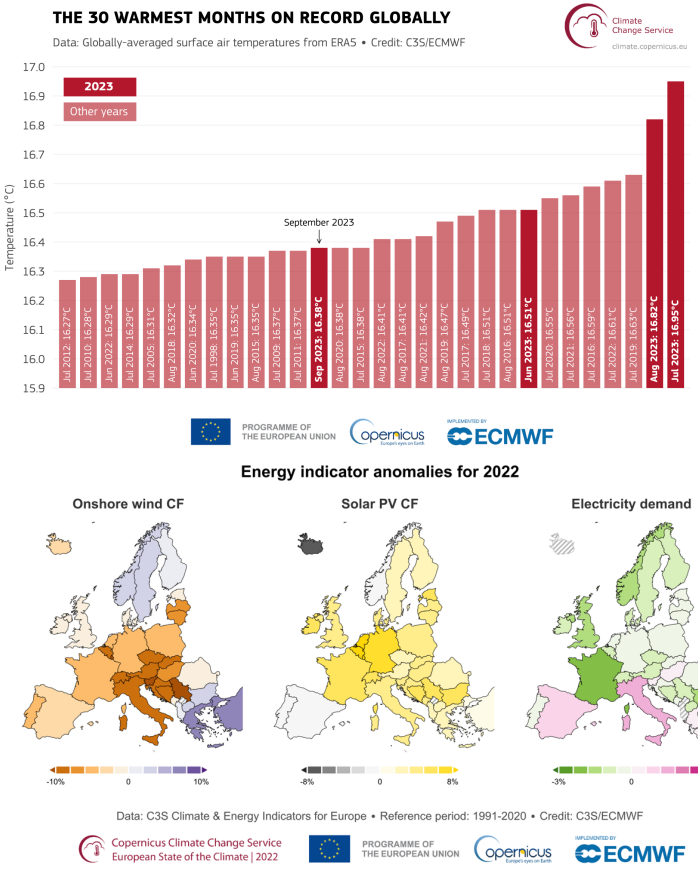
Copernicus Climate Change Service

Support adaptation policies of the European Union by providing consistent and authoritative information about climate change

Climate Change Service — IMPLEMENTED BY ECMWF

Read the full ESOTC 2022 report here





Explainer

- C3S provides reliable access to state-of-the-art data available on the **past, present, and potential evolution of climate.**
- Services to EU and agencies on **climate monitoring, climate impact indicators** and **bespoke applications** in support of climate adaptation policies, incl. European Green Deal and transition to renewable energy.
- +255.000 users of **Climate Data Store** on **reanalysis** (ERA5), **seasonal forecasts**, CMIP6 and CORDEX **climate projections** and **observational data**
- Close engagements and partnerships with **EIB** and **EC DG CLIMA** as well as **EU Member States.** New policy workshop with DG CLIMA: Q1 2024
- *Know more* ➔ C3S
- Carlo.Buontempo@ecmwf.int

Copernicus Land Monitoring Service

To provide timely environmental information on land cover and land use changes to monitor climate change

European Environment Agency

European Commission

Corine Land Cover + System (**CLC+**)

CLC+ Core database and Web application

CLC+ Backbone (CLC+ BB)
Raster and vector land cover data

CLC+ instances
Tailor made 100m raster products

CLC+ BB
Raster 2018

CLC+ BB
Vector 2018

CLC+ BB
Raster 2021

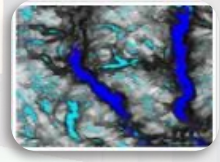
CLC+ BB
Raster 2023, 2025, etc. (every 2 years)

High Resolution Layer Imperviousness
2006-09-12-15-18-21

Urban Atlas
2006-12-18-21

Forest cover and change for World Forest Observatory from 2020

HR-Water, Snow and Ice
Near Real Time since 2017



Explainer

- **Need to account for carbon emission and removals - support EU LULUCF Regulation**

  CLMS offer - High resolution land cover / land use mapping at pan-European scale (CLC+), and a tailored product based on that (LULUCF instance).

  Status - *CLC+ Land Use, Land Use Change and Forestry Instance* first prototype is in testing. *CLC exists since 1990.*

- **Need to support urban climate adaptation and sustainability**

  CLMS offer - very high-resolution land cover mapping of all EU urban agglomerations (Urban Atlas, every 3 y), supported by additional data layers, such as building height and street trees, and another product for sealed areas (imperviousness).

  Status - *Urban Atlas* is available for 2006, 2012, 2018 years and is under production for 2021 and 2024.

- **Informing about state of water and water bodies**

  CLMS offer - *High Resolution Water, Snow and Ice* will monitor water in near real time. It will support drought and water scarcity analysis

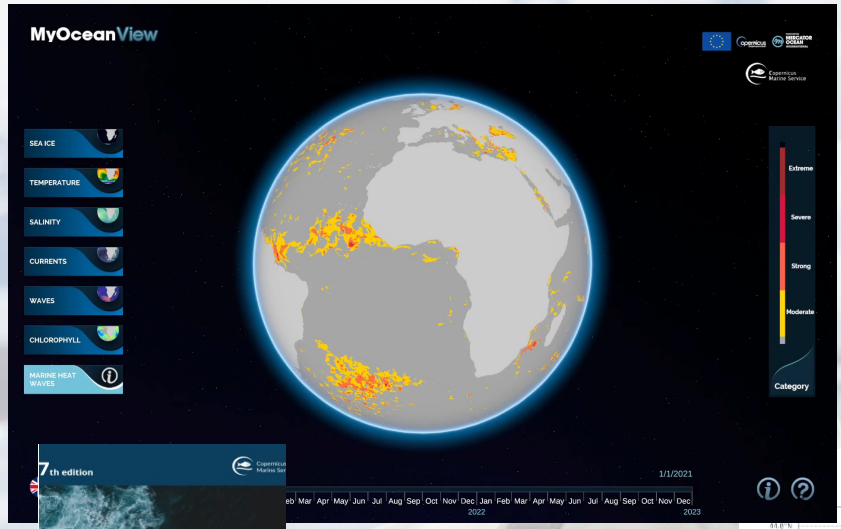
- **Supporting the regulation on Deforestation Free Commodities**

