# Copernicus Climate Change Service (C3S)

Climate Change

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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 capabilitie**s and infrastructures (nationally, in Europe and worldwide)
- **Stimulating the market** for climate services in Europe

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# Climate Change Service: Solutions

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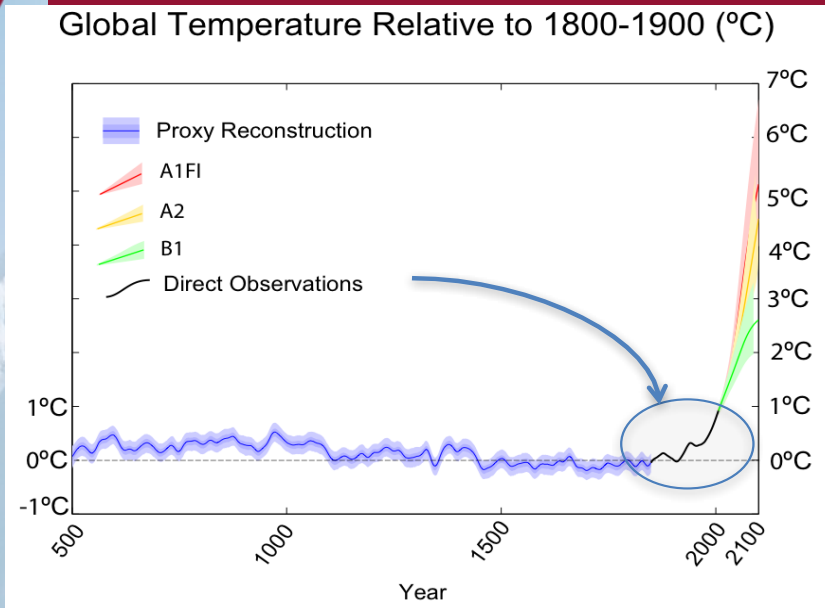


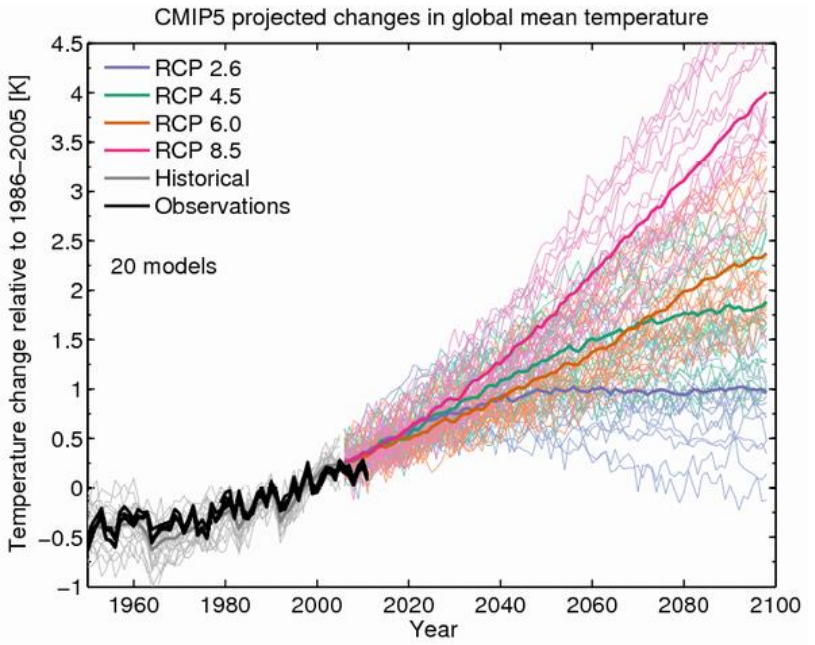


- How is the climate changing?
- How will it change in future?
- How will it impact society?

