



Climate Change

## How climate information can be made user relevant and usable: the case of the Sectoral Information System of C3S

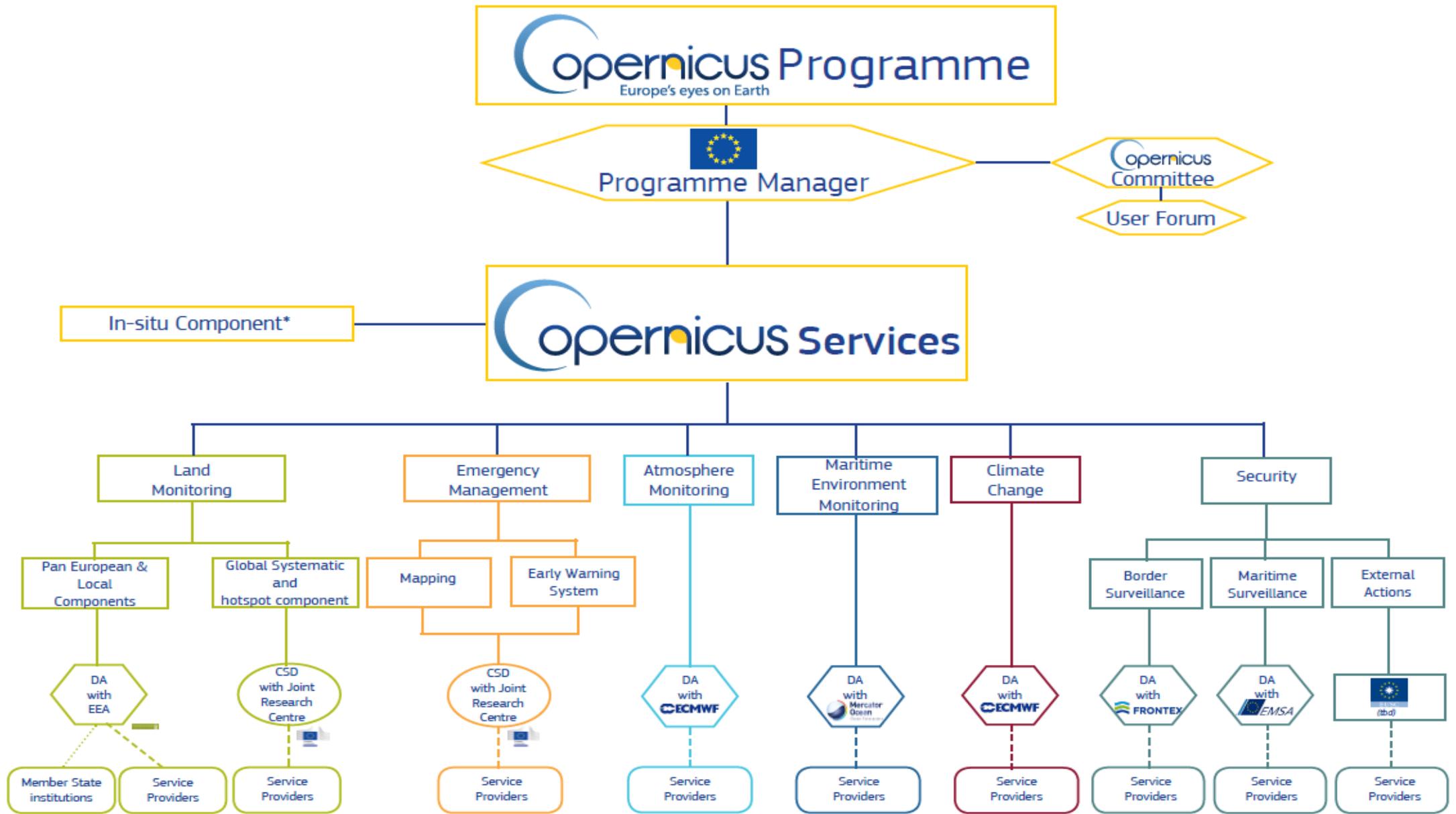
*UEF 2018*

Samuel Almond & Carlo Buontempo - ECMWF / C3S





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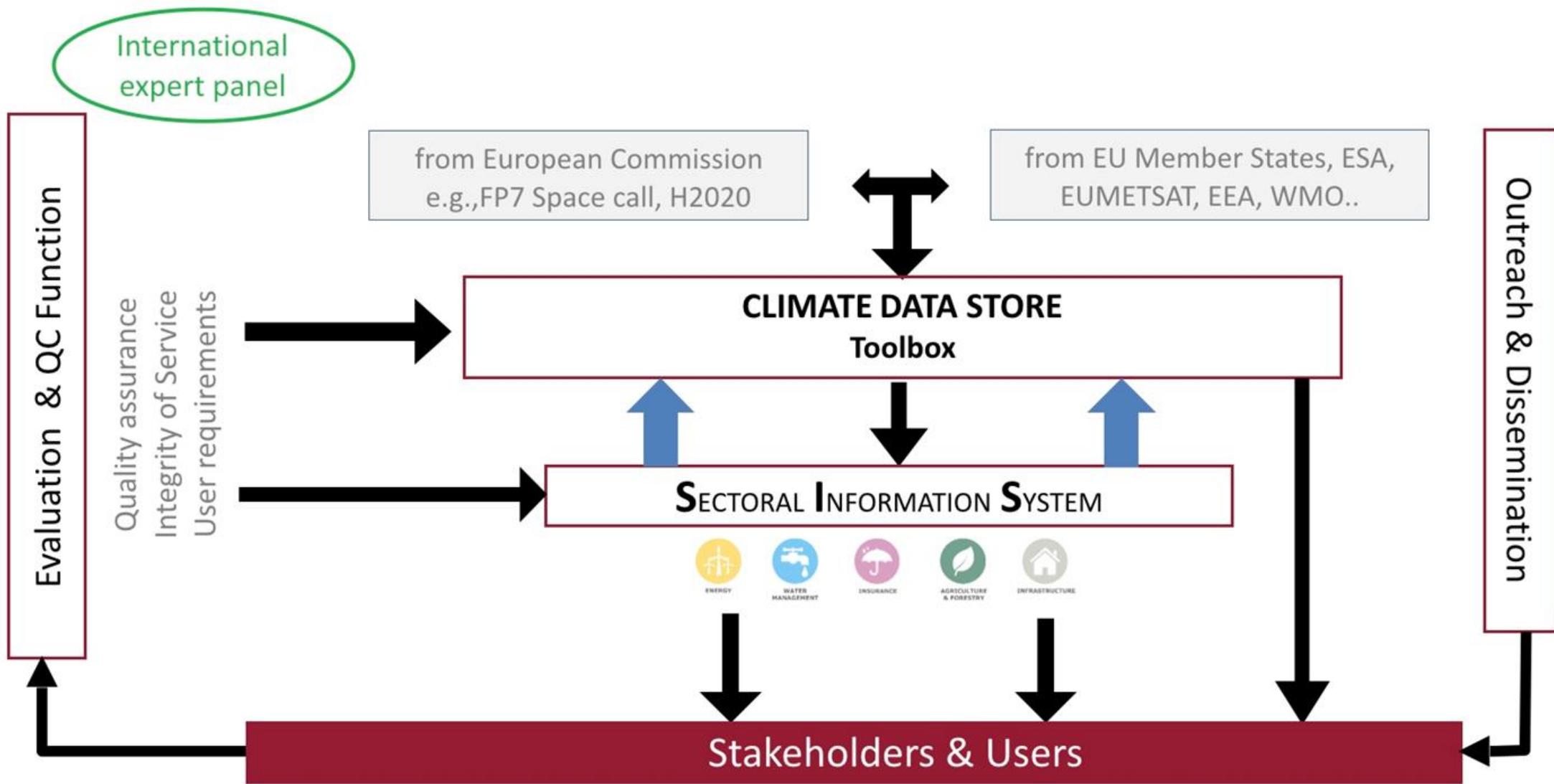


**Legend:**  
 Implementation mode still to be defined  
 --- Commercial contracts  
 ..... Grants  
 Copernicus component  
 Service Providers  
 Mode of Implementation (Direct/Indirect)  
 Direct Management  
 Indirect Management  
 \* Co-financed by EEA  
 DA - Designated Agency  
 CSD - Co-Sponsoring Agency  
 EEA - European Environment Agency  
 ECOWF - European Centre for Medium-Range Weather Forecasts  
 EUMETSAT - European Organisation for the Exploitation of Meteorological Satellites  
 ESA - European Space Agency  
 ECOWF - The European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union  
 ECOWF - The European Centre for Medium-Range Weather Forecasts



