

The Copernicus Climate Change Service and the ECV programme



Climate Change

Joaquín Muñoz Sabater & the C3S team
European Centre for Medium-Range Weather Forecasts (ECMWF)

ISSI workshop on ECVs and their uncertainties– Bern, Switzerland– 13-17 Nov 2023





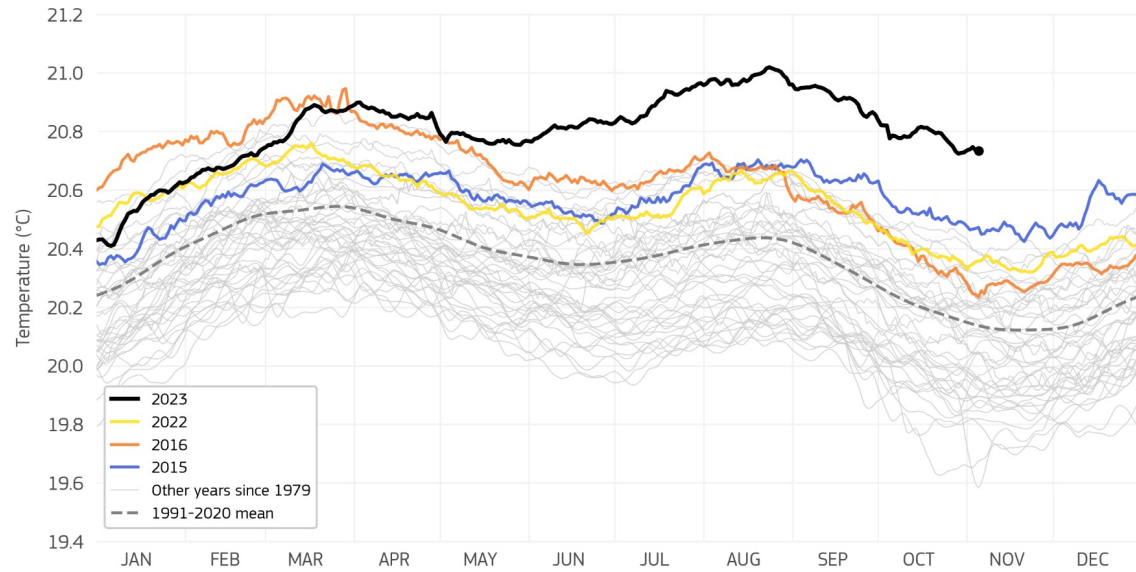
Climate Change

Living on uncharted territories

DAILY SEA SURFACE TEMPERATURE

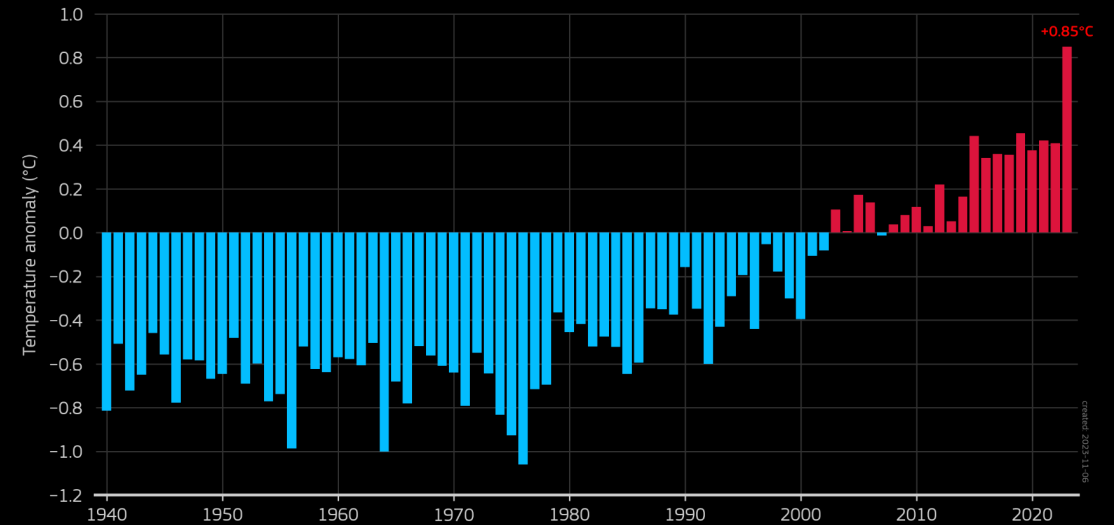
Extrapolar global ocean (60°S–60°N)

Data: ERA5 1979–2023 • Last data: 05 Nov 2023 • Credit: C3S/ECMWF




GLOBAL SURFACE AIR TEMPERATURE ANOMALIES • OCTOBER

Data: ERA5 • Reference period: 1991-2020 • Credit: C3S/ECMWF





Open, free, complete


Sentinels




CLIMATE CHANGE



MARINE MONITORING



ATMOSPHERE MONITORING



LAND MONITORING



SECURITY



EMERGENCY MANAGEMENT















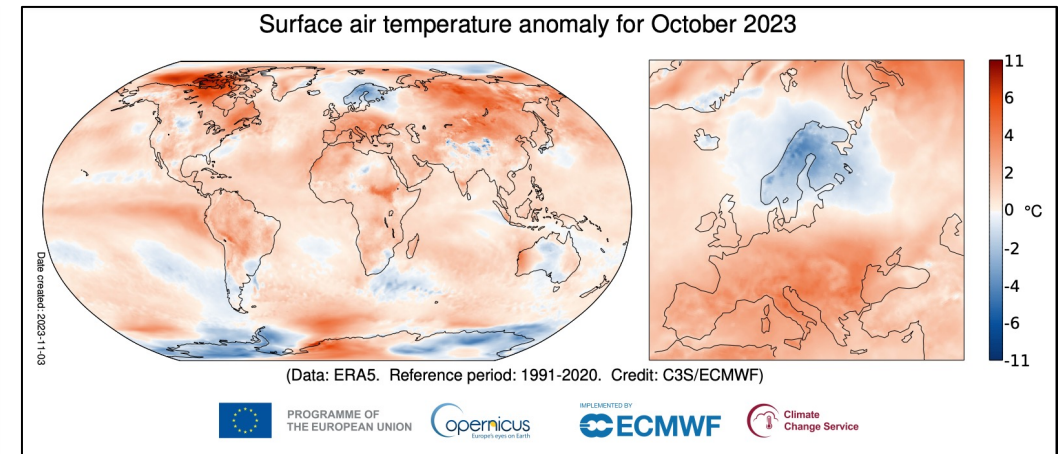
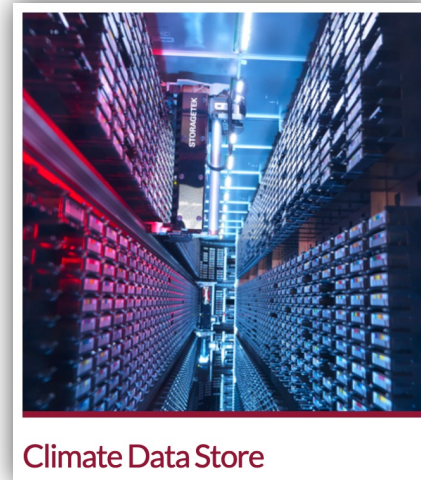


Climate Change

What is the Copernicus Climate Change Service (C3S)?

