



Climate Change

C 3 S

Service Changement Climatique de Copernicus

Atelier Copernicus

17 Novembre 2020





Climate
Change

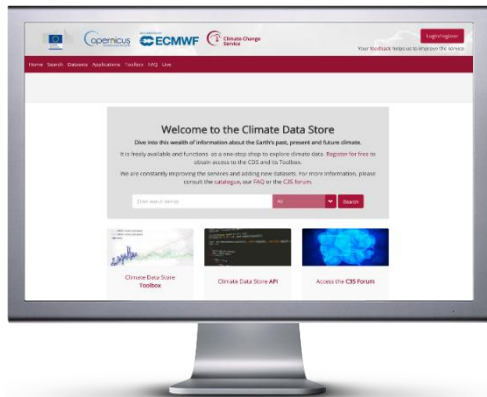
C3S overview

- We deliver what we said we would deliver
- High reliability of operational service, even with COVID
- Notable successes
- Launch of EQC
- What's next

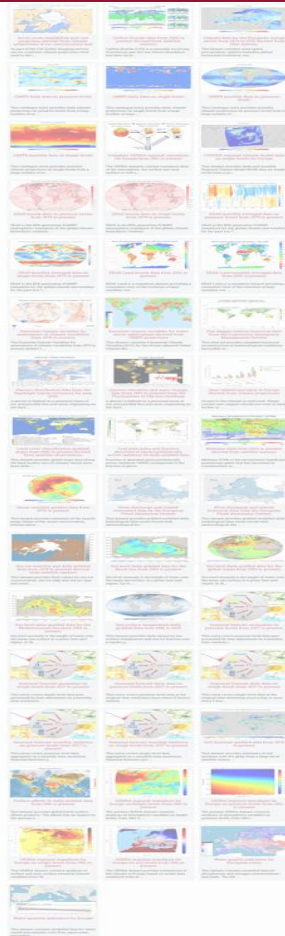


Climate Change

The Climate Data Store – highly operational with enhanced infrastructure



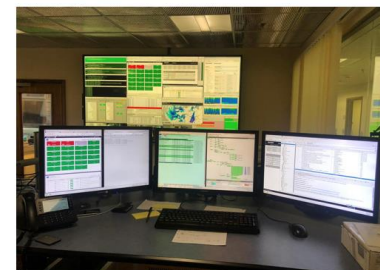
- Registered users: **≈63 000**
- TB/day: **~50 (40-70)**
- Datasets: **82**



Extended in July 2019
**+1.3PB storage + 50%
computational facilities**



On-Premises Private Cloud
72+ nodes, 4000+ CPUs, 13TB RAM
3.9 PB usable (of which 380TB SSD)



Monitoring, Capacity building,
reporting, backups, ...

Status on 13th Nov 2020



Understanding the users



Konstantin, the Consultant

SME company

- Uses remote infrastructure and existing applications
- Focuses on business needs

Goals & Needs

- Contracted to create reports and brochures for clients
- Has limited timeframe to produce them
- Needs to get reliable and repeatable performances
- Benefits from How To's and examples for the tool

Pain Points

- Can't mash-up climate data with user's data
- Lack of flexibility /customization
- Doesn't know what happens next (lack of roadmap)



Robert, the Researcher

Academia

- He wants to publish results in a traceable way (attribution, citation)
- Uses Toolbox for own research
- Has time on his hands

Goals & Needs

- Extracts information from data through analysis
- Needs data to be robust for his scientific papers

Pain Points

- If not familiar with the Toolbox, can't find support there ("You cannot Google it")
- Lack of specific functionalities



Carol, the Contractor

Research Institute

- She is a data provider
- Understands value and limitation of data
- 'Forced' to use Toolbox for creating apps (paid for it)

Goals & Needs

- Needs an easy way to develop simple apps
- Looking for good documentation about how to use Toolbox (code)

Pain Points

- Developing apps on Toolbox it's difficult
- Not aware/alerted when tool functionalities change



Geil, the Geek

Hobbyist

- Likes to play with tools and post results and reviews online
- He is an influencer

Goals & Needs

- Wants to write a great app to show off within his community

Pain Points

- Has no access to latest tech or language



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Communication – continued audience growth

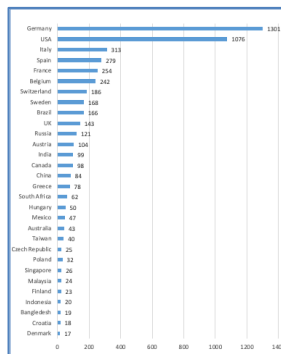
- **MEDIA mentions ~ 8480x in 2019, & 3859 in Q1 2020 alone.**
- **The number of articles on the Review of 2019 released in January 20 reached 1514 clippings – more than all clippings of Q1 2019 together.**
- According to our *Share of Voice analysis*, in European media, **C3S equalled, if not surpassed, NASA and NOAA as the number one source for journalists for specific topics.**

The **MEDIA PARTNERSHIPS** and their shows continue to perform well with production largely unaffected by the COVID-19 crisis.

