

C3S: Copernicus Climate Change Service Overview



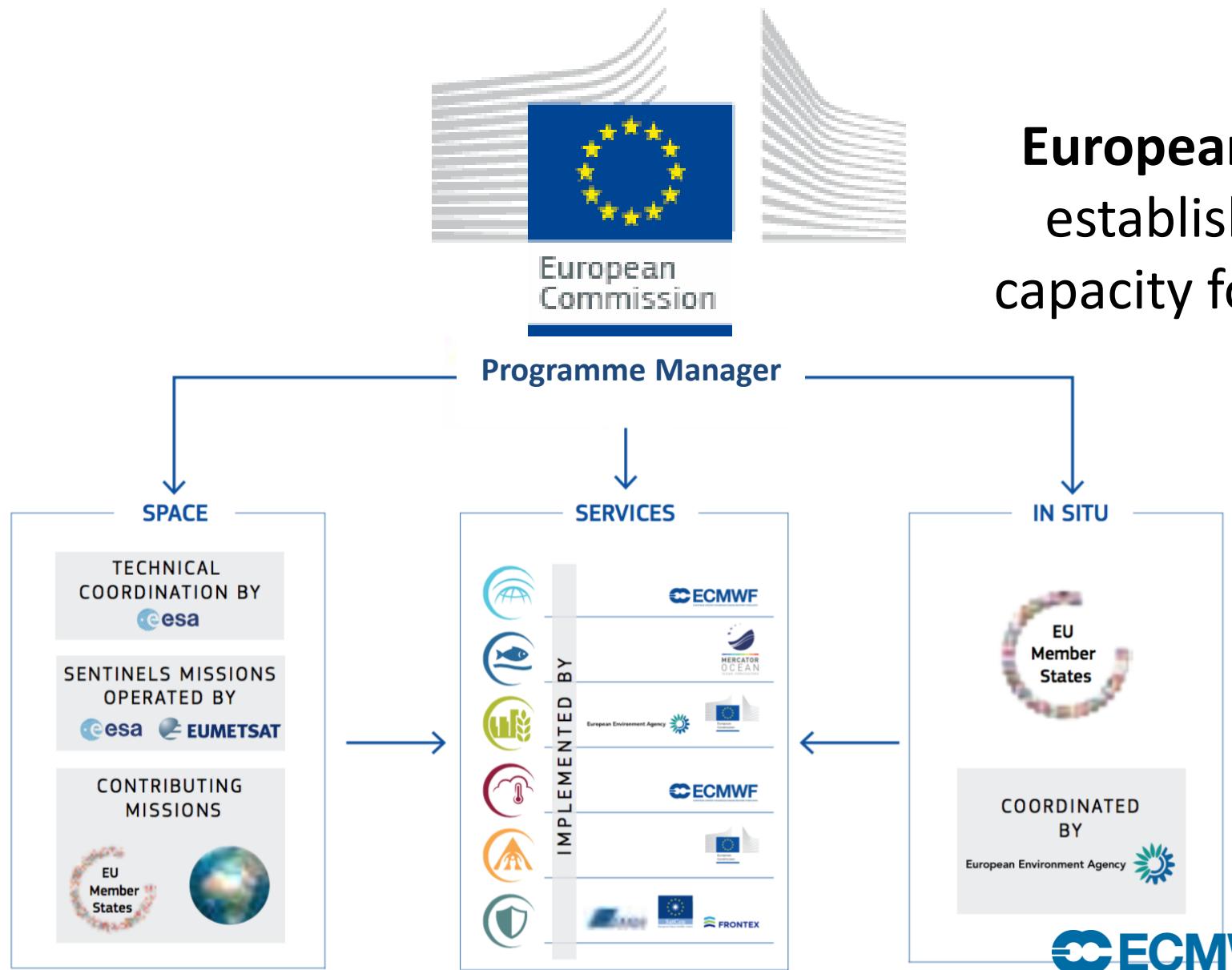
**Kevin Marsh,
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**(With thanks to C. Bergeron, A. Brookshaw,
F. Molteni, C. Buontempo and the rest of
the C3S team)**

**Climate model data for climate services workshop
Reading, UK
9 March 2018**





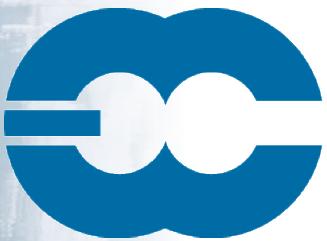
Copernicus is the European Programme for the establishment of a European capacity for Earth Observation



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Copernicus Climate Change Service - C3S

- The European Commission has **entrusted ECMWF** with the implementation of the **Copernicus Climate Change Service – C3S**
- The Copernicus Climate Change service will provide **information** to increase the **knowledge** base to support **adaptation** and **mitigation** policies.

 **ECMWF**



 **ECMWF**

 **Copernicus**
Europe's eyes on Earth

 European
Commission



C3S in a nutshell

Climate
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International
expert panel

Evaluation & Qc Function

Quality assurance
Integrity of Service
User requirements

from European Commission
e.g., FP7 Space call, H2020

from EU Member States, ESA,
EUMETSAT, EEA, WMO..

