



Climate Change

Climate Change Service

CDS, toolbox and the operational seasonal impact predictions

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With contributions from Jean-Noël Thepaut, Dick Dee, Anca Brookshaw,
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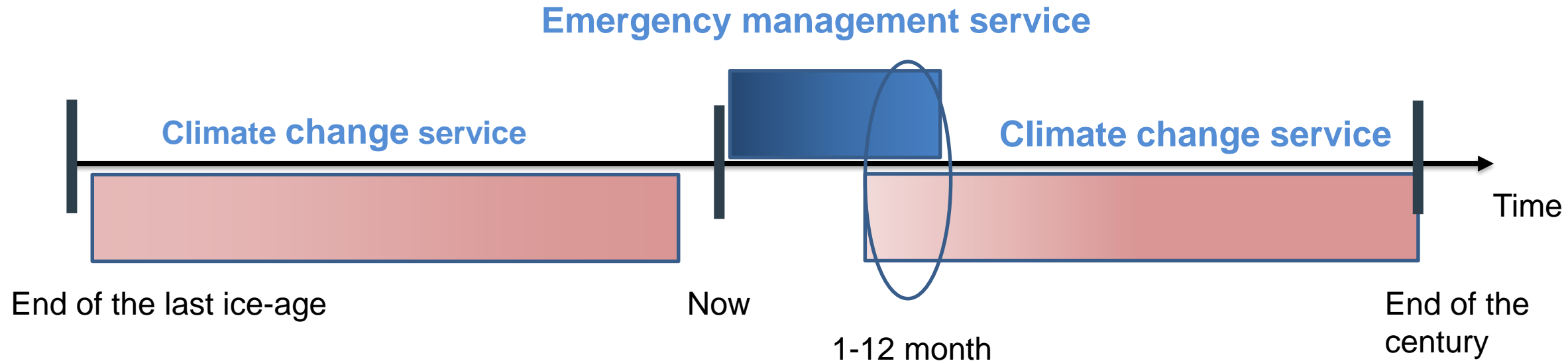
European
Commission





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Climate and emergencies

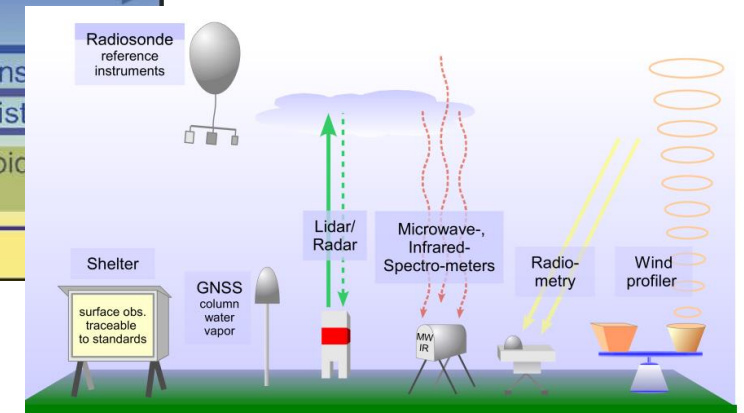
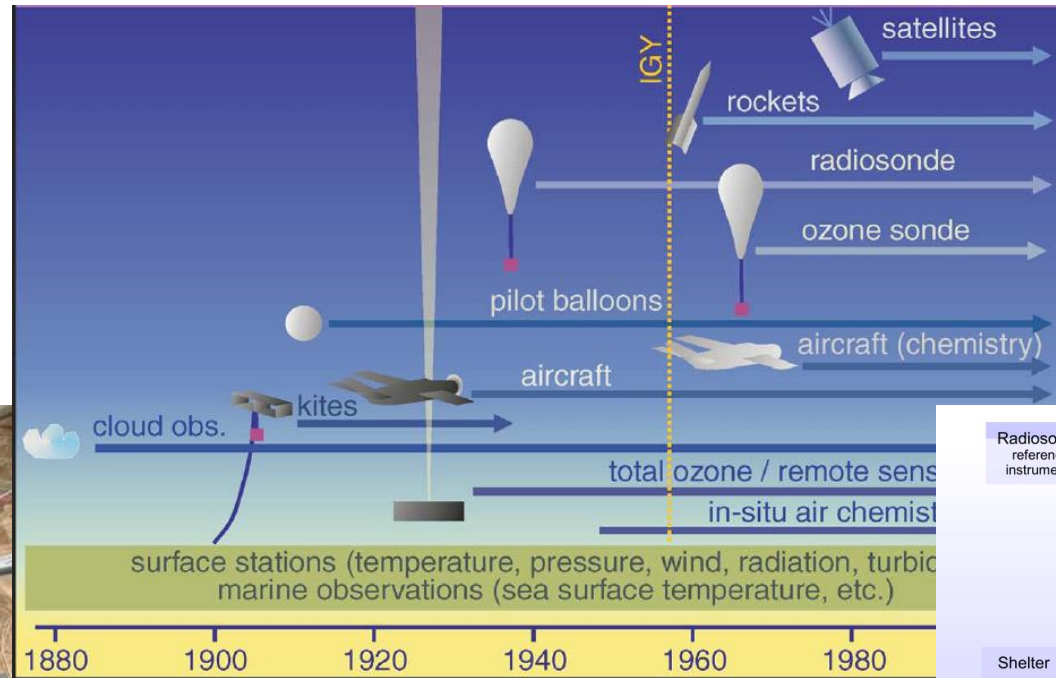
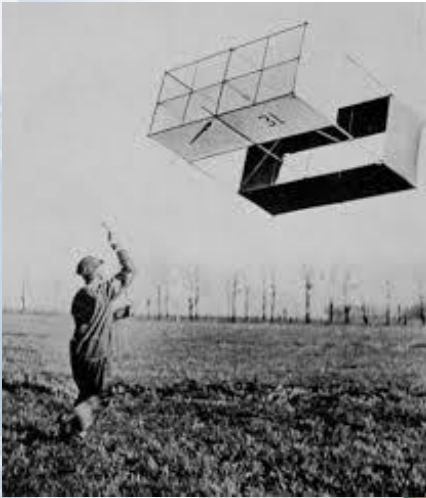




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In situ observations

Service: Providing users with full access to the *in situ* instrumental data record, in usable form





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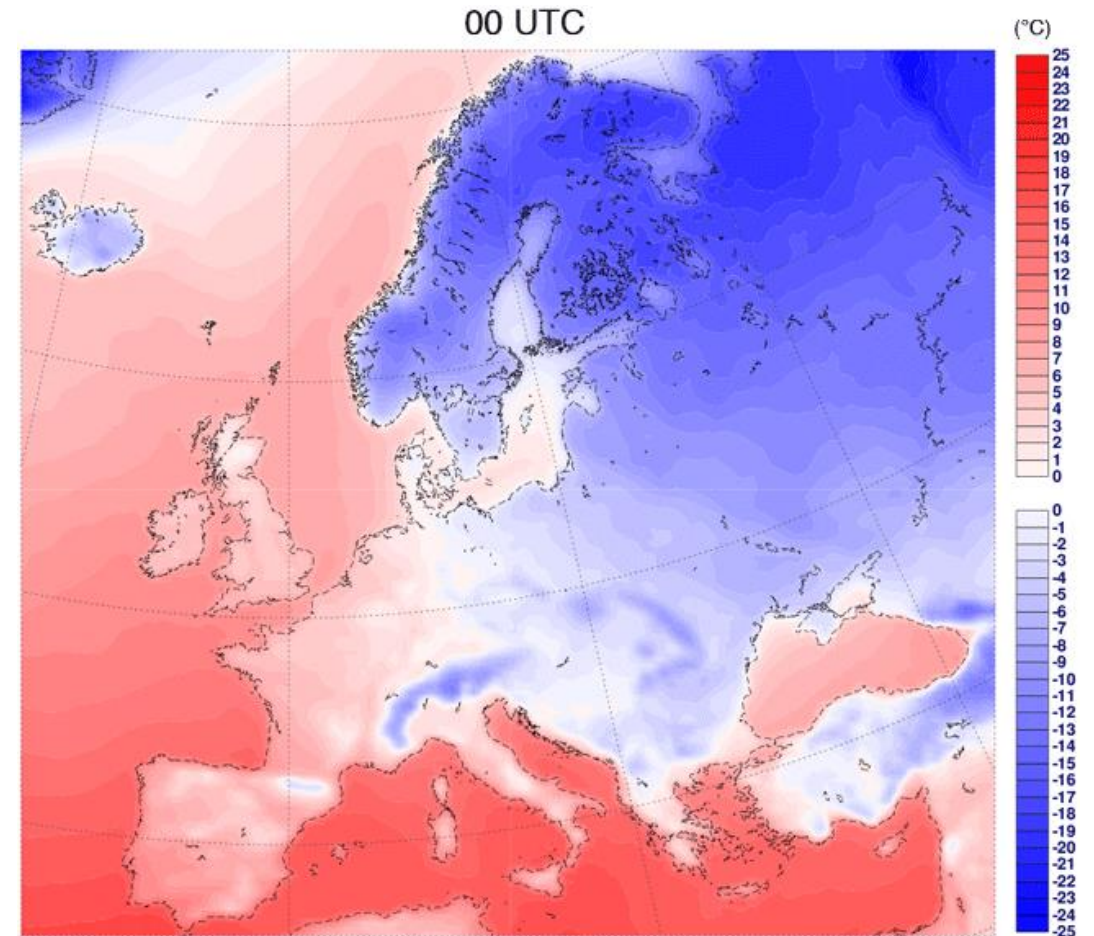
Climate reanalysis: ERA5

- Atmosphere/land/wave parameters
- 31 km global resolution, 137 levels
- Hourly output from 1979 onward

- Using 2016 ECMWF forecast system
- Using improved input observations
- Ensemble data assimilation method
- Uncertainty estimates for all ECVs

Data release plan:

