



Climate Change

# Copernicus Climate Change Service

Entebbe, Uganda, 31 October – 2 November 2018

**Cedric BERGERON**, European Centre for Medium-Range weather forecast (ECMWF)



European  
Commission





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# C O P E R N I C U S

**Copernicus**, previously known as GMES (Global Monitoring for Environment and Security), is the **European Programme** for the establishment of a European capacity for **Earth Observation**

A graphic for the Copernicus Earth Observation Program. It features a central image of Earth from space, with a satellite in orbit. To the right, a list of services is provided, each with a corresponding icon. The text 'FULL, FREE AND OPEN ACCESS TO DATA' is positioned above the satellite icon. The Copernicus logo and tagline 'Europe's eyes on Earth' are at the bottom.

FULL, FREE AND OPEN  
ACCESS TO DATA

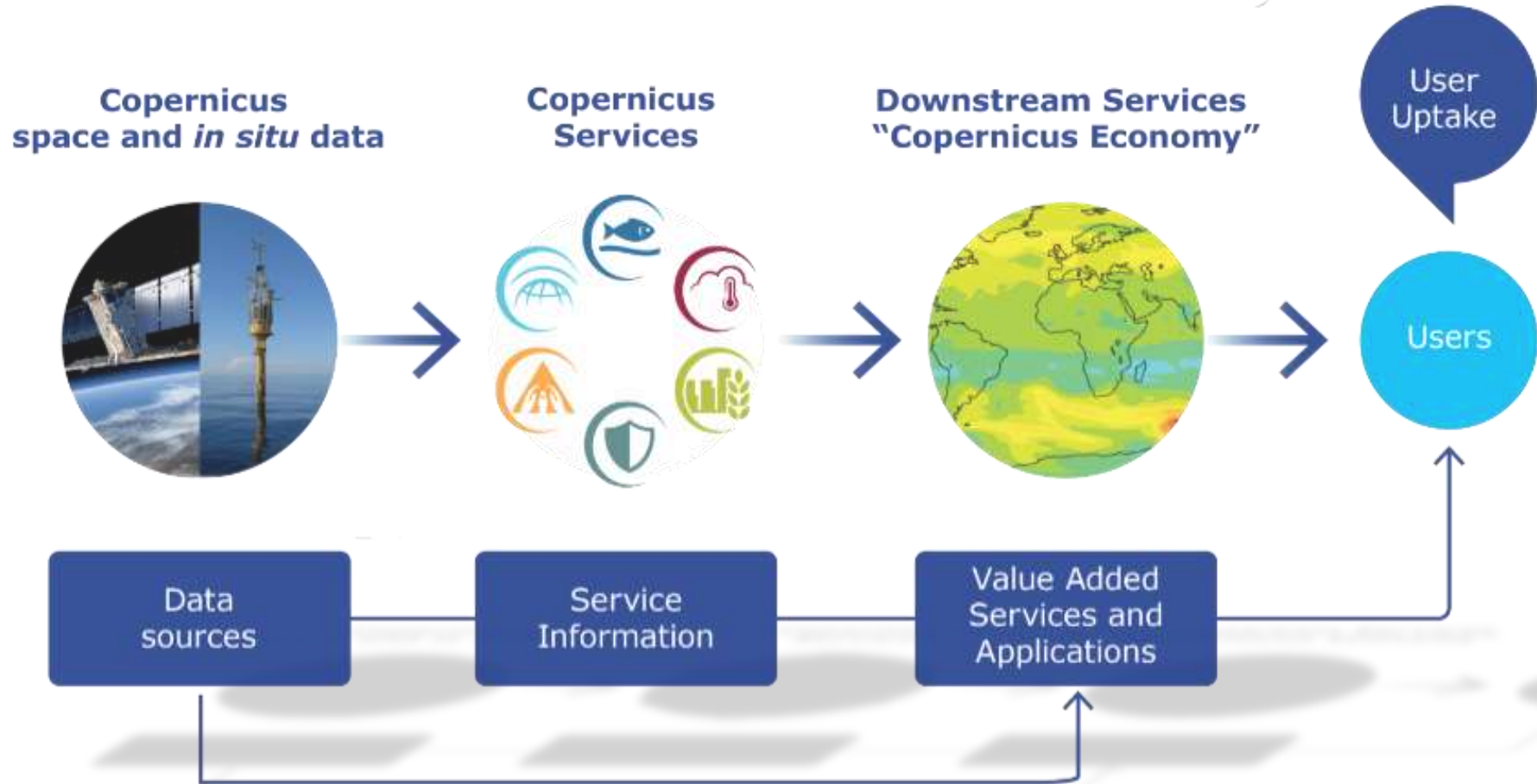
- ATMOSPHERE MONITORING
- MARINE ENVIRONMENT MONITORING
- LAND MONITORING
- CLIMATE CHANGE
- EMERGENCY MANAGEMENT
- SECURITY

**copernicus**  
Europe's eyes on Earth



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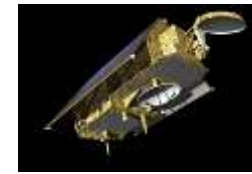
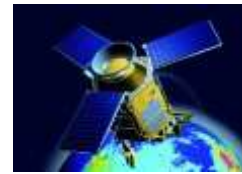
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# Copernicus Space Component: Dedicated Missions



**S1: Radar Mission**



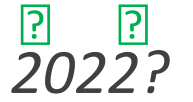
**S2: High Resolution Optical Mission**



**S3: Medium Resolution Imaging and Altimetry Mission**



**S4: Geostationary Atmospheric Chemistry Mission**



**S5P: Low Earth Orbit Atmospheric Chemistry Precursor Mission**



**S5: Low Earth Orbit Atmospheric Chemistry Mission**



**S6 (Jason-CS): Altimetry Mission**







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# C O P E R N I C U S





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# C O P E R N I C U S Climate Change service - C 3 S