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# C3S in a nutshell



# 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. Below the logos is a navigation bar with "Home", "Search", "Datasets", and "Help & support". The main heading is "Climate Data Store (CDS)". A paragraph 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." Below this is a call to action: "Discover data and resources in our catalogue". A search bar contains the text "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**

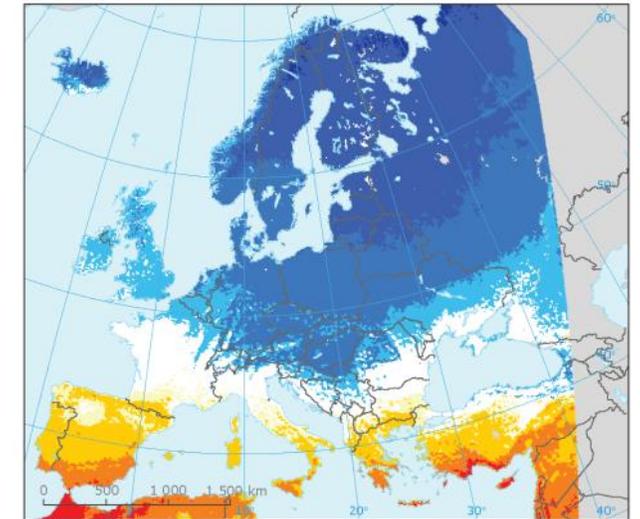
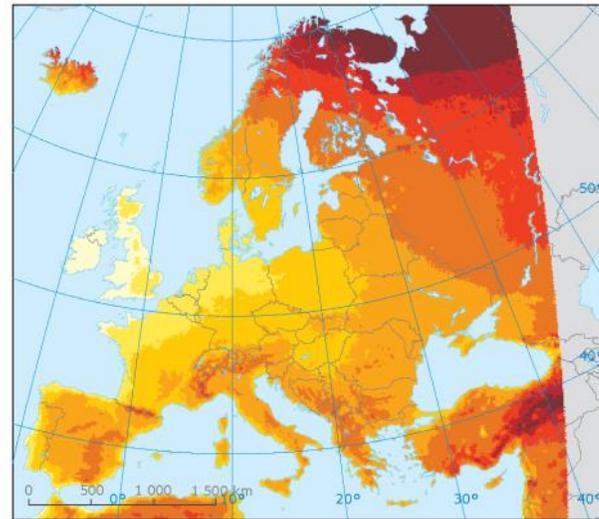
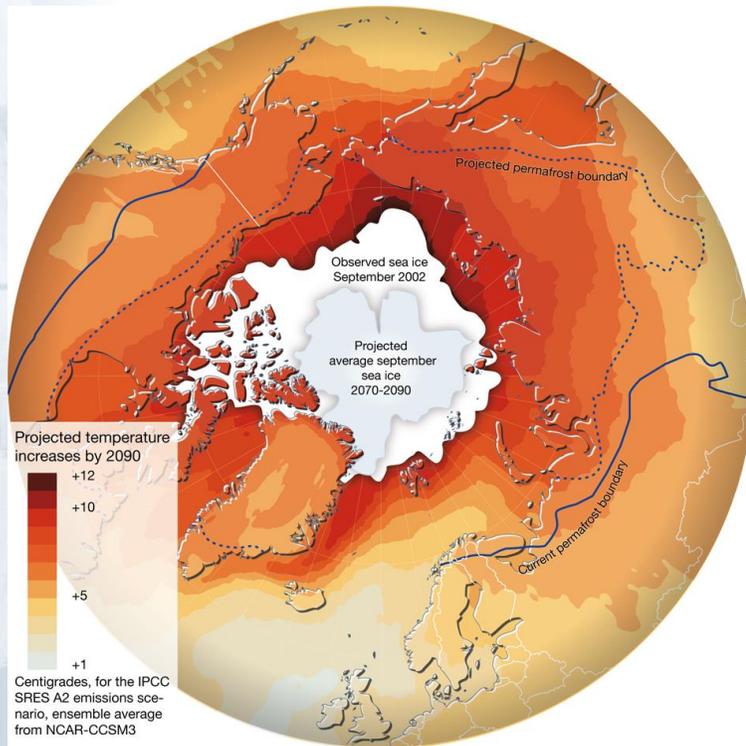




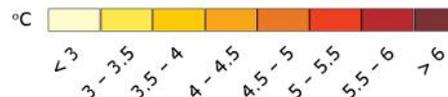
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# Climate projections

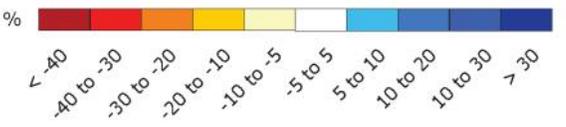
***Providing users with timely access to climate change scenarios produced with state-of-the-art climate models (CMIP, CORDEX)***



Projected changes in annual mean temperature (left) and annual precipitation (right)



