Climate Change

C 3 S

Service Changement Climatique de Copernicus

Atelier Copernicus

17 Novembre 2020

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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

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The Climate Data Store – highly operational with enhanced infrastructure

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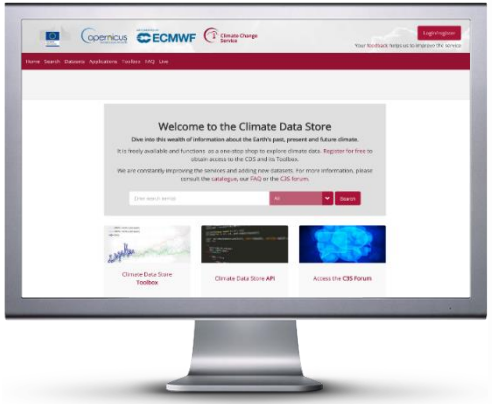
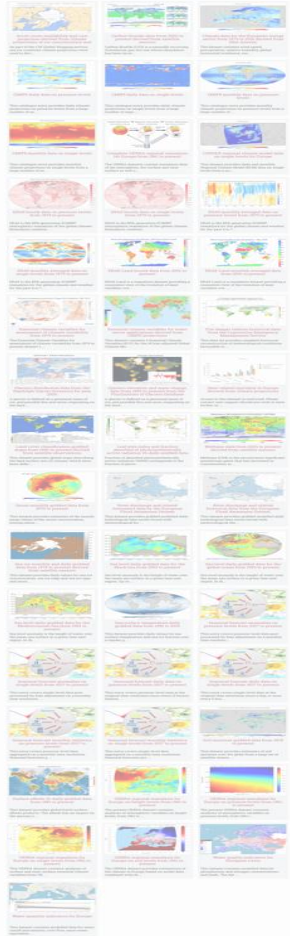
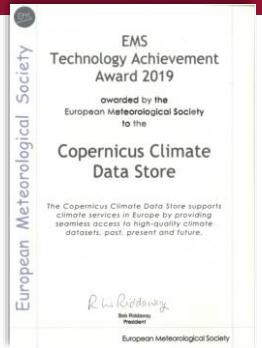
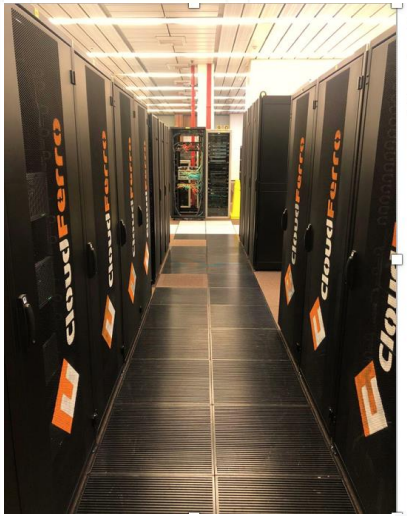






Extended in July 2019
+1.3PB storage + 50% computational facilities

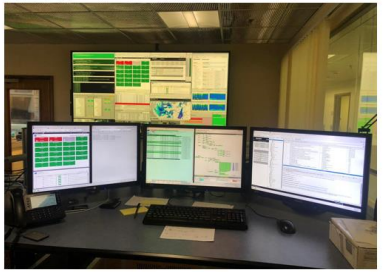
- Registered users: ≈**63 000**
- TB/day: ~**50** (40-70)
- Datasets: 82



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

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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)

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

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

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

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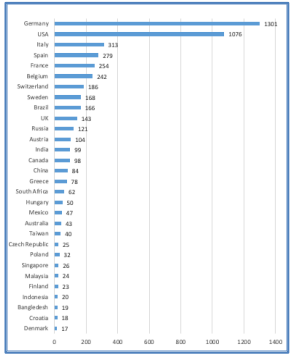
- **MEDIA mentions ~ 8480x in 2019**,& **3859** in **Q1 2020 alone.**
- ***The number of articles on the Review of 2019 released in January 20 reached 1514 clippings – more than all clippings of Q1 2019 together.***
- According to our *Share of Voice analysis,* **in European media, C3S equalled, if not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

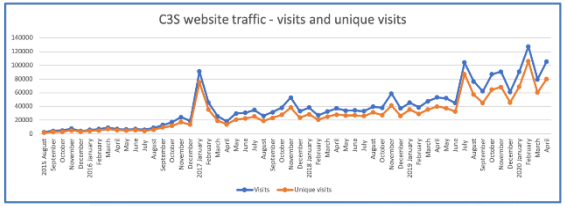
Countries with the highest coverage percentage in Q1 were Germany, USA and Italy, followed by Spain, France and Belgium.