The European Commission has **entrusted** ECMWF with the implementation of the **Copernicus Climate Change Service – C3S**





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## The C3S mission

### To support European adaptation and mitigation policies by:

- Providing consistent and authoritative information about climate
- Building on existing capabilities and infrastructures (nationally, in Europe and worldwide)
- Stimulating the market for climate services in Europe





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# What C3S provides

- Access to climate data
- Tools needed to use the data
- Information on sectoral impacts
- Quality assurance
- User support and training
- Climate change assessments
- Outreach and communication

The screenshot shows the top navigation bar of the Climate Change Service website, including the logo, navigation links (ABOUT US, WHAT WE DO, DATA, SEARCH), and logos for the European Commission, Copernicus, and ECMWF. The main content area features a heading 'What we do' followed by a paragraph: 'Our core objective is to provide reliable access to high-quality climate data. We do this through our Climate Data Store (CDS). We also offer tools and expert guidance that make it possible to transform the data into more visual products, such as maps and charts.' Below this is a grid of four service cards: 'Climate datasets', 'Tools for using climate data', 'Sectoral impacts', and 'Quality assurance'. Each card includes a brief description and a 'Read more' button.

## What we do

Our core objective is to provide reliable access to high-quality climate data. We do this through our Climate Data Store (CDS). We also offer tools and expert guidance that make it possible to transform the data into more visual products, such as maps and charts.

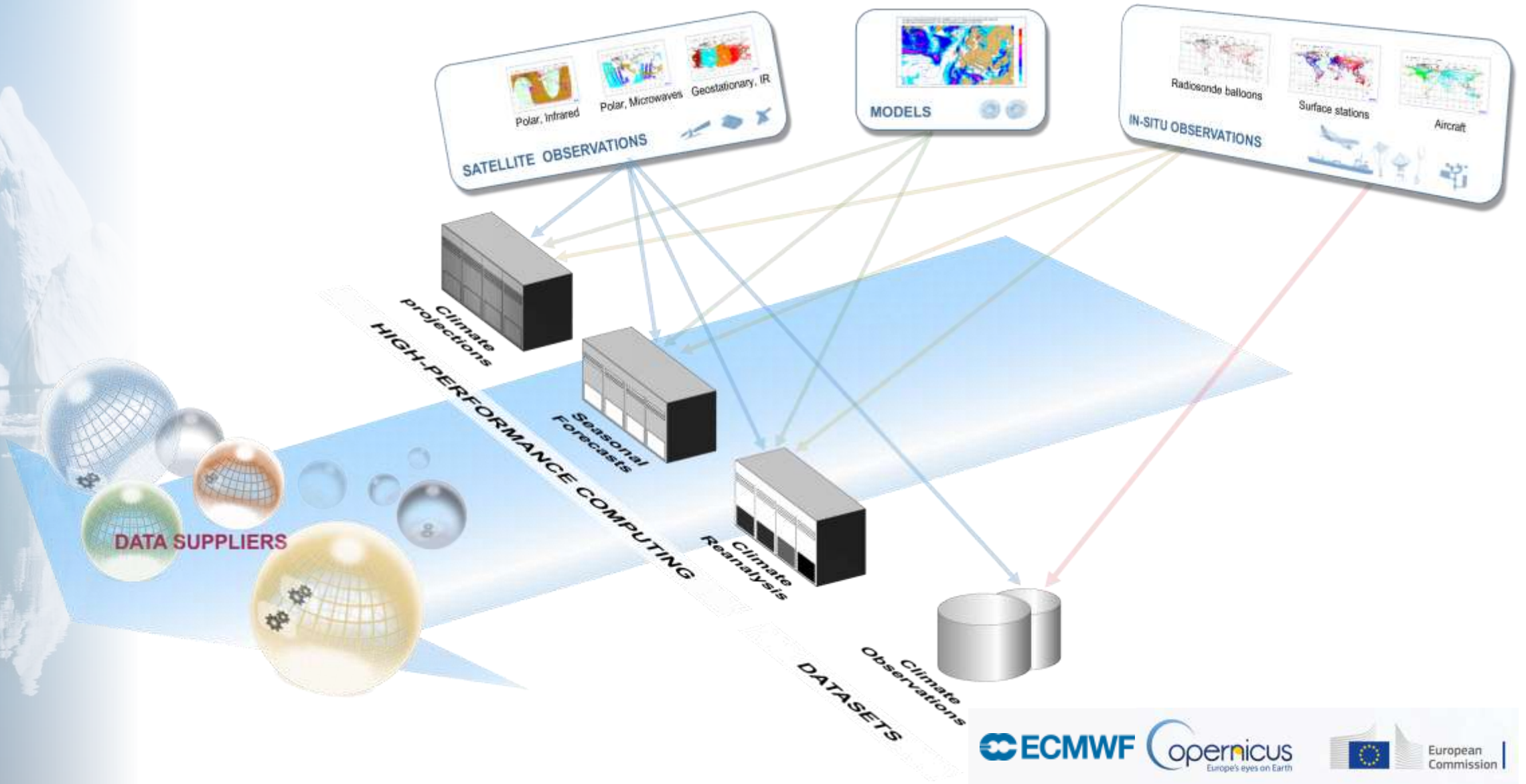
- Climate datasets**  
The CDS provides a single point of access to a variety of climate datasets, including observations, reanalyses of past observations, seasonal forecasts and climate model projections.  
[Read more](#)  
[Browse the CDS data catalogue](#)
- Tools for using climate data**  
The CDS features a powerful toolbox for processing and visualising data in the cloud, so that users can develop climate information suited to their needs.  
[Read more](#)  
[Browse the CDS toolbox](#)
- Sectoral impacts**  
We provide real applications of CDS data and tools that demonstrate how businesses, governments and citizens can make informed decisions on how to mitigate the effects of climate change.  
[Read more](#)
- Quality assurance**  
We provide quality assurance for all CDS data, tools and applications. We continuously engage with users and independent experts to evaluate our services and ensure that they are fit for purpose.  
[Read more](#)