Nov 2017	Test data (Jan-Feb 2016)
Dec 2017	Hourly data from 2010 - 2016
Jun 2018	Daily updates at short delay
Oct 2018	Complete from 1979 onward

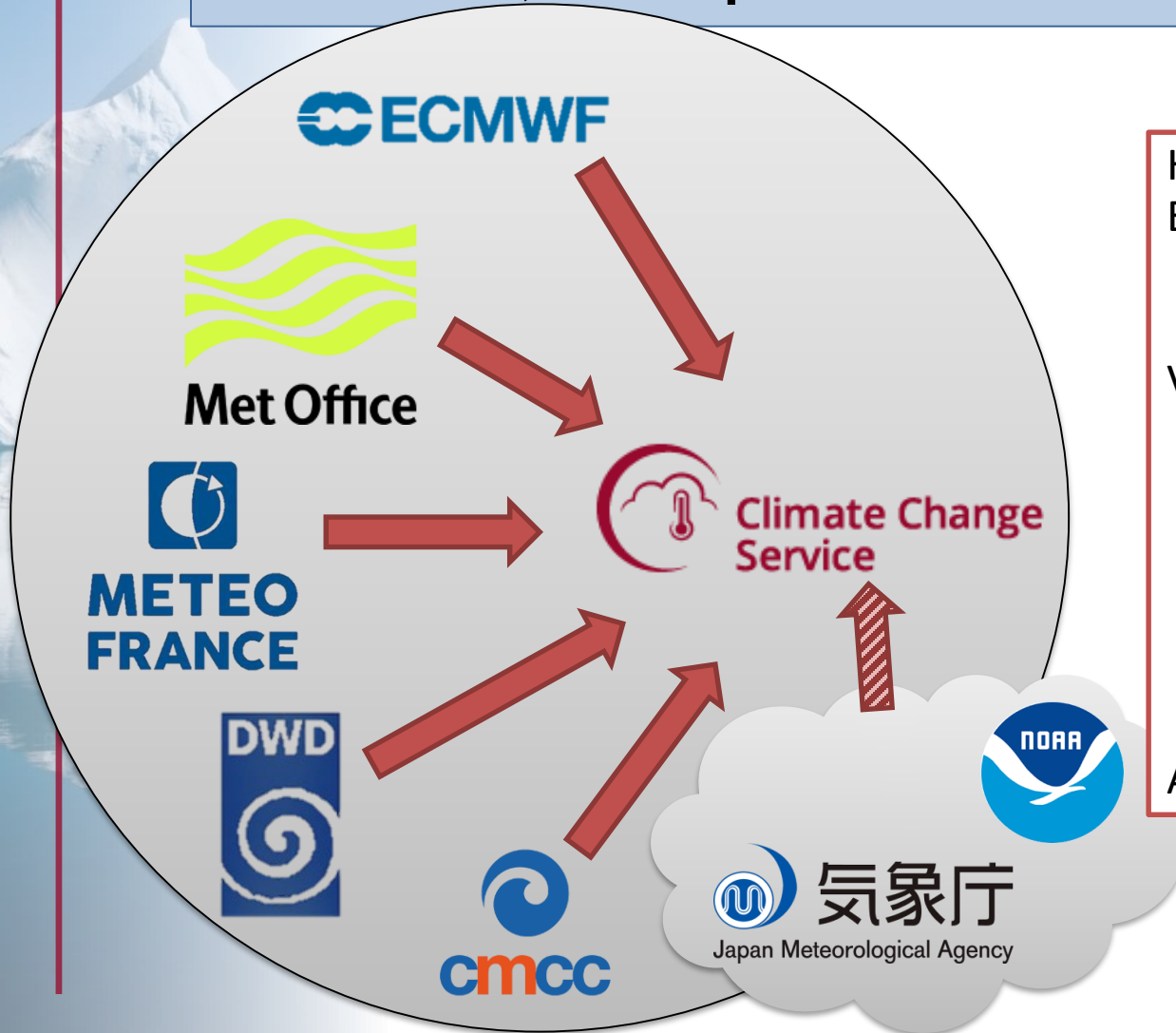




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C3S seasonal forecasts - Introduction

Aim: to generate **seasonal forecast** products based on the **best information available**, to an **operational schedule**, and make them **publicly available**.



Horizontal grid: global 1deg x 1deg

Ensemble size:

- Forecasts: ~50 members
- Hindcasts: ~25 members x 24 years (1993-2016)

Variables

- Surface
 - 7 vars every 6h
 - +30 vars every 24h
- Pressure (11 levels, from 925 hPa to 10 hPa)
 - 8 vars every 12 h

Agreed NetCDF specification C3S-0.1 (based on CF)

IMPLEMENTED BY





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Climate Data Store – CDS

The screenshot shows the Copernicus Climate Data Store (CDS) website. At the top left is the Copernicus logo with the tagline "Europe's eyes on Earth". Next to it is the "Climate Change Service BETA" logo. A "Login/register" button is in the top right. A navigation bar contains "Home", "Search", "Datasets", and "Help & support". The main heading is "Climate Data Store (CDS)". Below this is a descriptive paragraph: "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 call to action says "Discover data and resources in our catalogue". A search bar is present with the placeholder "Enter Search Term(s)", a dropdown menu set to "All", and a "Search" button. Three data product cards are displayed: "Access the C3S Climate Reanalysis (ERA5)" with a temperature map, "Access Sea Ice data products" with an image of sea ice, and "Access Greenhouse Gases data products" with an image of industrial smokestacks.

The CDS contains **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**

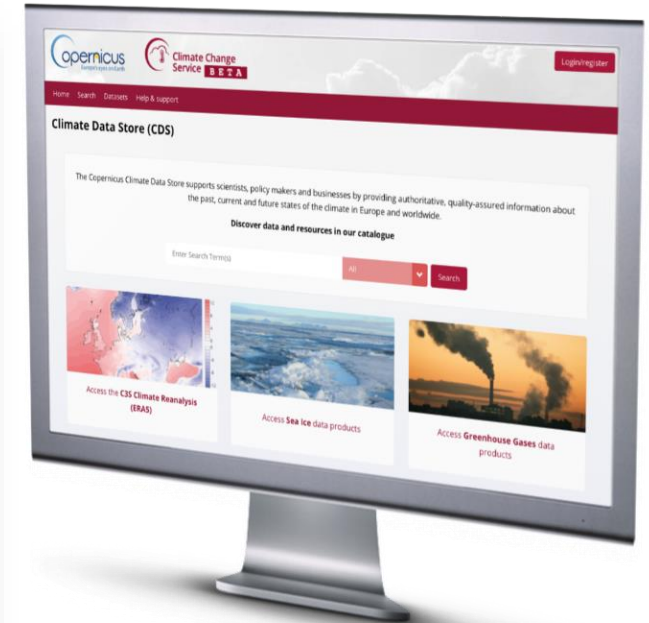


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Climate Data Store

Searching and Browsing Functions

The screenshot displays the Copernicus Climate Data Store (CDS) website. At the top, there are logos for Copernicus (Europe's eyes on Earth) and Climate Change Service BETA. A navigation bar includes links for Home, Search, Datasets, and Help & support, along with a Login/register button. The main content area is titled "Search Results" and features a search bar with a magnifying glass icon. Below the search bar, a dropdown menu is open, showing sorting options: "Sort by Relevancy" (selected), "Title", "Product type", "Variable domain", "Spatial coverage", and "Temporal coverage". The search results are displayed in a list format, with each item starting with a database icon and a title. The first result is "Mediterranean delayed-time sea surface heights and derived variables", followed by "Global delayed-time sea surface heights and derived variables", "Black sea delayed-time sea level anomalies and derived variables", "Southern hemisphere sea ice concentration from satellites for the period 2015 onwards", "Northern hemisphere sea ice thickness for the period 2002-2017", and "Northern hemisphere sea ice edge for the period 1979-2015". Each result includes a brief description of the dataset.





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Climate Data Store

Discovery and Retrieve Functions

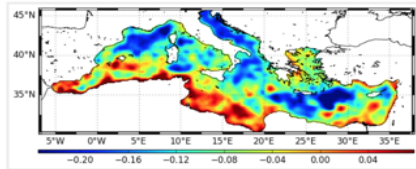
Gridded Satellite Observation Example



Mediterranean delayed-time sea surface heights and derived variables

- Overview
- Download data
- Validation and verification
- Documentation
- Sample application