The Copernicus Climate Change Service (C3S) operationally provides authoritative climate information and data in support of **adaptation** decision and **mitigation** policies

 <p>Water management</p> <p>We provide our users with the data and tools they need to prepare for climate variability and change in the water sector. For example, our data services provide information on changes in river discharge, droughts and floods.</p>	 <p>Agriculture and forestry</p> <p>We use climate data to help the agricultural sector predict the climate-dependent variations in annual crop yield at the regional to global level. Our data have been used to assess how long-term variations in the climate may affect investment decisions for woody crops and forests.</p>	 <p>Insurance</p> <p>We support the insurance sector with data that identifies the historical occurrence of some specific extreme weather events, such as windstorms.</p>	 <p>Energy</p> <p>We support the energy sector, which is increasingly relying on renewable energy production, by providing climate-related information, such as forecasts of air-temperature, atmospheric transparency, wind strength, and projections of wave size and frequency.</p>
 <p>Infrastructure, Transport and Associated Standards</p> <p>We provide climate indicators that can be used to help build resilient cities able to mitigate the challenges that climate change pose to infrastructure.</p>	 <p>Health</p> <p>We provide access to high-resolution maps of temperature and heat-wave frequency for major urban centres across Europe. We also provide forecasts of the distribution of pollen and vector-borne diseases.</p>	 <p>Coastal areas</p> <p>Fisheries are an important part of the European economy. We provide information on the future distribution of key ocean variables and their impacts on the aquatic ecosystem, including species distribution and possible changes in fish stocks.</p>	 <p>Disaster risk reduction</p> <p>We provide climate information to support policies related to disaster risk reduction, as well as practice to address weather-related risks.</p>
 <p>Shipping</p> <p>We use seasonal predictions and climate projections to inform shipping companies of new opportunities and hazards using up-to-date climatologies and future trends in key climate variables such as winds, waves and sea ice.</p>	 <p>Tourism</p> <p>The warming climate has the potential to significantly affect the appeal of tourist destinations. Working with experts we provide indicators able to inform personal and business decisions on seasonal and multi-decadal time-scales.</p>	 <p>Biodiversity</p> <p>Climate change puts high pressure on global biodiversity and is likely to become one of the most significant drivers of biodiversity loss in the 21st century.</p>	 <p>Global Users</p> <p>We aim to facilitate climate adaptation worldwide and offer an interactive web application with refined data, guidance and practical showcases.</p>



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Climate
Change

Climate datasets available in the Climate Data Store



Observations

Observations are key to understanding the climate system. C3S users can access a vast variety of instrumental data records, ranging from historic weather observations to the latest measurements from

[Read more >](#)



Climate reanalyses

Climate reanalyses combine past observations with models to generate consistent time series for a large set of climate variables. Reanalyses are among the most-used datasets in the geophysical sciences.

[Read more >](#)

[Reanalysis data on the CDS >](#)

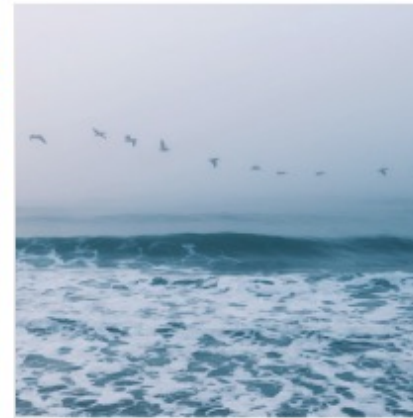


Seasonal forecasts

C3S seasonal forecasts combine outputs from several state-of-the-art seasonal prediction systems from providers in Europe and elsewhere. The latest data and products are published monthly on the Climate Data Store.

[Read more >](#)

[Seasonal forecast data on the CDS >](#)



Climate projections

Projections of future climate change are available for different scenarios for concentrations of greenhouse gases and aerosols, based on outputs from multiple global and regional climate models.

[Read more >](#)

[Climate projection data on the CDS >](#)



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Climate Change

ECVs & C3S

Essential Climate Variables are required to support the work of the UNFCCC and the IPCC

- Provide empirical evidence to understand the evolution of climate (climate indicators)
- Guide mitigation and adaptation measures (decision making)
- Assess risks and enable attribution of climate events to underlying causes
- Underpin climate services.

C3S uses historical observations from satellite sensors to build Climate Data Records of Essential Climate Variables (ECVs)

- C3S responds to the GCOS implementation needs
- C3S facilitates transitions from research to operations

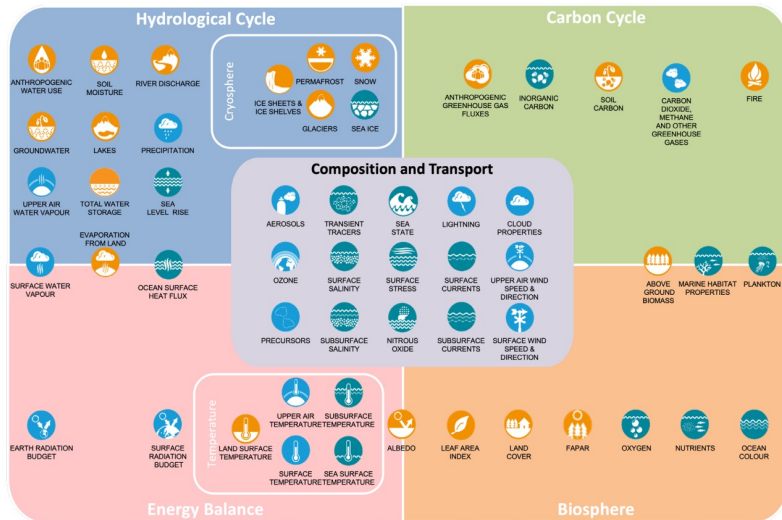
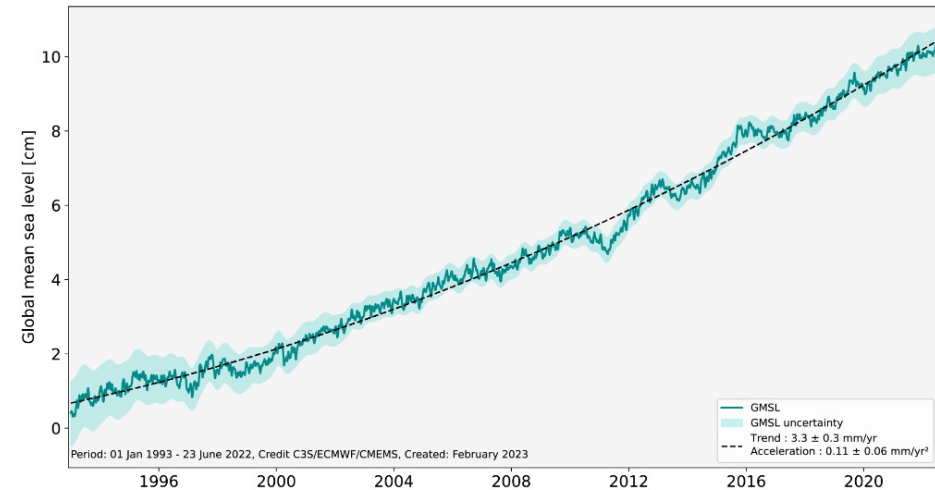