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# **Past**, present and future climate information

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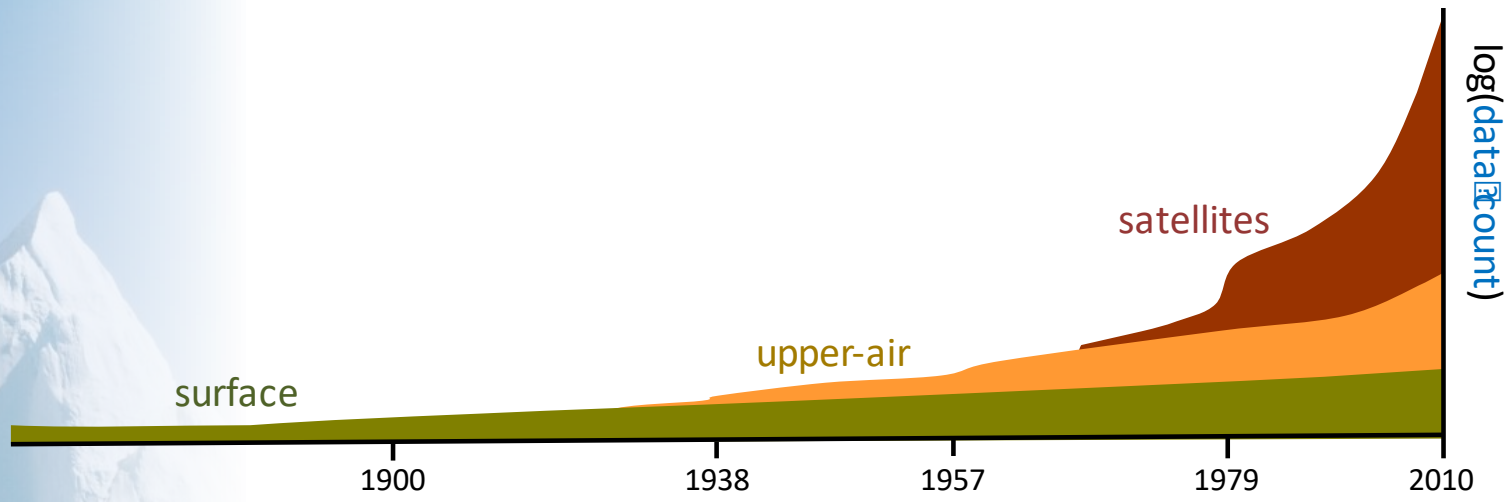
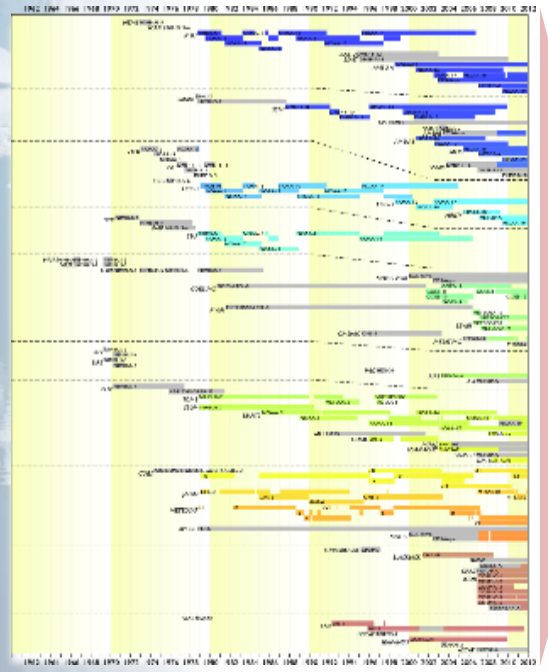
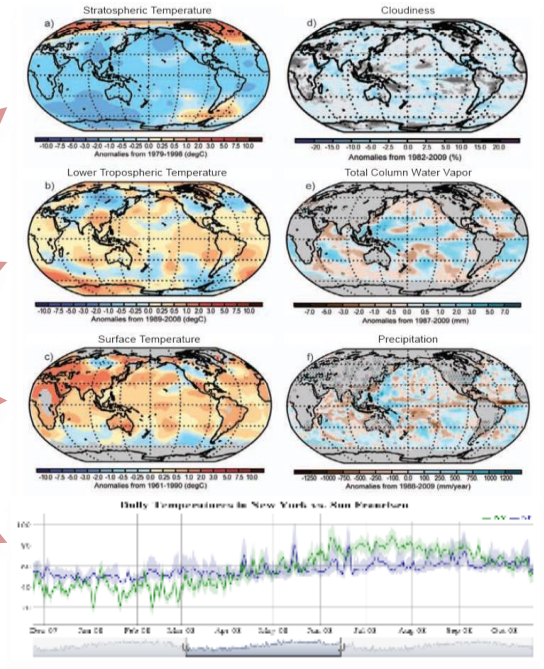