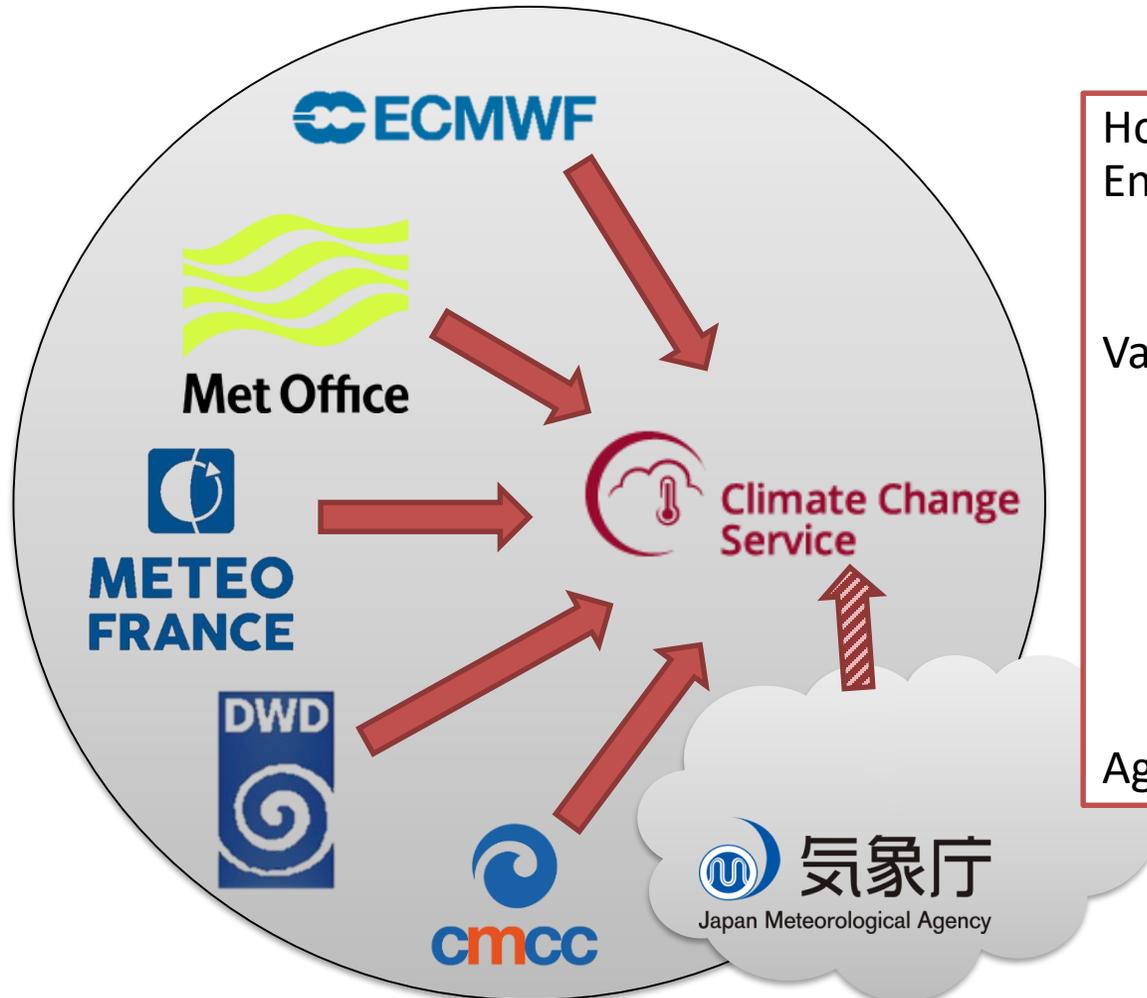
Outside coverage





# 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

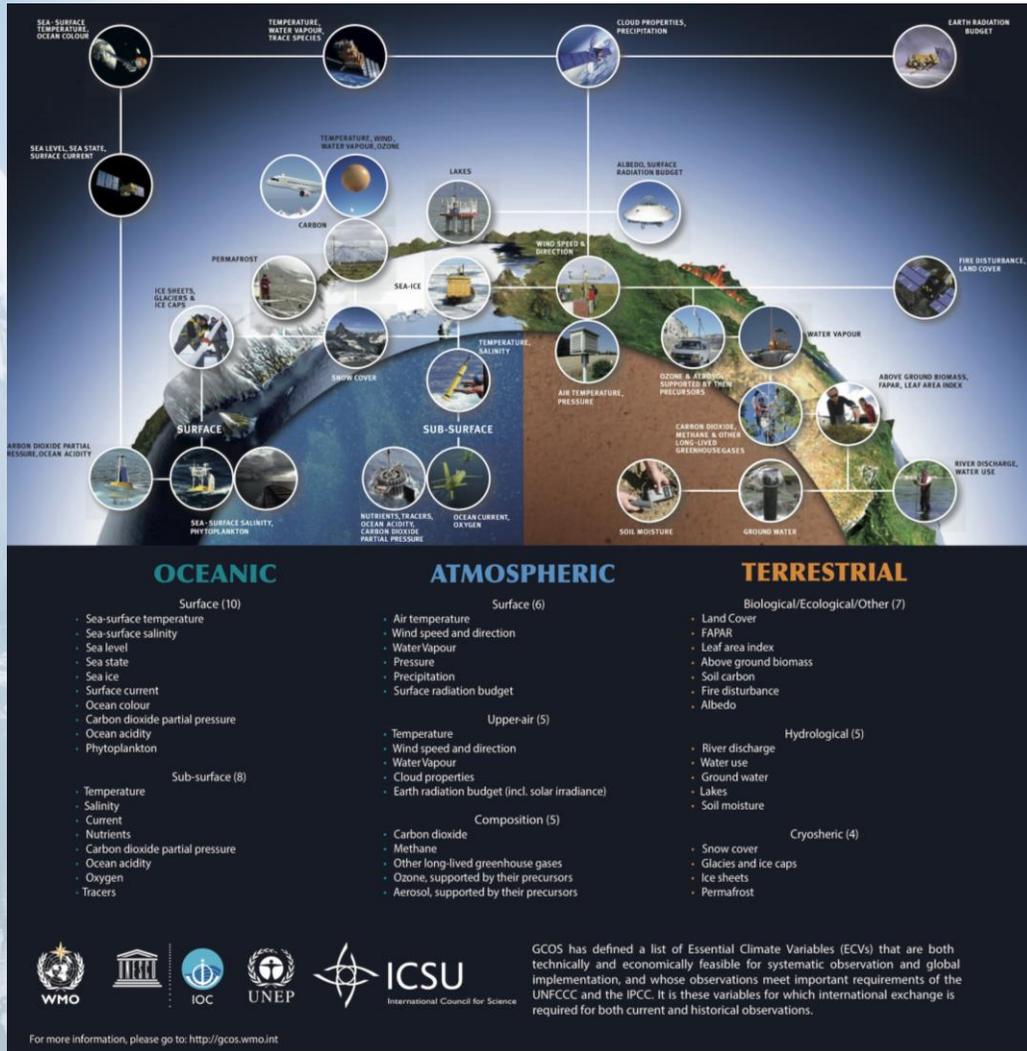
- Surface
  - 7 vars every 6h
  - +30 vars every 24h
- Pressure (11 levels, from 925 hPa to 10 hPa)
  - 8 vars every 12 h

Agreed NetCDF specification C3S-0.1 (based on CF)



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# Essential Climate Variables



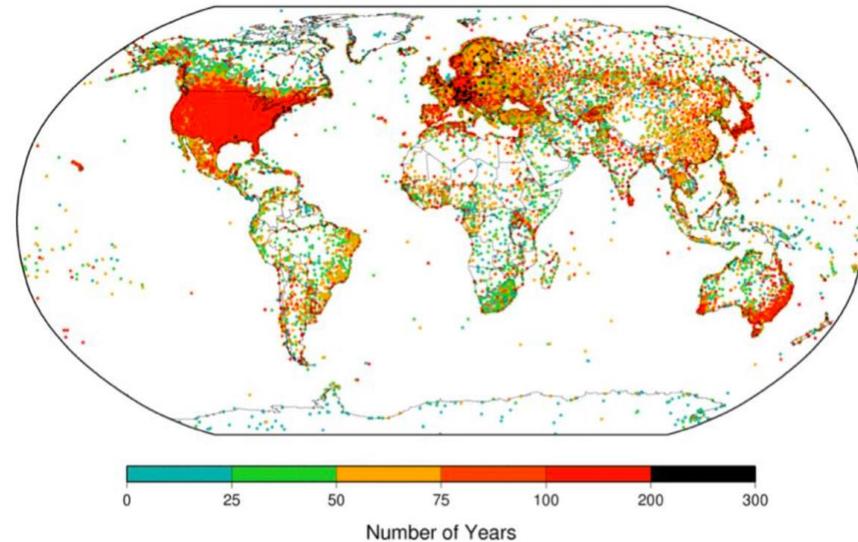
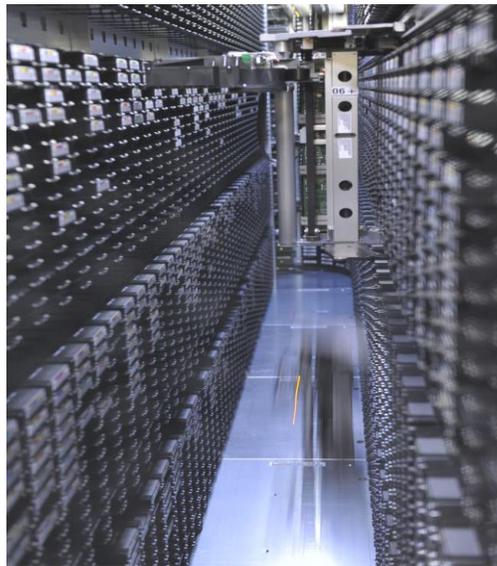
		C3S_312a		C3S_312b			
		GCOS	2017	2018	2019	2020	2021
<b>Atmospheric physics</b>							
	Precipitation	4.3.5					
	Surface Radiation Budget	4.3.6					
	Water Vapour	4.5.3					Lot 1
	Cloud Properties	4.5.4					
	Earth Radiation Budget	4.5.5					
<b>Atmospheric composition</b>							
	Carbon Dioxide	4.7.1	Lot 6				
	Methane	4.7.2	Lot 6				Lot 2
	Ozone	4.7.4	Lot 4				
	Aerosol	4.7.5	Lot 5				
<b>Ocean</b>							
	Sea Surface Temperature	5.3.1	Lot 3				
	Sea Level	5.3.3	Lot 2				
	Sea ice	5.3.5	Lot 1				Lot 3
	Ocean Colour	5.3.7					
<b>Land hydrology &amp; cryosphere</b>							
	Lakes	6.3.4					
	Glaciers	6.3.6	Lot 8				Lot 4
	Ice sheets and ice shelves	6.3.7					
	Soil moisture	6.3.16	Lot 7				
<b>Land biosphere</b>							
	Albedo	6.3.9	Lot 9				
	Land Cover	6.3.10					
	Fraction of Absorbed Photosyntheti	6.3.11	Lot 9				Lot 5
	Leaf Area Index	6.3.12	Lot 9				
	Fire	6.3.15					
			2017	2018	2019	2020	2021



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# Old Weather: C3S data rescue & Observations from Global Climate Data Archives

- Support for selected high-priority data rescue activities
- Merge of major land and marine surface data collections
- Data quality control and homogenisation
- Harmonisation of data and metadata under a Common Data Model
- Unified data access via the Climate Data Store