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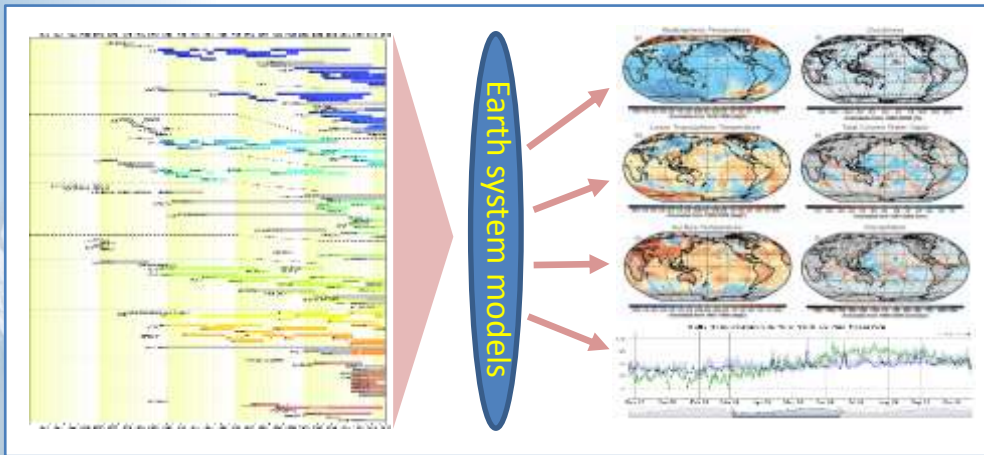
# What do we mean by Data?





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# Access to past, present and future climate information



Observations and climate reanalysis

Seasonal forecast data and products

Climate model simulations

**Seasonal forecasts**

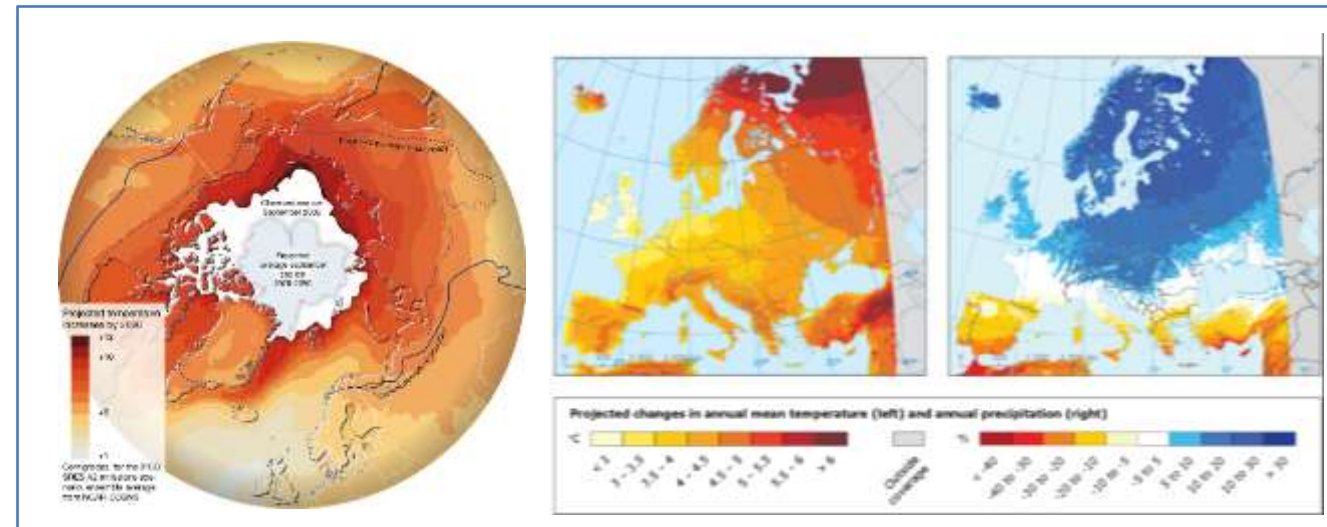
ECMWF Met Office Meteo-France  
NDJ 2017/18

Mean forecast SST anomaly

Normal forecast date: 01/09/17

Reference: standard mean

Legend: -0.5°C, -0.1°C, 0.1-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-2.5, 2.5-3.0, 3.0-3.5, 3.5-4.0