  CLMS offer - *Tree cover density maps* will support the Global World Forest Observatory providing information forest cover change and deforestation risk

- *Know more* ➔ https://land.copernicus.eu/en
- Contact point : https://land.copernicus.eu/en/contact-service-helpdesk

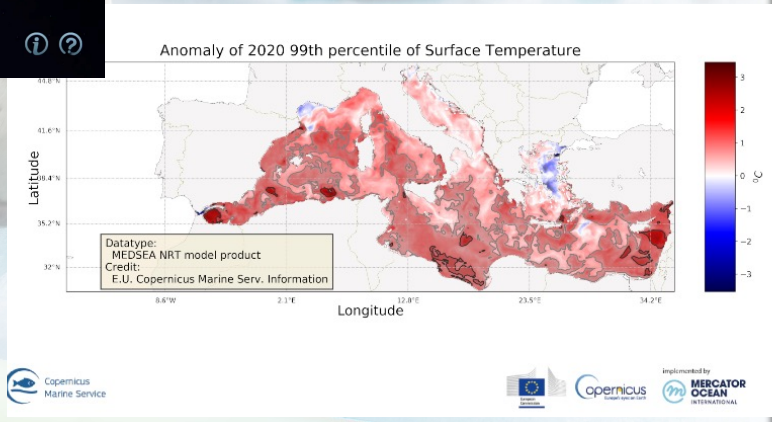
Copernicus Marine Environment Monitoring Service

Critical information about oceanic climate-induced variations



✓ CMEMS allows more comprehensive understanding of oceanic climate variations, enabling rapid response to changing conditions, a critical factor in climate adaptation.

✓ OCEAN STATE REPORTS provide extensive annual analyses over the state of the ocean over nearly 20 years and severe/notable events.

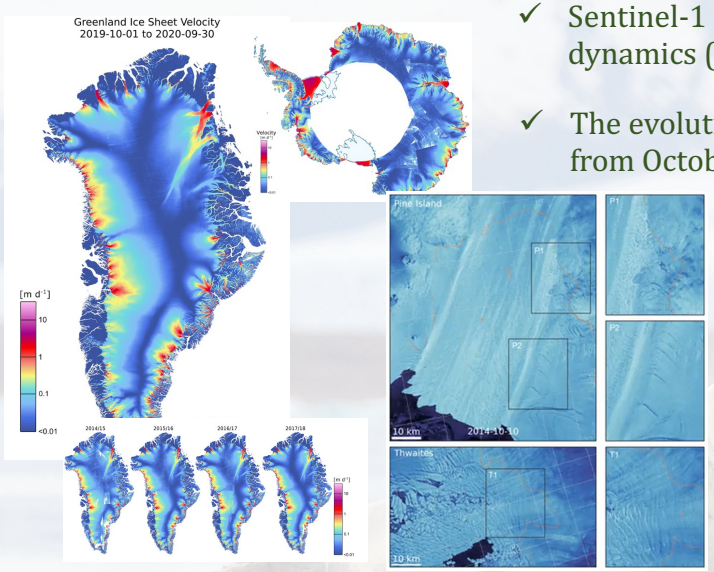


Explainer

- CMEMS provides precise near real-time data for marine heatwaves and sea surface temperature anomalies; data mapping and visualization; and trend analysis and diagnostics.
- Long-term data trends are giving invaluable insights into vulnerable areas.
- CMEMS provides critical marine data, including sea surface temperature, which is indispensable for monitoring climate change and developing effective adaptation measures.
- **Main products:** Global Ocean OSTIA Sea Surface Temperature and Sea Ice Analysis; Global Ocean Physics Analysis and Forecast
- **Main applications**: Mercator Ocean: Marine heatwave bulletin; Ocean Monitoring Indicators
- Know more at THIS LINK

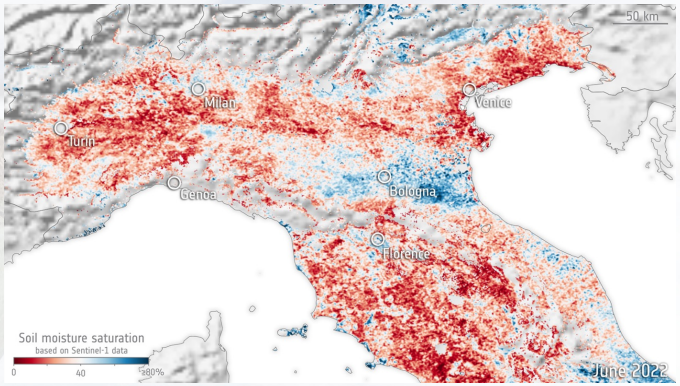
Sentinel-1

Watching glaciers shrink and the land drying up



© contains modified Copernicus Sentinel data (2014-20), processed by Stef Lhermitte (TUDelft)

- ✓ Sentinel-1 supports monitoring of glacier dynamics (Read article here)
- ✓ The evolution of glacier damage in Antarctica, from October 2014 to July 2020.