- **CNN** broadcasts continued with an estimated **174,572,966** combined total number of impacts in Q1 across Europe, S Asia, LATAM and EMEA.
- **Euronews** content also outperforms expectations when broadcasts transfer online
 - **133k total Climate Now** page views in Q1, compared to around 98k in the last quarter (**up buy 36%**);
 - A very high audience for March's written article 'What will be the new face of European agriculture in the coming years?' **51.8k page views by the end of its first Quarter.**

On SOCIAL MEDIA: Q1 20 followers went up for all channels, impressions went up for all channels (Twitter +50%, Instagram +7%, LinkedIn +120%) and engagement rate was also slightly higher for all channels with respect to Q4 2019. **Twitter finished Q1 with over 20k followers and 32k in Nov.**

Countries with the highest coverage percentage in Q1 were Germany, USA and Italy, followed by Spain, France and Belgium.

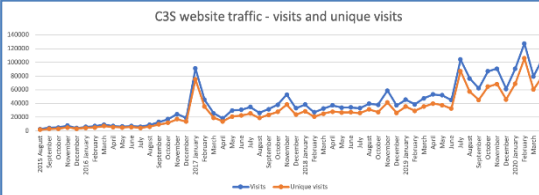


EVENTS played a big part in engagement and profile raising. C3S was honoured to be asked to take part in the **UNFCCC mandated Earth Information Day Plenary panel at COP25**, in addition to other 5 other side events.



Traffic to the C3S WEBSITE continues to grow Q1 2020 vs Q1 2019

- **220% more users** (119,562 vs 37,310)
- **171% more sessions** (149,864 vs 55,230)
- **125% more page views** (298,097 vs 132,277)





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Dynamic response to societal challenges

Home Search Datasets Applications Your requests Toolbox FAQ Live

Monthly climate explorer for COVID-19

Overview Application Documentation Source code

Recently published papers have suggested that, as happens with the diffusion of other viruses, air temperature and humidity could alter the spread of COVID-19. This application, provided by the Copernicus Climate Change Service, allows the user to explore some of these claims by plotting the average air temperature and humidity of the most recent months, alongside the mortality data obtained from Johns Hopkins University.

Month: April 2020 Variable: Temperature

Click on a red circle to see the time evolution for that location.

The white areas on the plots are regions where climate conditions are more conducive to the community diffusion of the disease according to recent scientific literature (Sajadi et al 2020, see documentation for details). Meteorological data are from ERA5 reanalysis: hourly data on single levels and monthly averages on single levels and pressure levels. For the upcoming months, the average values, based on the climatology of the most recent 20 years, are presented.

Disclaimers:

- COVID-19 related data are provided by Johns Hopkins University Center for Systems Science and Engineering (JHU CSSE), and are available at the following GitHub repository: [https://github.com/CSSEGISandData/COVID-19](#). These are used in the application without any prior quality control by CSS.
- The designations employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Version: 4.7.2 - July 2020

Fast Toolbox application development in the COVID-19 crisis context

Climate Data Store - Monthly climate explorer for COVID-19

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Month: April 2020 Variable: Humidity

Click on a red circle to see the time evolution for that location.

The white areas on the plots are regions where climate conditions are more conducive to the community diffusion of the disease according to recent scientific literature (Sajadi et al 2020, see documentation for details). Meteorological data are from ERA5 reanalysis: hourly data on single levels and pressure levels. For the upcoming months, the average values, based on the climatology of the most recent 20 years, are presented.

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France

Cumulated number of deaths in France. Data is from the Johns Hopkins University Center for Systems Science and Engineering, without CSS quality control.

Daily average of the air temperature near the surface at the centre of the circle, not representative of the whole country.



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Entities contributing to C3S

+88 Invitation to Tenders (ITTs) and Requests for Proposals (RFPs) launched via a competitive procurement process

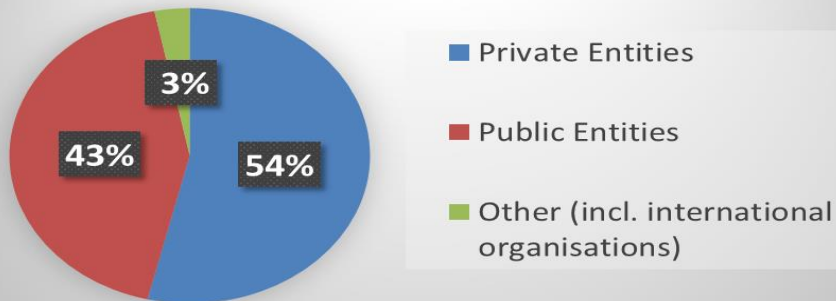
153 signed contracts

345 entities involved as contractor or subcontractor

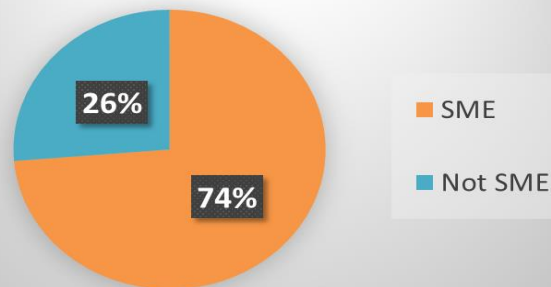
Total value of signed Framework Agreements

~151 MEUR

Type of (sub-)contractors



Private (sub-)contractors





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Routine production for the years to come
(target portfolio)





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C3S Global Reanalysis: ERA5 and ERA5-Land

ERA5: *A full-observing-system global reanalysis for the atmosphere, land and ocean waves*

ERA5 has replaced ERA-Interim (end date 31 August 2019).