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

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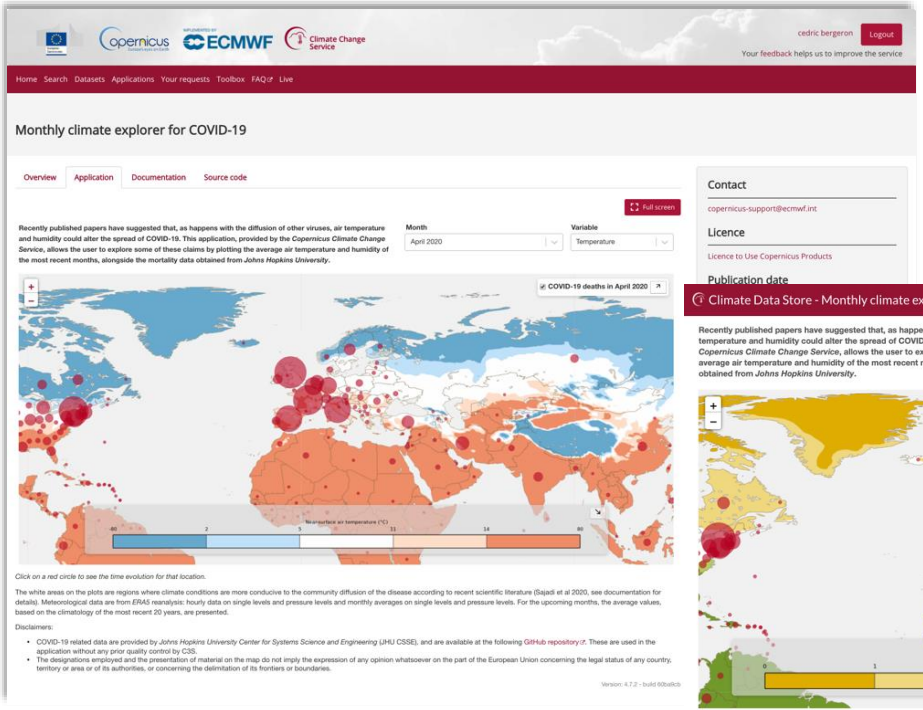
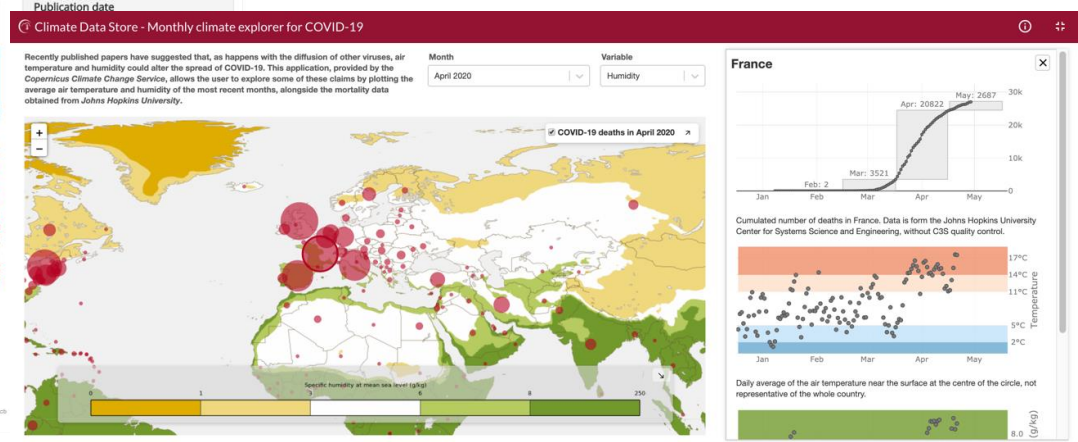


Fast Toolbox application development in the COVID-19 crisis context



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 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. These are used in the application without any prior quality control by C3S.
- 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.

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Entities contributing to C3S

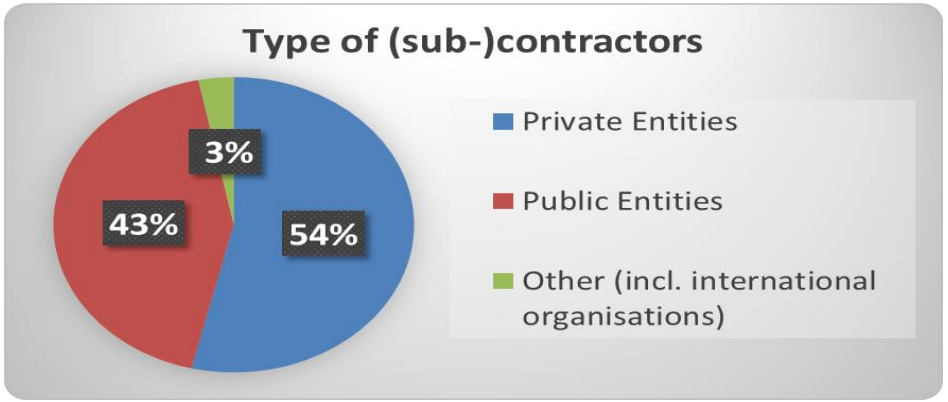
+88 Invitation to Tenders (ITTs) and Requests for Proposals (RFPs) launched via a competitive procurement process