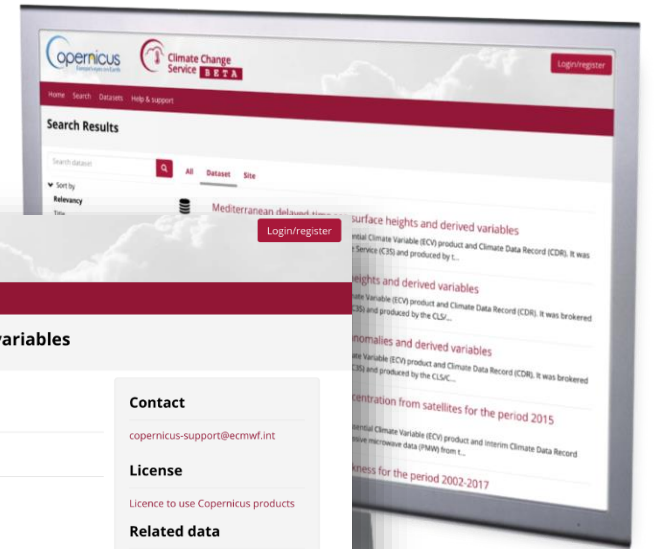
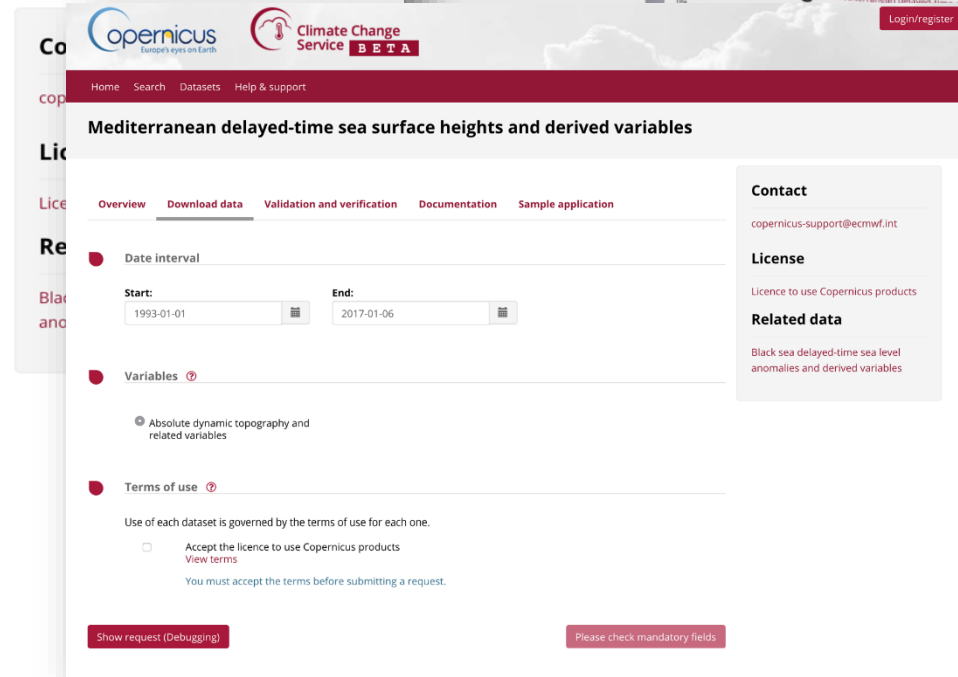
This **Mediterranean sea** dataset is a **Level-4 Essential Climate Variable (ECV)** product and **Climate Data Record (CDR)**. It was brokered by **ECMWF Copernicus Climate Change Service (C3S)** and produced by the **CLS/CNES DUACS** satellite altimeter production system. Within the production process, the long-term stability and large scale changes are built upon the records from the reference missions (**TOPEX-Poseidon, Jason-1, Jason-2 and Jason-3**). The additional missions (**ERS-1, ERS-2, Envisat, CryoSat-2, SARAL/AltiKa and Sentinel-3A**) are homogenized with respect to the reference mission and contribute to improve the sampling of mesoscale processes, provide the high-latitude coverage and increase the product accuracy. The steady number of satellites used in the constellation contributes to the long-term stability of the sea level record.



Sea level anomalies and derived variables are computed with respect to a twenty-year mean reference period (1993-2012) where up-to-date altimeter standards are used to estimate the sea level anomalies with mapping algorithms dedicated to this region. Contrary to near-real time and interim sea level products, the stability and accuracy of the **delayed-time** product make it adapted to climate applications. This product is delayed about 4-5 months due to the timeliness of the input data, the centred processing temporal window and the validation process. Any modification of past input data, or of the processing chain, will provoke the issuing of a new version of the whole dataset. These products were previously distributed by **AVISO+**. Details on the altimeter and processing algorithms, validation results and uncertainties are available in the **Algorithm Theoretical Basis Document (ATBD)**, the **Product User Guide and Specification (PUGS)** and the **Product Quality Assessment Report (PQAR)** in the **Documentation** section.

Keywords: Altimetry, Sea Level, Climate, Currents, Ocean Topography

Metadata	
Horizontal coverage:	Mediterranean sea (cartesian projection)
Horizontal resolution:	1/8 degree
Temporal coverage:	From January 1993 until present with a few months delay
Temporal resolution:	Daily
Data format:	NetCDF
Data type:	GRID



+ APIs





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Climate Data Store

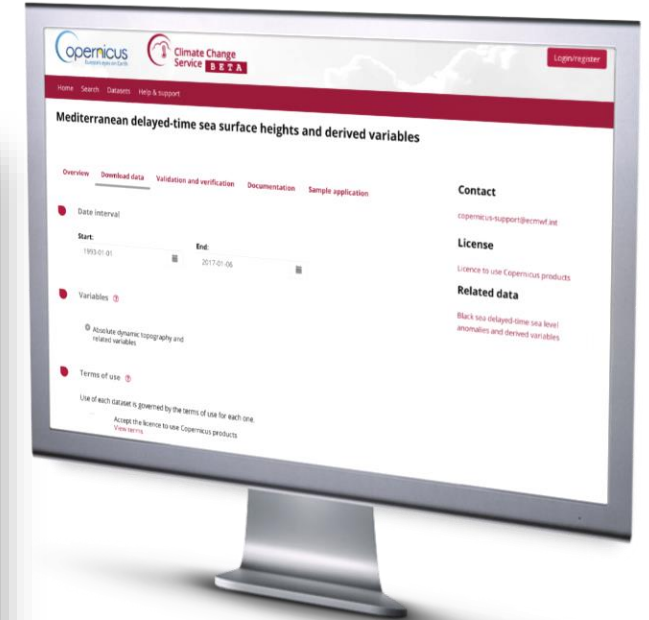
User Requests and Download Functions

Your requests

Home Search Datasets Applications Your requests Help & support

Greenhouse gases: Methane

Product	Submission date	End date	Duration	Size	Status
Greenhouse gases: Methane	2017-11-30 11:34:42	2017-11-30 11:40:56	0:06:14	206.4 MB	Download
Surface soil Moisture	2017-11-30 11:29:02	2017-11-30 11:29:03	0:00:00	968.7 KB	Download
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
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
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





Climate Change

Toolbox

Toolbox editor

Applications Data Documentation

Search for app or example

workspace

Test plot swicca

02 Plot Map-1

01 Retrieve Sample Data

02 Plot Map

21 Anomaly

examples

01 Retrieve Sample Data

02 Plot Map

03 Plot Line

04 Plot Location

11 Monthly Mean and Standard Deviation

12 Climatology

21 Anomaly

22 Anomaly Time Reference

31 Trends

41 Regrid

51 Indices GDD

52 Indices CSU

61 Zonal Mean Winds

71 ECV Total Column Ozone

72 ECV Sea Ice Fraction

02 Plot Map-1

Console

History

Save

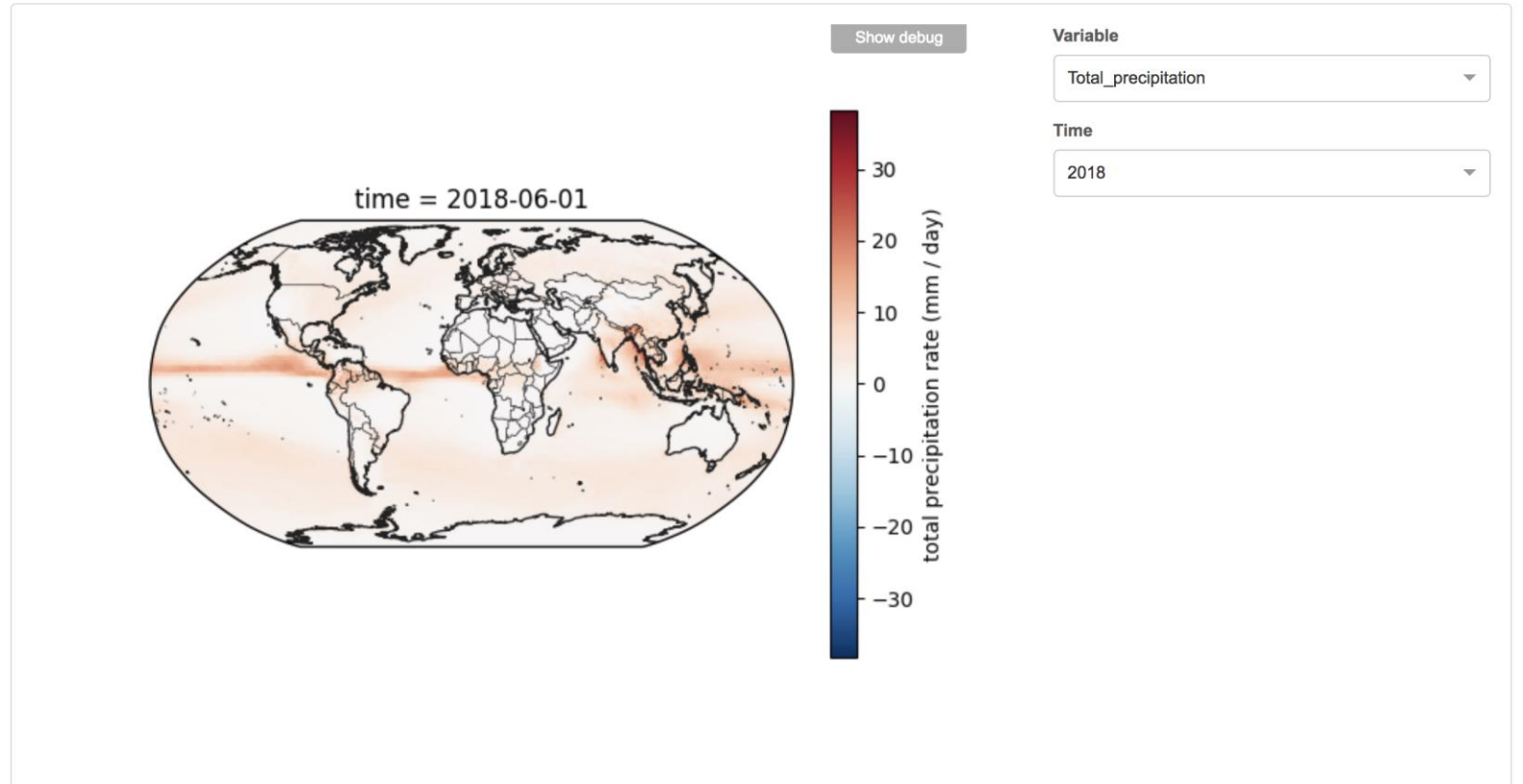
Run

Layout

```
9 @app.output.figure()
10 def plot_map(variable, time):
11     """
12     Retrieve data over a defined time range and plot average on a map.
13     """
14
15     dataset = ct.catalogue.sample('ERA-Interim', variable, 'month')
16     dataset_sel = ct.util.select(dataset, time=time)
17     dataset_mean = ct.util.average(dataset_sel, 'time')
18
19     projection = cp.crs.Robinson()
20     fig = cp.figure(subplot_kw={'projection': projection})
21     cp.geomap(
22         dataset_mean, pcolormesh_kwargs={'cmap': 'RdBu_r'}, fig=fig,
23         #!
24     )
25
26     return
```