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# Climate Data Store

## Search “datasets”

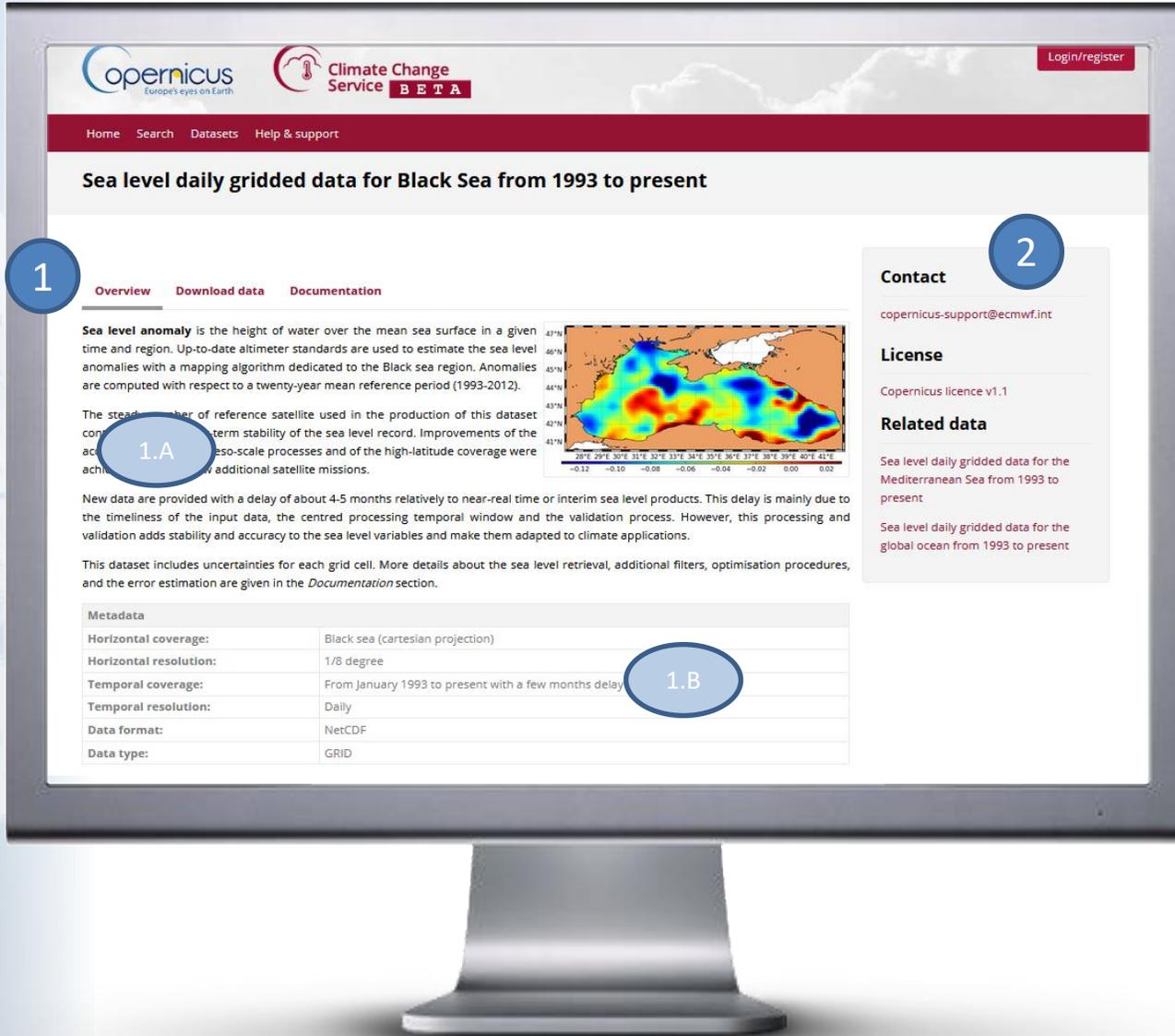
The screenshot displays the Copernicus Climate Data Store search results page. At the top, there are logos for Copernicus and Climate Change Service BETA, along with a 'Login/register' button. The navigation bar includes 'Home', 'Search', 'Datasets', and 'Help & support'. The main content area is titled 'Search results' and features a search bar with the text 'Search dataset' and a magnifying glass icon. Below the search bar, there are tabs for 'All' and 'Datasets'. A 'Sort by' section is visible, followed by a list of filters for 'Product type', 'Variable domain', 'Spatial coverage', and 'Temporal coverage'. The search results are displayed as a list of products, each with a title, a brief description, and a count of results. Numbered callouts 1-4 highlight specific features: 1. Search bar, 2. Filter menu, 3. Faceted search filters, and 4. Product title link.

- 1 **Textual search:** free text.
- 2 **Facetted search:** Multiple criteria, only available combinations are displayed.
- 3 **Current searching criteria** (acumulative: textual + facetted + tipology of product)
- 4 **List of matching products in the catalogue:** Navigable by clicking on the title to the product dedicated area.



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## Product "overview"



### 1 Product toolbar:

- *Overview*: Global textual description (abstract)
- *Download data*: Subsetting form.
- *Documentation*: Access to detailed documentation (technical guidelines, user manuals, EQC reports)

**Abstract:** user readable explanation about the product.

1.A

**Detailed information:** Metadata about the product

1.B

### 2 Related information block:

- *Contact*: Mail box for questions about the product.
- *License*: All data is freely available but subject to some use licences.
- *Related data*: Products sharing facets.



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## “Your request” management

**1**

**2**

**3**

Opennicus Europe's eyes on Earth | Climate Change Service BETA | Angel Lopez Alas Logout

Home Search Datasets Applications Your requests Help & support

### Your requests

All Queued In progress Failed Unavailable Complete Delete selected

Auto refreshed : 08:03:42

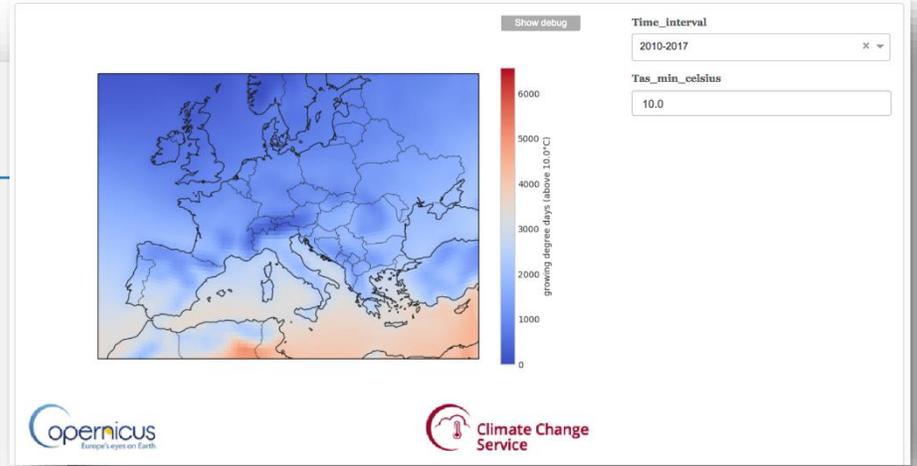
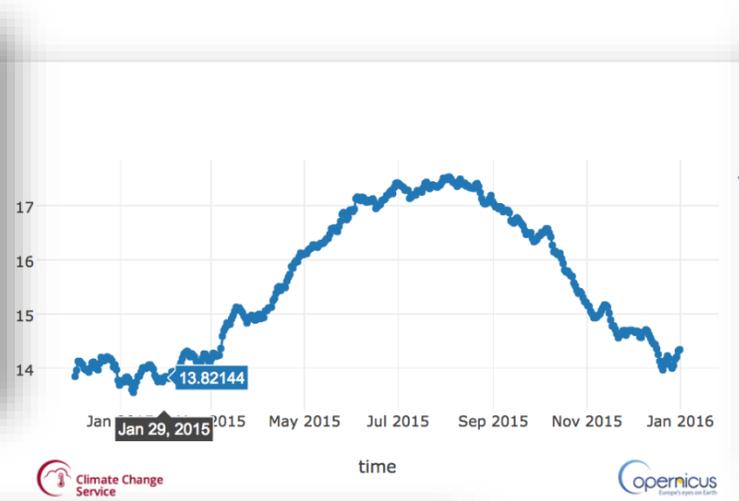
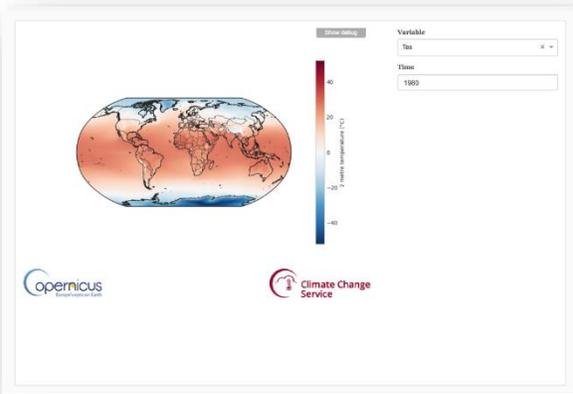
Product	Submission date	End date	Duration	Size	Status	
Directional albedo for global land surface	2018-02-24 08:28:36	2018-02-24 08:30:18	0:01:42	1.8 GB	Download	<input type="checkbox"/>
Request ID: 682301e7-a9fe-4321-8bb7-e45e0af1e92e						
Year:	2012					
Month:	October					
Nominal day:	13					
Variables:	Directional albedo for global land surface variables					
Global surface soil moisture from satellite sensors	2018-02-23 10:27:55	2018-02-23 10:27:55	0:00:00	4.4 MB	Download	<input checked="" type="checkbox"/>
SIS SWICCA: Air climate indicators	2018-02-20 09:23:19	2018-02-20 09:23:19	0:00:00	12.2 MB	Download	<input checked="" type="checkbox"/>
SIS Agriclass: Specialized indicators	2018-02-20 09:22:34	2018-02-20 09:22:36	0:00:01	35.3 MB	Download	<input type="checkbox"/>
SIS: EDgE Gridded indicators of change in annual streamflow	2018-02-20 09:21:44	2018-02-20 09:21:50	0:00:05	61.7 MB	Download	<input type="checkbox"/>
Global glaciers distribution	2018-02-12 15:19:23	2018-02-12 15:19:23	0:00:00	462.2 MB	Download	<input type="checkbox"/>
Greenhouse Gases: Global surface Methane	2018-02-10 11:45:50	2018-02-10 11:45:53	0:00:03	7.8 MB	Download	<input type="checkbox"/>
Greenhouse Gases: Global surface Methane	2018-02-09 23:13:29	2018-02-09 23:13:30	0:00:01	7.8 MB	Download	<input type="checkbox"/>