Better model, higher resolution, more and better input data

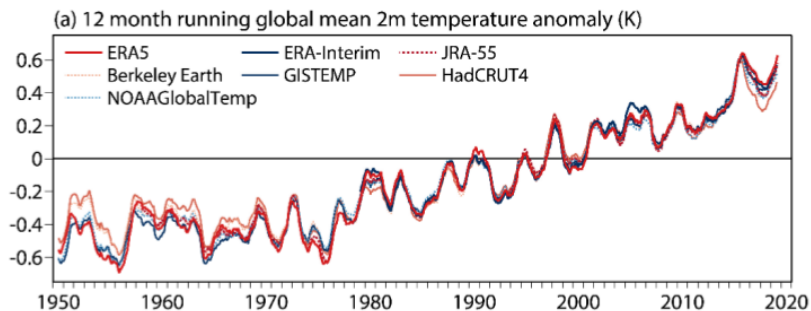
Most popular dataset in the CDS (>26,000 users)

available from **1950 onwards**

daily updates 5 days behind real time

Correction for stratosphere 2000-2006 (ERA5.1) now available

Production of an additional decade (1940s) to start soon



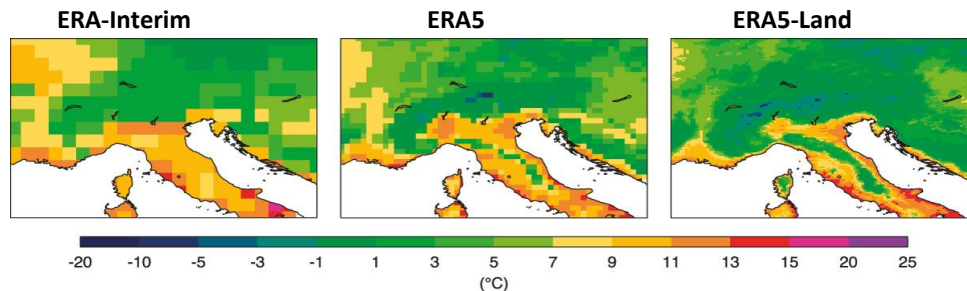
ERA5-Land: *a dynamical downscaling to 9km*