Plot Map

Plot Map





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Climate Data Store - implementation

- **Ongoing physical implementation:**

- On-Premises Private **Cloud** :

- CloudFerro Phase I and II

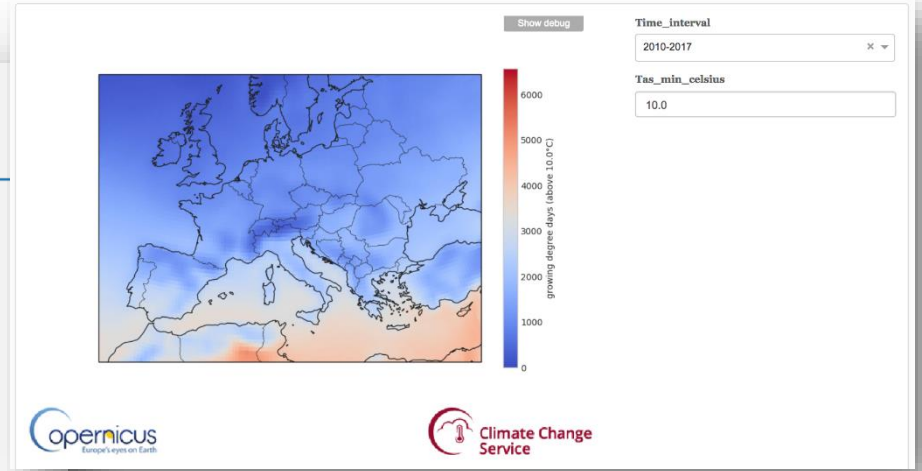
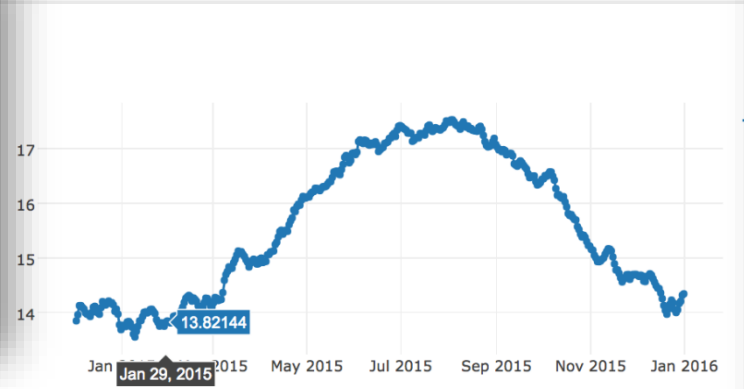
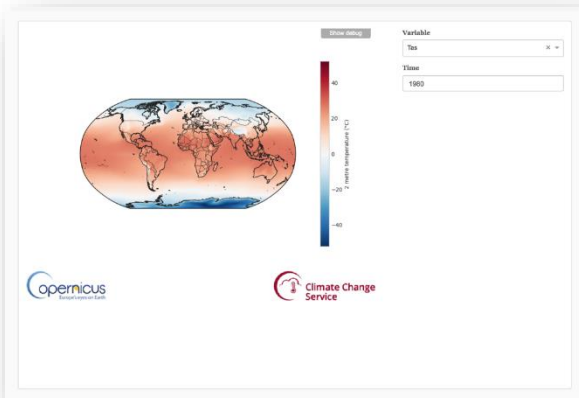
- **32** compute servers (230, 4 GHz cores and 64 GB RAM)
 - **100** TB SSD and **900** TB HDD





Climate Change

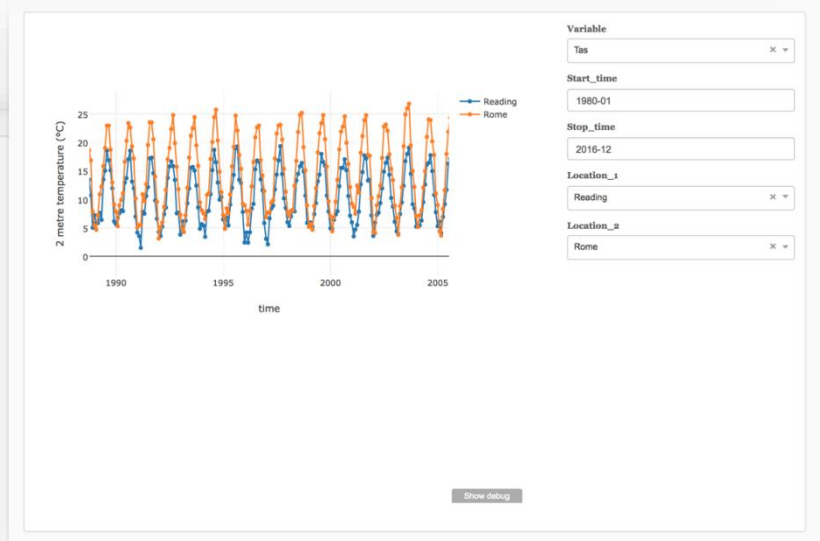
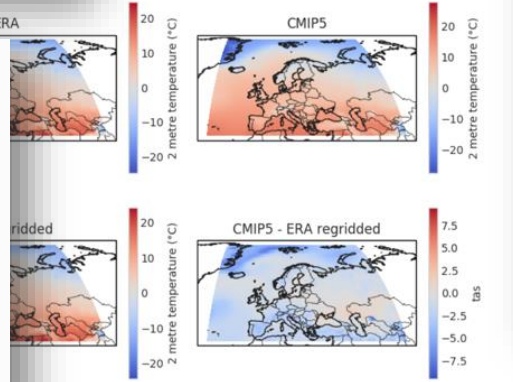
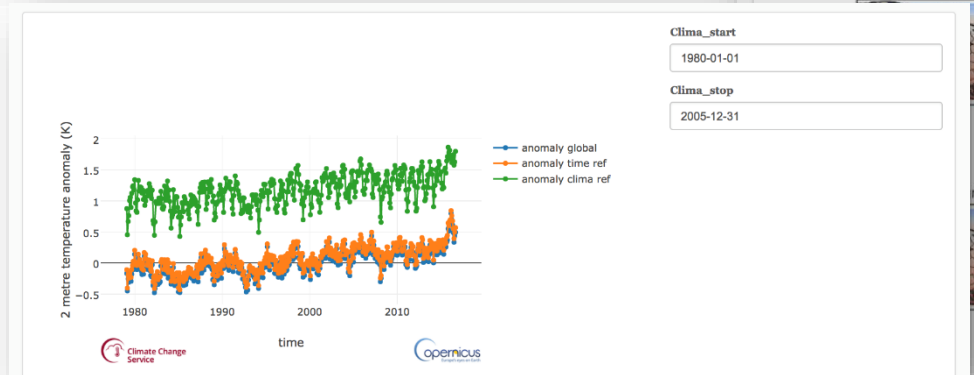
Climate Data Store - Toolbox



Download [d04fca38b2970f31ec8ff01d7599b57dfd4a4886-0.nc](#)