Outreach & Dissemination

CLIMATE DATA STORE

SECTORAL INFORMATION SYSTEM

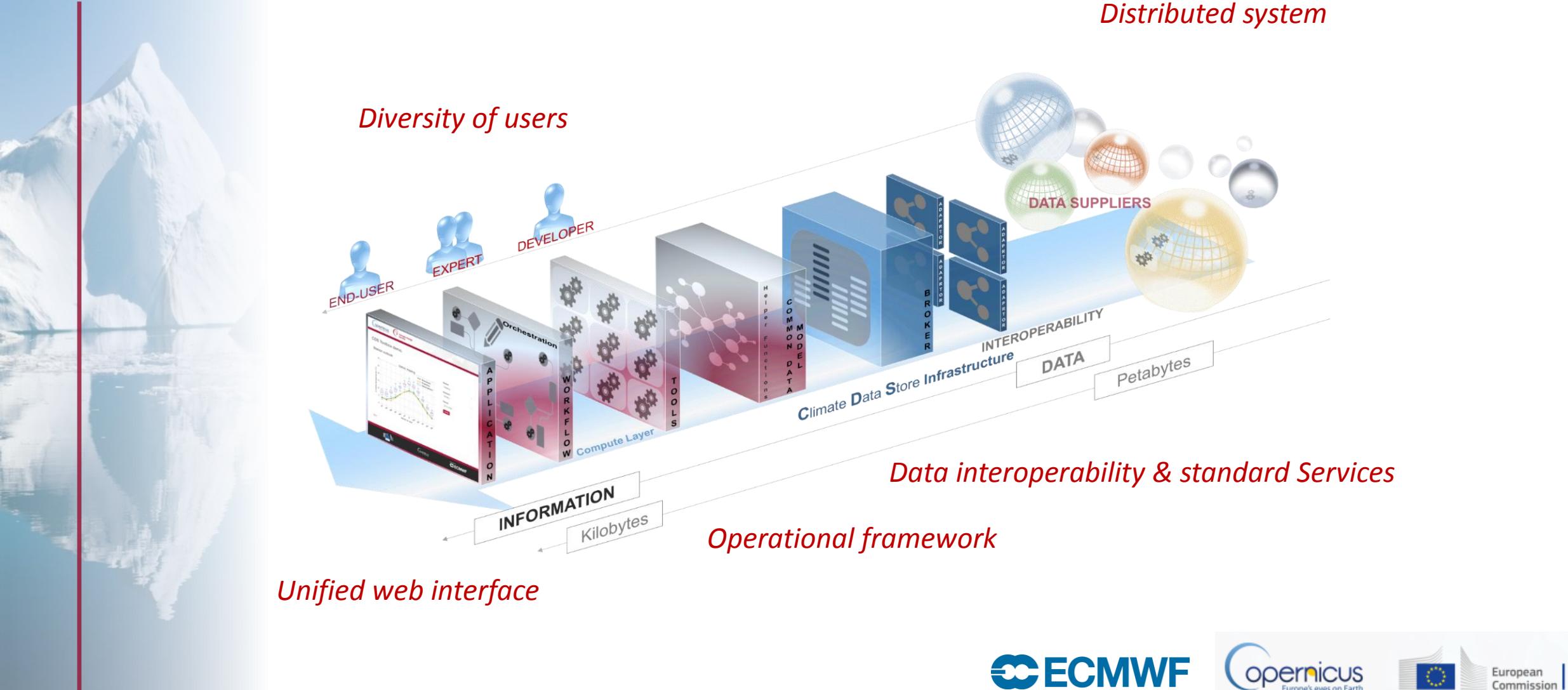


Stakeholders & Users



C D S : Overview

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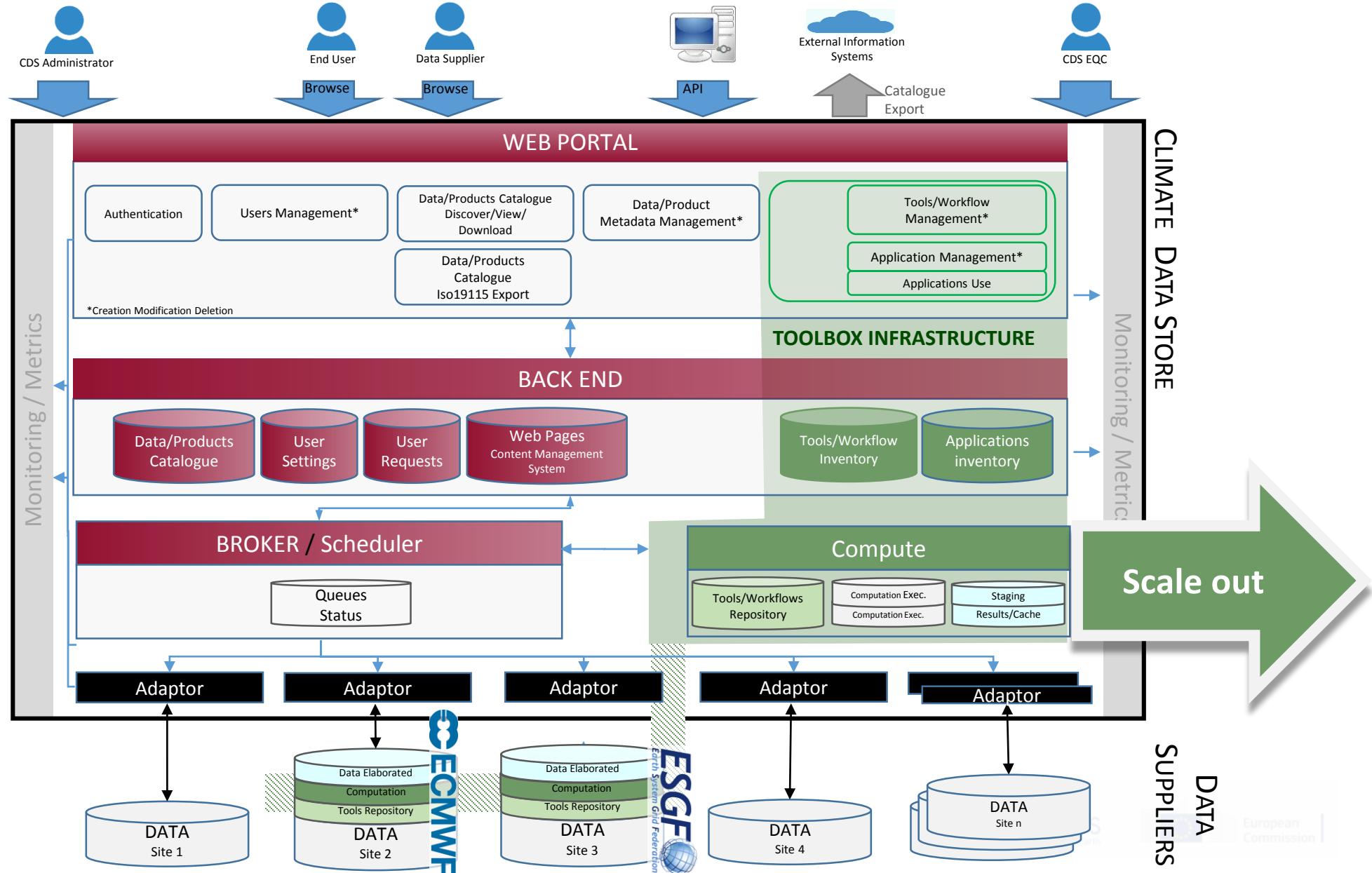