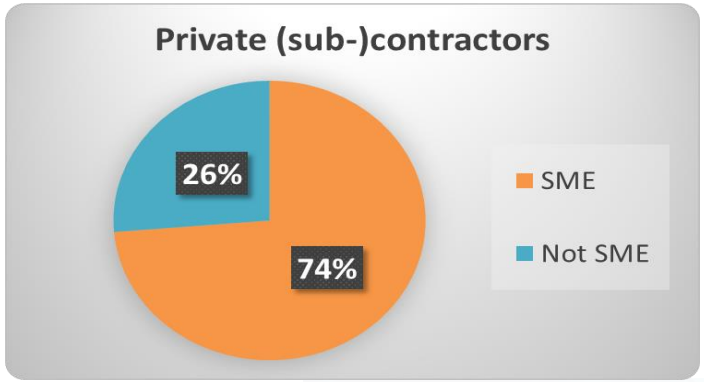
153 signed contracts

345 entities involved as contractor or subcontractor

Total value of signed Framework Agreements

~151 MEUR





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Routine production for the years to come
(target portfolio)

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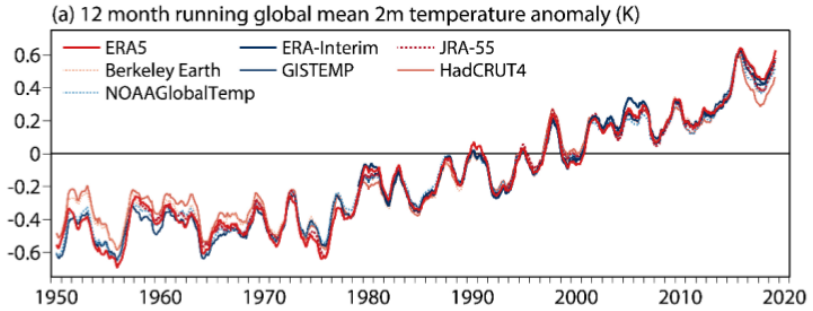
C3S Global Reanalysis: ERA5 and ERA5-Land

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

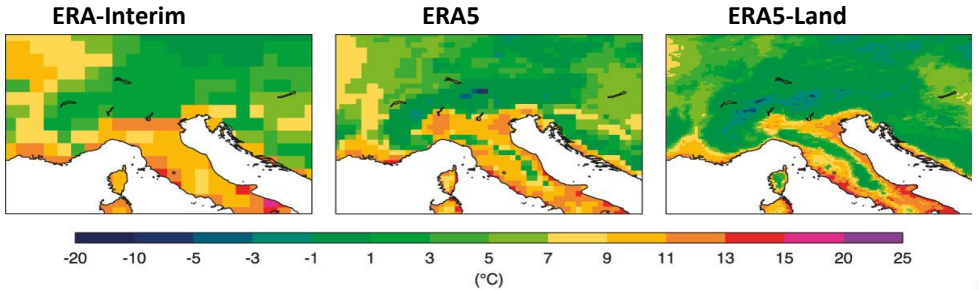
Most popular dataset in the CDS (>26,000 users)
available from 1950 onwards
daily updates 5 days behind real time

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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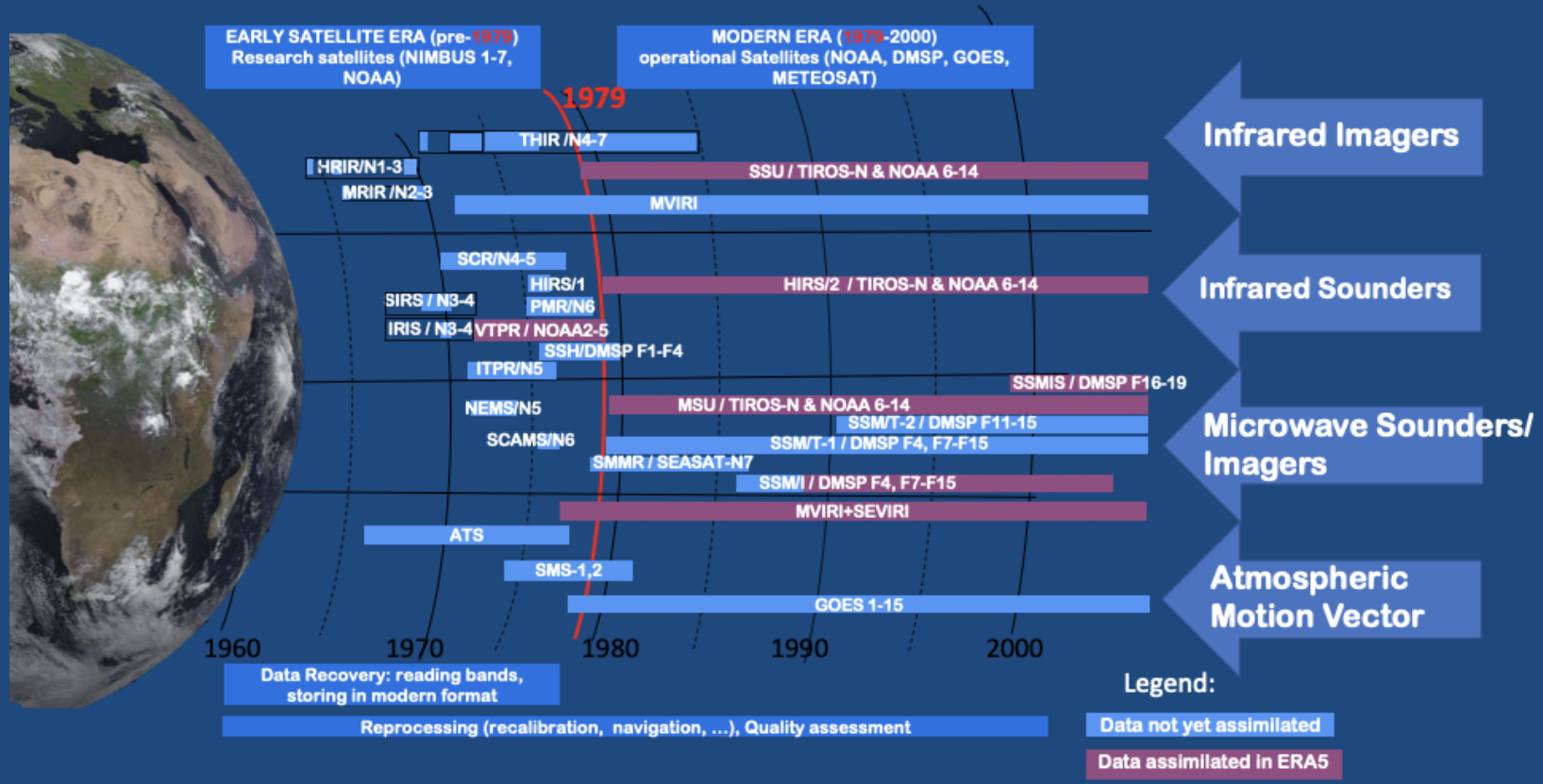
Satellite Reprocessing and Data Rescue