Show debug

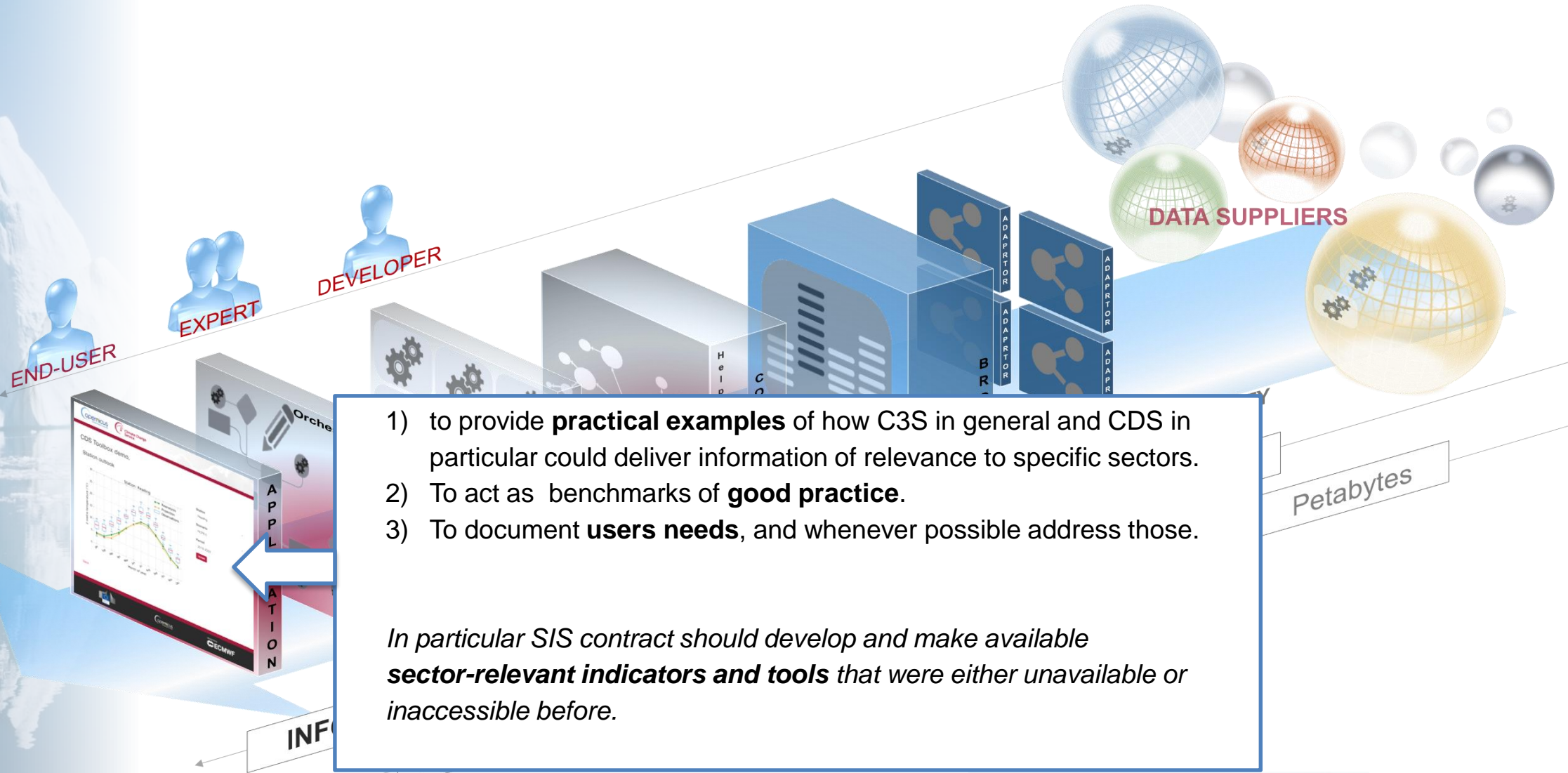
Var: Tas





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Climate data store



- 1) to provide **practical examples** of how C3S in general and CDS in particular could deliver information of relevance to specific sectors.
- 2) To act as benchmarks of **good practice**.
- 3) To document **users needs**, and whenever possible address those.

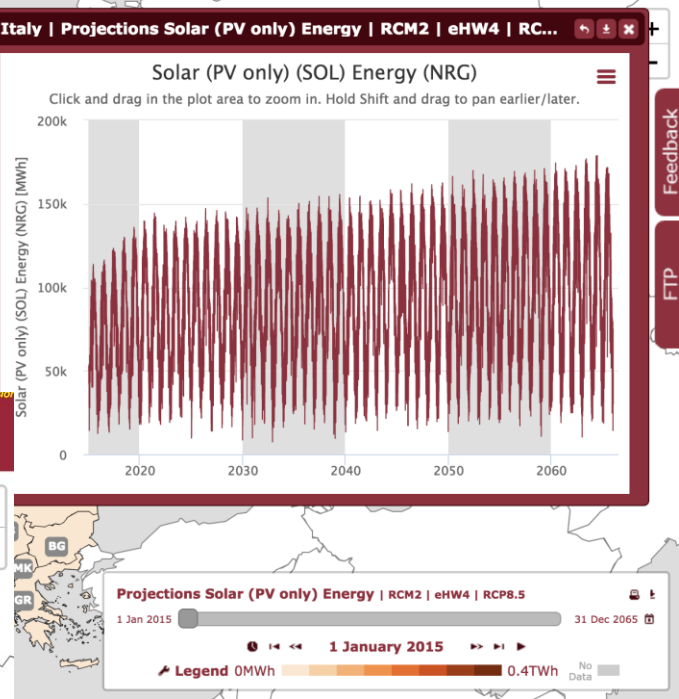
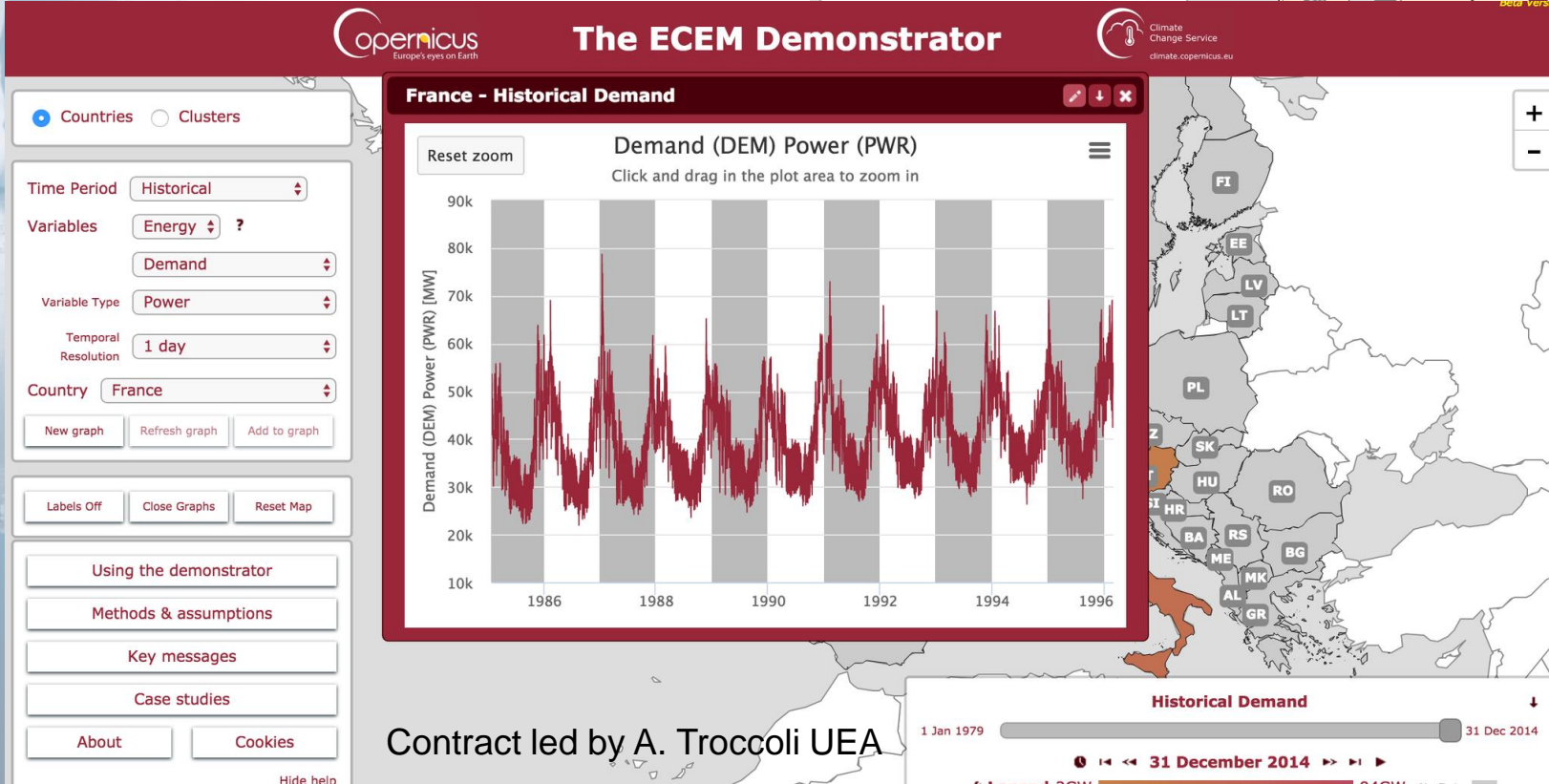
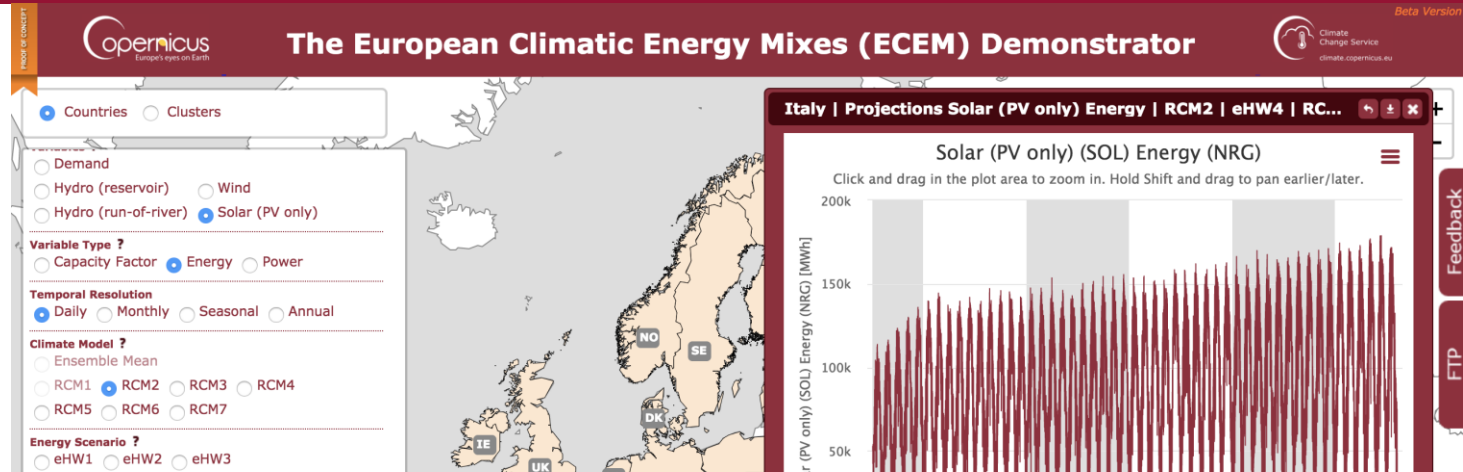
*In particular SIS contract should develop and make available **sector-relevant indicators and tools** that were either unavailable or inaccessible before.*



Climate Change

Energy projections

Integrating climate and energy scenarios to learn how well prepared our infrastructure is to cope with the climate of the future. Will the renewable dominated energy mix of the future able to cope with the expected change in the energy demand profile?