Figure 2. Essential Climate Variables and the climate cycles (See section 2.4). Many ECV contribute to understanding several different cycles – this only indicates the main links.

ECVs belong to three panel domains: ● Atmosphere ECVs (AOPC); ● Ocean ECVs (OOPC); ● Terrestrial ECVs (TOPC)



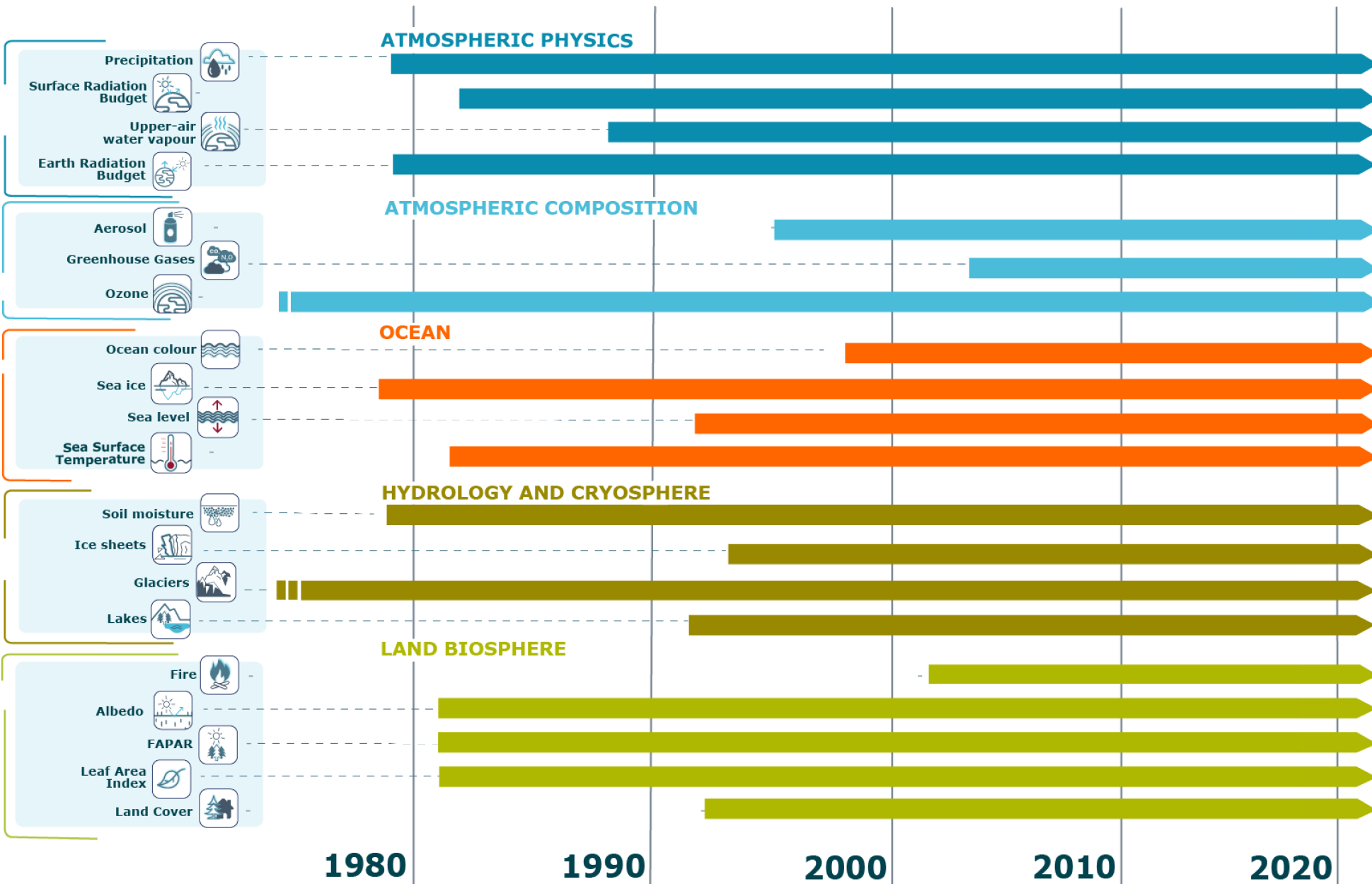
Copernicus Climate Change Service Programme of the European Union Copernicus ECOWF





Climate Change

Satellite ECV data records



IN COLLABORATION with more than **50** organisations.



Mainly use Sentinel-3 data

Future use of other Sentinel data



Climate Change Service
climate.copernicus.eu



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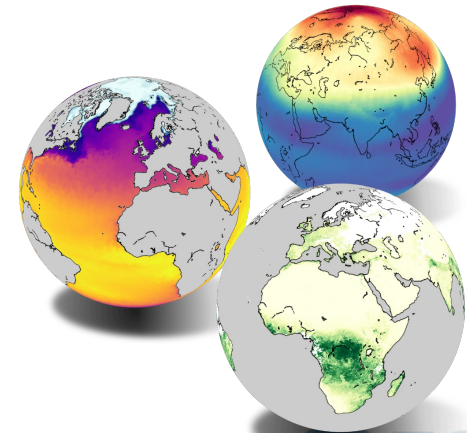
ECVs operational services

Basic requirements of data records

- Be suitable for use as CDRs, i.e. be of sufficient **length, consistency, homogeneity and continuity** to represent past climate variability and change and have global or near-global coverage;
- Be derived primarily from **satellite observations**;
- Provide the **best achievable spatial coverage and resolution**, consistent with meeting the quality required for ECVs and given the quality of available input observations;
- **Include meaningful estimates of uncertainty**, in terms of accuracy and precision;
- Include metadata on data provenance to ensure **full traceability of information**;

C3S ECV services

- Access to quality assured, high-quality gridded CDRs, and regular extensions in time.
- Associated comprehensive documentation
- Independent Quality Assurance
- User Support
- Training material
- Use cases
- Tailored products for media, policy makers
-



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Climate
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Access to the data; The Climate Data Store

The screenshot shows the homepage of the Climate Data Store. At the top, there are logos for the European Union, Copernicus, and ECMWF, along with the text 'IMPLEMENTED BY' and 'Climate Change Service'. A user profile for 'cedric.bergeron' with a 'Logout' button is visible in the top right. Below the navigation bar, a large red banner displays '260,000 + users'. The main content area features a 'Welcome to the Climate Data Store' section with a search bar and a 'Search' button. Below this, there are three featured tiles: 'Climate Data Store Toolbox' with a line graph, 'Climate Data Store API' with a code editor, and 'Access the C3S Forum' with a blue abstract graphic. The footer contains links for 'About C3S', 'Contact us', 'Cookies', 'Disclaimer', and 'Privacy'.