## Past Observations

- Exponential increase
- EO data since 1979




## Climate Reanalysis

e.g. ERA-5.

Many observation data feed into physical Earth System Models to produce multidimensional data sets.

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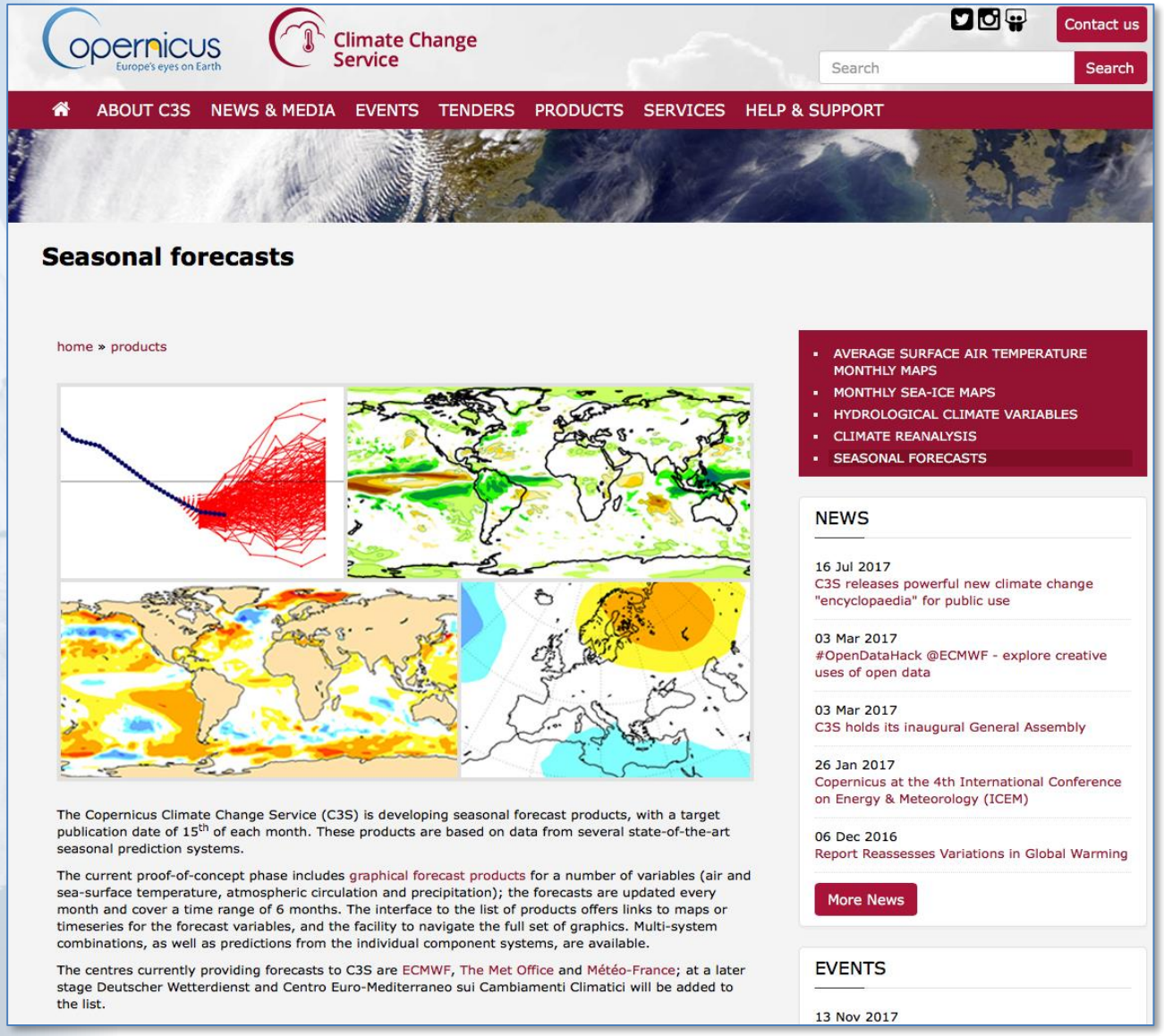
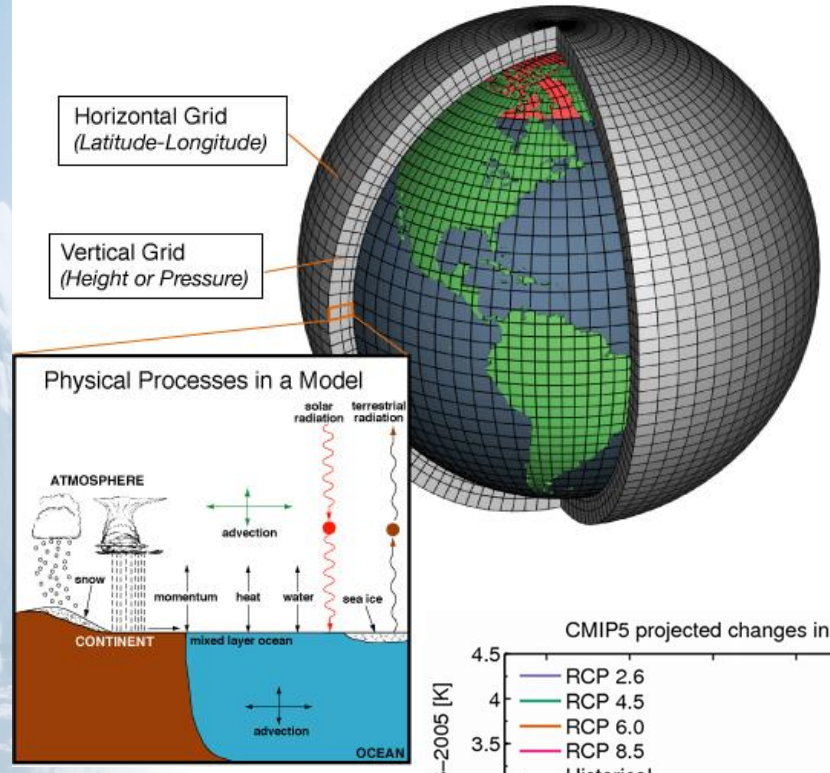
# Past, **present** and future climate information