C D S d e s i g n

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- **CDS is “Standards Based”**
- Catalogue contents will be available for ‘harvesting’
- CDS will export INSPIRE compliant ISO records and support standards based data services (w*s) for greater interoperability





C D S – c u r r e n t s t a t u s

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The screenshot shows the homepage of the Copernicus Climate Data Store (CDS). At the top, there are navigation links for Home, Search, Datasets, and Help & support. The main title is "Climate Data Store (CDS)". Below the title, a text box states: "The Copernicus Climate Data Store supports scientists, policy makers and businesses by providing authoritative, quality-assured information about the past, current and future states of the climate in Europe and worldwide." A button labeled "Discover data and resources in our catalogue" is present. Below this is a search bar with fields for "Enter Search Term(s)", "All", and a dropdown menu, followed by a red "Search" button. Three featured data products are displayed: "Access the C3S Climate Reanalysis (ERA5)" with a map of Europe showing temperature anomalies, "Access Sea Ice data products" with an image of sea ice, and "Access Greenhouse Gases data products" with an image of industrial smokestacks. The background of the slide features a large, stylized image of clouds.

The CDS is being populated with various datasets, including **observations**, global and regional **climate reanalyses**, global and regional **climate projections** and **seasonal forecasts**.

The CDS is designed as a **distributed system**, providing improved access to **existing datasets** through a **unified web interface**.



C D S c o n t e n t o v e r v i e w

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Scientific basis for selection:

- Essential Climate Variables as defined by GCOS
- GCOS Status Report and Implementation Plan
- IPCC, CMIP

- Many ITT's issued to procure data – CDS team currently liaising with more than 30 data providers

Observations

Global estimates
of ECVs from
satellite and in-situ
observations

Reprocessed
CDRs, reference
observations

Support for data
rescue, climate
data collections

Climate
reanalysis

Global atmosphere,
ocean, land

Regional
reanalyses for
Europe and
Arctic

*Coupled climate
reanalysis for
100 years**

Model
output

Multi-model seasonal
forecast products

Access to CMIP
data and
products, global
and regional

Reference set of
climate projections
for Europe

Climate Indicators



C D S : s e a r c h a n d b r o w s e

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Search dataset

All Dataset Site

Mediterranean delayed-time sea surface heights and derived variables

This Mediterranean sea dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by ECMWF Copernicus Climate Change Service (C3S) and produced by t...

Global delayed-time sea surface heights and derived variables

This global sea dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by ECMWF Copernicus Climate Change Service (C3S) and produced by the CLS/...

Black sea delayed-time sea level anomalies and derived variables

This Black sea dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by ECMWF Copernicus Climate Change Service (C3S) and produced by the CLS/C...

Southern hemisphere sea ice concentration from satellites for the period 2015 onwards

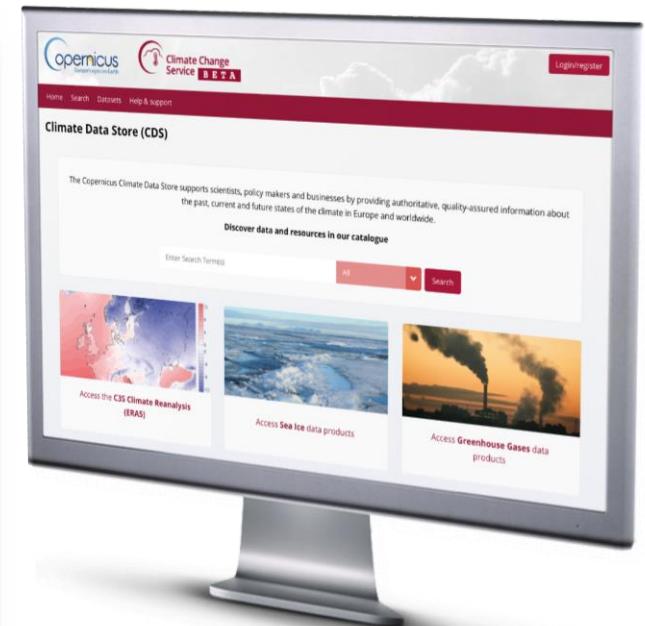
This sea ice concentration dataset is a Level-3 Essential Climate Variable (ECV) product and Interim Climate Data Record (ICDR) produced by EUMETSAT OSI SAF using passive microwave data (PMW) from t...

Northern hemisphere sea ice thickness for the period 2002-2017

The sea ice thickness dataset is a Level-3 Essential Climate Variable (ECV) product and Climate Data Record (CDR) brokered by ECMWF Copernicus Climate Change Service (C3S). The sea ice thickness is ...

Northern hemisphere sea ice edge for the period 1979-2015

This sea ice edge dataset is a Level-2 Essential Climate Variable (ECV) product and Climate Data Record (CDR) brokered by



CMWF

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C D S : d i s c o v e r a n d r e t r i e v e

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SIS: EDgE Gridded indicators of change in annual streamflow

SIS EDgE project: Gridded indicators of change in annual streamflow for 2015 – 2100 for RCP2.6 and RCP8.5 over greater Europe from an ensemble of climate and hydrological models.