The **Climate Data Store** is an online **open and free** service.

It allows users to browse and access the wide range of climate datasets via a searchable catalogue...

... It allows users to build their own applications, maps and graphs

<https://cds.climate.copernicus.eu>

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The Climate Data Store

Climate

Seasonal forecast monthly statistics on single levels

Overview Download data Quality assessment Documentation

Originating centre

ECMWF
 UK Met Office
 Météo France
 CMCC
 NCEP
 JMA

System

1
 2
 3
 4
 7
 8
 12
 13
 21
 35
 600
 601

Variable

10m u-component of wind
 10m wind gust since previous post-processing
 2m dewpoint temperature
 East-west surface stress rate of accumulation
 Maximum 2m temperature in the last 24 hours
 Mean sub-surface runoff rate
 Minimum 2m temperature in the last 24 hours
 Runoff
 Sea-ice cover
 Snow depth
 Soil temperature level 1
 Surface latent heat flux
 Surface solar radiation
 Surface thermal radiation
 Top solar radiation
 Total cloud cover
 10m v-component of wind
 10m wind speed
 2m temperature
 Evaporation
 Mean sea level pressure
 Mean surface runoff rate
 North-south surface stress rate of accumulation
 Sea surface temperature
 Snow density
 Snowfall
 Solar insolation rate of surface
 Surface sensible heat flux
 Surface solar radiation
 Surface thermal radiation
 Top thermal radiation
 Total precipitation

Select all Clear all

Surface radiation budget from 1982 to present derived from satellite observations

Overview Download data Quality assessment Documentation View

Product family

At least one selection must be made

CLARA (CLOUD, Albedo and Radiation)
 CCI (Climate Change Initiative)

Origin

At least one selection must be made

C3S (Copernicus Climate Change Service)
 EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites)
 ESA (European Space Agency)

Variable

At least one selection must be made

Surface upwelling shortwave flux
 Surface upwelling longwave flux
 Surface downwelling shortwave flux
 Surface downwelling longwave flux
 Surface net downward shortwave flux
 Surface net downward longwave flux
 Surface net downward radiative flux
 All variables (CCI product family)

Climate and energy indicators for Europe from 2005 to 2100 derived from climate projections

Overview Download data Documentation

Variable

Electricity demand
 Hydro power generation reservoirs
 Hydro power generation rivers
 Wind power generation offshore
 Solar photovoltaic power generation
 Wind power generation onshore

Spatial aggregation

Country level
 Maritime country level
 Original grid
 Sub-country level
 Maritime sub-country level

Energy product type

Capacity factor ratio
 Energy
 Power

Temporal aggregation

3 Hourly
 Monthly
 Annual
 Daily
 Seasonal

CMIP6 climate projections

Overview Download data Documentation

Temporal resolution

Monthly
 Daily
 Fixed (no temporal resolution)

Experiment

Historical
 SSP4-6.0
 SSP1-1.9
 SSP3-7.0
 SSP2-2.6
 SSP5-8.5
 SSP4-3.4
 SSP5-3.40S
 SSP2-4.5

Level

Single levels
 20 hPa
 100 hPa
 300 hPa
 700 hPa
 1 hPa
 30 hPa
 150 hPa
 400 hPa
 850 hPa
 5 hPa
 50 hPa
 200 hPa
 500 hPa
 925 hPa
 10 hPa
 70 hPa
 250 hPa
 600 hPa
 1000 hPa

Variable

Air temperature
 Daily maximum near-surface air temperature
 Eastward near-surface wind
 Evaporation including sublimation and transpiration
 Grid-cell area for atmospheric grid variables
 Land ice area percentage
 Near-surface air temperature
 Capacity of soil to store water
 Daily minimum near-surface air temperature
 Eastward wind
 Geopotential height
 Grid-cell area for ocean variables
 Moisture in upper portion of soil column
 Near-surface relative humidity

Simplicity and consistency are key



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CDS Datasets

The screenshot shows the search results for 'ERA5 hourly single levels'. The top result is highlighted with a red box:

ERA5 hourly data on single levels from 1959 to present

Dataset | Atmosphere (surface) | Atmosphere (upper air) | Global | Reanalysis

ERA5 is the fifth generation ECMWF reanalysis for the global climate and weather for the past 4 to 7 decades. Currently data is available from 1950, with Climate Data Store entries for 1950-1978 (preliminary back extension) and from 1959 onwards (final release plus timely updates, this page). ERA5 replaces the ERA-Interim reanalysis. Reanalysis combines model data with observations from across the...

Updated 2022-08-08

The second result is 'ERA5 hourly data on single levels from 1950 to 1978 (preliminary version)'. It includes a description: 'This entry is a preliminary version of the ERA5 reanalysis back extension from 1950 to 1978. Although in many other respects the quality of this dataset is quite satisfactory (Bell et al., 2021), this preliminary data does suffer from tropical cyclones that are sometimes unrealistically intense. This is in contrast with the ERA5 product from 1959 onwards. For more details see the articles, ERA5 ba...'



The screenshot shows the documentation page for the ERA5 dataset. It has tabs for 'Overview', 'Download data', 'Quality assessment', and 'Documentation'. The 'Documentation' tab is active.

- [ERA5 data documentation](#)
 - Detailed information relating to the ERA5 data archive can be found in the web link above.
- [The ERA5 global reanalysis: Preliminary extension to 1950](#)
 - Journal article describing the ERA5 preliminary extension.
- [The ERA5 global reanalysis](#)
 - Journal article describing ERA5.
- [Renamed variable: form ocean waves 10m wind to ocean surface stress equivalent 10m neutral wind](#)
 - The reason for the change was a parameter name clash between variables in ERA5 wind and ERA5 ocean waves.