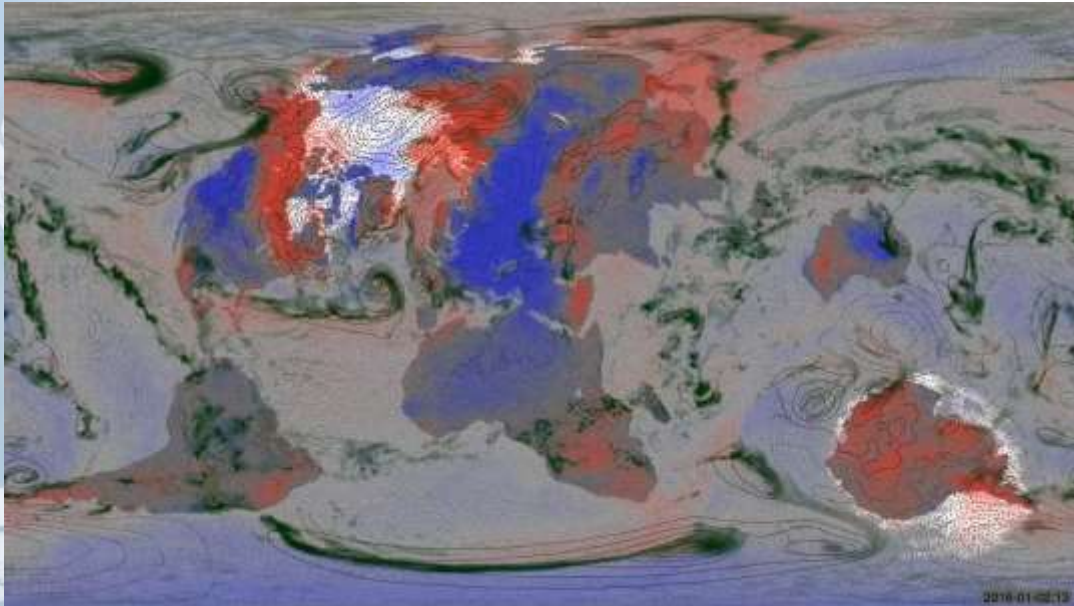




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# C3S: Reanalysis based Essential Climate Variables (30km global ERA5)

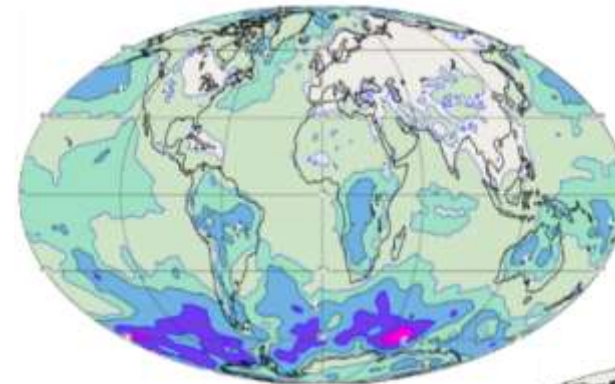
## Hourly data and increased number of parameters



Courtesy: Philip Brohan

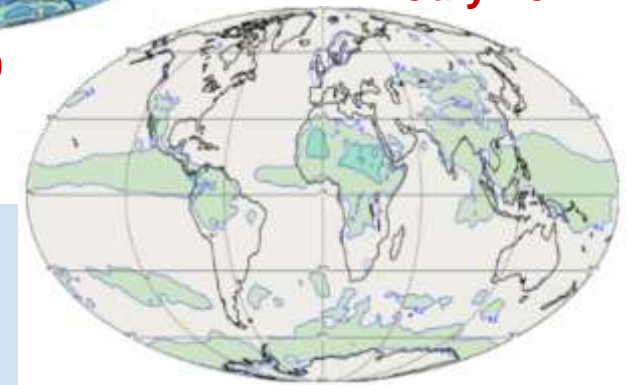
## Uncertainty estimate

Spread in Surface Pressure (hPa)



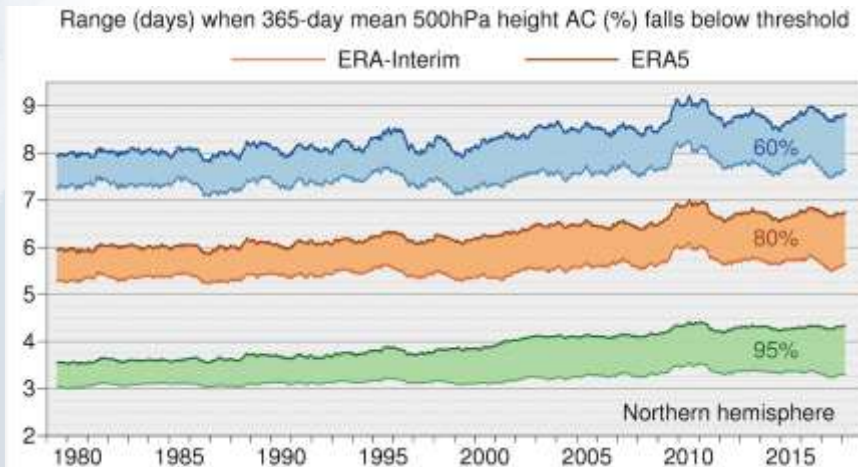
January 1979

July 2014



ERA5 Almost complete!

(1979/2018)