- 1 Request information:** User have access to submitted requests.
  - *Product:* Short name of requested data product.
  - *Submission/End dates.*
  - *Duration.*
  - *Size of the file.*
  - *Status:*
    - Queued: waiting to by dispatched to provider.
    - Running/In progress: Already dispatched to provider.
    - Download: data ready to be downloaded.
    - Failed: request migh fail. Error message should be presented.
    - Unavailable: requested result data no longer available.

- 2 Request information:** By clicking on the left arrow, detailed information about the scope of the request is dplayed.

- 3 Delete requests:** User can remove old requests from the list by selecting them and clicking on the delete function.

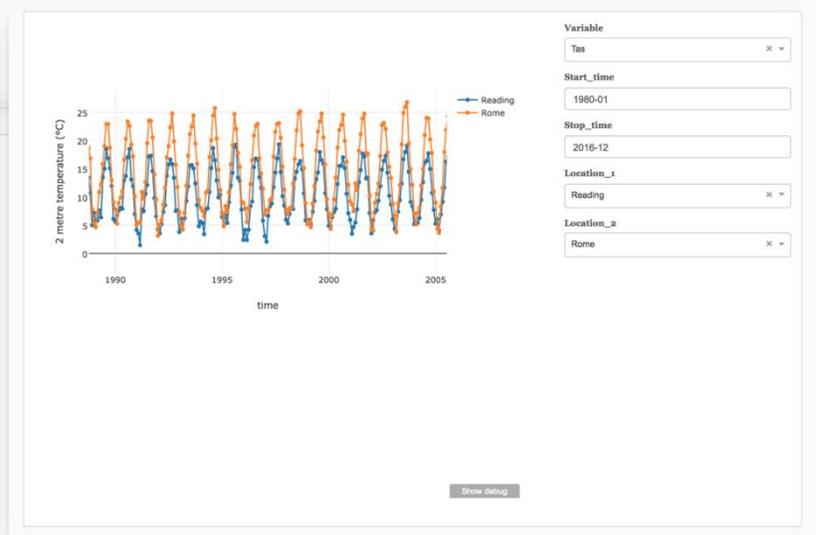
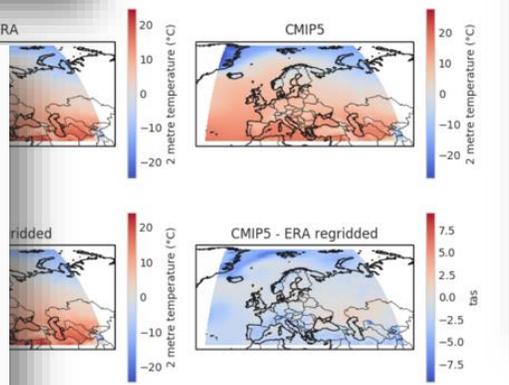
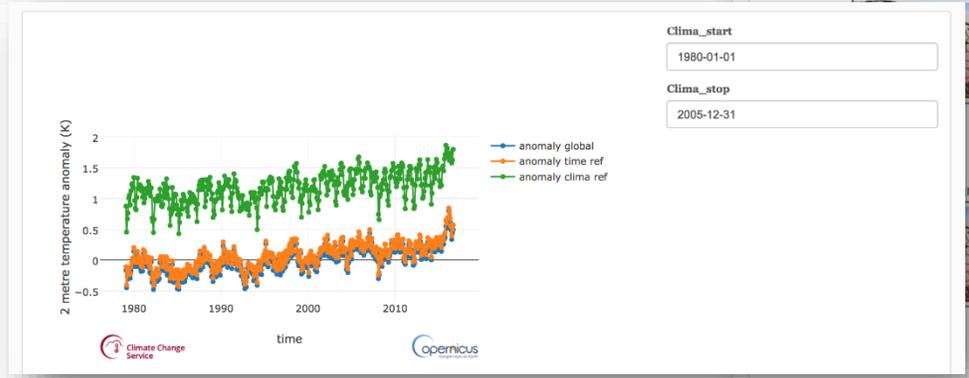
# Climate Data Store - Toolbox



Download [d04fca38b2970f31ec8ff01d7599b57dfd4a4886-0.nc](https://data.copernicus.eu/data-store/d04fca38b2970f31ec8ff01d7599b57dfd4a4886-0.nc)