Simplicity and consistency are key

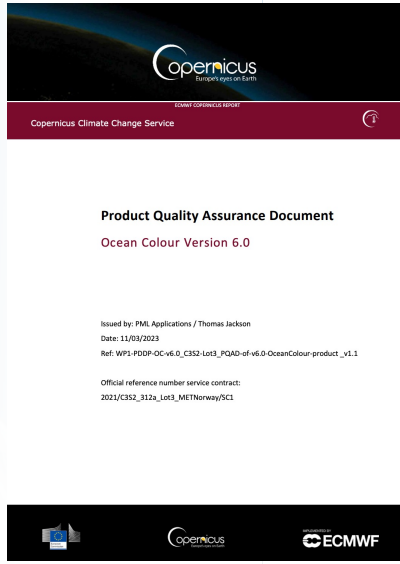


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Uncertainty information



Product Quality Assurance Document
Ocean Colour Version 6.0

Issued by: PML Applications / Thomas Jackson
Date: 11/03/2023
Ref: WP2-FODP-OC-v6.0_C3S2_Lot3_PQAD-of-v6.0-OceanColour-product_v1.1
Official reference number service contract: 2021/C3S2_312a_Lot3_METNorway/SCI



Product Quality Assessment Report
Ocean Colour Version 6.0

Issued by: PML Applications / Thomas Jackson
Date: 22/03/2023
Ref: WP2-FODP-2022-04_C3S2-Lot3_PQAR-of-v6.0-OceanColour-product_v1.1
Official reference number service contract: 2021/C3S2_312a_Lot3_METNorway/SCI

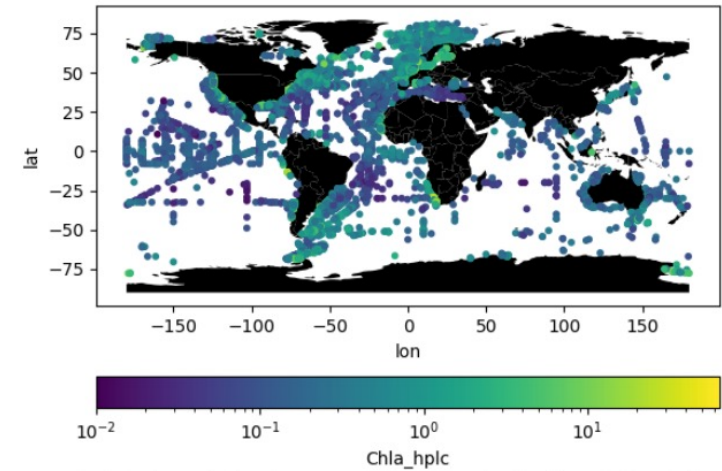


Figure 1 Global distribution of chlorophyll a concentration per intervals of the observed value. All chlorophyll data were considered, but for a given station High Performance Liquid Chromatography (HPLC) data were selected if available.

Overview Download data Quality assessment Documentation

This is a new feature, work in progress. Should any inconsistency be found, please report to <https://support.ecmwf.int/>

The CDS datasets are assessed by the Evaluation and Quality Control (EQC) function of C3S independently of the data supplier. EQC encompasses a framework of processes aimed to assure technical and scientific quality harmonized across all dataset types available through the CDS. During the EQC process, the documentation provided with the dataset is scrutinized and data are checked for usability and reliability.

Variable:

Projection:

Version:

Variable: Mass concentration of chlorophyll-a - Projection: Regular latitude-longitude grid - Version: 5.0 (deprecated) Last updated on 23/08/2021

INTRODUCTION	USER DOCUMENTATION	ACCESS	INDEPENDENT ASSESSMENT
Dataset overview	User guide	Toolbox compatibility	Data check
Temporal and spatial coverage and resolution	Scientific methodology	Archive	Expert evaluation
Providers	Uncertainty quantification		Dataset maturity
Dataset version	Validation		Key strengths and limitations
Data update	Inter-comparison		

Uncertainty quantification Last update on 23/08/2021

General practices and findings used to characterize and represent uncertainty in the data record

Has an uncertainty characterisation been completed? Yes

Uncertainty characterisation report <https://datastore.copernicus-climate.eu/documents/satellite-ocean-colour/v5.0/D.../>

Description of uncertainty analysis
The root-mean-square (RMS) uncertainty and the bias in the log10 chlorophyll-a concentration are provided, based on comparison with match-up in situ data. The chlorophyll-a values are calculated by blending algorithms based on the water-type as documented ATBD.

Global uncertainty
Global uncertainty characteristics for oceanic properties derived from OC-CCI merged Rrs data are described in table 1 from the PQAD.

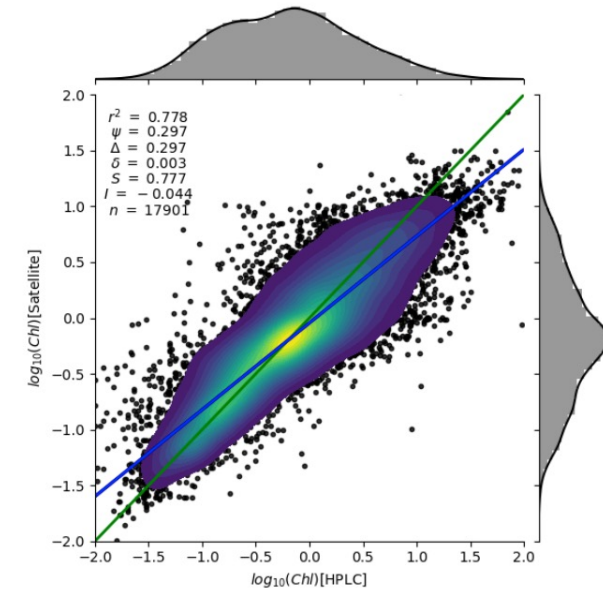


Figure 2 OC_CCI v5 chlorophyll-a match-up density plot. The 1:1 line (green), linear regression (blue), squared correlation coefficient (r^2), RMSE (ψ), unbiased RMSE (Δ), bias (δ), Slope (S) and intercept (l) of regression and number of match-ups (n) are shown.