- ✓ Measurements of actual soil moisture content of the surface are possible from from Sentinel-, as it is shown in this example in Central Italy (source)

(©contains modifies Copernicus Sentinel data (2022), processed by TU Wien/ESA)

Explainer

- Only Sentinel-1 together enable a truly global all-weather day-and-night monitoring of our changing environment at high resolution
- Sentinel-1 monitors the large and rapid changes of the Arctic and Antarctic Ice Sheet and the melting of glaciers, ice caps and disappearing sea ice.
- Sentinel-1 monitor surface soil moisture over bare surfaces with a resolution of 1km helping map of water availability and water use
- Sentinel-1C needs to be launched soon following Sentinel-1B unavailability
- Long-term continuity of Sentinel-1 missions is the guarantee that these climate trends can be monitored
- Know more AT THIS LINK

© contains modified Copernicus Sentinel data (2022), processed by TU Wien/ESA

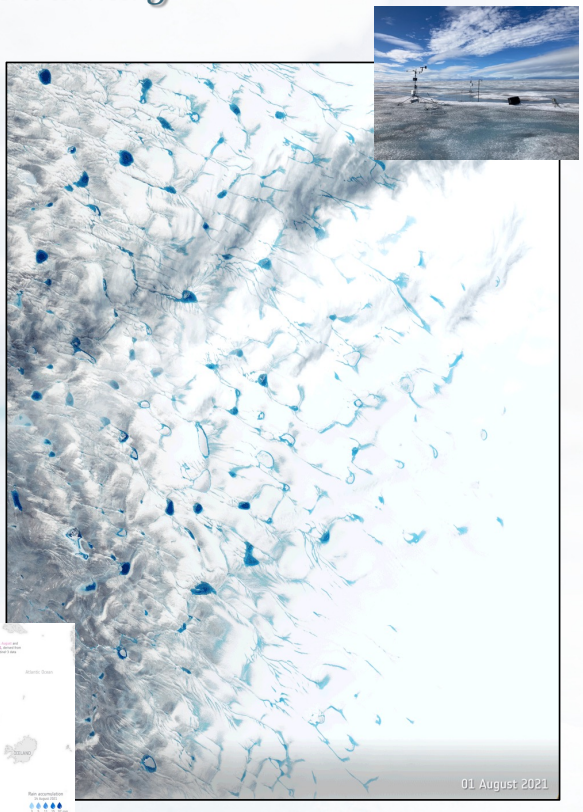
Sentinel-2

A sharp sight to monitor multiple impacts of global warming

✓ When temperatures soar and rain does not fall, the scorched land is apparent. Especially when images are compared through time…

Agricultural fields in Denmark summer 2017 vs 2018
([Read more here])

Greenland snowline retreat and rainfall.



Meltwater and surface lakes on the Greenland ice sheet.
Read more here

Explainer

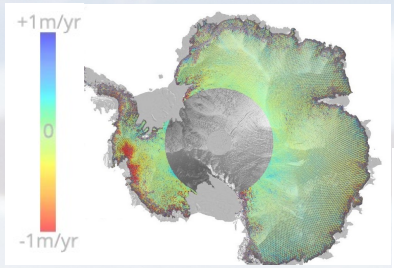
- Sentinel-2 images the planet in the visible part of the spectrum and in the near infrared, which enables it to spot multiple impacts of climate change: from glaciers and snow extent to vegetation health, from soil and land use changes to coral bleaching.
- Sentinel-2 systematically acquires over all landmasses up to 20km off-coast, and over Europe's internal seas.
- Sentinel-2 continuity with the USGS/NASA Landsat mission allows to take stock and complement the 50years+ time series.
- Long-term continuity will be ensured through the Next Generation Sentinels.
- Know more AT THIS LINK

Sentinel-3 Mission (land)

Every day providing a largescale view of changing land and cryosphere conditions

✓ Land ice mass loss is the largest source of global sea level rise. Measuring variations of ice sheets is a key element for understanding the trends in climate changes.

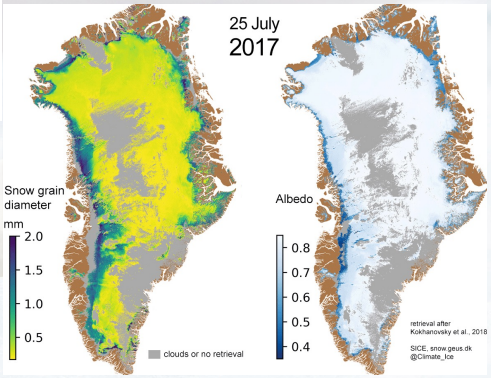
✓ Monitoring Land Surface Temperature (LST) is fundamental to better understanding and forecasting weather and climate patterns and to designing climate adaptation strategies.

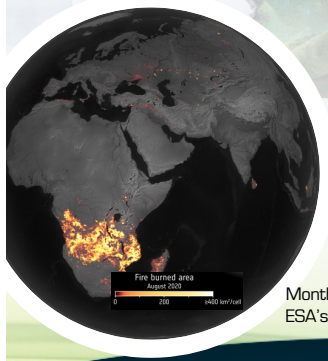


©processed by CPOM/McMillan.