Show debug

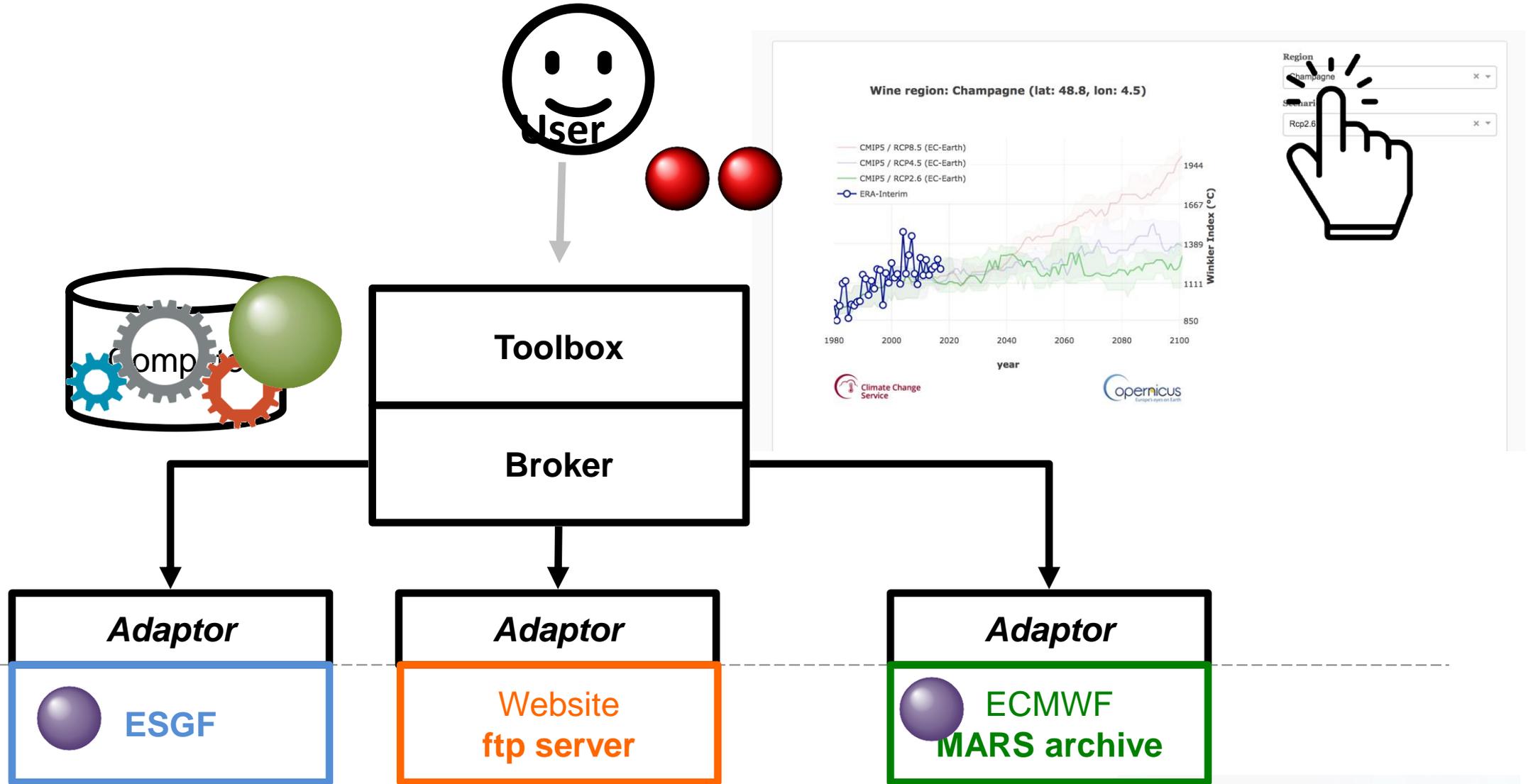
Var: Tas





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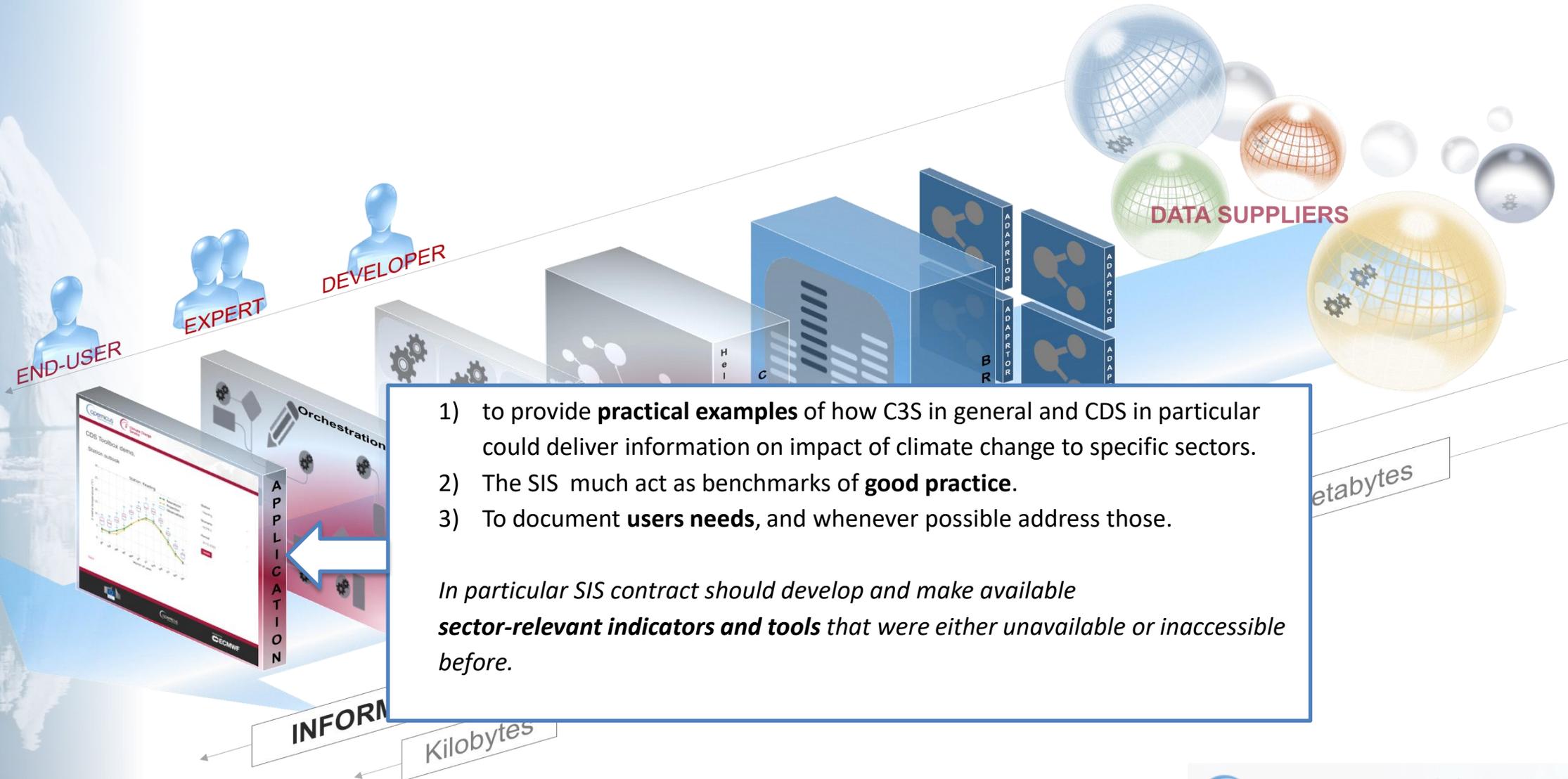
# Concept of the CDS & Toolbox: application development





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# Climate data store – The Sectoral Information System: From TB to Information



- 1) to provide **practical examples** of how C3S in general and CDS in particular could deliver information on impact of climate change to specific sectors.
- 2) The SIS much 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.*



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# Sectoral Information System

## WHAT WILL THE INFORMATION BE USED FOR?

The wealth of climate information will be the basis for generating a wide variety of climate indicators aimed at supporting adaptation and mitigation policies in Europe in a number of sectors. These include, but are not limited to, the following:



## C3S WILL DELIVER SUBSTANTIAL ECONOMIC VALUE TO EUROPE BY:

- 1 **INFORMING**  
POLICY DEVELOPMENT TO PROTECT CITIZENS FROM CLIMATE-RELATED HAZARDS SUCH AS HIGH-IMPACT WEATHER EVENTS
- 2 **IMPROVING**  
PLANNING OF MITIGATION AND ADAPTATION PRACTICES FOR KEY HUMAN AND SOCIETAL ACTIVITIES
- 3 **PROMOTING**  
THE DEVELOPMENT OF NEW SERVICES FOR THE BENEFIT OF SOCIETY



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# S I S c o n t r a c t s

Proof of  
concept

- **The past (2016-2018):**
  - Energy (UEA, CEA), Water (CEH, SMHI), Insurance (CGI), *Urban (SMHI), Agriculture (Telespazio Vega)*

Operational  
phase

- **The present (2018-2019 and beyond):**
  - European: Storm-Surges (Deltares), Fisheries (PML), Tourism (TEC), Cities/Health (Vito)
  - Global: Shipping (OSM), Global Impacts (SMHI), Agriculture (WEnR)
- **The future:**
  - Commenced: Energy, Water, Insurance
  - Coming Soon: Quality Assurance for SIS, Biodiversity, Forestry, Cultural heritage, Case studies, Transport, Disaster Risk Reduction