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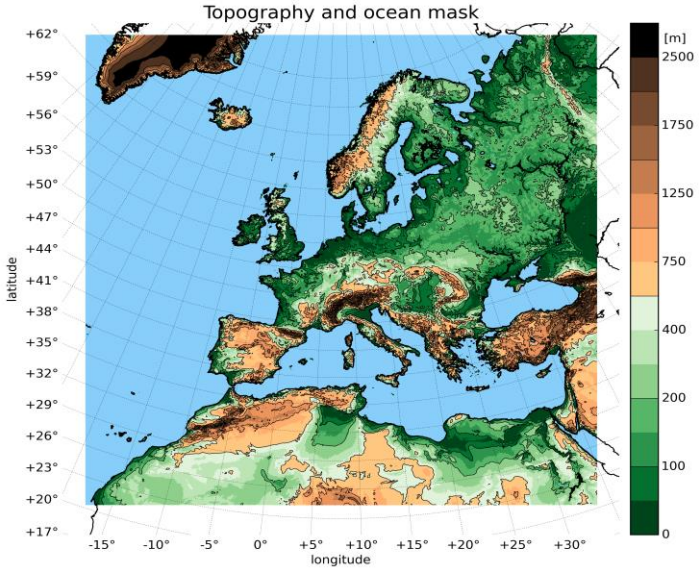
Regional reanalyses

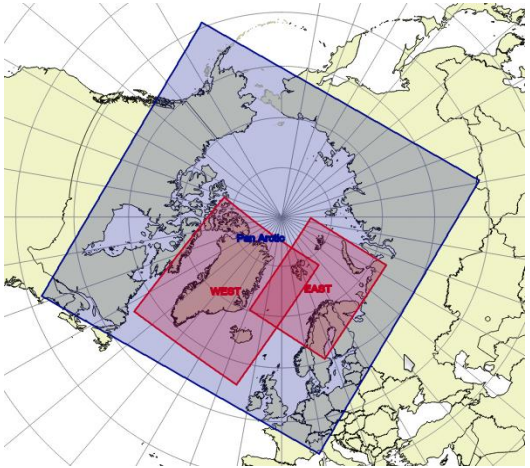
European Domain



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.

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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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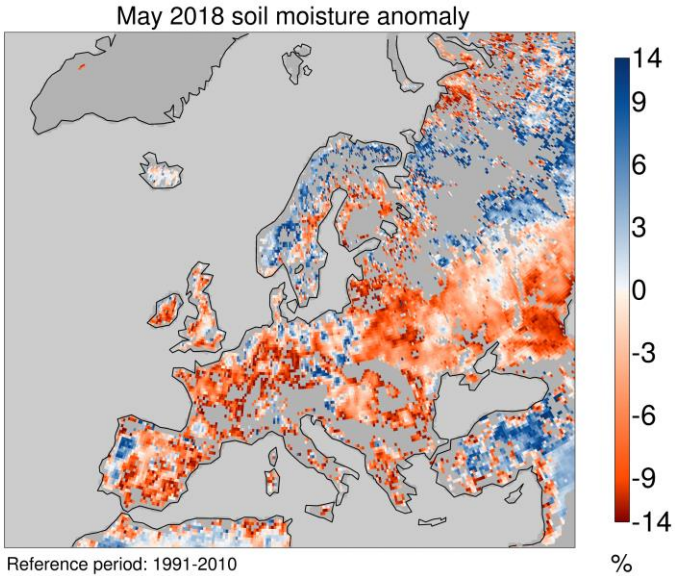
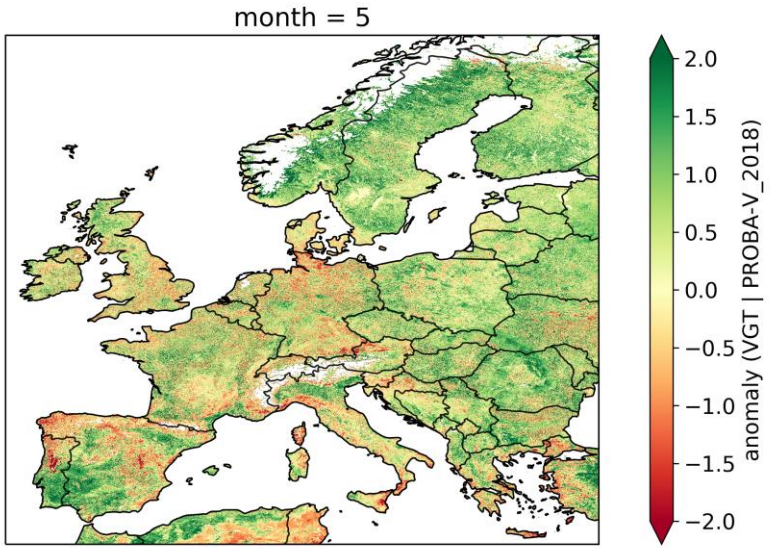
Examples of ECV products