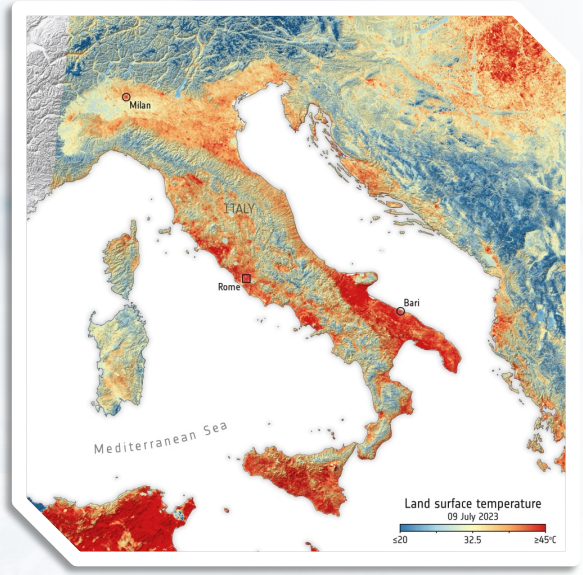
Antarctic Ice Sheet elevation change mapped by S3A altimeter between 2016 and 2018 (know more AT THIS LINK)

Experimental Snow grain size & Albedo retrieved from S3 optical sensors





Monthly Fire Burnt Areas from ESA's World Fire Atlas and CCI



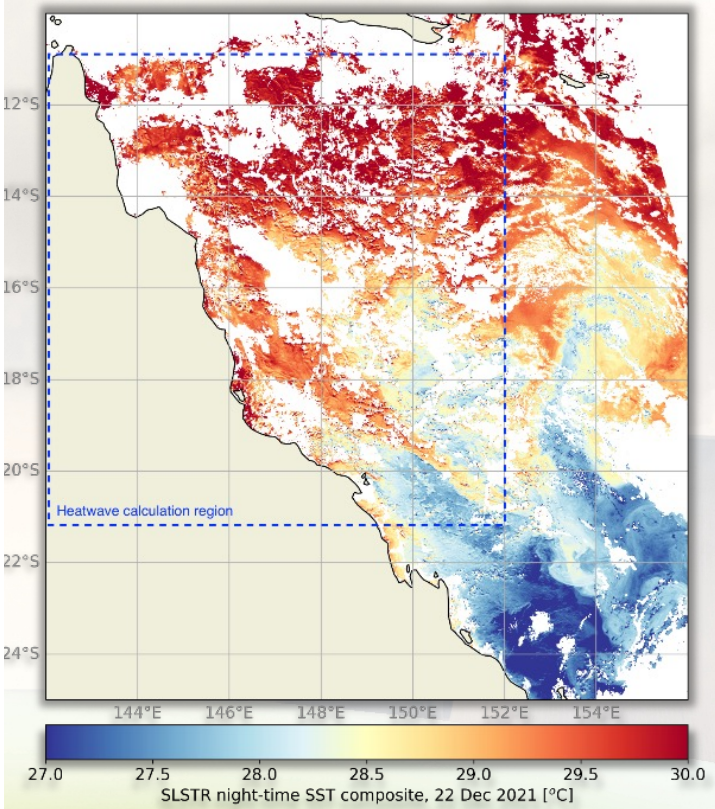
Land surface temperature on 17 July 2023 as observed during last heatwave in Europe by the Sentinel-3 mission's radiometer instrument (SLSTR) (know more AT THIS LINK).

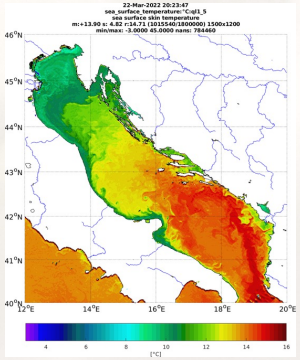
Explainer

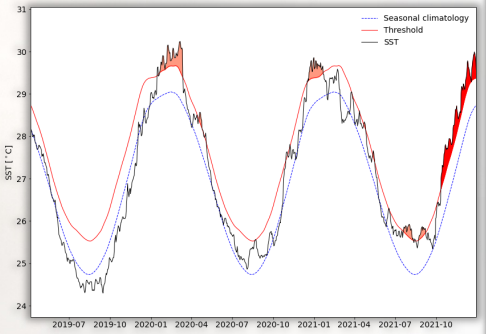
- Sentinel-3 contributes to several Essential Climate Variables such as Landcover, Albedo, Fire, Land (and Sea) Surface Temperature, Ice sheets, Lakes, Sea Ice, Ocean Colour, Aerosols and Clouds.
- Sentinel-3 carries: an optical sensor to measure ocean and land surface colour with 21 bands at spatial resolution of 250m and large coverage; a SAR altimeter which provides high resolution measurements of the height of the ice sheet and of the sea ice, in continuity with ESA's Cryosat; and a thermal instrument measuring sea and land and ice surface temperature, at 1km resolution.
- Sentinel-3 large swath ensures high repetitiveness of the observations.
- Long-term continuity will be ensured through the S3C and S3D units and the Next Generation Sentinels.
- Know more AT THIS LINK