> 6,000 CDS users,

available from 1981

updates 2-3 months behind real time

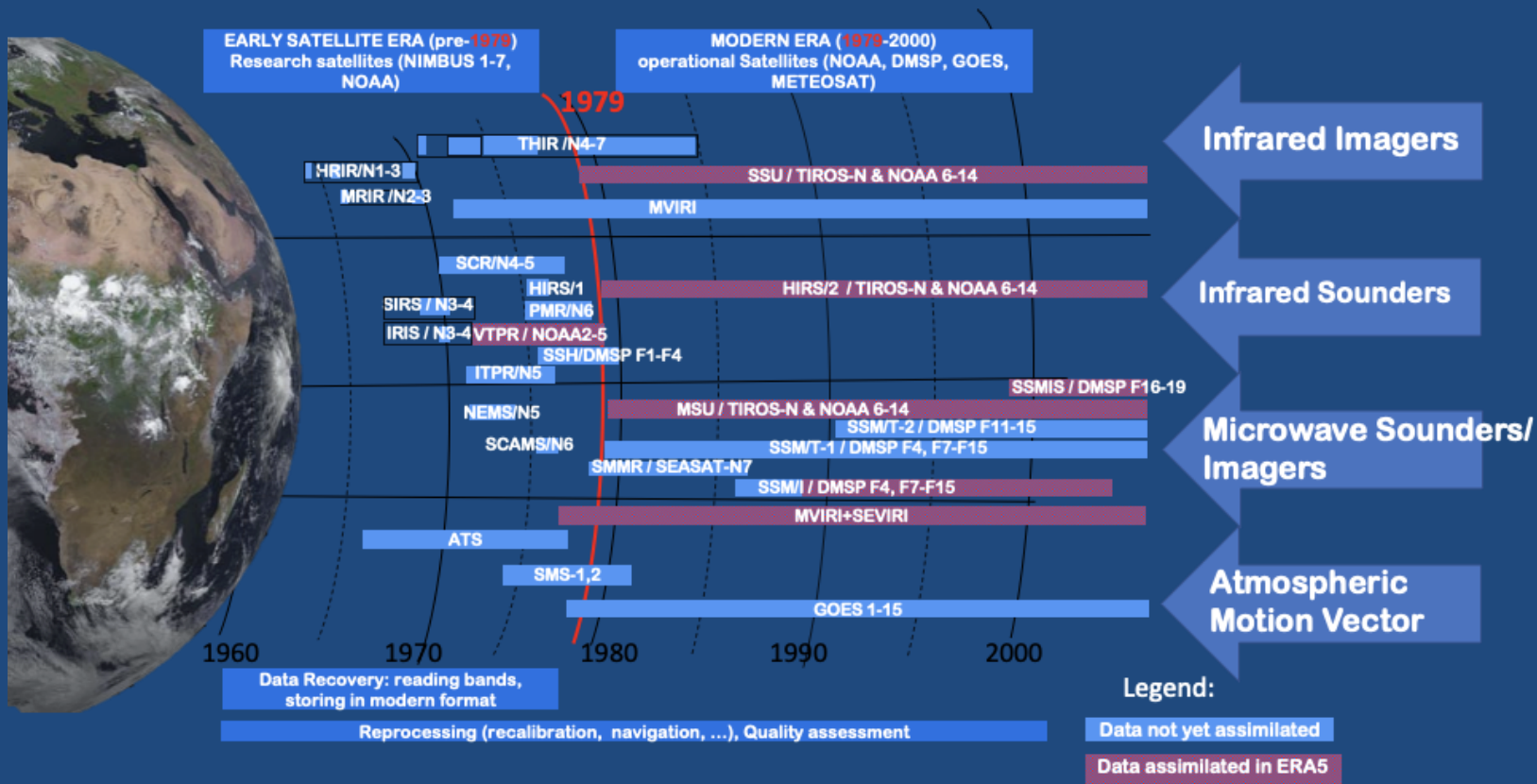
1950 onwards in production





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Satellite Reprocessing and Data Rescue

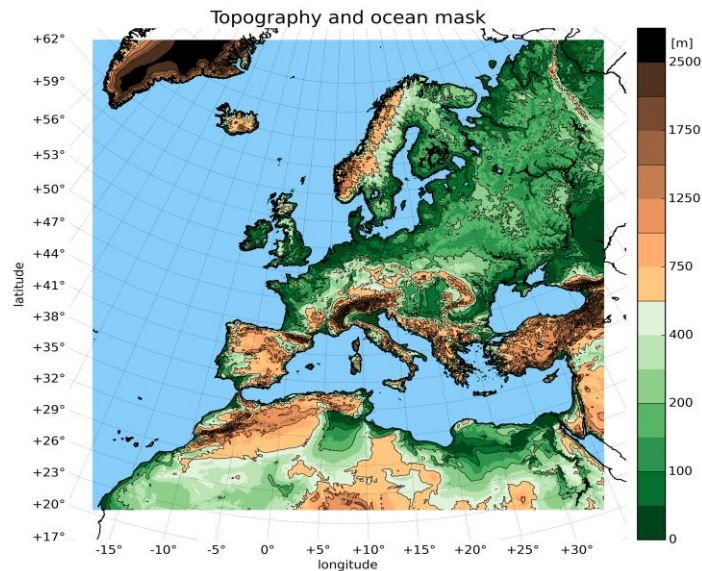




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Regional reanalyses

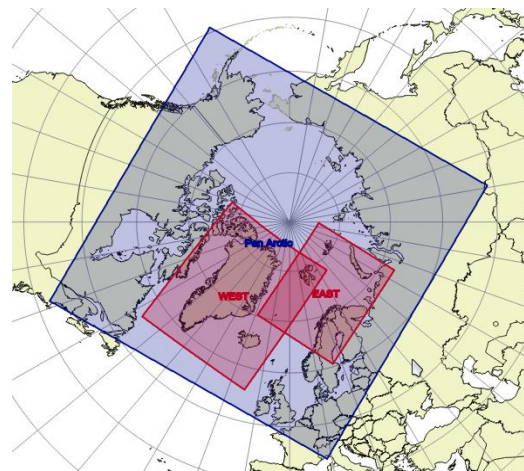
European Domain



Available in the CDS (> 900 users):
UERRA, **1961 – mid 2019 @ 11/5.5km**

Currently in production: CERRA,
early 1980 – May 2021 @ 5.5km
SMHI, Météo-France - MET Norway

Arctic Domain



Currently in production: (red sub domains)
CARRA, **July 1997 – June 2020 @ 2.5km**

Proof of concept: (grey domain)
1-year pan-Arctic reanalysis, **Sep 2017/18 @ 3.75km**
Met Norway, Nordic countries and Météo-France.