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



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

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



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 ▼

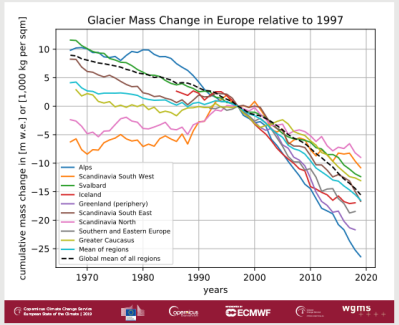
in ice thickness since 1957

In Europe observed

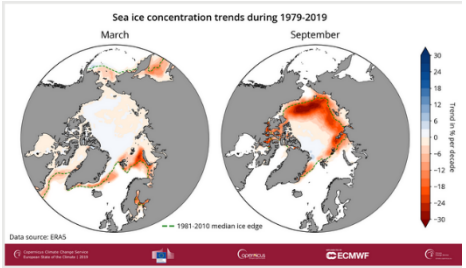
4–35 m loss ▼

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

Reference glacier network with more than 30 years of ongoing observations



Cumulative mass changes in Europe from 1967 to 2019 for glaciers with long-term records in nine different regions. Mass balance values are given in the unit 'metre water equivalent (m w.e.)' relative to 1997. Data source: WGMS (2019, updated). Credit: WGMS /Copernicus Climate Change Service (C3S).



Linear trends in sea ice concentration during 1979-2019 in % per decade for March (left) and September (right). The dashed green line shows the position of the median ice edge during 1981-2010. Data source: ERA5. Credit: Copernicus Climate Change Service (C3S)/ECMWF.

Greenhouse gases

Concentrations of atmospheric carbon dioxide (CO_2) and methane (CH_4) 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.

CO_2 increase by about

0.6% per year ▲

in atmospheric concentrations

CH_4 increase by about

0.4% per year ▲

in atmospheric concentrations

Concentrations (column-averaged mixing ratios) estimated from satellite data for CO_2 and CH_4 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

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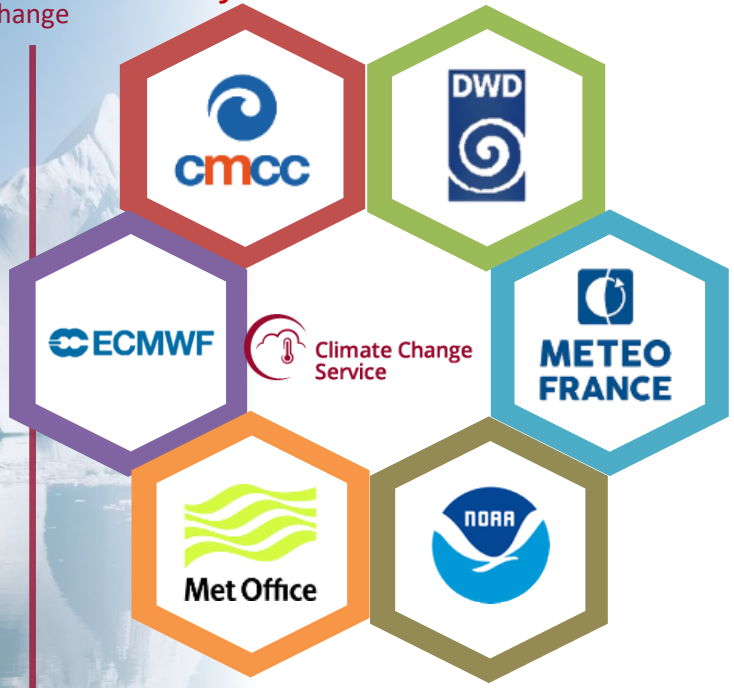
Multi-system seasonal forecast service



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.