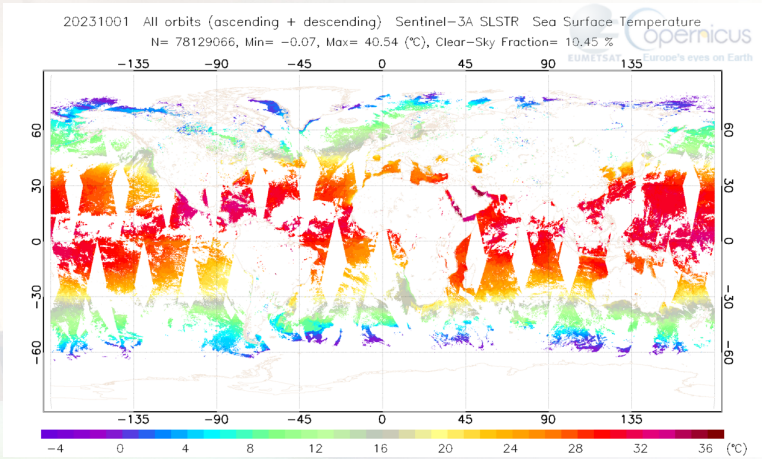
Sentinel-3 (Ocean temperature)

Data to quantify environmental baselines and extreme events









Explainer

- Sentinel-3 SLSTR data and downstream products derived from it can support the characterisation of (water) surface temperature.
- SLSTR is the reference sensor for **sea surface temperature**:
  - Fundamental measurement for quantifying ocean warming and heat content.
- Data can also quantify extreme events such as marine heatwaves.
- Contact: ops@eumetsat.int

Case study examples:

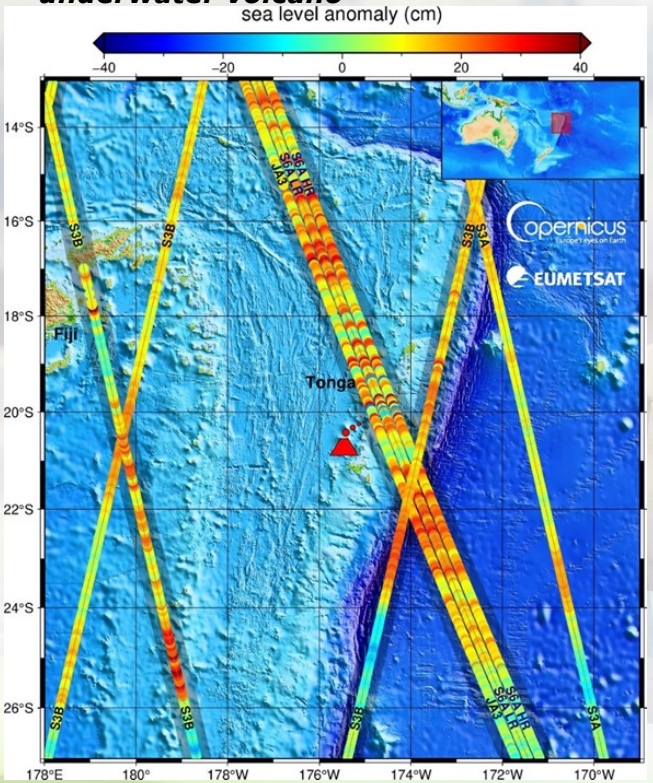
- https://www.eumetsat.int/marine-heatwave-intensification-threatens-coral-reef-health
- https://www.youtube.com/watch?v=40C03UJpdLM&list=PLOQg9n6Apif1HPiQfv3u_9ZJm5o4MxhY3&index=43&t=8s
- https://www.youtube.com/watch?v=wfN7TSXrFmk&list=PLOQg9n6Apif1HPiQfv3u_9ZJm5o4MxhY3&index=38
- https://www.youtube.com/watch?v=bVWZdb-riXk&list=PLOQg9n6Apif1HPiQfv3u_9ZJm5o4MxhY3&index=39
- Know more AT THIS LINK

Sentinel-3 & 6

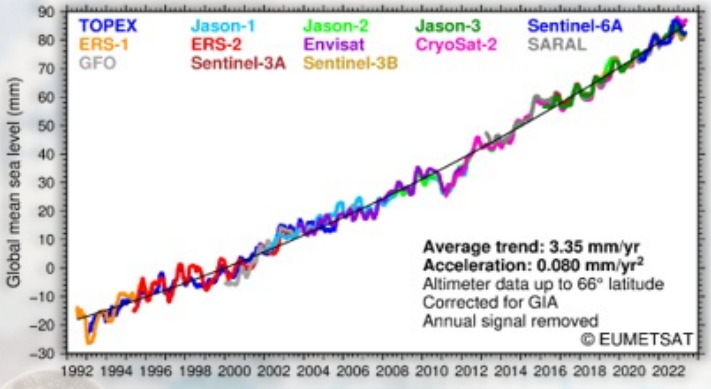
Monitoring Sea level rise, currents and waves

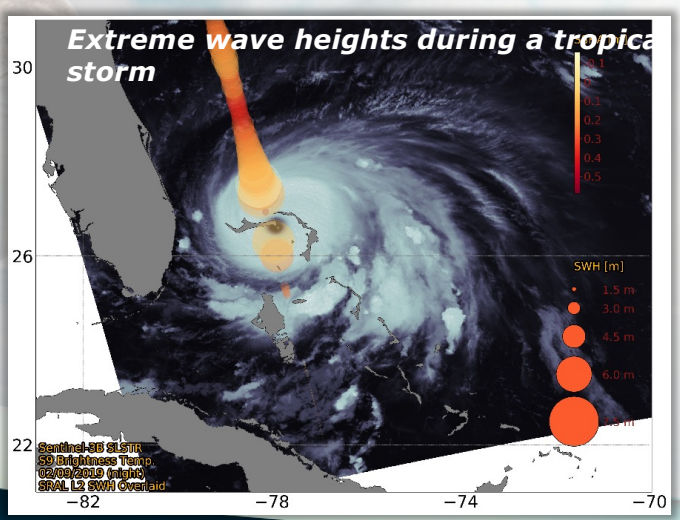
EUMETSAT

2022 Eruption of the Hunga Tonga underwater volcano



Sea-Level rise since the '90s, measured by satellites





Explainer

- Sentinel-3 and Sentinel-6 Altimeter data and downstream products can support the characterization of physical oceanography (waves, height, fronts, currents etc).
- **Altimetry data** – provides sea surface height, significant wave height, and wind speed measurements.
  - Utility for nowcasting, forecasting, and towards other metocean related variable derivation
- High-Precision Ocean Altimetry (Sentinel 6-MF) continues to monitor the key climate change indicator of **global sea level rise**