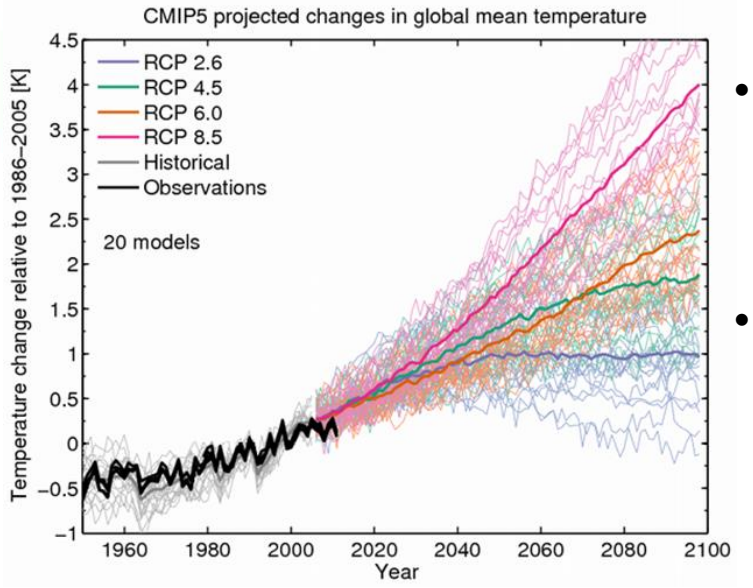



## Seasonal Forecasts

- C3S regularly publishes seasonal forecast products
- Updated every month – currently on the 13th day at 12 UTC
- Cover a time range of six months.
- Includes data as well as graphical products
- Based on data from several state-of-the-art seasonal prediction systems.

## Past, present and **future** climate information




# Climate Projections

- Simulations of Earth's climate in future decades, typically until 2100
- From numerical models of Earth system physics, assuming various 'scenarios' (RCP) for the concentrations of greenhouse gases, aerosols, and other atmospheric constituents that affect the planet's radiative balance.
- Global Climate Models (GCMs) – also known as General Circulation Models – from the Coupled Model Intercomparison Project phase 5 (CMIP5).
- Regional Climate Models (RCMs) from the Coordinated Regional Climate Downscaling Experiment (CORDEX).

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# Essential Climate Variables

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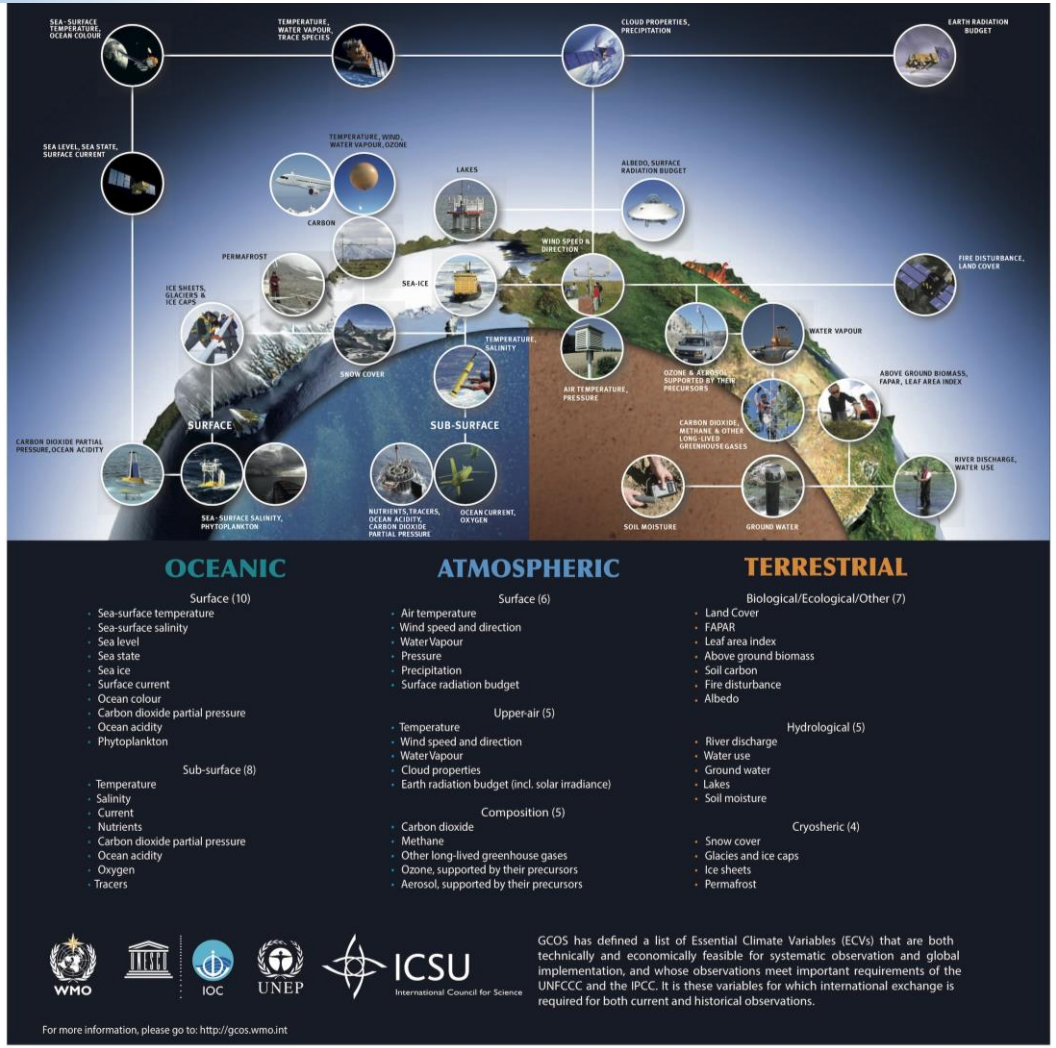
## Global Climate Observing System (GCOS) list of Essential Climate Variables (ECV)