Climate projections by GCM and RCM

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Recent developments

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Evaluation and Quality Control (EQC)

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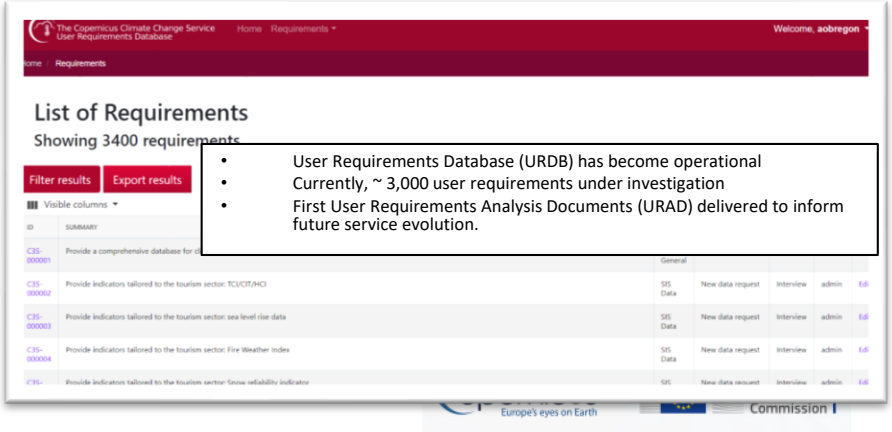
Overview

- 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



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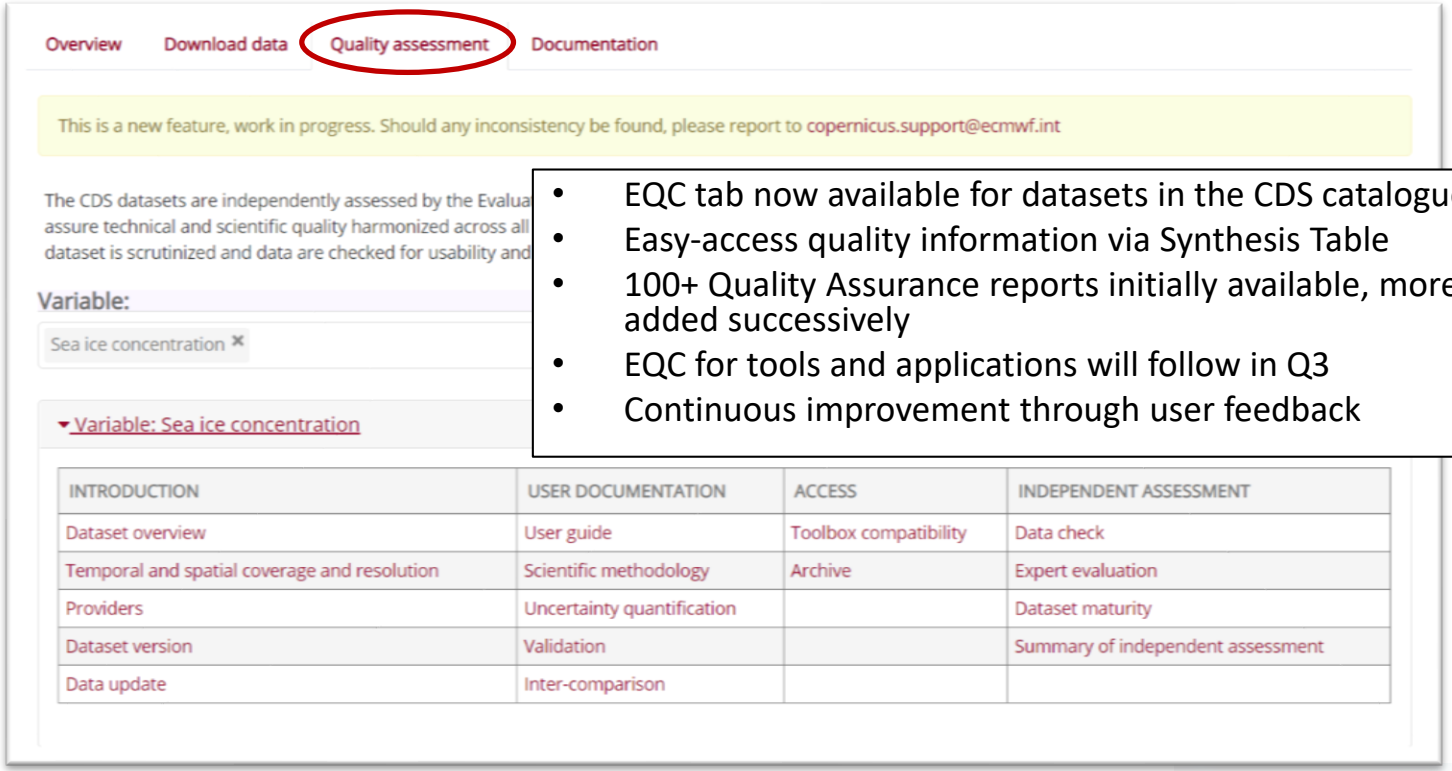
Evaluation and Quality Control (EQC)