[Overview](#) [Download data](#) [Documentation](#) [Interactive map](#)

Climate drivers from 5 Global Climate Models were downscaled to a 5km grid over a greater European domain and used as input to 4 hydrological models to model streamflow from 2011-2100 as part of the End-to-end Demonstrator for improved decision making in the water sector in Europe (EDgE) project . Indicators of change in streamflow were calculated at 5 year intervals over this period (at points from 2030 to 2085), representing the change in mean annual streamflow for the 30-year period centred at these points compared to a baseline period of 1961-1990 (i.e. 2015-2045, 2020-2050, etc). The indicator for a grid cell represents the change in the total streamflow from all upstream grid cells.

Keywords: Streamflow, hydrology, water, climate projection

DATA DESCRIPTION
Gridded indicators of change in annual streamflow for 2015 – 2100 for RCP2.6 and RCP8.5 over greater Europe from an ensemble of climate and hydrological models.

Spatial coverage:	Greater European domain
Temporal coverage:	2015 – 2100
Temporal resolution:	5 year intervals over this period
Data format:	NetCDF
Data type:	GRID

Digital Object Identifier (DOI): <http://doi.org/10.5072/cds.9f10ed25-2802-422a-b603-08ea6d9c839b>

Contact copernicus-support@ecmwf.int

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Related data SIS: SWICCA European River flow (catchments) Climate Impact Indicator

SIS: EDgE Gridded indicators of change in annual streamflow

SIS EDgE project: Gridded indicators of change in annual streamflow for 2015 – 2100 for RCP2.6 and RCP8.5 over greater Europe from an ensemble of climate and hydrological models.

[Overview](#) [Download data](#) [Documentation](#) [Sample application](#)

Global Circulation Model (GCM)

- Global coupled climate-carbon Earth System Model (GFDL's ESM2)
- Hadley Global Environment Model 2 - Earth System (HadGEM2-ES)
- IPSL Earth System Model for the 5th IPCC report - Low resolution (IPSL-CM5A-LR)
- Atmospheric chemistry coupled version of MIROC-ESM earth system model (MIROC-ESM-CHEM)
- Norwegian Earth System Model (NorESM1-M)

Select all Or Clear

Representative Concentration Pathways (RCPs)

- RCP 2.6
- RCP 8.5

Select all Or Clear

Hydromodel

- Grid-based global hydrology and water resources model (PCRGLOBWB)
- Large-scale, semi-distributed hydrologic model (VIC)
- Noah-Multiparameterization Land Surface Model (noah-mp)
- Mesoscale hydrologic model (rHM)

Select all Or Clear

Combiner format

- Zip archive (.zip)
- Compressed tar file (.tar.gz)

Terms of use

Climate Indicators Example

Search Results

mean delayed-time sea surface heights and derived variables dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by Copernicus Climate Change Service (C3S) and produced by the CLS...

delayed-time sea level anomalies and derived variables dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by Copernicus Climate Change Service (C3S) and produced by the CLS...

hemisphere sea ice concentration from satellites for the period 2015 dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by EUMETSAT OSI SAF using passive microwave data (PMW) from L...

hemisphere sea ice thickness for the period 2002-2017

+ APIs



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C D S : user requests and download

The screenshot shows the 'Your requests' section of the CDS. At the top, there are filters: All, Queued, In progress, Failed, Unavailable, Complete (which is selected). A red 'Delete selected' button is located at the top right. Below the filters, a message says 'Auto refreshed : 15:17:55'. The main table lists five requests:

Product	Submission date	End date	Duration	Size	Status	Action
Greenhouse gases: Methane	2017-11-30 11:34:42	2017-11-30 11:40:56	0:06:14	206.4 MB	Download	<input type="checkbox"/>
Surface soil Moisture	2017-11-30 11:29:02	2017-11-30 11:29:03	0:00:00	968.7 KB	Download	<input type="checkbox"/>
SIS: Gridded indicators of change in annual streamflow	2017-11-22 11:04:53	2017-11-22 11:05:01	0:00:07	61.7 MB	Download	<input type="checkbox"/>
Global glaciers elevation changes and mass balance	2017-11-22 10:59:54	2017-11-22 10:59:54	0:00:00	145.8 KB	Download	<input type="checkbox"/>
Global glaciers elevation changes and mass balance	2017-11-21 15:53:07	2017-11-21 15:53:09	0:00:02	145.8 KB	Download	<input type="checkbox"/>

The screenshot shows the 'Overview' tab of a dataset page. The title is 'Mediterranean delayed-time sea surface heights and derived variables'. The page includes sections for Overview, Download data (selected), Validation and verification, Documentation, Sample application, Contact, License, and Related data.

Overview

- Date interval: Start 1993-01-01, End 2017-01-06
- Variables:
 - Absolute dynamic topography and related variables
- Terms of use:
 - Use of each dataset is governed by the terms of use for each one.
 - Accept the terms of use
 - View terms