Climate Change

Statistics from the CDS (01 Nov 2023)

Registered users (global)

254,319

Represented countries (>=15users)

185

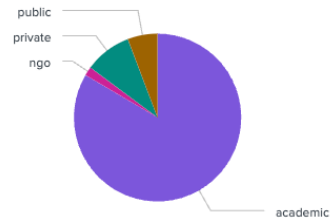
New users in the last 24h

300

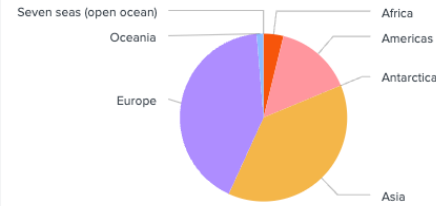
Daily registration (avg) (global)

172

Distribution by sector (global)



Users by World Region



- Current rate of downloaded data: 130 Tb/day

Total number of users

33,201

Total volume downloaded (in GB)

628,314

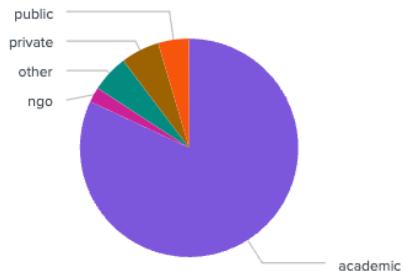
Total number of requests

1,832,559

Top 10 users (countries)

China	7258
United States	2421
India	2011
United Kingdom	1585
Germany	1410
Italy	1069
France	1060
Indonesia	754
Unknown	704
Spain	665

Distribution per sector



- Every month between 700-900 new users
- Current rate of downloaded data: 13-17 Tby/month
- After reanalysis, ECVs are the second most popular category of CDS products
- This is not the whole picture...



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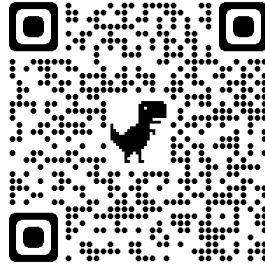
ALL CDS

ECVs

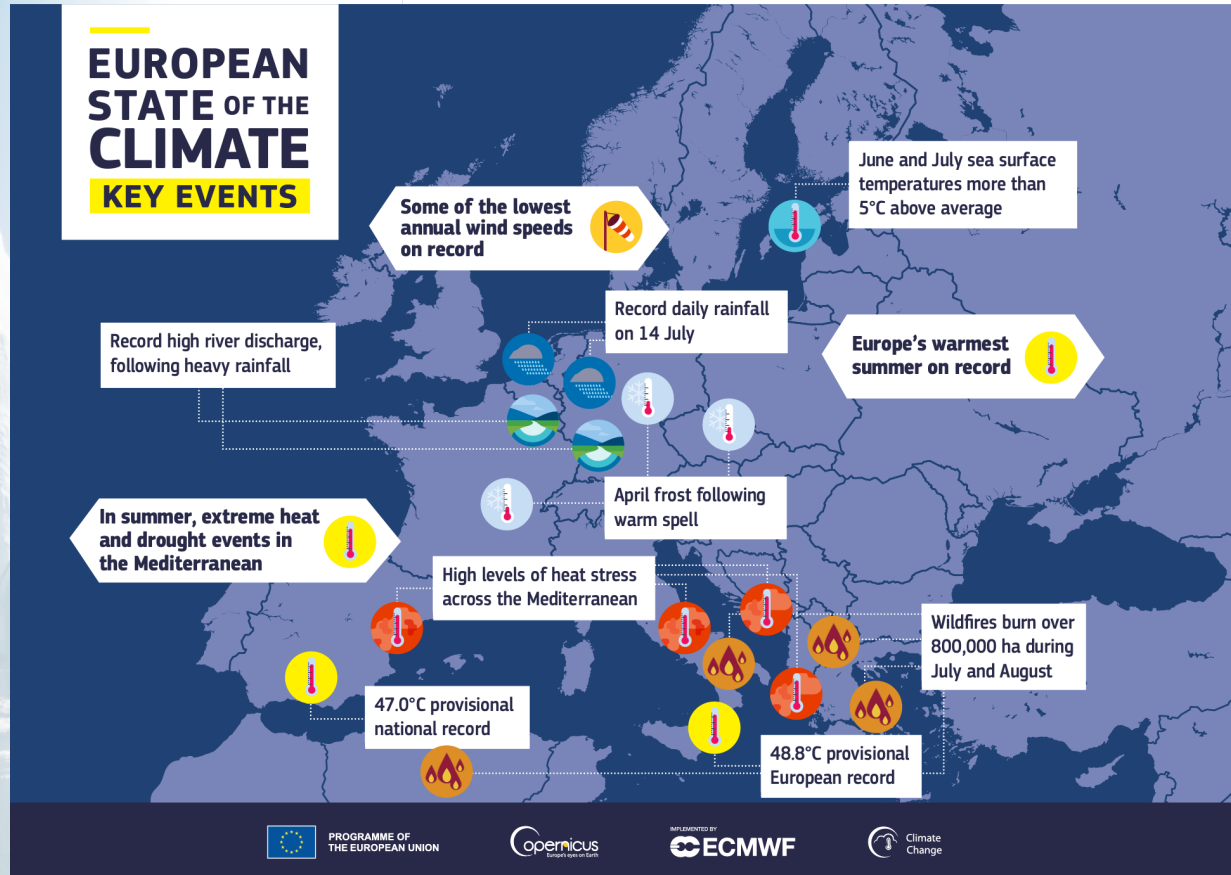


Climate Change

A tool for outreach ESOTC 2022

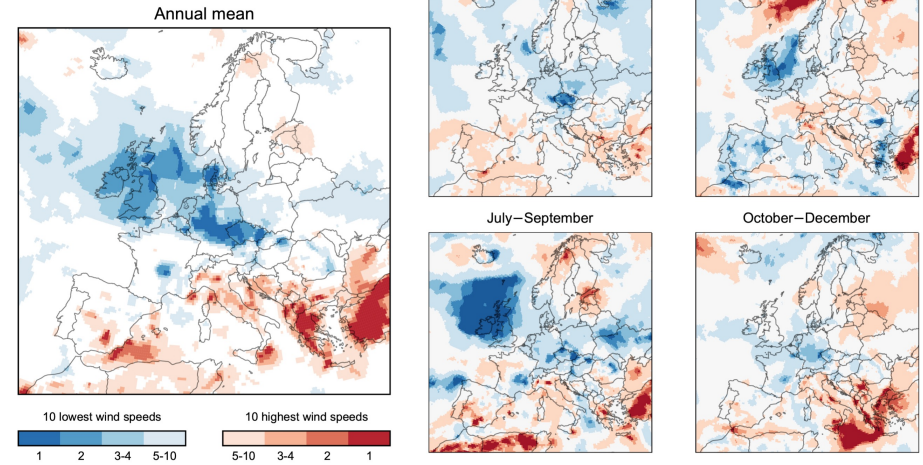


EUROPEAN STATE OF THE CLIMATE KEY EVENTS



100m wind speed rankings in 2021

within the 43-year record (1979-2021)



Data: ERA5 • Credit: C3S/ECMWF

Thematic

Key events that occurred during the year are described within a climatic context.