EQC function has become operational



- 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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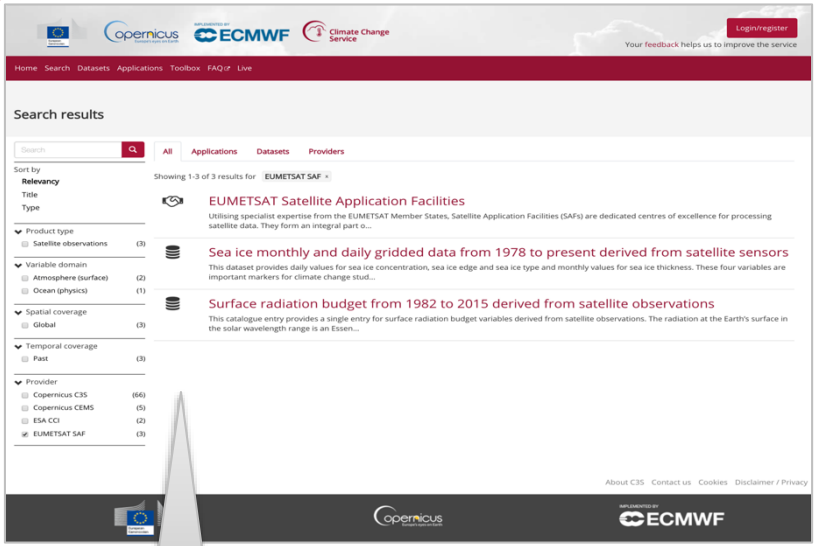
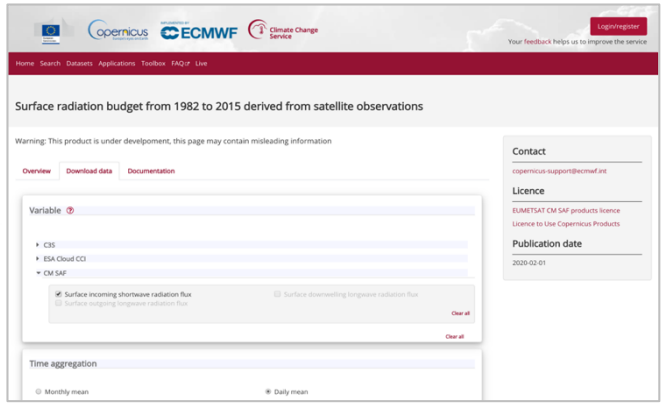
Increased transparency for data providers