Climate Change

Climate variables in C3S

(satellite ECVs)

Atmospheric physics

- Precipitation
- Surface radiation budget
- Water vapour
- Cloud properties
- Earth radiation budget

Coordination with CM-SAF / ROM SAF / ESA CCI / Uni. Maryland / NASA / NOAA



Atmospheric composition

- Carbon dioxide
- Methane
- Ozone
- Aerosol

Coordination with ESA-CCI and other national projects



Ocean

- Sea surface temperature
- Sea level
- Sea ice
- Ocean colour

Coordination with ESA-CCI / OSI-SAF



Land hydrology & cryosphere

- Lakes
- Glaciers
- Ice sheets & ice shelves
- Soil moisture

Coordination with ESA-CCI, GloboLakes, Arc-Lake, HydroWeb



Land biosphere

- Albedo
- Land cover
- Fraction of absorbed photosynthetic
- Leaf area index
- Fire

Coordination with ESA-CCI, CGL, QA4ECV, LSA-SAF



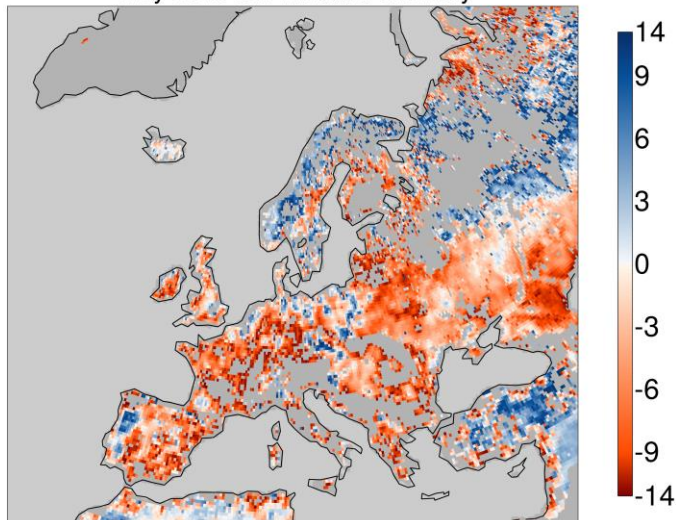


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Examples of ECV products

2018 monthly mean soil moisture anomaly with respect to 1991-2010

May 2018 soil moisture anomaly

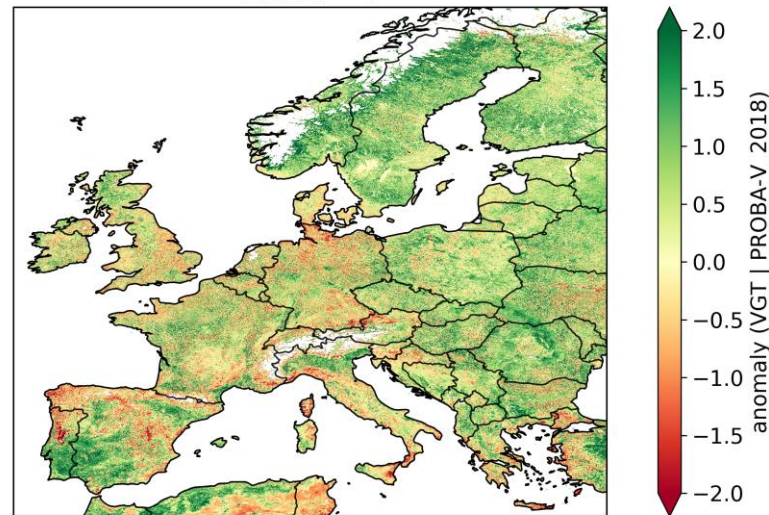


Reference period: 1991-2010

Credit: Copernicus Climate Change Service (C3S)/EODC.

2018 monthly mean LAI anomaly with respect to a PROBA-V mean value

month = 5



Credit: Copernicus Climate Change Service (C3S)/VITO.

- **C3S ECV products** are already **fit for climate monitoring**. In this example a combination of ECV products is used to monitor and analyse the 2018 heatwave & drought event in Northern Europe.



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European State of the Climate

Glaciers

Both globally and in Europe, glaciers are seeing a substantial and prolonged loss of ice mass.

Over most of the 20th century, the rate of mass loss was lower, and some periods of mass gain were observed at both regional and decadal scales. Since 1997, the monitored glaciers in Europe have lost 10 to 29 m of mass, with a regional average loss of around 16 tonnes of freshwater per square metre, of around 16 tonnes of freshwater per square metre.

Ice thickness loss



Globally around

30 m loss ▼

in ice thickness since 1957

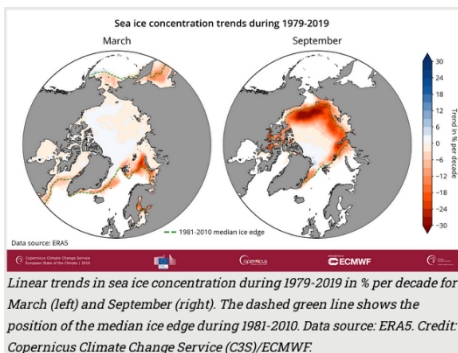
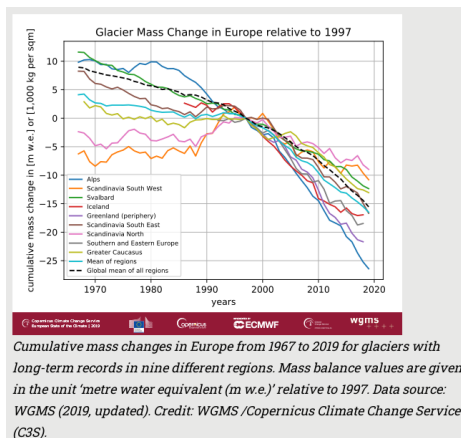
In Europe observed