### Reflects variations in:

- ingested observing system
- flow-dependent sensitivity

Credit: H. Hersbach, ECMWF





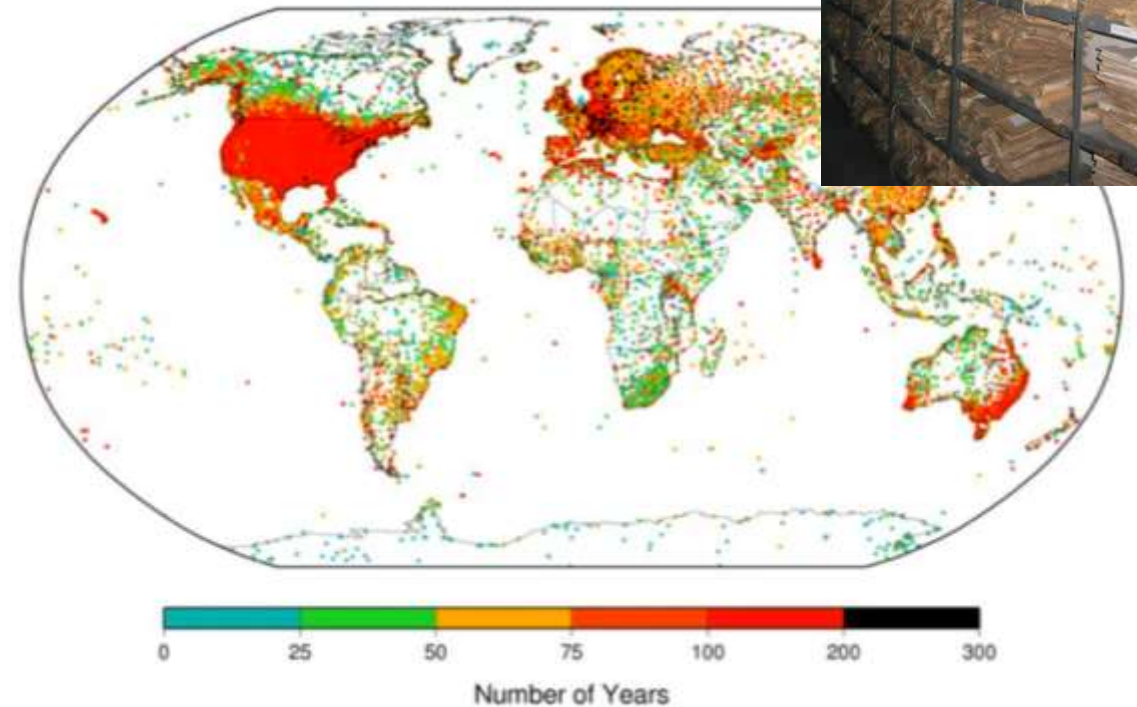




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# C3S and in-situ observations

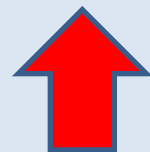
- EO - Lot 1: C3S data rescue
- EO - Lot 2: Observations from global climate data archives
- EO - Lot 3: Observations from Basins and Reference Networks
- EO - Lot 4: High-resolution ECV products for Europe



# C3S: Operational production of climate indicators



Surface temperature



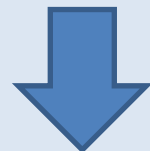
Greenhouse gases



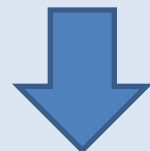
Rain



Sea Ice



Glaciers



Sea Level



Soil Moisture



*Credit: Victor & Kennel, Nature Climate Change, 2014.*

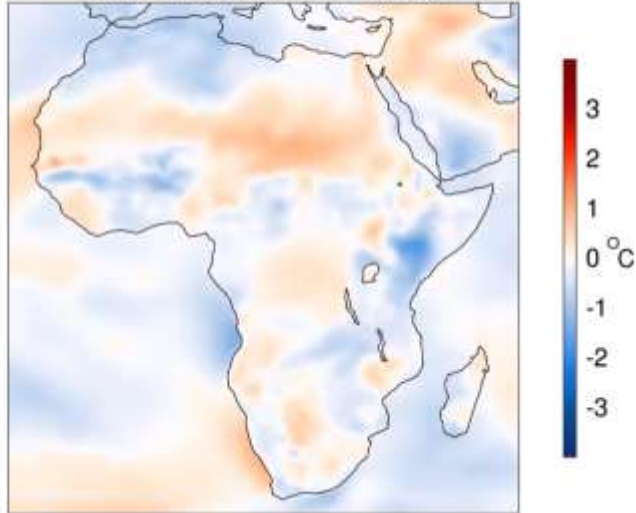




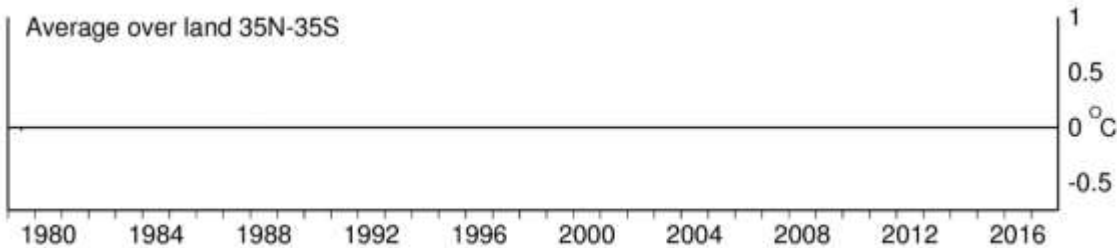
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# Monthly State of Climate

Surface air temperature averaged from 197901 to 197912 relative to its 1981-2010 average

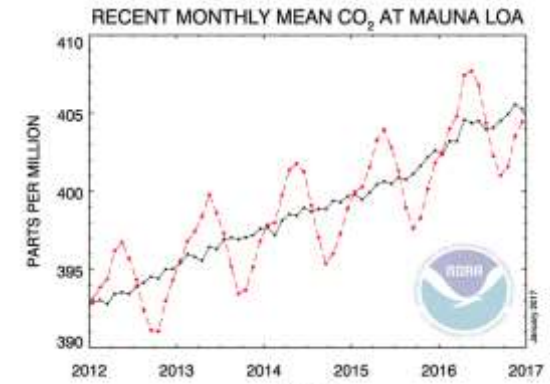


Average over land 35N-35S



## Climate drivers:

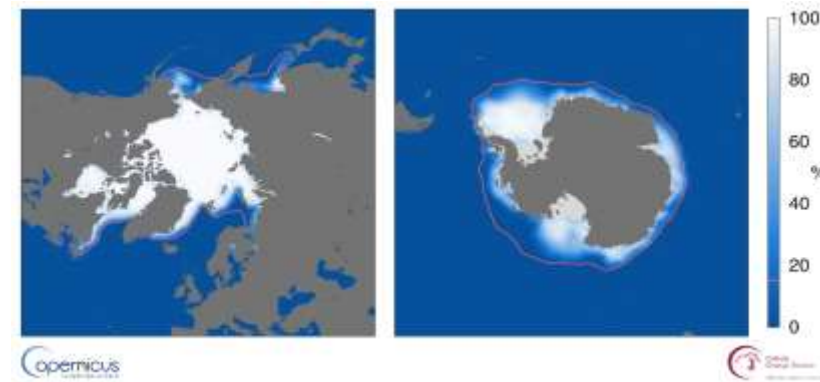
- Greenhouse gases, aerosols, ...