Clear ECV access for users

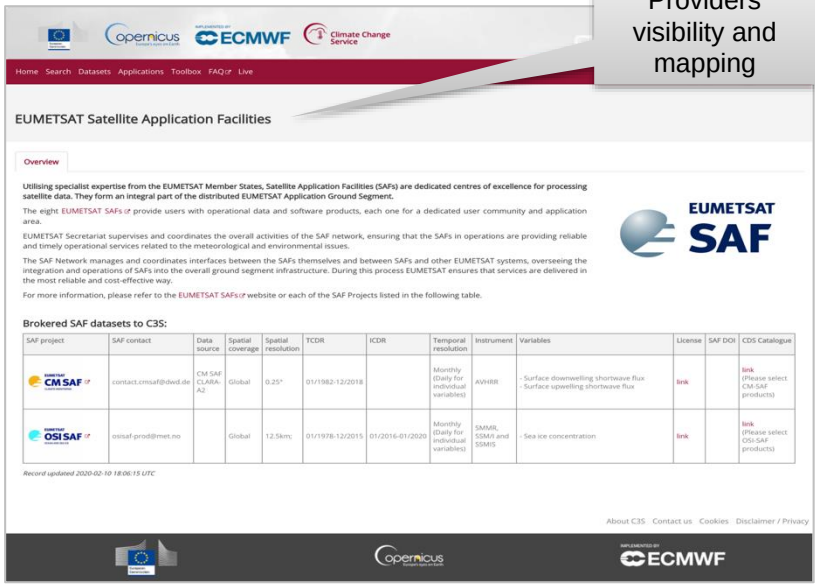


Search per ECV providers



Clear multi-source ECV datasets

Providers visibility and mapping



Increasing toolbox accessibility

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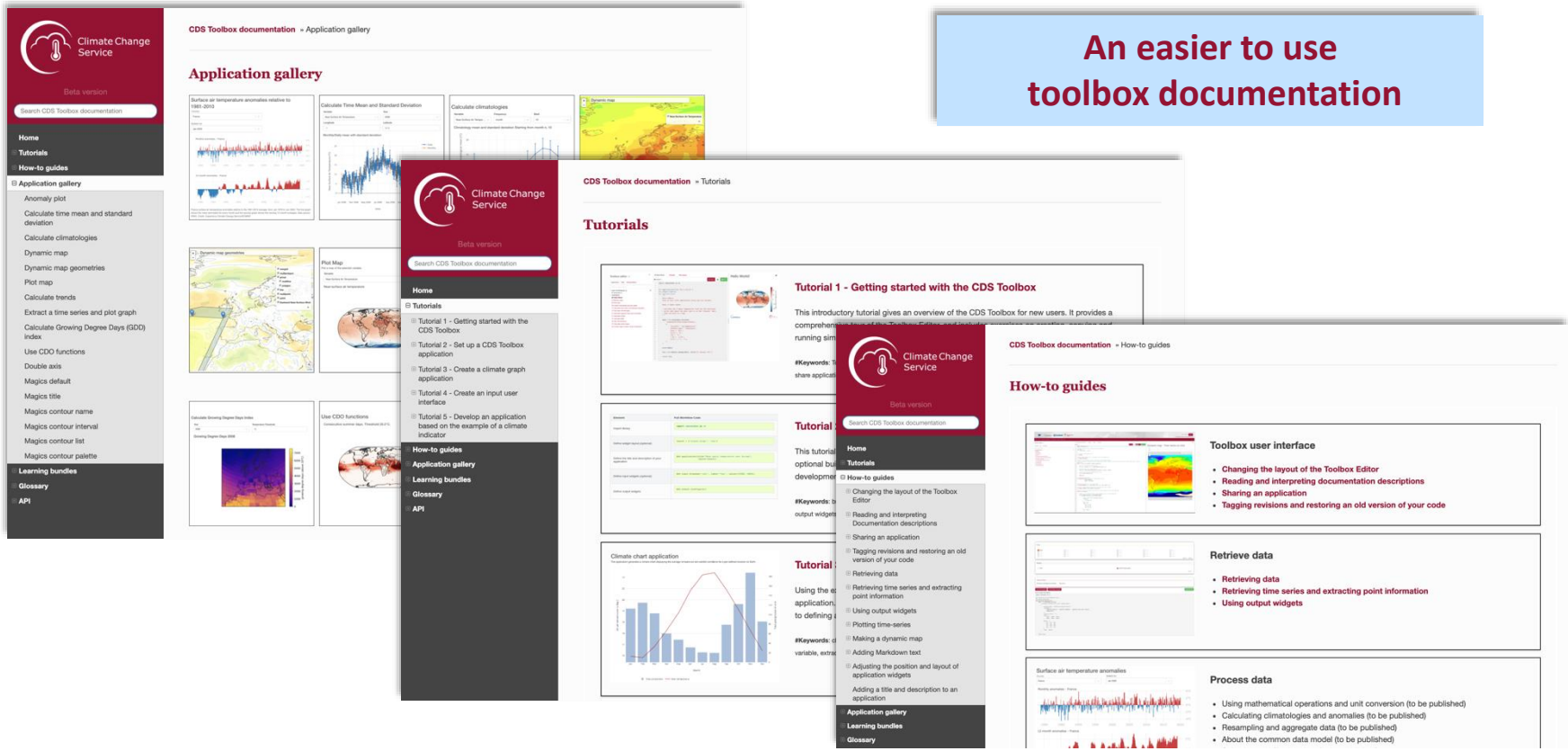
An easier to use toolbox documentation



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

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Evolution

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- 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

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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

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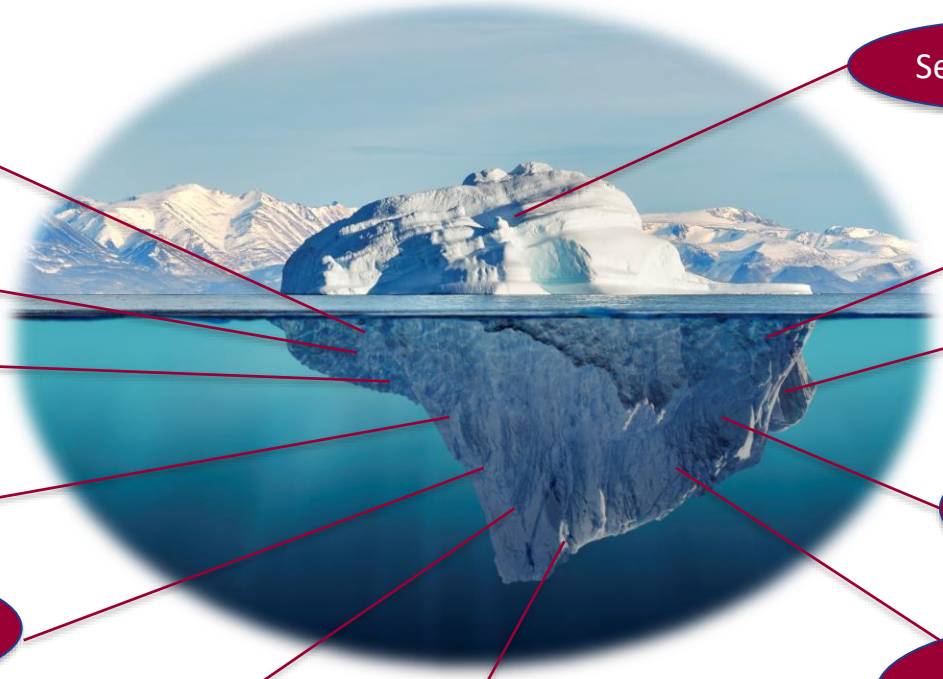
There is much more than you can see...



Forum

User support

Knowledge Base

Workshops, GA

Sectorial Information Systems

User satisfaction monitoring

Toolbox applications

Service Desk

Mailing list

Contractors on support

Collaboration with comm, EQC

Engagement with other teams

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