## ECVs supported by C3S contracts

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

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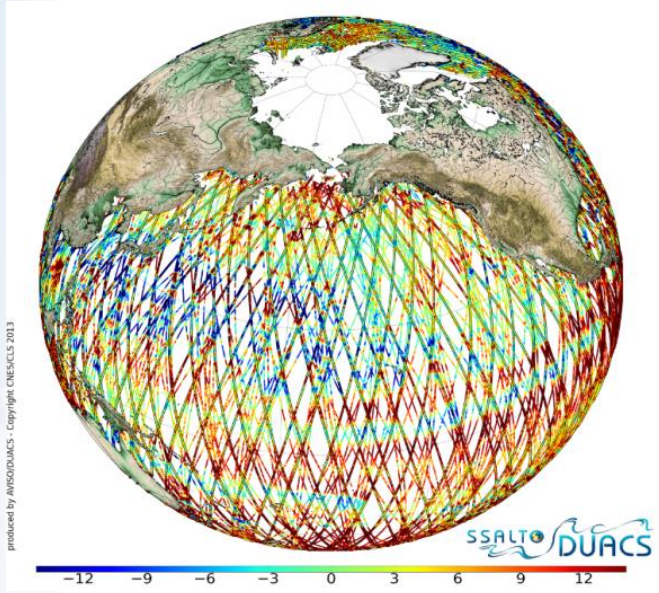
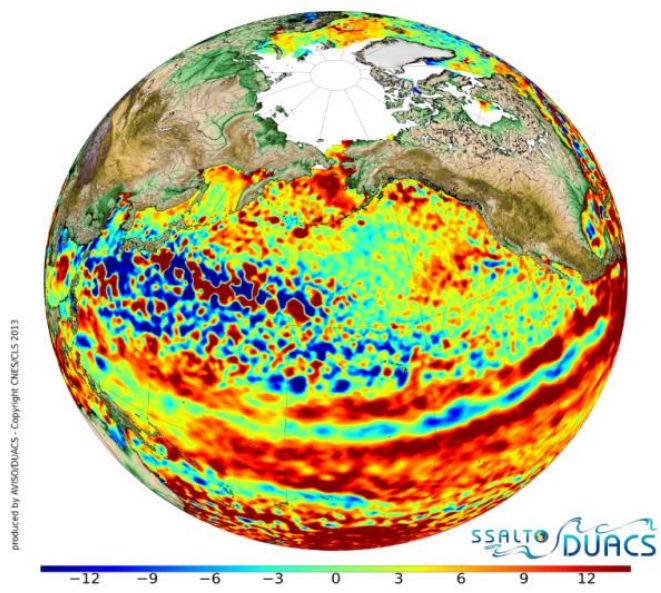
# Example: Sea Level ECV production service