Using a combination of historical data, reanalysis, seasonal predictions and climate projections the SIS contracts demonstrated how will be possible to address some of these questions through the CDS.

Contract led by A. Troccoli UEA



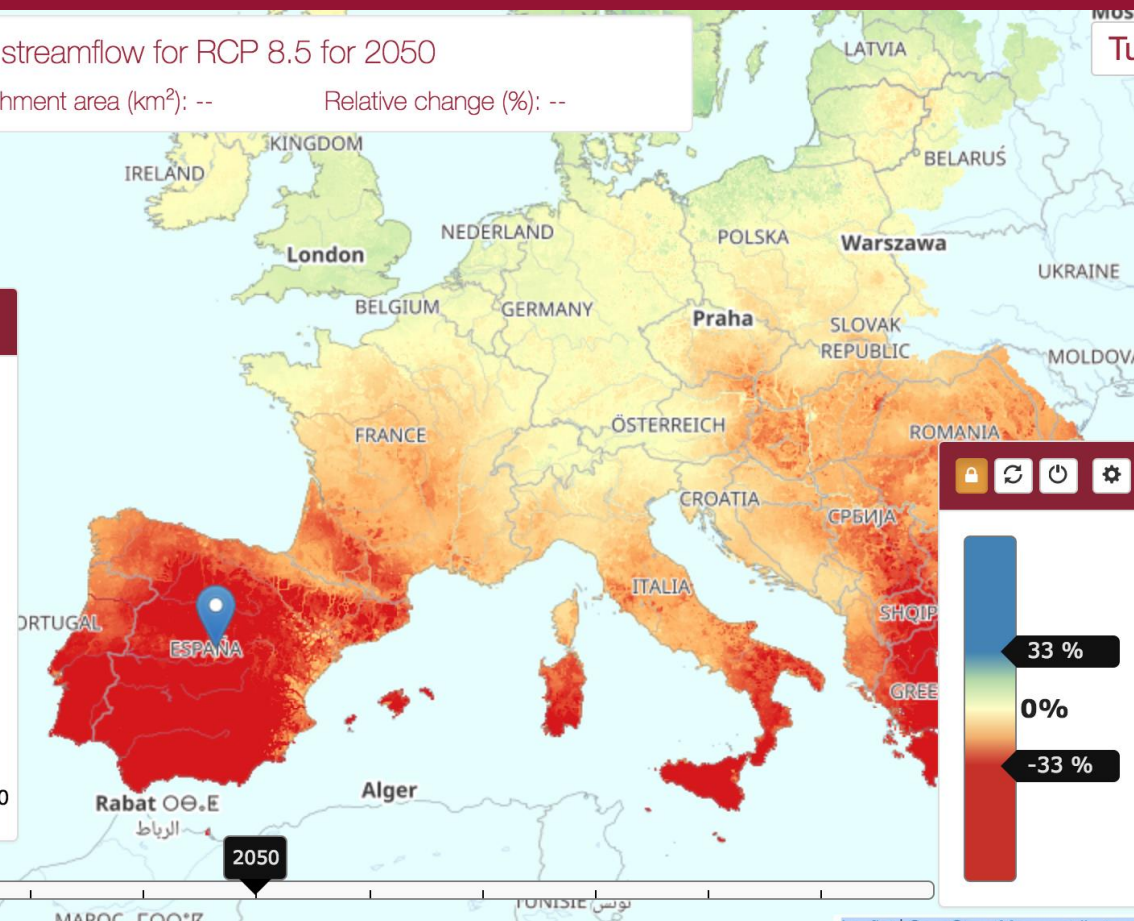
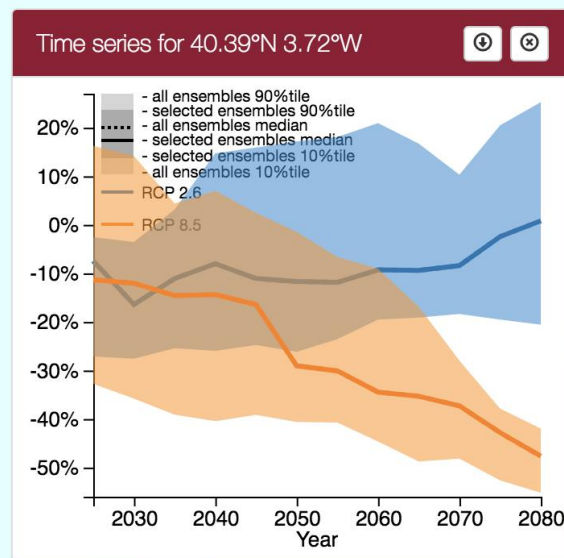


Climate Change

Water resources and drought

Relative change in mean annual streamflow for RCP 8.5 for 2050

Lat: 45.28 Lon: -37.74 Upstream catchment area (km²): -- Relative change (%): --

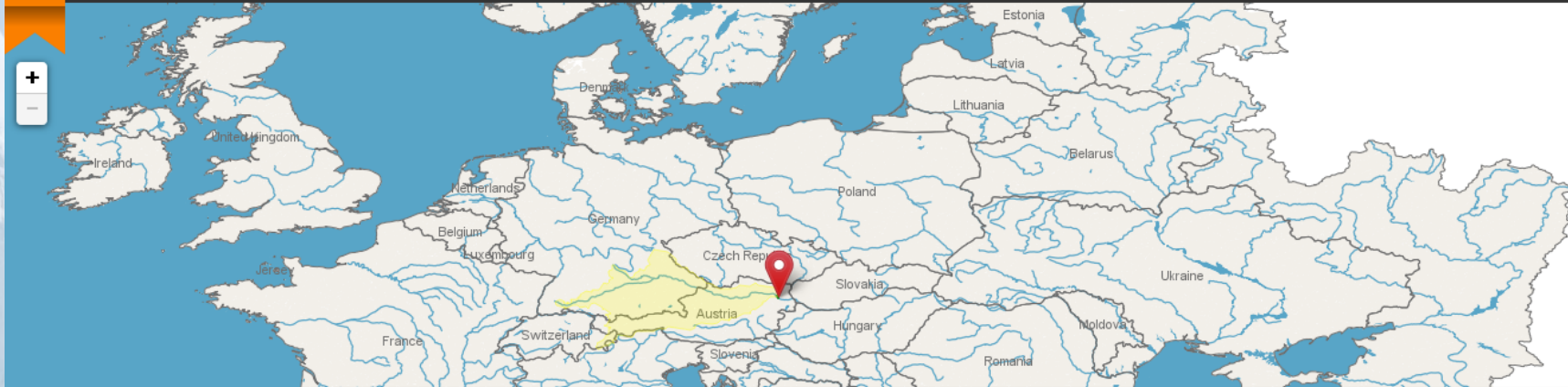


Using a combination of chain of models linking future climate scenarios with hydrological parameters it has been possible to produce an operational assessment of current and future conditions. The water-agriculture-energy nexus provide a good example of how climate mitigation and adaptation can be intertwined. Madrid, in the small plot faces significantly different hydrological futures depending on the mitigation strategy adopted.



Climate Change

PROOF OF CONCEPT



SEASONAL FORECASTS

MAPS | GRAPHS AND DOWNLOAD

Select coordinate

Click in map to select coordinate or fill in coordinate below

Selected coordinate: 48.21, 16.42
Catchment subid: 9602258

Lat: Lon:

Subid:

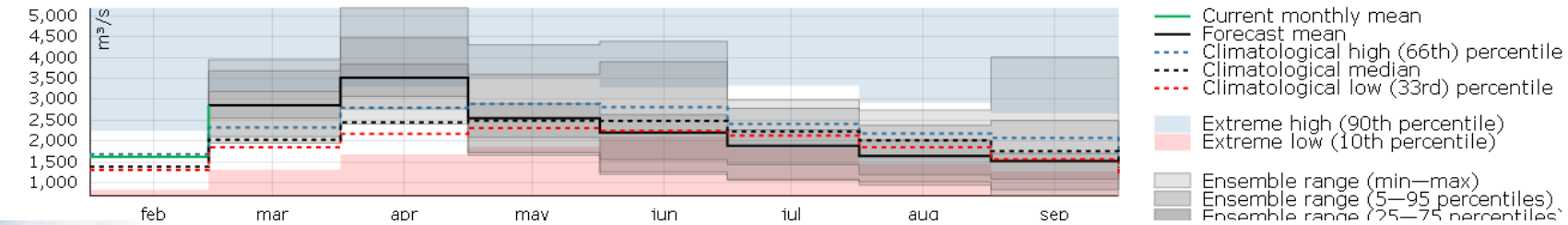
Variables & Models

Variable:
River flow (monthly mean)

Model:
HYPE

Seasonal Forecast:
ECMWF

River flow (monthly mean)



Contract led by SMHI
Pechlivanidis et al EGU2018-5194



Water quantity indicators for European catchments

Overview

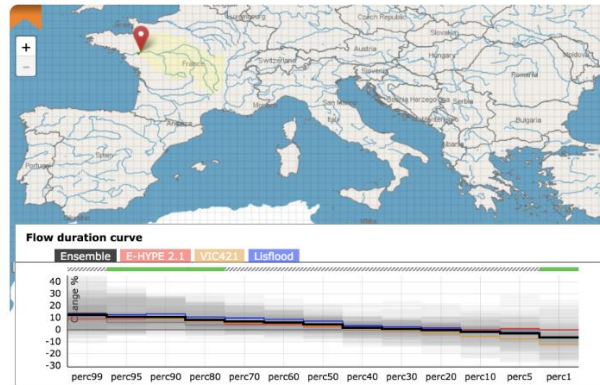
Download data

Documentation

Water quantity indicators for European catchments.