## Climate impacts:

- Temperature, precipitation, sea-ice, sea level, etc.

Sea-ice cover for April 2017. The pink line denotes the climatological ice edge for April for the period 1981-2010. Source: ERA-Interim



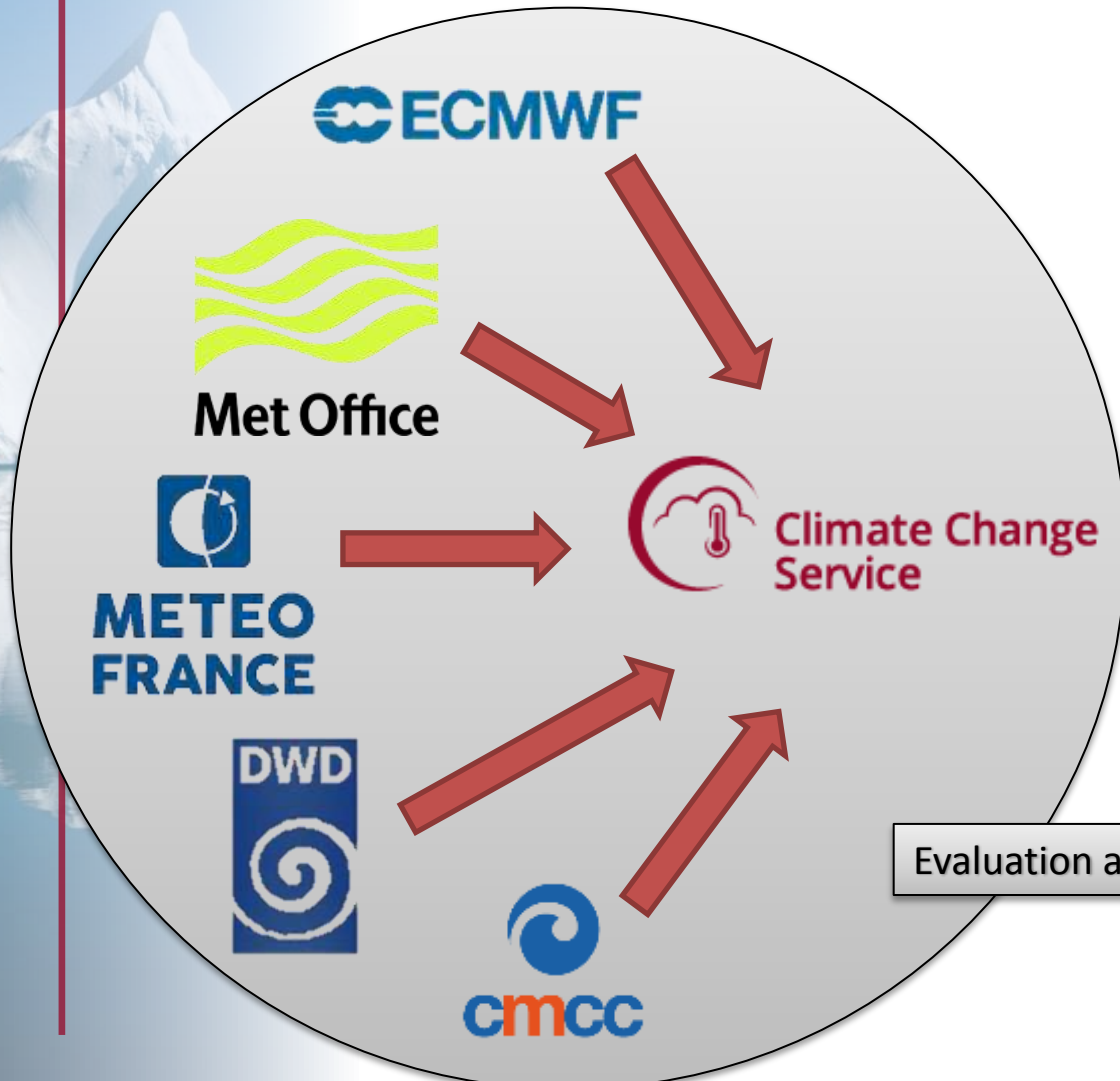




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# C3S seasonal forecasts

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)