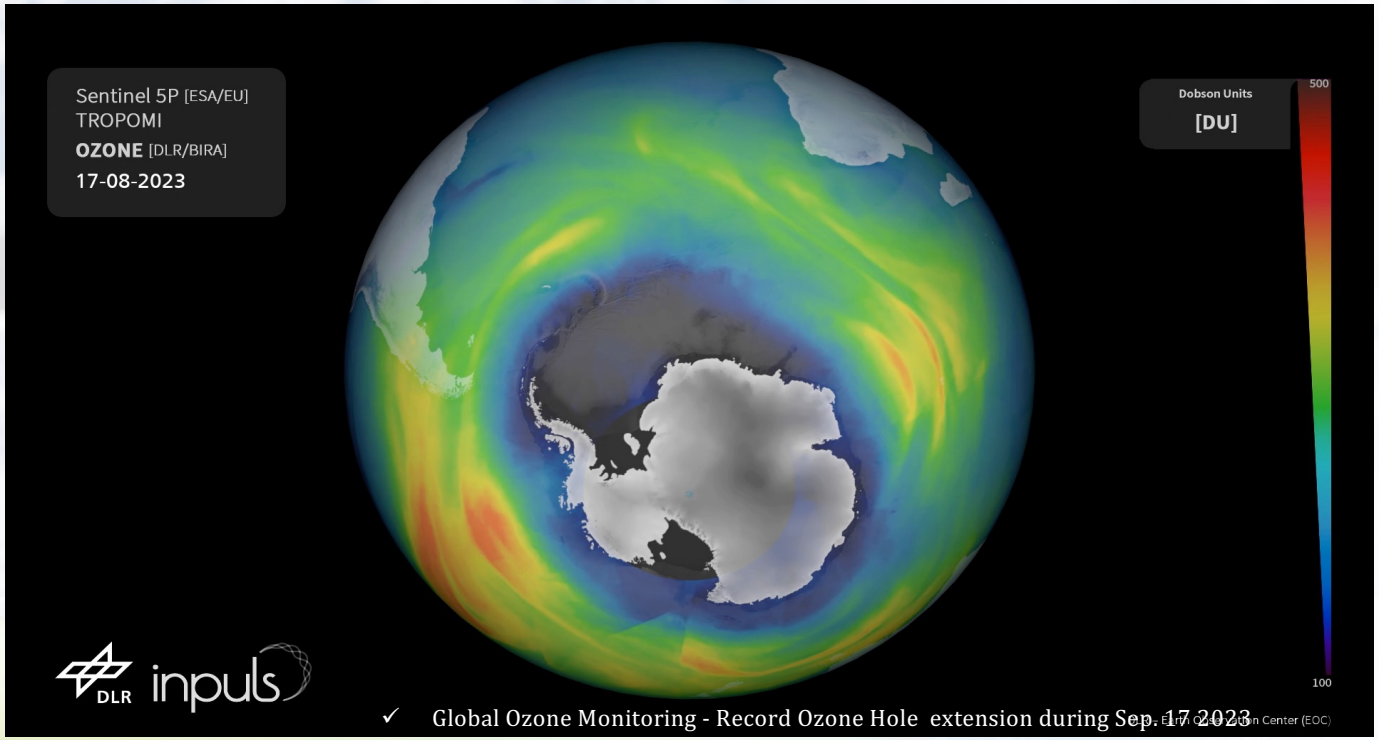
Case study examples:

- https://www.eumetsat.int/multiple-perspectives-hurricane-dorian
- https://www.eumetsat.int/monitoring-tropical-cyclones-pacific-ocean-2013-2019
- https://www.eumetsat.int/tracking-tropical-cyclone-impacts-using-altimetry
- Know more AT THIS LINK

Sentinel-5P

The essential view on the stratospheric ozone layer and its hole

- ✓ Ozone is strongly linked to climate due to its influence on Earth's radiative budget, absorbing solar UV radiation in the stratosphere and terrestrial infrared radiation in the troposphere.