Late spring frost



Mediterranean summer extremes



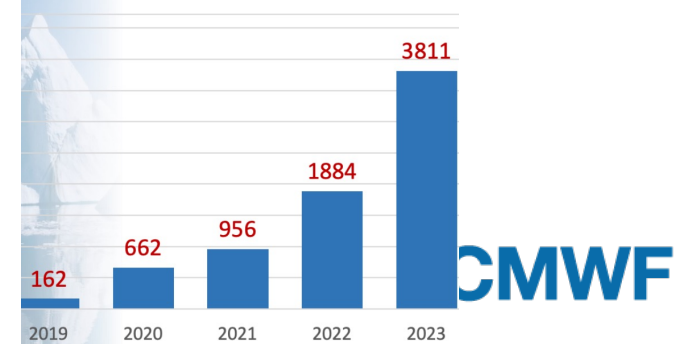
Flooding in Europe



Low winds

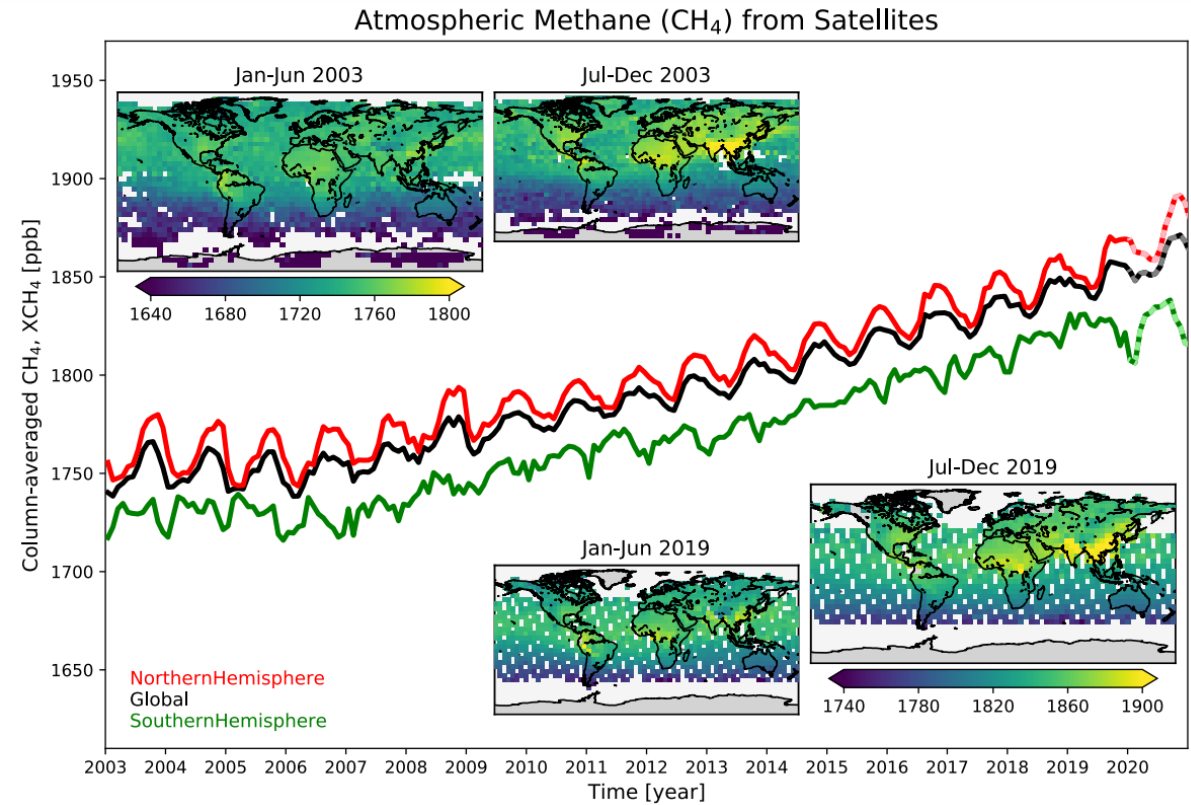
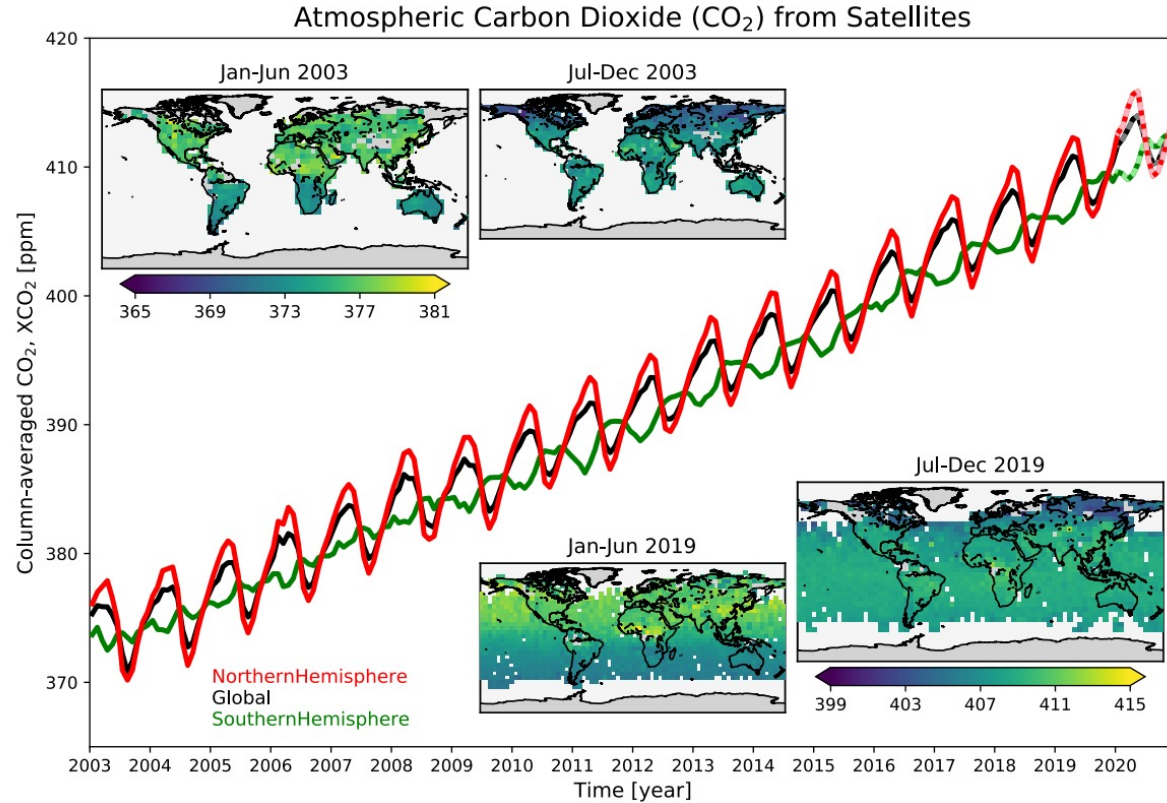