Contact: copernicus-support@ecmwf.net

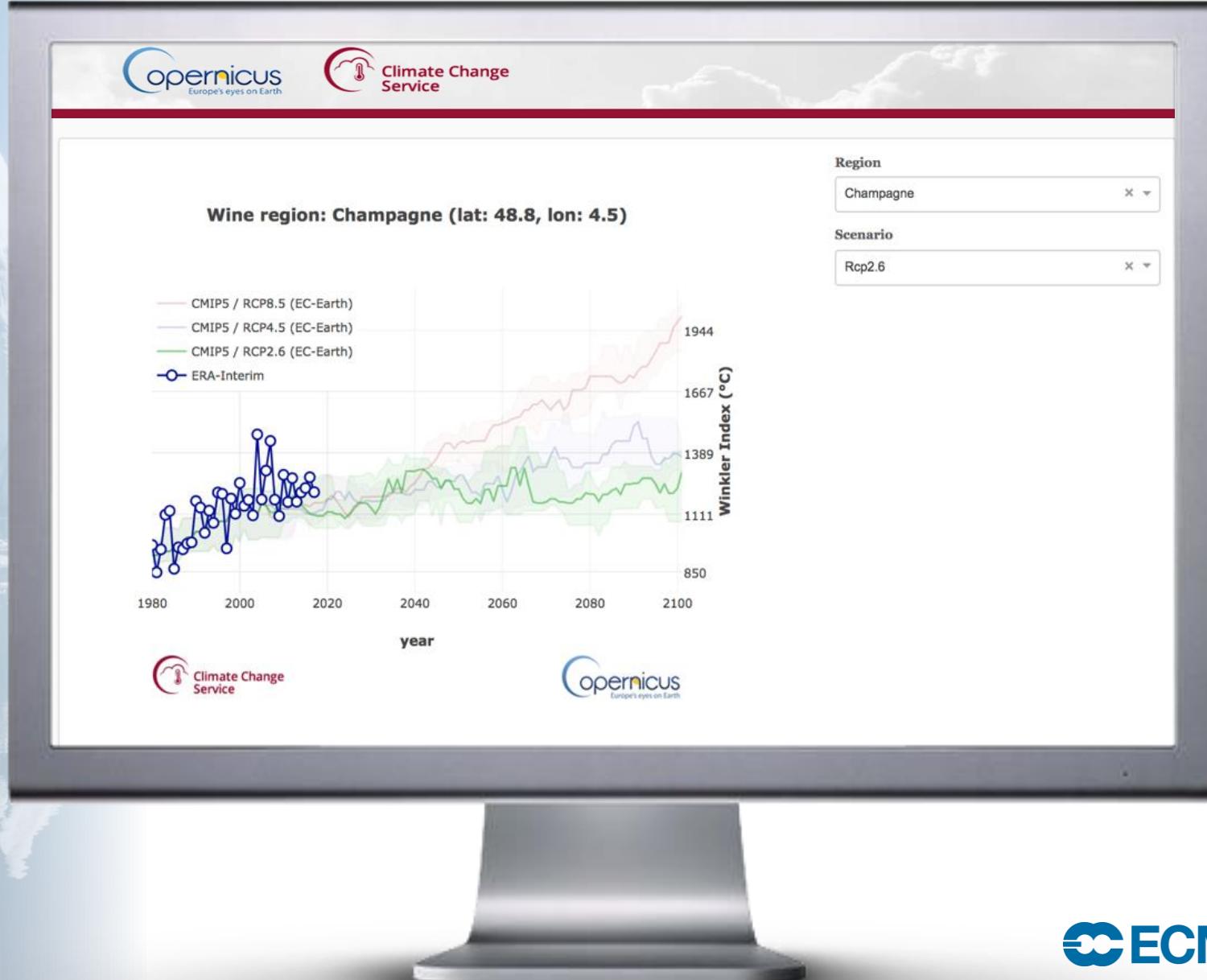
License: Licence to use Copernicus products

Related data: Black sea delayed-time sea level anomalies and derived variables



C D S : t o o l b o x

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Toolbox:

- The CDS provides an **authoritative set of software** allowing users to **develop applications** that make use of the content of the CDS
- Utilises a Common Data Model (CDM)



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C D S : t o o l b o x

Toolbox Editor

Applications Data Documentation

+ - demo

- Wine Regions
- Station Outlook
- Seasonal Outlook
- Infrastructure Planning
- Forecast Evaluation
- Download

+ - examples

- 01 Retrieve Download
- 02 Plot 2D
- 03 Plot 1D
- 04 Plot Location
- 05 Retrieve and Plot
- 05a Retrieve ERAS Daily
- 05b Retrieve ERAS Moda
- 05c Retrieve CDR
- 05d Retrieve ICOR
- 11 Mean Standard Deviation
- 12 Climatology
- 21 Anomaly
- 22 Anomaly Time Reference
- 23 Anomaly Climatology Reference
- 31 Trends
- 41 Regrid
- 51 Indices GDD
- 52 Indices CSU

Wine Regions Console

```

1 from typing import List, Tuple
2
3 import cartopy.crs as ccrs
4 from matplotlib import colors
5 import numpy as np
6 import xarray as xr
7
8 import c3s.tools as ct
9 from c3s.tools import matplotlib as mplt
10 from c3s.tools import plotly as plt
11
12 #
13 # Winkler index parameters
14
15 WINKLER_BOUNDARIES = [850., 1111., 1389., 1667., 1944., 2222., 2700.]
16 WINKLER_COLORS = [
17     '#5259a2',
18     '#769199', '#cfb04b', # Region 1 a/b
19     '#be7736',
20     '#924136',
21     '#c16d89',
22     '#dcad22', '#b498ba', # Region 5
23     '#988e95',
24 ]
25 WINKLER_CHAP = colors.LinearSegmentedColormap.from_list('winkler', WINKLER_COLORS)
26 WINKLER_PARAMS = {
27     'tan_min_celsius': 10., # °C
28     'dayofyear_start': 91, # 1st of April
29     'dayofyear_stop': 304, # 31st of October
30 }
31
32 #
33 # Processing parameters
34 #
35 CALIBRATION_INTERVAL = ('1979-01-01', '2005-12-31')
36 EUROPE_EXTENT = (-11., 34., 31., 60.)