4–35 m loss ▼

in ice thickness in southwestern Scandinavia and the Alps respectively, since the 1960s



Reference glacier network with more than 30 years of ongoing observations



Greenhouse gases

Concentrations of atmospheric carbon dioxide (CO₂) and methane (CH₄) are increasing. We would have to look back millions of years in history to find concentrations as high as they were in 2019.

Greenhouse gas concentrations

The amount of a gas contained in a certain volume of air.



CO₂ increase by about

0.6% per year ▲

in atmospheric concentrations

CH₄ increase by about

0.4% per year ▲

in atmospheric concentrations



Concentrations (column-averaged mixing ratios) estimated from satellite data for CO₂ and CH₄ covering 2003-2019

Sea level

Between 1993 and 2019, the global mean rise in sea level has been around 3.3 mm ± 0.4 mm per year; a total increase of around 8 cm.

Regional trends can deviate considerably from global mean. For example, across Europe, sea level changes differ between the open ocean and coastal areas due to various geophysical processes.

Between 1993 and 2019



Globally around

3.3 mm per year ▲

mean sea level increase

In Europe by

2–4 mm per year ▲

mean sea level increase



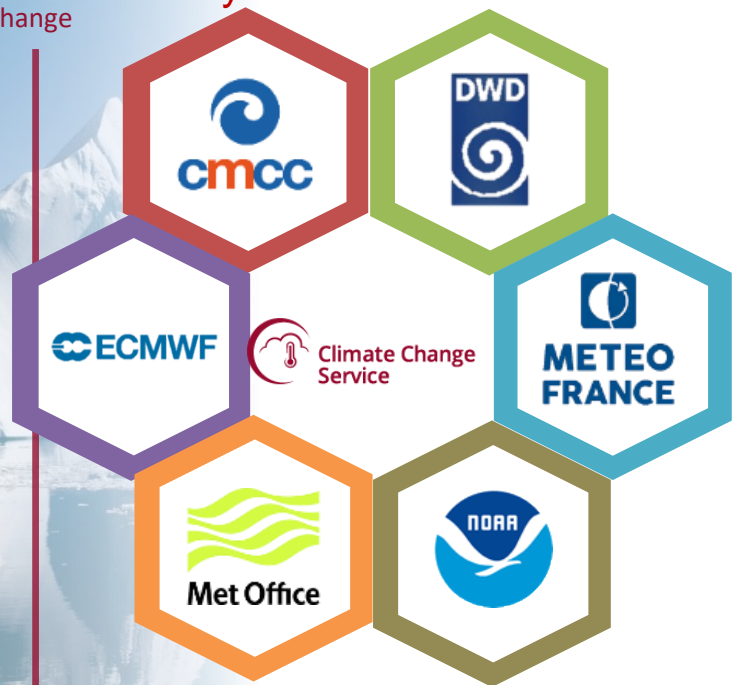
Sea level data record covering January 1993 to October 2019

- C3S ECV products are being used in the European State of the Climate, as climate indicators and as a measure of the state of health of our environment.



C3S seasonal prediction & climate projections components

Climate Change Multi-system seasonal forecast service



Climate projections by GCM and RCM

Operational service: 6-month forecasts issued every month on the 13th

- **Graphical products through C3S webpage**
https://climate.copernicus.eu/charts/c3s_seasonal/
- **Data service through CDS**
<https://cds.climate.copernicus.eu/cdsapp#!/search?type=dataset>

Non-European providers:

- NCEP** - joined the service in November 2019;
- JMA** – joined in 2020;
- ECCC & BoM** - expression of interest for 2021.

European contributions to C3S:

- provision of forecasts, allowing users from around the world the benefit of state-of-the art data and information;

C3S support to member-state activities:

- generation of graphical and digital (data) products;
- support to member-state development and operational activities in seasonal forecasting;
- access to data from other providers and associated user support.



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C3S

Recent developments





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Evaluation and Quality Control (EQC)

Overview

- Three coordinated EQC contracts for CDS and SIS (>100 person-years of effort)
- EQC function now operational; initially for datasets; tools and applications follow in autumn
- Dashboard to monitor service performance via KPIs in place; rating widgets implemented
- User Requirements Database operational; currently ~ 3,000 user requirements
- First User Requirement Analysis Documents delivered to inform service evolution



The screenshot shows the 'User Requirements Database' interface. The header includes 'The Copernicus Climate Change Service User Requirements Database' and a 'Welcome, aobregon' message. The main content area is titled 'List of Requirements' and shows 'Showing 3400 requirements'. Below this, there are buttons for 'Filter results' and 'Export results'. A table of requirements is visible, with columns for ID, SUMMARY, and General. A text box is overlaid on the right side of the screenshot, containing the following text:

- User Requirements Database (URDB) has become operational
- Currently, ~ 3,000 user requirements under investigation
- First User Requirements Analysis Documents (URAD) delivered to inform future service evolution.