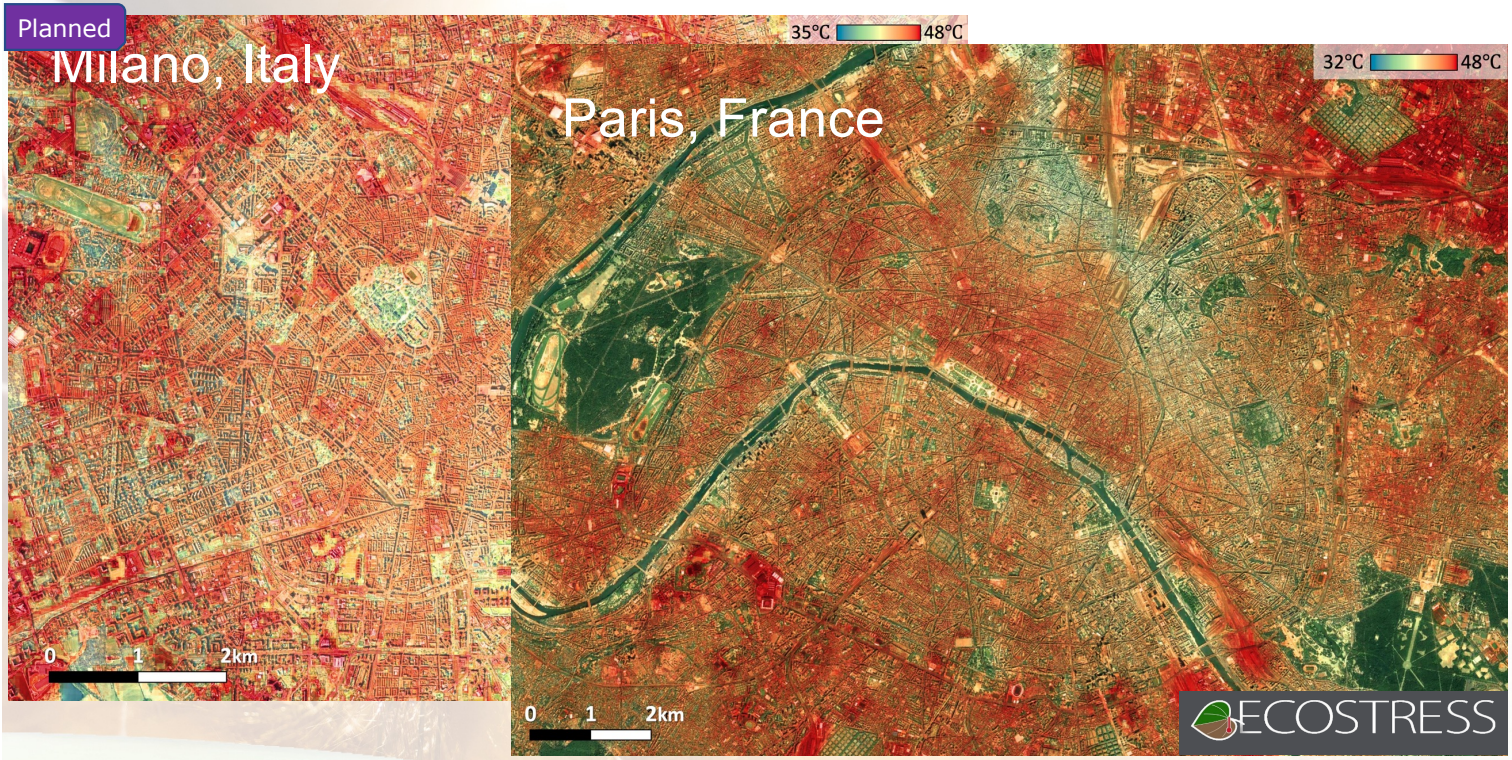
✓ Global Ozone Monitoring - Record Ozone Hole extension during Sep. 17 2023

Explainer

- Sentinel-5P's TROPOMI provides estimates of ozone profiles as well as total columnar content and tropospheric ozone columns. The retrieved ozone profiles are used to monitor the evolution of stratospheric and tropospheric ozone.
- Sentinel-5P's TROPOMI total ozone measurements are extending Europe's capability of the continuous global ozone monitoring from space since 1995
- The stratospheric ozone layer protects life on Earth against harmful UV radiation.
- Sentinel-5P is a precursor to Sentinel-5. Its continuity will be ensured by the Sentinel-5 series
- Know more AT THIS LINK

LSTM – Land Surface Temperature Monitoring

The space-based thermometer for urban heat stress and heat waves



✓ **Land Surface Temperature monitoring at high resolution supports for urban planning as part of climate adaptation measures** (shading trees, green roofs, cooling pavements)**.**

A Nature Medicine publication estimates over 60,000 heat-related deaths in Europe in the summer 2022

Explainer

- LSTM provides Thermal Infra-Red observations in **5 thermal bands with w**orld-class radiometric accuracy (**1-1.5K LST**) **with 2 days revisit** at Equator (with 2 satellites)
- LSTM measurements of Land Surface Temperature (LST), at an unprecedented **50 meter** resolution, are compatible with requirements for mapping urban hotspots at city scale.
- LSTM is a Sentinel Expansion Mission. Two units are currently being developed and will be available for launch as from 2028 subject to budget availability. .
- Know more AT THIS LINK

CIMR - Copernicus Imaging Microwave Radiometer

A step-change in Europe's ability to gather evidence of changes in the Arctic

- ✓ CIMR is dedicated to EU Actions on Safeguarding the Arctic and monitoring climate change expressed in the EU Arctic Policy for a safe, stable, sustainable, peaceful and prosperous Arctic.

Planned

(Northern Sea Route) shipping activities in 2022 (chnl.no).