```

Wine Regions (build: 4d2037c6143c3591978f23054a30f60a25eb3c74)

Show debug

Region: Champagne

Scenario: Rcp2.6

Winkler regions for ERA-Interim 1979-1986

2700
2222
1944
1667
1389
1111
850

growing degree days (above 10°C) (°C)

Copernicus Europe's eyes on Earth Climate Change Service



Application creation Functions

ECMWF

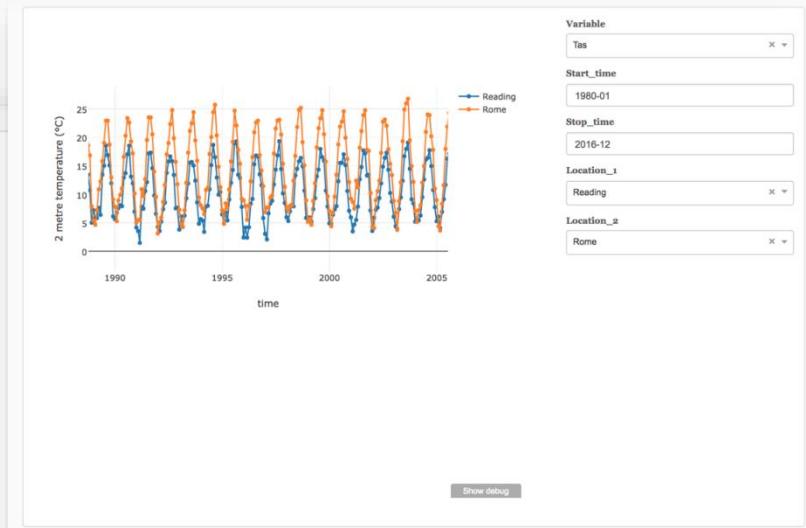
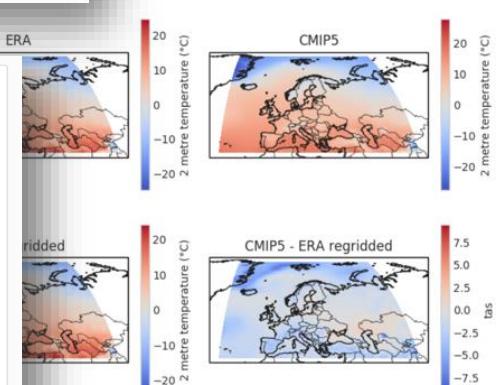
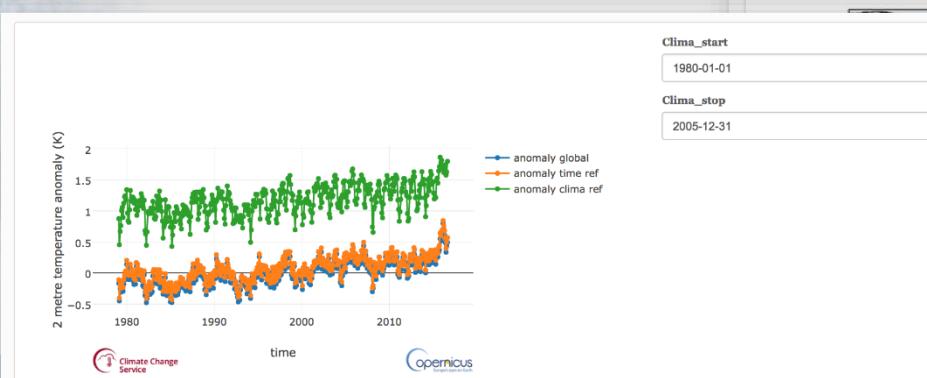
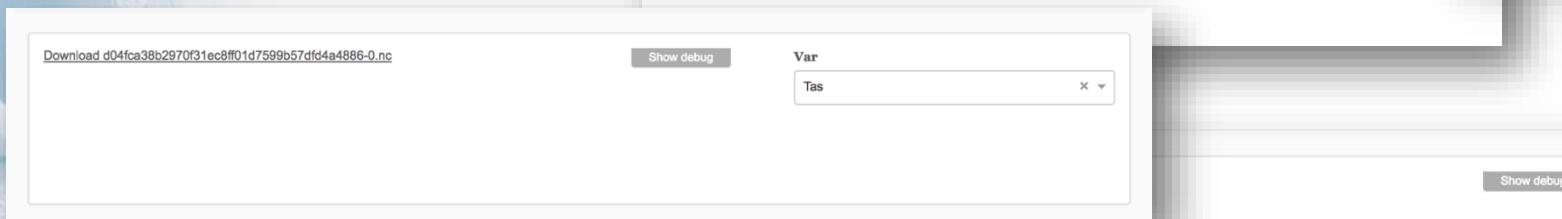
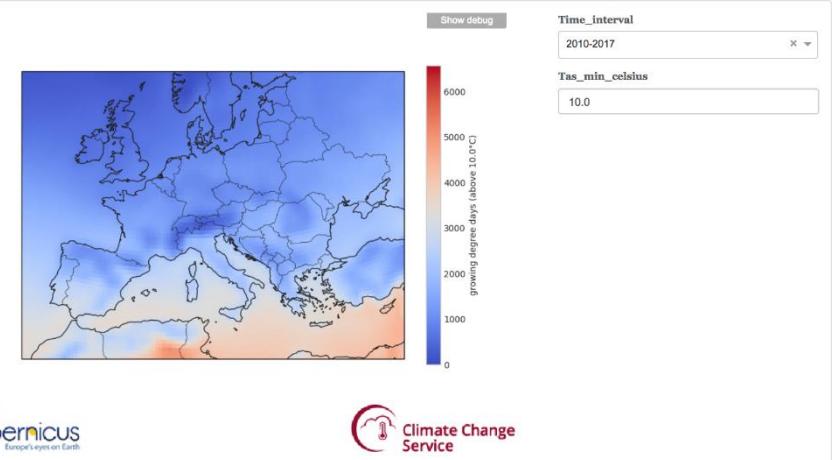
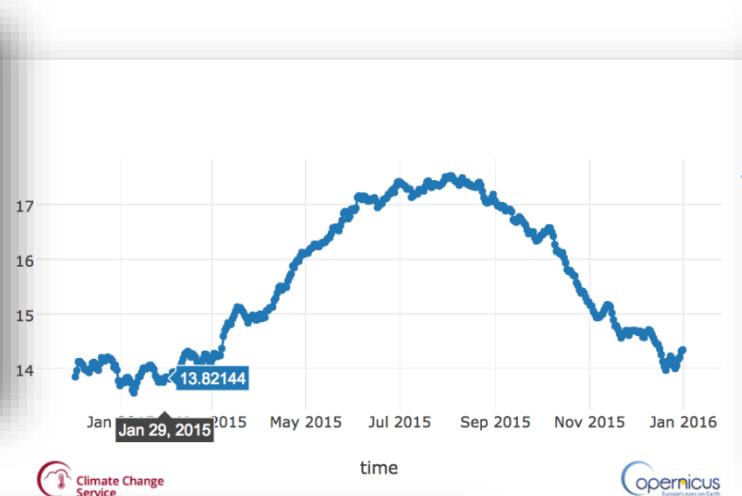
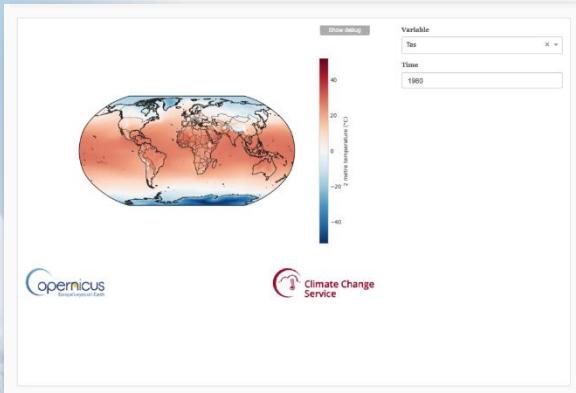
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C D S : t o o l b o x e x a m p l e o u t p u t