C2	C3	C4	C5	CP1
User Requirement (UR) description	UR class	Raw requirement	User sector	ECV
Free text. Be specific and quantify statements where possible.	<b>Choose from:</b> - Product (complete CP) - Variable (complete CP) - General (complete CG)	Original text. Extract from project source material.	<b>Choose one or more sector from C3S Sectors:</b> - Agriculture and forestry - Coastal - Disaster risk reduction - Energy - Health - Infrastructure - Insurance - Tourism - Transport - Water management	Use terms fi
Seasonal forecasts of precipitation for the insurance sector should be available before the underwriting/renewal season	Variable	seasonal rainfall forecast: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season.	Insurance	Precipitator
Seasonal forecasts of sea surface temperature for the insurance sector should be available before the underwriting/renewal season	Variable	seasonal forecast of ocean surface temperature: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season.	Insurance	Sea surface
Seasonal forecasts of surface temperature for the insurance sector should be available before the underwriting/renewal season	Variable	seasonal forecast of surface temperature: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season.	Insurance	Surface air t
Seasonal forecasts of tropical cyclone activity, specifically the number of storms, for the insurance sector should be available before the underwriting/renewal season	Variable	seasonal forecast of tropical cyclone activity: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season.	Insurance	
Seasonal forecasts of tropical cyclone activity, specifically the Accumulated Cyclone Energy, for the insurance sector should be available before the underwriting/renewal season	Variable	seasonal forecast of tropical cyclone activity: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season.	Insurance	
Seasonal forecasts of precipitation for the insurance sector should cover the full upcoming year	Variable	seasonal rainfall forecast: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season.	Insurance	Precipitator
Seasonal forecasts of sea surface temperature for the insurance sector should cover the full upcoming year	Variable	seasonal forecast of ocean surface temperature: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season.	Insurance	Sea surface
Seasonal forecasts of surface temperature for the insurance sector should cover the full upcoming year	Variable	seasonal forecast of surface temperature: Seasonal forecast be made available prior to renewal timeline (Jan 1st - April 1st): Seasonal forecasts do not align with insurance timeline. To be truly useful, a seasonal forecast would need to be made prior to the underwriting/renewal season.	Insurance	Surface air t
Seasonal forecasts of precipitation should have more ensemble members to capture full level of uncertainty	Variable	seasonal rainfall forecast: More ensemble to represent uncertainty. Current ensembles do not capture the full level of uncertainty.	Insurance	Precipitator
Seasonal forecasts of sea surface temperature should have more ensemble members to capture full level of uncertainty	Variable	seasonal forecast of ocean surface temperature: More ensemble to represent uncertainty. Current ensembles do not capture the full level of uncertainty.	Insurance	Sea surface
Seasonal forecasts of surface temperature should have more ensemble members to capture full level of uncertainty	Variable	seasonal forecast of surface temperature: More ensemble to represent uncertainty. Current ensembles do not capture the full level of uncertainty.	Insurance	Surface air t
Seasonal forecasts of precipitation should be available at a higher spatial resolution	Variable	seasonal rainfall forecast: Increasing spatial resolution	Insurance	Precipitator
Seasonal forecasts of surface temperature should be available at a higher spatial resolution	Variable	seasonal forecast of surface temperature: Increasing spatial resolution	Insurance	Surface air t
Seasonal forecasts of precipitation should include forecasts of extremes	Variable	seasonal rainfall forecast: make forecast of extremes	Insurance	Precipitator

Already ~1400 entries !



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# Data is not information without users and context: co-design in practice



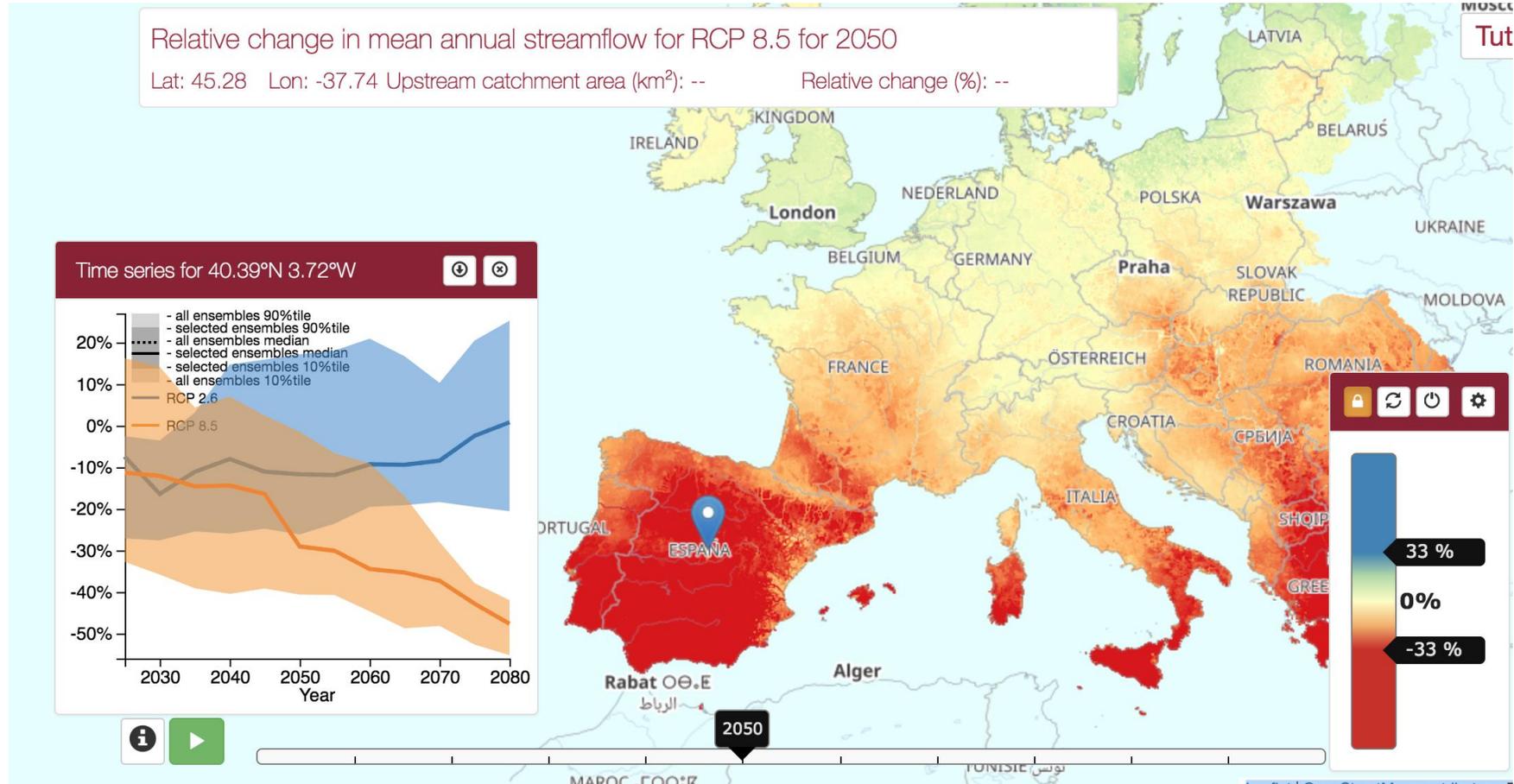
This is a small subset of the set of users SMHI have engaged with in one of our SIS (water) contracts. We had so far 17 of those contracts. It is difficult to summarise all we learnt but:

- 1) Many users just want data: good data, easy to access and well characterized.
- 2) Our primary users are not necessarily the end-user but rather the intermediate ones



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# Example: Water resources and drought



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..

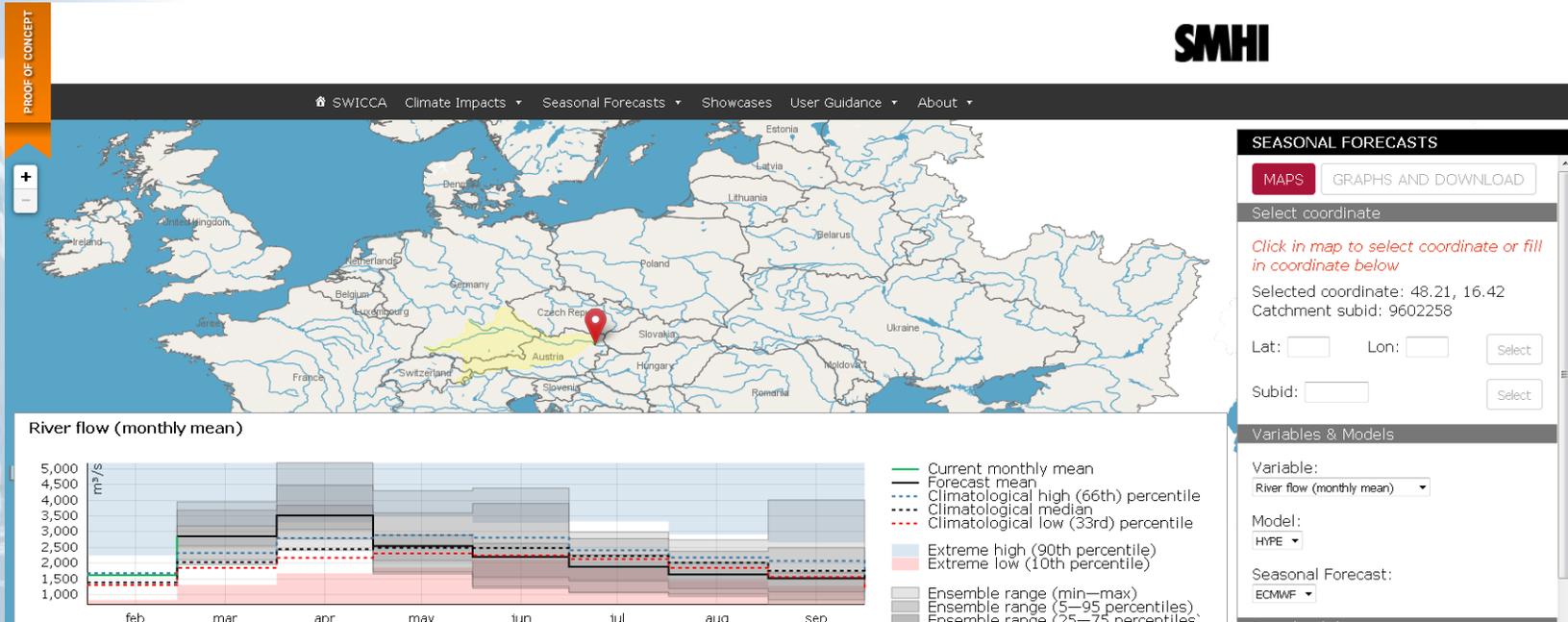
*Samaniego et al. Nature Climate Change* **volume 8**, pages421–426 (2018)  
doi:10.1038/s41558-018-0138-5