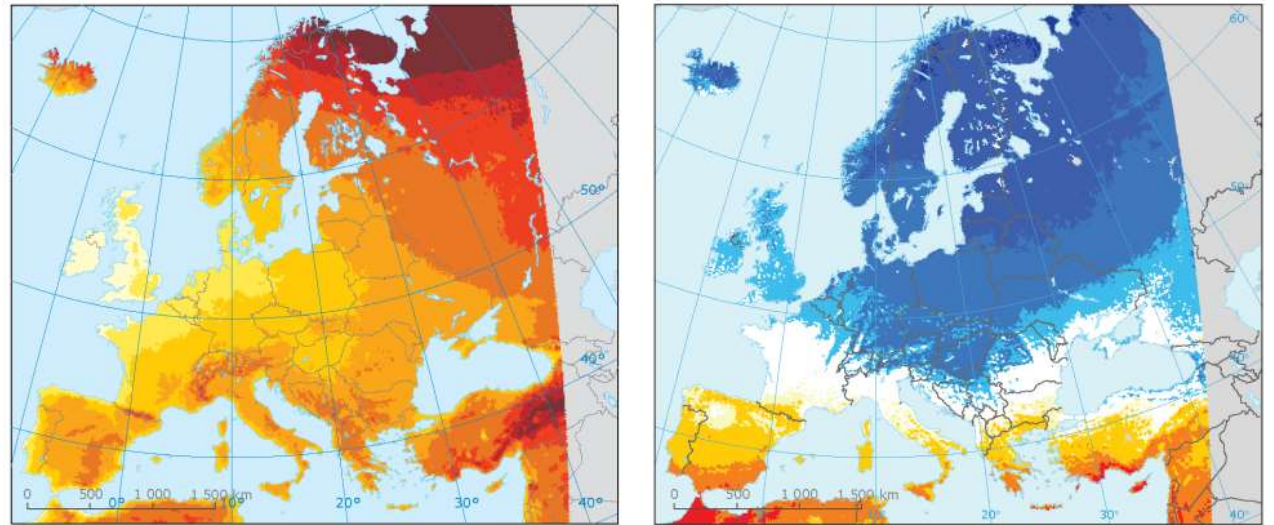
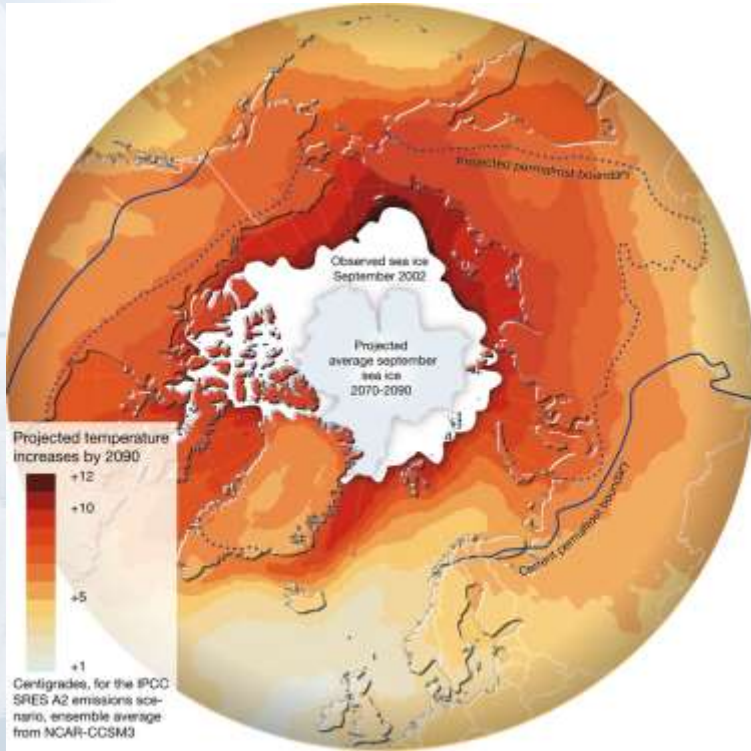




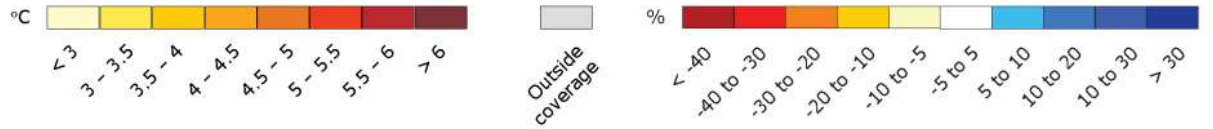
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# Climate projections

**Service:** 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)

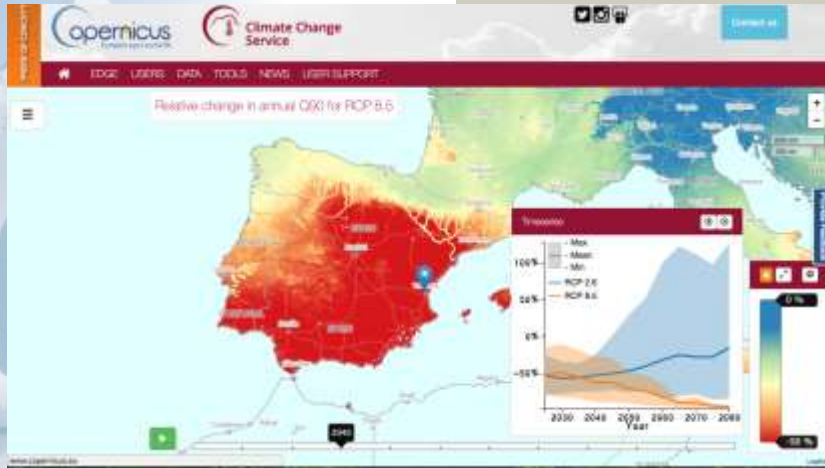




# S e c t o r a l I n f o r m a t i o n S y s t e m

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Proof-of-concepts of climate services:  
Demonstration of the value chain  
with end-to-end demonstrators



ALL THE INFORMATION BE USED FOR?

will be the basis for generating a wide variety of climate indicators aimed at informing policy development 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:

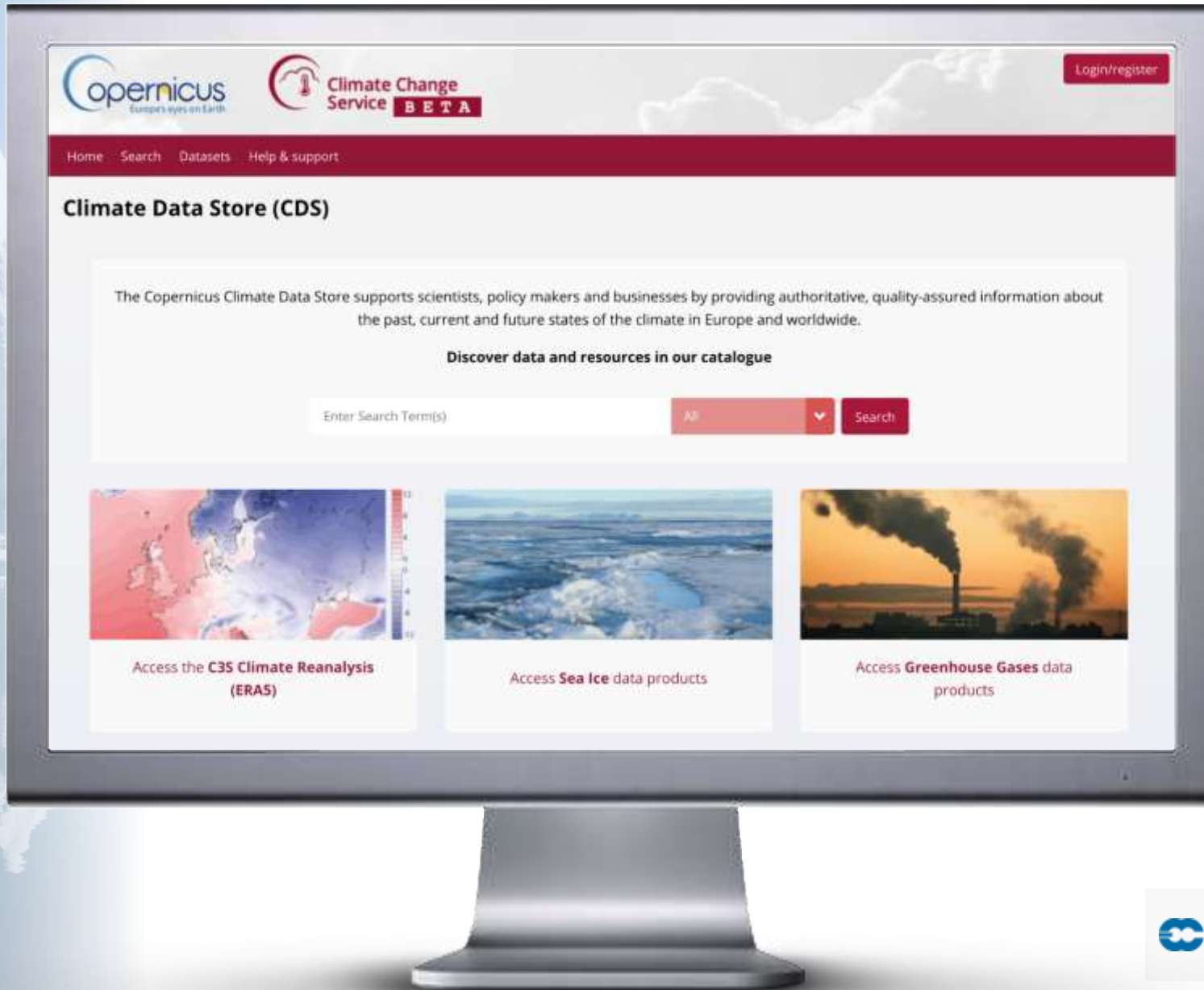
- 1 **INFORMING**  
POLICY DEVELOPMENT TO PROTECT CITIZENS FROM CLIMATE-RELATED HAZARDS SUCH AS HIGH-IMPACT WEATHER EVENTS
- 2 **IMPROVING**  
PLANNING OF MITIGATION AND ADAPTATION PRACTICES FOR KEY HUMAN AND SOCIETAL ACTIVITIES
- 3 **PROMOTING**  
THE DEVELOPMENT OF NEW SERVICES FOR THE BENEFIT OF SOCIETY

**As an operational Service, C3S has the ambitions to become an enabler of downstream climate services, by providing or brokering high quality and sector relevant climate data, good practices, tools and compelling use cases.**





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The CDS contains **observations**, global and regional **climate reanalyses**, global and regional **climate projections** and **seasonal forecasts**. It also contains generic and **sectoral climate indicators**.

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



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# C3S ecosystem



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etc...



National Climate Services

- Value chain at local level, governments, etc.
- Provision of pan-European dimension for national businesses



EEA (Climate Adapt):

- State of Climate for Europe
- Climate Indicators
- CDS toolbox
- CC IV report

DG-Clima



GFCS:

- Global products (ECVs, reanalyses, seasonal forecasts and projections)
- WIS compliance
- Training and outreach
- Global SIS
- Liaison with RCCs



H2020/ERA4CS/JPI/KIC/etc.:

- CDS as a data resource
- Liaison with RD projects
- Underpinning science

Coordination with DG-DEVCO



GEO & UNFCCC:

- C3S discoverable through GEOSS portal
- Contribution to many SDGs



WMO & GCOS:

- C3S ECVs and global indicators
- WMO State of the Climate



NOAA:

- Coordination on observations and CDR issues with NCEI
- In-kind contribution of NCEP seasonal forecasts





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# Conclusions

- C3S has developed a state-of-the-art cloud infrastructure that makes it simple for users to freely access an unprecedented range of quality-controlled climate data and information.
- C3S serves a wide range of European and worldwide users and bodies: EU DGs, WMO, GCOS, GFCS, EEA, etc.
- The Climate Data Store provides a compute layer allowing users to create and run their own applications/workflows on the cloud without downloading huge volumes of data.
- The system comes with a series of exemplar applications to show how the infrastructure can be used to address specific user needs:
  - SISs (Europe, Global), Use Cases, Demonstrators
  - Downstream Services
- Training (including training the trainers) is now becoming an important component of the Service
- The Quality Assurance process within C3S is unique and absolutely critical



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[climate.copernicus.eu](https://climate.copernicus.eu)

Thank You

Implemented by ECMWF as part of The Copernicus Programme

News Events Press Tenders Help & Support

**Climate Change Service** ABOUT US WHAT WE DO DATA QSEARCH

European Commission Copernicus ECMWF x close

We support scientists, policy makers and businesses by providing authoritative, quality-assured information about the past, present and future climate.

Key products and services

- Climate bulletins
- Climate Data Store
- Data in action

**In focus**  
Welcome to the 'European State of the Climate 2017' report, compiled by the Copernicus Climate Change (C3S) and Atmosphere Monitoring (CAMS) Services.

Read More ▶