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Evaluation and Quality Control (EQC)

EQC function has become operational

Overview Download data **Quality assessment** Documentation

This is a new feature, work in progress. Should any inconsistency be found, please report to copernicus.support@ecmwf.int

The CDS datasets are independently assessed by the Evaluation function to assure technical and scientific quality harmonized across all datasets. Each dataset is scrutinized and data are checked for usability and accuracy.

Variable:
Sea ice concentration ✕

▼ Variable: [Sea ice concentration](#)

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		Summary of independent assessment
Data update	Inter-comparison		

- EQC tab now available for datasets in the CDS catalogue
- Easy-access quality information via Synthesis Table
- 100+ Quality Assurance reports initially available, more will be added successively
- EQC for tools and applications will follow in Q3
- Continuous improvement through user feedback



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Increased transparency for data providers

Home Search Datasets Applications Toolbox FAQ Live

Search results

Showing 1-3 of 3 results for EUMETSAT SAF

- EUMETSAT Satellite Application Facilities**
Utilising specialist expertise from the EUMETSAT Member States, Satellite Application Facilities (SAFs) are dedicated centres of excellence for processing satellite data. They form an integral part...
- Sea ice monthly and daily gridded data from 1978 to present derived from satellite sensors**
This dataset provides daily values for sea ice concentration, sea ice edge and sea ice type and monthly values for sea ice thickness. These four variables are important markers for climate change stud...
- Surface radiation budget from 1982 to 2015 derived from satellite observations**
This catalogue entry provides a single entry for surface radiation budget variables derived from satellite observations. The radiation at the Earth's surface in the solar wavelength range is an Essen...

Product type: Satellite observations (3)
Variable domain: Atmosphere (surface) (2), Ocean (physics) (1)
Spatial coverage: Global (3)
Temporal coverage: Real (3)
Provider: Copernicus C3S (64), Copernicus CEMS (2), ESA CCI (2), EUMETSAT SAF (3)

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Search per ECV providers

Clear multi-source ECV datasets

Home Search Datasets Applications Toolbox FAQ Live

Surface radiation budget from 1982 to 2015 derived from satellite observations

Warning: This product is under development, this page may contain misleading information

Overview Download data Documentation

Variable:

- C3S
- ESA Cloud CO
- CM SAF

Surface incoming shortwave radiation flux Surface downwelling longwave radiation flux

Time aggregation: Monthly mean Daily mean

Contact: copernicus-support@ecmwf.eu

Licence: EUMETSAT CM SAF products licence Licence to Use Copernicus Products

Publication date: 2020-02-01

Clear ECV access for users

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EUMETSAT Satellite Application Facilities

Overview

Utilising specialist expertise from the EUMETSAT Member States, Satellite Application Facilities (SAFs) are dedicated centres of excellence for processing satellite data. They form an integral part of the distributed EUMETSAT Application Ground Segment.

The eight EUMETSAT SAFs provide users with operational data and software products, each one for a dedicated user community and application area.

EUMETSAT Secretariat supervises and coordinates the overall activities of the SAF network, ensuring that the SAFs in operations are providing reliable and timely operational services related to the meteorological and environmental issues.

The SAF Network manages and coordinates interfaces between the SAFs themselves and between SAFs and other EUMETSAT systems, overseeing the integration and operations of SAFs into the overall ground segment infrastructure. During this process EUMETSAT ensures that services are delivered in the most reliable and cost-effective way.

For more information, please refer to the EUMETSAT SAFs website or each of the SAF Projects listed in the following table.

Brokered SAF datasets to C3S:

SAF project	SAF contact	Data source	Spatial coverage	Spatial resolution	YCDR	ICDR	Temporal resolution	Instrument	Variables	Licence	SAF DOI	CDS Catalogue
CM SAF	contact.cmisat@dwd.de	CM SAF CLARA-A2	Global	0.25°	01/1982-12/2018		Monthly (Daily for individual variables)	AVHRR	- Surface downwelling shortwave flux - Surface upwelling shortwave flux	link		link (Please select CM SAF products)
OSI SAF	osisaf.prod@meteo.no		Global	12.5km	01/1978-12/2015	01/2016-01/2020	Monthly (Daily for individual variables)	SAMX2, SSM/I and SSM/IS	- Sea ice concentration	link		link (Please select OSI SAF products)

Recent updated 2020-02-10 18:06:15 UTC

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Providers visibility and mapping