Mentions of ESOTC report



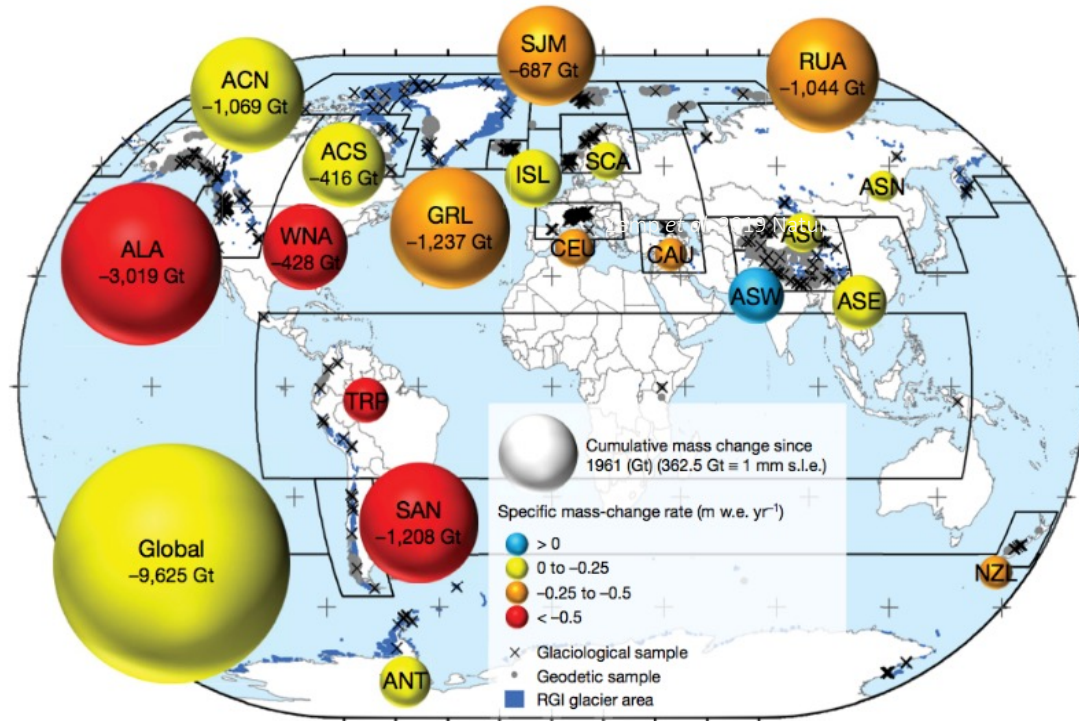
Climate information

Generation of key information for policy makers, published in the ESOTC

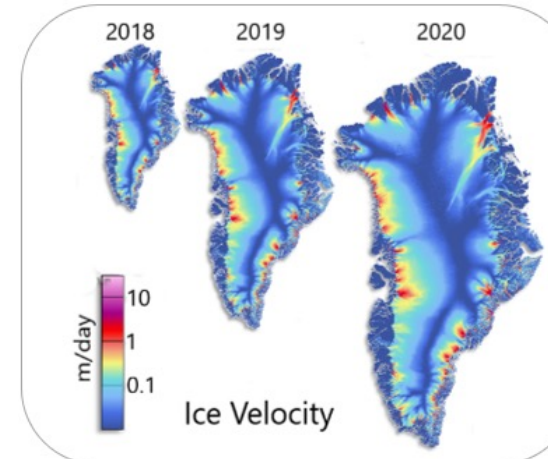
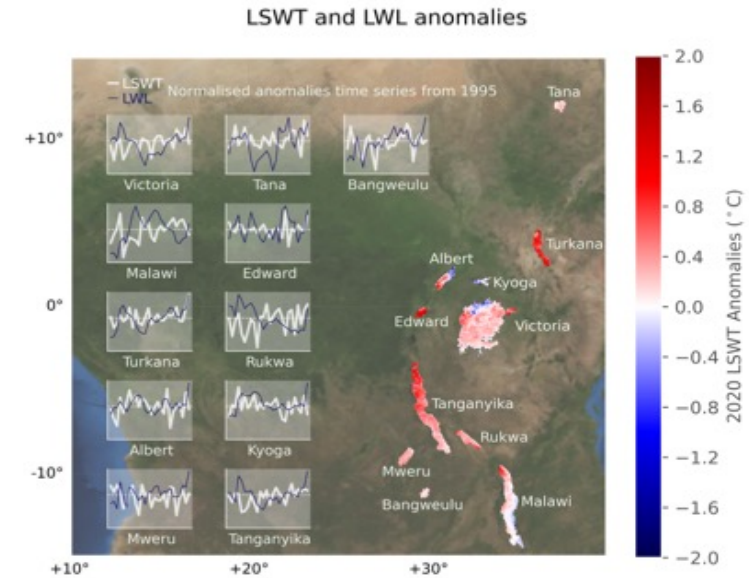




- Generation of state-of-the-art climate products



Sea level contribution of glaciers in the 19 RGI regions (1961 to 2016)



**New in 2022:
Land cryosphere
monitoring section**

Winter snow deficit &
summer heatwaves'
impact on Alpine glaciers

Data: World Glacier Monitoring Service



5.4 times
the height of the Eiffel Tower

**RECORD LOSS
OF GLACIER ICE
EUROPEAN ALPS
IN 2022**

more than

5 km³

New opportunities to Tender for ECVs in C3S

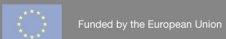


Copernicus Climate Change Service Volume II

Provision of data access and services of
Essential Climate Variable derived from
observations -

Atmospheric Composition Hub

ITT Ref: C3S2_313a
ISSUED BY: ECMWF Administration Department Procurement Section
Date: XXXXXX
Version: Final



- A minimum of 5 ITTS will be released between Q4-2023 and Q1-2024, for the provision of ECV services based on satellite observations
- The first one will be for the provision of atmospheric composition services

Thematic ECV Hub	End current contract
atmospheric physics	31 st July 2024
atmospheric composition	30 th April 2024
ocean	1 st Feb 2025
hydrosphere & cryosphere	31 st July 2024
Land biosphere	30 th Sept 2024

- The total procurement process is expected to last between 4-6 months, depending on the complexity of negotiations.
- Calls for services related to new ECVs could be anticipated.
- It is not ruled out that before the end of our current Framework Agreement, services for yet new ECVs are requested.
- UK entities will be able to bid once the MS ratify the contribution of UK to the Copernicus programme.



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Climate Change

Meet the ECV team

ECV manager



Joaquín Muñoz Sabater

Contract Officer



Kevin Lossouarn



SCL

Technical Officers



Anne-Marie Fjæraa



Dinand Schepers



Julien Nicolas



Francesca Guglielmo



Joao Martins



Ruth Wilson



Ned Dwyer



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Thank you for your attention