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# Operational Water SIS

SMHI



Contract led by SMHI

We entered in an operational contract for water with SMHI.

The contract will provide:

- Multi-model (e-hype, VIC and LISFLOOD) seasonal predictions for a number of t-ECVs and SCIs
- Seasonal Forecasting - Will use ECMWF system 5 inputs to start with.
- Climate change projections for the same variables based on Euro-Cordex
- Will run on ECMWF machines using EC-Flow and will push the data onto the CDS catalogue.



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# Example: Energy Applications

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?

The screenshot displays the Copernicus ECEM Demonstrator interface. At the top, it says "The European Climatic Energy Mixes (ECEM) Demonstrator". The interface includes a sidebar with filters for Countries, Clusters, Demand, Hydro, Wind, Solar (PV only), Variable Type (Capacity Factor, Energy, Power), Temporal Resolution (Daily, Monthly, Seasonal, Annual), and Climate Model (Ensemble Mean, RCM1, RCM2, RCM3, RCM4). The main area shows a map of Europe with several windows overlaid:

- Italy | Projections Solar (PV only) Energy | RCM2 | eHW4 | RC...:** A line chart showing Solar (PV only) (SOL) Energy (NRG) [MWh] from 2020 to 2060. The y-axis ranges from 0 to 200k. The chart shows a highly volatile, sawtooth-like pattern that increases over time.
- France - Historical Demand:** A line chart showing Demand (DEM) Power (PWR) [MW] from 1986 to 1996. The y-axis ranges from 10k to 90k. The chart shows a clear seasonal cycle with peaks around 70-80k MW and troughs around 20-30k MW.
- Projections Solar (PV only) Energy | RCM2 | eHW4 | RCP8.5:** A map showing projected solar energy with a color scale legend from 0MWh to 0.4TWh.
- Historical Demand:** A map showing historical demand with a color scale legend from 2GW to 94GW.

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



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# Insurance services – Wind Storm Database

Secure https://wisc.climate.copernicus.eu/wisc/#/indicators

WISC HOME PRODUCTS EXPLORE USER GUIDANCE ACCOUNT HELP C3S

## Historic Losses

home > Historic Losses

This interactive visualisation shows economic losses estimated using the footprints of the most extreme windstorms to hit Europe between 1979 and 2013.

The purpose of these data is to provide consistent loss estimates across all the storms, using an open method.

For further details, click [here](#).  
For help on using the tool, click [here](#).

### Controls

Loss type:

Total

Aggregate by year

Sort countries:

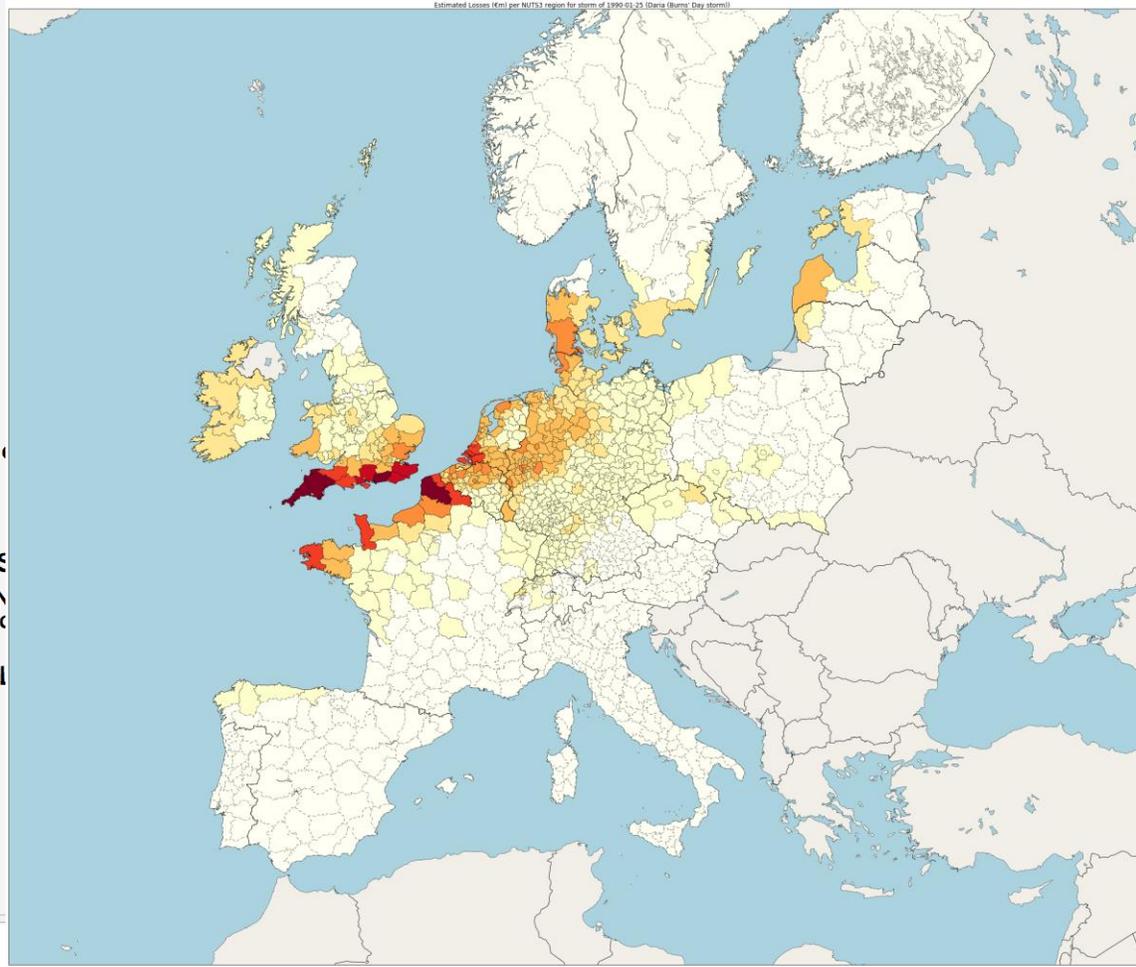
Alphabetically

By Total Damage

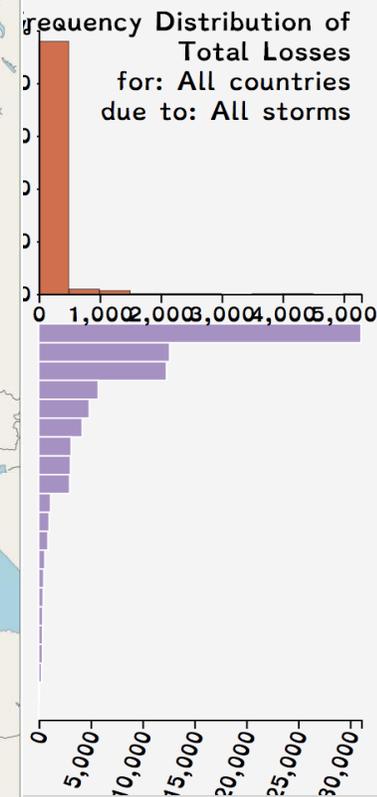
Sort storms:

Chronologically

By Total Damage



Frequency Distribution of Total Losses for: All countries due to: All storms



# www.climate.copernicus.eu

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