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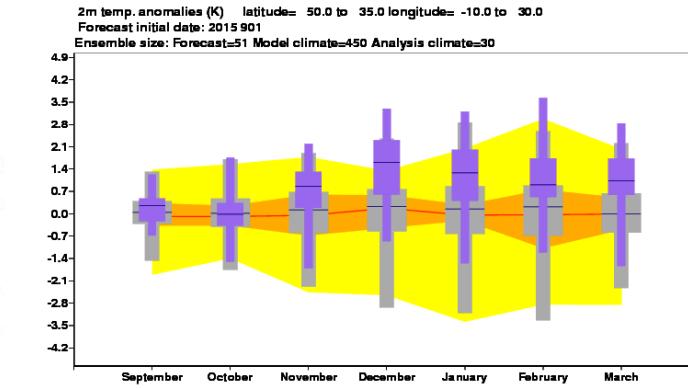
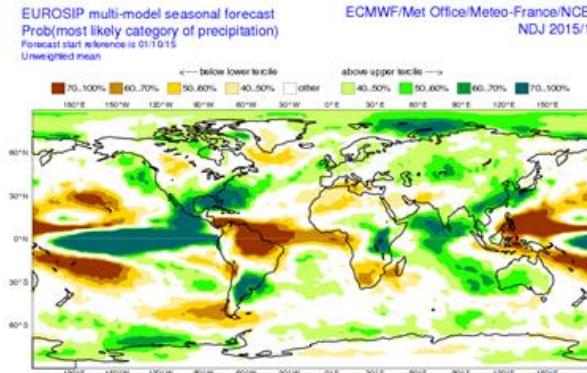
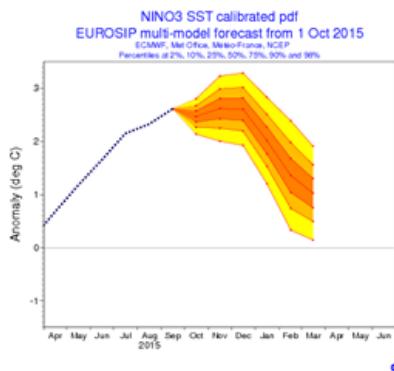
C3S seasonal forecasts service

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The service is based on a **multi-system** framework (ensembles, **coupled climate models** from ECMWF, Met Office, Météo France, CMCC, DWD) .

Products (graphics and data) will be publicly available, to an operational schedule.

- Products are also developed, in collaboration, for the C3S Sectoral Information System demonstrators.
- “Raw” data: Set of atmosphere & ocean variables, 1x1 degree grid, at daily or sub-daily resolution, from 6-month forecasts.



Defined C3S netCDF convention for raw data (based on CF, SPECS) to meet the needs of seasonal forecast data
No standards yet for processed products

Evaluation and quality control (EQC) function for seasonal forecast products; includes:

- assessment of *user needs* and the degree to which the product portfolio addresses them
- recommendations for *bridging identified gaps*
- *prototype* for on-demand user evaluation of seasonal information.



Global projection service (C3S 34a)

- **Lot 1: Support to one Earth System Grid Federation node in Europe (CP4CDS:** lead contractor: STFC (UK), start 1 Oct. 2016, **end Dec. 2019**)
- **Lot 2: Multi-model product generation (MAGIC:** lead contractor: KNMI, start 1 Oct. 2016, **end Mar 2019**)
- **Lot 3: Roadmap towards a reference set of climate projections for Europe (CRECP;** lead contractor: UKMO, start 1 Sep. 2016, **end Nov. 2018**)

Regional projection service (C3S 34b)

- **Lot 1: CORDEX for the Copernicus Data Store (CORDEX4CDS;** lead contractor: CNRS (France), start 1 May 2017, **end Apr 2021**) :
- **Lot 2: Producing regional climate projections leading to European services (PRINCIPLES;** lead contractor: SMHI (Sweden), start 1 May 2017, **end Apr 2021**)

Evaluation and quality control for climate projection services

- **C3S 51 Lot 4: Data evaluation for climate models (DECM:** lead contractor: FMI, start 1 Aug. 2016, **end Oct. 2018).**



CDS : climate projection datasets

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File Edit View History Bookmarks Tools Help

Search results https://cds-test.climate.copernicus.eu/#!/search?text=cmip5 90% C Search Kevin Marsh Logout

Copernicus Europe's eyes on Earth Climate Change Service B E T A

Home Search Datasets Applications Your requests Help & support

Search results

cmip5 All Datasets

Sort by Relevancy

Title Type

Product type Spatial coverage Temporal coverage

Showing 1-3 of 3 results for cmip5

CP4CDS: HadCM3 model output prepared for CMIP5 RCP4.5

HadCM3 model output prepared for CMIP5 RCP4.5

CP4CDS: CanESM2 model output

CanESM2 model output prepared for CMIP5 pre-industrial control.