Climate Change

Increasing toolbox accessibility

An easier to use toolbox documentation

Climate Change Service

Beta version

Search CDS Toolbox documentation

Home

Tutorials

How-to guides

Application gallery

Anomaly plot

Calculate time mean and standard deviation

Calculate climatologies

Dynamic map

Dynamic map geometries

Plot map

Calculate trends

Extract a time series and plot graph

Calculate Growing Degree Days (GDD) index

Use CDO functions

Double axis

Magics default

Magics title

Magics contour name

Magics contour interval

Magics contour list

Magics contour palette

Learning bundles

Glossary

API

CDS Toolbox documentation - Application gallery

Application gallery

Surface air temperature anomalies relative to 1981-2010

Calculate Time Mean and Standard Deviation

Calculate climatologies

Dynamic map

Dynamic map geometries

Plot Map

Use CDO functions

Double axis

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API

Climate Change Service

Beta version

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API

CDS Toolbox documentation - Tutorials

Tutorials

Tutorial 1 - Getting started with the CDS Toolbox

This introductory tutorial gives an overview of the CDS Toolbox for new users. It provides a comprehensive overview of the toolbox and its capabilities. It covers the basic concepts of the toolbox and how to use it to retrieve data and create visualizations.

#Keywords: Getting started, Tutorial, User interface

Tutorial 2 - Set up a CDS Toolbox application

This tutorial shows how to set up a CDS Toolbox application. It covers the basic concepts of the toolbox and how to use it to retrieve data and create visualizations.

#Keywords: Application, Tutorial, User interface

Tutorial 3 - Create a climate graph application

This tutorial shows how to create a climate graph application. It covers the basic concepts of the toolbox and how to use it to retrieve data and create visualizations.

#Keywords: Climate graph, Tutorial, User interface

Tutorial 4 - Create an input user interface

This tutorial shows how to create an input user interface for a CDS Toolbox application. It covers the basic concepts of the toolbox and how to use it to retrieve data and create visualizations.

#Keywords: Input user interface, Tutorial, User interface

Tutorial 5 - Develop an application based on the example of a climate indicator

This tutorial shows how to develop a CDS Toolbox application based on the example of a climate indicator. It covers the basic concepts of the toolbox and how to use it to retrieve data and create visualizations.

#Keywords: Climate indicator, Tutorial, User interface

How-to guides

Application gallery

Learning bundles

Glossary

API

CDS Toolbox documentation - How-to guides

How-to guides

Toolbox user interface

- Changing the layout of the Toolbox Editor
- Reading and interpreting documentation descriptions
- Sharing an application
- Tagging revisions and restoring an old version of your code

Retrieve data

- Retrieving data
- Retrieving time series and extracting point information
- Using output widgets

Process data

- Using mathematical operations and unit conversion (to be published)
- Calculating climatologies and anomalies (to be published)
- Resampling and aggregate data (to be published)
- About the common data model (to be published)

<https://cds.climate.copernicus.eu/toolbox/doc/index.html>



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C3S

Evolution





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C3S beyond 2020

- Three priorities
 - Service consolidation at large
 - Enhancement of the CDS and operationalisation of the SIS offer
 - Promotion of user uptake (i.e. EU policies, downstream service providers, media, academia)



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Addressing emerging requirements

Decadal prediction service (prototype)

- technical elements: bias correction, verification, data encoding
- case studies for user-relevant applications

Enhanced collaboration with IPCC

- CMIP6 data in the CDS catalogue
- World-wide CORDEX simulations on the CDS, connected to the IPCC Climate Atlas

Extreme events attribution service (prototype)

- Develop and test (for past events) protocols for
 - Communication / service protocol
 - Fast track attribution analysis for specific event types
- Develop educational and communications products for a wider range of event types



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Evolution - (1)

Increase ECV portfolio from the current 22 up to 35 ECVs (*)

- Potential ECVs for next phase: river discharge, permafrost, LST, snow, upper-air temperature, surface ocean currents, etc.

Progressive transition towards the use of Sentinel data

- cloud properties, ozone, aerosols, sea-ice thickness, sea level, SST, ocean colour, soil moisture, lakes, ice sheets, land cover, fire radiative power.

Enhancement of individual ECV services

- Cross-signposting of ECV products with other data suppliers
- Increased collaboration with ESA-CCI and EUMETSAT SAF programmes, as well as with the other Copernicus Services to maximize the catalogue of data services provision

(*) budget-permitting



Evolution - (2)

High-resolution ensemble of global climate integrations back to 1850 or earlier (@ about 25km)

- Coupled with the ocean for cross-domain consistency if possible
- Constrained by sea surface temperature to provide the correct low-frequency variability
- To provide high-resolution climatological information including rare/extreme events.
- Production to start around 2021

Next full-observing-system global coupled global reanalysis (ERA6)

- State-of-the-art NWP system, data assimilation system coupled with the ocean and improved coupling with land
- Will make use of the new and reprocessed datasets as delivered by C3S
- Production to start around 2023

Next regional reanalyses at high resolution

- Centennial reanalysis for the European domain, based on the dense network of observations in the 20th century
- Truly pan-Arctic reanalysis



Climate
Change

There is much more than you can see...