Explainer

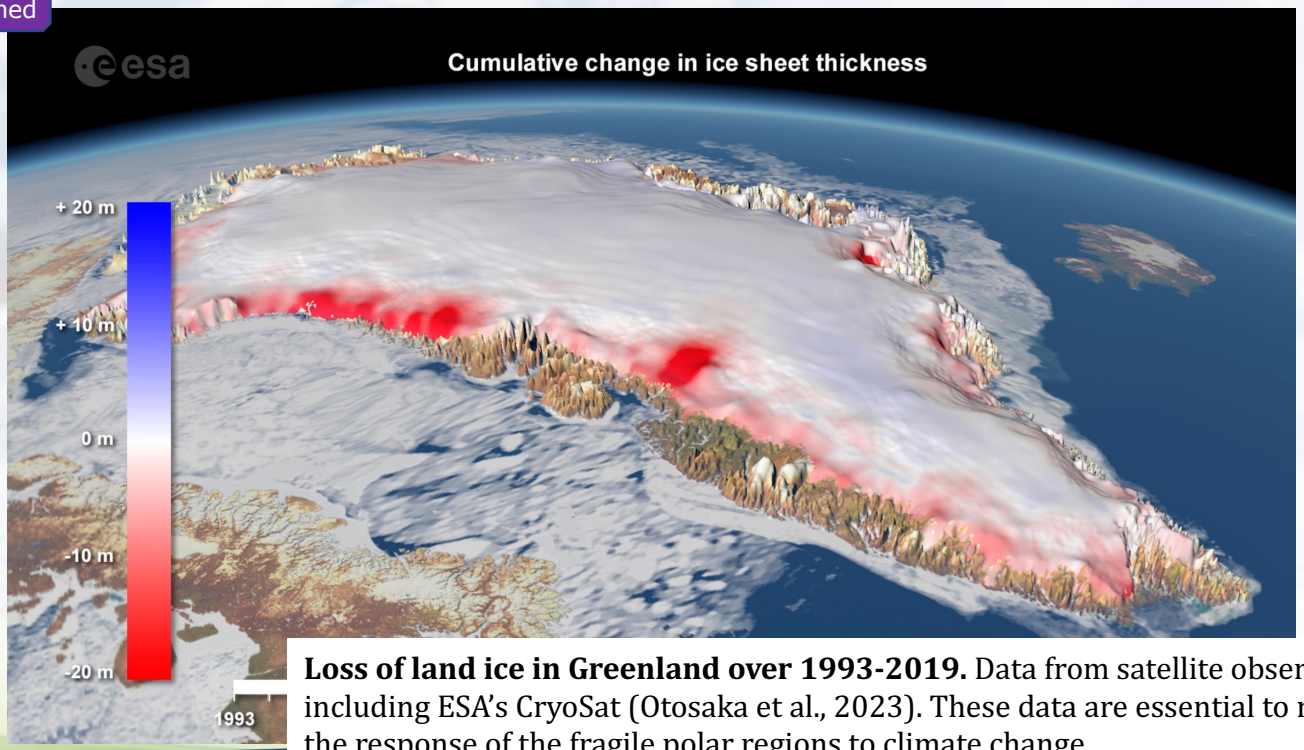
- CIMR will provide **unique** L- and Ka-band measurements to give decision-makers evidence of change and impact in the Polar Regions, with a focus on the Arctic in a global context.
- CIMR will employ a suite of low-frequency but high resolution measurements to determine spatial maps of sea ice concentration, sea ice thickness, sea surface temperature, sea surface Salinity, ocean wind vectors, ocean, snow and ice sheet surfaces with a sub-daily revisit in the Arctic region. No other sensor has the capability that CIMR brings to address the Integrated European Policy for the Arctic.
- CIMR is a Sentinel Expansion Mission. Two units are currently being developed and will be available for launch as from 2028 subject to budget availability.
- Know more AT THIS LINK

CRISTAL – Copernicus polaR Ice and Snow Topography ALtimeter

The cutting-edge radar altimeter mission to monitor land ice, sea ice and snow

✓ CRISTAL will respond to the needs for Safeguarding the Arctic and monitoring climate change expressed in the EU Arctic Policy

Planned



Loss of land ice in Greenland over 1993-2019. Data from satellite observations including ESA's CryoSat (Otosaka et al., 2023). These data are essential to monitor the response of the fragile polar regions to climate change.

Explainer

- CRISTAL will build on the heritage of ESA's CryoSat mission, continuing and expanding its unique capability of monitoring sea ice thickness and land ice elevation changes in the polar regions, **covering up to 88°.**
- CRISTAL's cutting-edge dual-band radar altimeter will enable us to measure the snow layer as well, resulting in much more accurate estimates of sea ice thickness and volume.
- CRISTAL' s products will also support polar and global oceanography and global river and lake studies.
- CRISTAL is a Sentinel Expansion Mission. Two units are currently being developed and will be available for launch as from 2028 subject to budget availability.
- Know more AT THIS LINK

Copernicus4regions User Stories

Selected user testimonials from European public authorities

Cloud-free Sentinel image obtained August 30th, 2017 roughly covers 2/3 of Iceland.
Credit: Contains modified Copernicus Sentinel data (2017)

Using the Sentinel images to update our (glaciers) map database has not only improved our data but also our productivity."

Magnús Guðmundsson, General Director National Land Survey of Iceland (LINK)

The WhereIsWater portal has made a significant contribution to increasing knowledge about water conditions and has helped to improve the flood alert warning system."

Mojca Robič, hydrologist, Slovenian Environment Agency (LINK)

General view of Mulargia reservoir in Sardinia.
Source: Ente acque della Sardegna (ENAS)

With SPACE-O water quality forecast service we can now be proactive and mitigate challenging water quality threats to the benefit of our water users."

Maria Antonietta Dessena, Ente acque della Sardegna (ENAS) (LINK)

The use of satellite data to enhance our knowledge and monitoring of marine ecosystems will contribute to the regional blue growth strategy we are currently launching."

Marie-Agnès Dupouey, Blue Growth at Région Nouvelle-Aquitaine (LINK)

User quotes from NEREUS/ESA/EC 2018

Question Time!

BACK TO POLICY AREAS

BACK TO MEETING AGENDA