CP4CDS: FGOALS-s2 model output

FGOALS-s2 model output prepared for CMIP5 pre-industrial control.

About C3S Contact us

- Configuring the CDS to serve climate projection datasets

File Edit View History Bookmarks Tools Help

CP4CDS: FGOALS-s2 model output prepared for CMIP5 pre-industrial control. https://cds-test.climate.copernicus.eu/cdsapp/admin#/dataset/cp4cds-fgoals-s2-model-output-prepared-for-cmip5-pre-industrial-control 90% C Search Kevin Marsh Logout

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CP4CDS: FGOALS-s2 model output prepared for CMIP5 pre-industrial control.

Flexible Global Ocean-Atmosphere-Land System model, Spectral Version 2 (FGOALS-s2) prepared for CMIP5 pre-industrial control.

Overview Download data Metadata

Tentative abstract taken from: Bao, Q., Lin, P., Zhou, T. et al. *Adv. Atmos. Sci.* (2013) 30: 561 DOI: <https://link.springer.com/article/10.1007/s00376-012-2113-9#citeas>

The Flexible Global Ocean-Atmosphere-Land System model, Spectral Version 2 (FGOALS-s2) was used to simulate realistic climates and to study anthropogenic influences on climate change. Specifically, the FGOALS-s2 was integrated with Coupled Model Intercomparison Project Phase 5 (CMIP5) to conduct coordinated experiments that will provide valuable scientific information to climate research communities. The performances of FGOALS-s2 were assessed in simulating major climate phenomena, and documented both the strengths and weaknesses of the model. The results indicate that FGOALS-s2 successfully overcomes climate drift, and realistically models global and regional climate characteristics, including SST, atmospheric circulation. In particular, the model accurately

License

Freely available

Related data

CP4CDS: HadCM3 model output prepared for CMIP5 RCP4.5

Winter (December - February)

Summer (June - August)



What do users gain from C3S?

- Improved **ease of access** to climate projection data through the CDS;
- **Products** computed from models which show good fidelity in the simulation of climate during the recent decades (as quantified by appropriate metrics);
- Improved estimates of **uncertainties** allowed by focusing on models that provide ensemble simulations of individual scenarios;
- User defined indices and products **tailored** to specific application sectors;
- **Quality and usability** of products tested by an Evaluation and Quality Control consortium.

-Adding value to existing datasets for climate services



*The goal is to provide **practical examples** of how C3S in general and CDS in particular could deliver **information of relevance** to specific sectors.*

Proof of
concept

- **Previous work (2016-2018):**

- energy (UEA, CEA), water (CEH,SMHI), insurance (CGI), *cities (SMHI), agriculture (TelespazioVega)*

Operational
phase

- **Current work(2018-2019,...):**

- European: storm-surges (Deltares), fisheries (PML), tourism (TEC), cities/health (Vito)
 - Global: shipping (OSM), global impacts (SMHI), agriculture (WEnR)

- **Future work :**

- in negotiation: energy, water, insurance
 - quality assurance for SIS, biodiversity, forestry, cultural heritage, case studies, transport, ...



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SIS : proof of concept - example



Carlo Buontempo Logout

Home Search Datasets Applications Your requests Help & support

SIS SWICCA: Water Quantity

Water quantity indicators: Flood recurrences, flow duration curve, river flow, snow water equivalent, soil water content, runoff, wetness.

[Overview](#) [Download data](#) [Documentation](#)

Copernicus SWICCA Sectoral Information System (SIS) offers readily available climate-impact data to speed up the workflow in climate-change adaptation of water management across Europe.

Available **water quantity indicators** are:

- **Flood recurrences** are given as daily river flows that correspond to return periods of 2, 5, 10, 50, and 100 years. The return period values are calculated using a Gumbel distribution fitted to the yearly maximum river flows for a given 30-year period. For the reference period (1971-2000) the absolute values are given, while for the future periods the relative changes are provided.
- **Flow duration curve (FDC)** gives information about how frequently certain river flow rates occur. The FDC is described through 13 percentiles of the distribution of daily river flows during a 30-year period: 1%, 5%, 10% to 90% in steps of 10%, 95%, 99 %. In case of the FDC for the full period, it is based on all daily data for a 30-year period. In the case of FDC's seasonality, it is based on all daily data for a 30-year period that belong to the same month, evaluated for all 12 months of a year (i.e. all



Contact

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Related data

[SIS Agriclass: Specialized indicators](#)

[SIS: EDgE Gridded indicators of change in annual streamflow](#)

[SIS SWICCA: Water Quality](#)

[SIS SWICCA: Precipitation](#)

[SIS SWICCA: Air](#)

[SIS SWICCA: Socio-economic](#)



Aiming for the CDS version 1.0 (Beta) to be released during Q2 2018

The screenshot shows the Copernicus Climate Change Service website. At the top, there are logos for Copernicus (Europe's eyes on Earth) and Climate Change Service, along with social media icons and search bars. Below the header is a large banner with three images: a sunset over mountains, a port with shipping containers, and a coastal area. The banner text reads "CLIMATE INFORMATION FOR YOUR PLANNING". The main content area is divided into sections: "IN FOCUS" (Users shaping new Climate Data Store), "MONTHLY MAPS & CHARTS" (Monthly maps and charts of essential climate variables), and "NEWS" (articles from 19 Dec 2017, 18 Dec 2017, and 13 Dec 2017). At the bottom are "READ MORE" and "ARCHIVE" buttons.

climate.copernicus.eu

Thank you
for your attention