This dataset contains data related to flood recurrences, flow duration curve, river flow, snow water equivalent, soil water content, runoff and wetness.

The datasets was developed as part of a proof of concept contract. The indicators were co-designed with a set of user representatives to simplify the climate-change adaptation of water management practices 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%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 95%, 99%.

Contact

copernicus-support@ecmwf.int

License

Licence to Use Copernicus Products

Related data

[Water quality indicator for European rivers](#)



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SIS contracts

Proof of
concept

- **The past (2016-2018):**
 - Energy (UEA, CEA), Water (CEH, SMHI), Insurance (CGI), *cities (SMHI), agriculture (TelespazioVega)*

Operational
phase

- **The present (2018-2019,..):**
 - European: storm-surges (Deltares), fisheries (PML), tourism (TEC), cities/health (Vito)
 - Global: shipping (OSM), global impacts (SMHI), agriculture (WEnR)
- **The future :**
 - in negotiation: energy, water, insurance
 - quality assurance for SIS, biodiversity, forestry, cultural heritage, case studies, transport, ...



Take home messages

- We are making a significant amount of climate data easily accessible
- C3S infrastructure is designed to facilitate the up development of sector-specific forecasts (even commercial).
- C3S is working closely with JRC and the GLOFAS team to make their runs available on the Climate Data Store and to promote a common approach to Global Hydrological Predictions on the common time-horizons.
- The climate data store will open in June but it is already running now in beta mode If you want to have a look at it come and find me after the session.



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climate.copernicus.eu

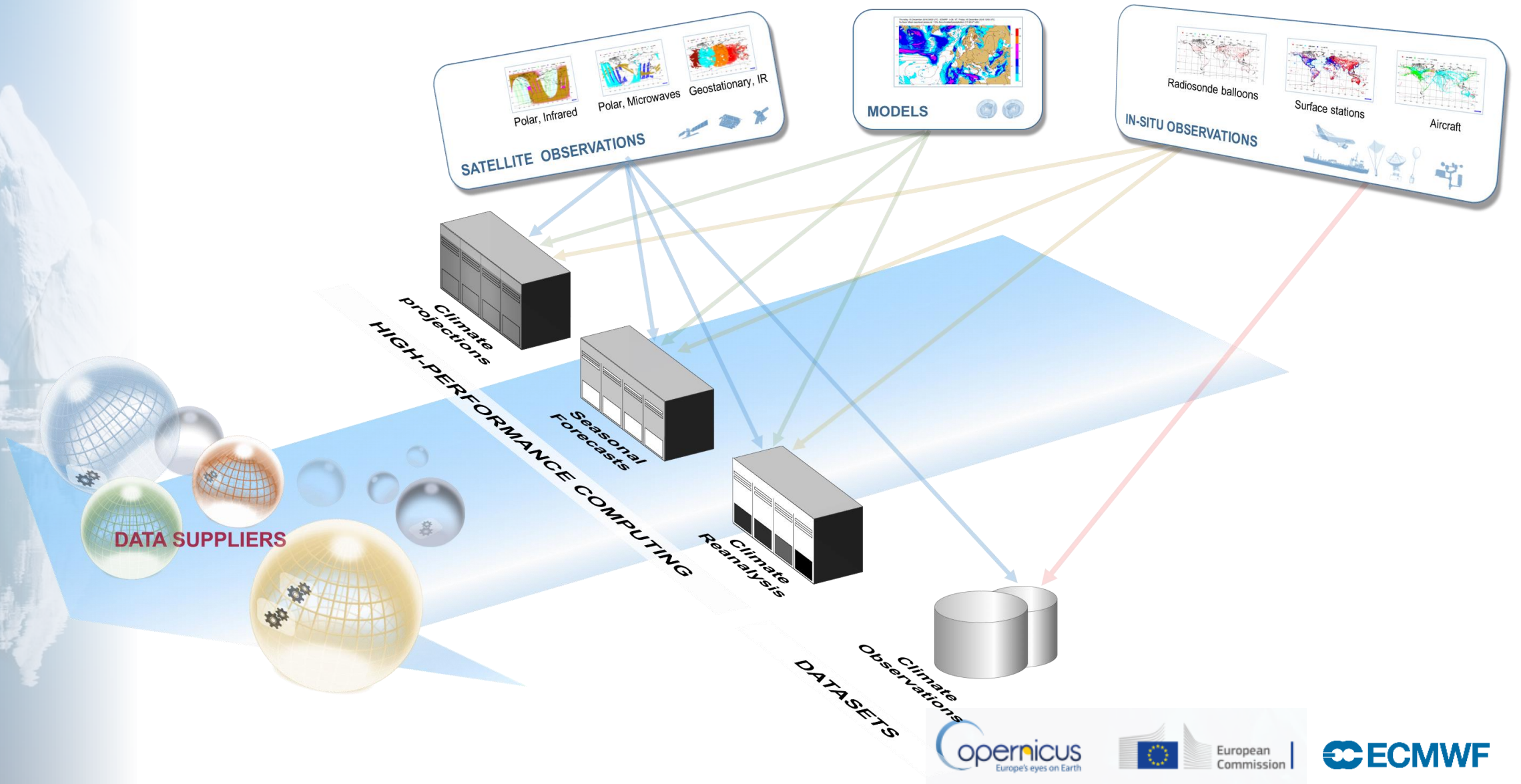
Carlo.Buontempo@ecmwf.int
[@carlo_twitter](https://twitter.com/carlo_twitter)

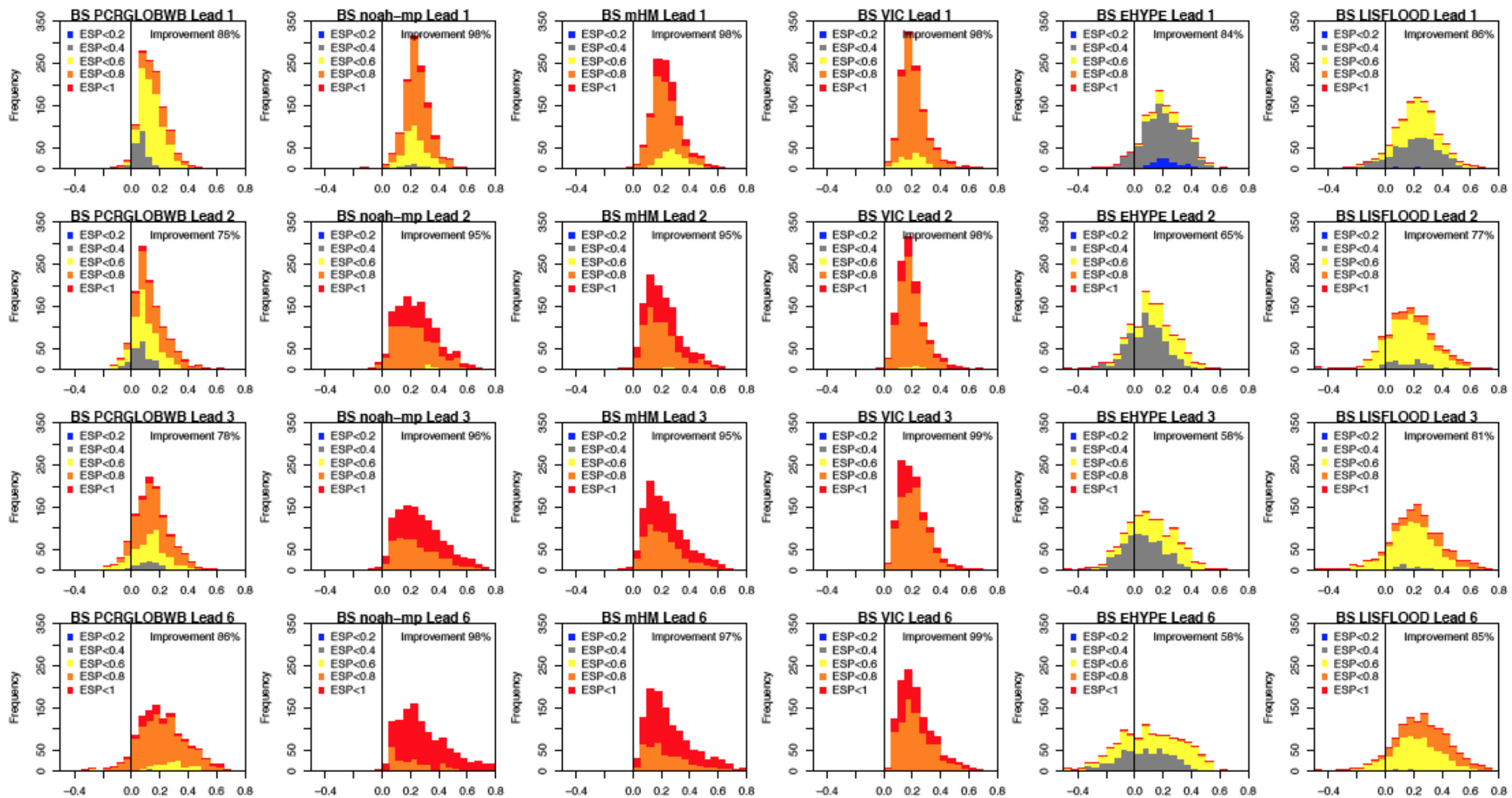
The screenshot shows the homepage of climate.copernicus.eu. At the top, there is a navigation bar with links for ABOUT C3S, NEWS & MEDIA, EVENTS, TENDERS, PRODUCTS, SERVICES, and HELP & SUPPORT. Below the navigation bar is a large banner image divided into three sections: a cracked, dry landscape under a sunset, a busy port with many colorful shipping containers, and a coastal town with a pier. Below the banner, there are three main content sections: 'IN FOCUS' featuring a laptop with a globe and code, 'MONTHLY MAPS & CHARTS' showing various climate maps and charts, and 'NEWS' with three recent news items dated 16 Jan 2018, 19 Dec 2017, and 18 Dec 2017.



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What do we mean by Data?

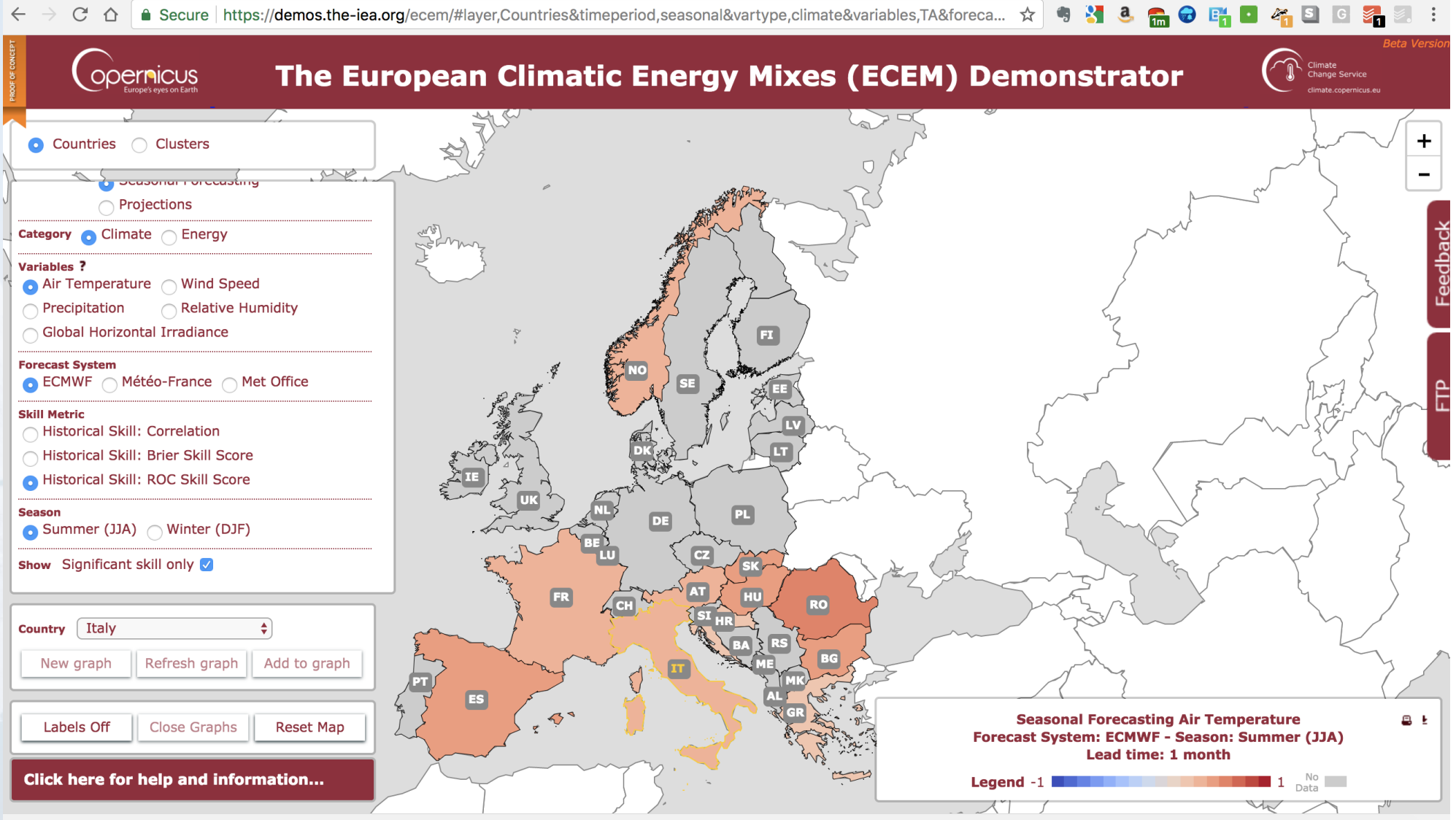






Climate Change

Energy





Climate Change

C3S seasonal forecasts – graphical products

Variables:

- sea-level pressure
- geopotential height
- precipitation
- air temperature
- sea-surface temperature

Type of plots:

- maps:
 - global
 - pre-defined regions
- time series

Publication schedule:

- monthly updates
- on the 15th of each month
 - will be on the 10th

C3S seasonal charts

28 matching items
No filters applied

Filters
Show All

Parameters

- MSLP (4)
- SST (8)
- T2m (4)
- T850 (4)
- geopotential height 500hPa (4)
- precipitation (4)

Plot type

- Maps (24)
- Time series (4)

Centres

- C3S multi-system (7)
- ECMWF (7)
- Met Office (7)
- Meteo-France (7)

Thumbnail titles in the grid:

- C3S multi-system MSLP
- C3S multi-system NINO plumes
- C3S multi-system SST
- C3S multi-system T2m
- C3S multi-system T850
- C3S multi-system geopotential height
- ECMWF MSLP
- ECMWF NINO plumes
- ECMWF SST
- ECMWF T2m
- ECMWF T850
- ECMWF precipitation
- ECMWF geopotential height
- ECMWF precipitation
- Met Office MSLP
- Met Office NINO plumes
- Met Office SST
- Met Office T2m
- Met Office T850
- Met Office geopotential height
- Met Office precipitation
- Met Office precipitation
- Meteo-France MSLP
- Meteo-France NINO plumes
- Meteo-France SST

http://climate.copernicus.eu/s/charts/c3s_seasonal/

IMPLEMENTED BY



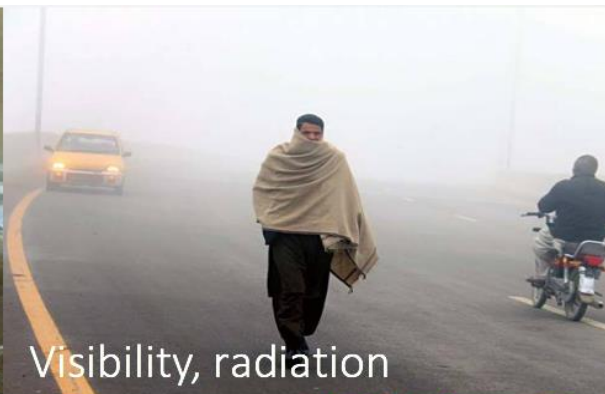


Atmosphere
Monitoring

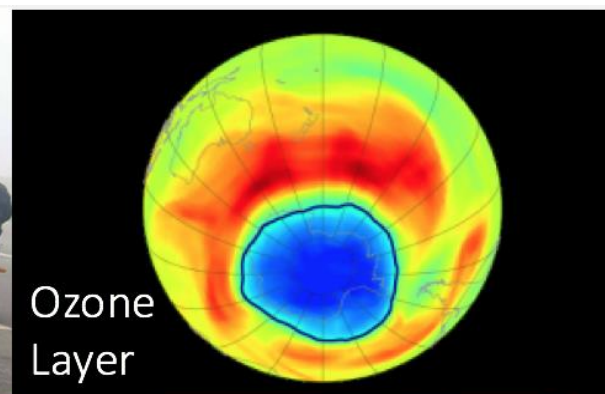
REASONS TO CARE ABOUT ATMOSPHERIC COMPOSITION



Disasters



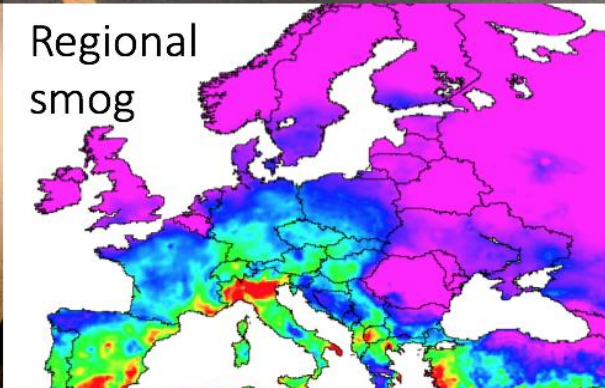
Visibility, radiation



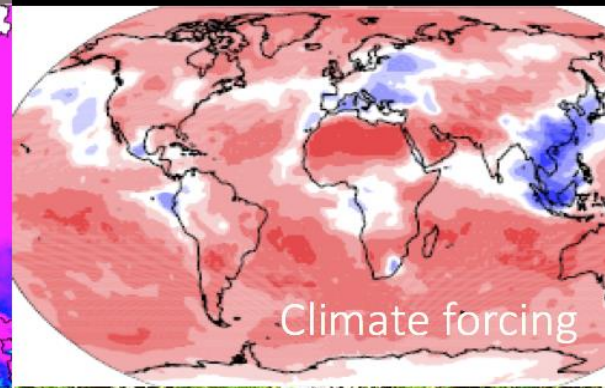
Ozone
Layer



Urban smog



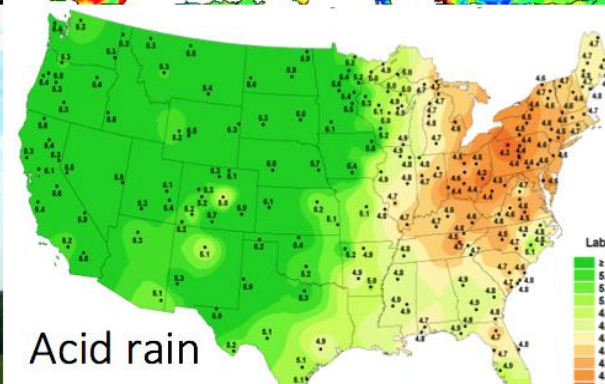
Regional
smog



Climate forcing



Plume dispersion



Acid rain



Biogeochemical cycles

Local < 100km

Regional 100-1000km

Global > 1000km

from D. Jacob