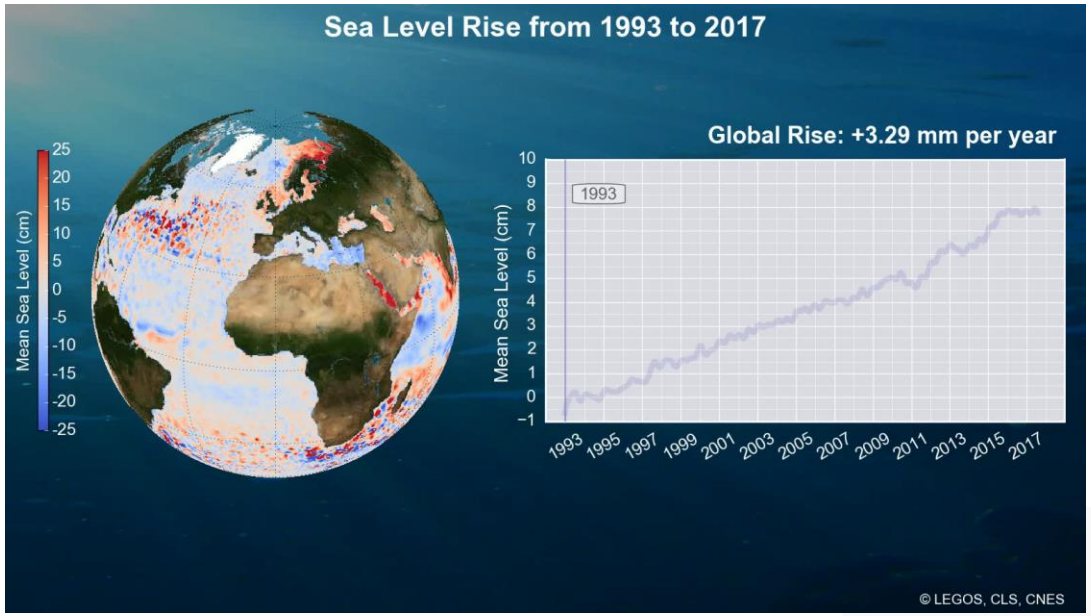



From satellite along-track altimetry measurements…

… to sea level gridded maps…




… to derive Ocean Monitoring Indicators

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# C3S and UNFCCC Sustainable Development Goals

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| C3S contribution to SDGs | |
|---|---|
| 2 ZERO HUNGER | C3S SIS addresses agriculture, and some of the global services will focus on food security |
| 3 GOOD HEALTH AND WELL-BEING | C3S SIS addresses health, providing relevant climate change indicators |
| 6 CLEAN WATER AND SANITATION | Two Proof-of-concept SIS projects in C3S dedicated to water management. A urban PoC SIS is also addressing this SDG at city level. |
| 7 AFFORDABLE AND CLEAN ENERGY | Two proof-of-concept SIS projects in C3S dedicated to the Energy Sector. Reanalyses (produced by C3S) are also highly relevant. |
| 8 DECENT WORK AND ECONOMIC GROWTH | C3S activities contribute indirectly to this SDG insofar that the energy climate impact indicators (see goal 7) are relevant. |
| 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE | C3S is working closely with the standardisation community (via DG-CLIMA) on developing climate change information required for the writing of standards in infrastructure and transport. |

| C3S contribution to SDGs | |
|---|---|
| 11 SUSTAINABLE CITIES AND COMMUNITIES | C3S SIS related to urban aspects of climate change, as well as health and infrastructure aspects, contribute indirectly to this SDG. Reanalysis products too. |
| 12 RESPONSIBLE CONSUMPTION AND PRODUCTION | C3S SIS products and indicators on water management are directly relevant for this goal. |
| 13 CLIMATE ACTION | ECV products, including from reanalysis, CDRs, seasonal forecasts and climate scenarios, directly relevant for adaptation. The SIS also delivers relevant indicators in support of adaptation. Cooperation: EEA Climate ADAPT |
| 14 LIFE BELOW WATER | Some of the ECV products generated by C3S (including reanalysis ORAS5) are ocean relevant. This is done in coordination with CMEMS. |
| 15 LIFE ON LAND | Biodiversity is a future sectoral application of C3S. Relevant products will contribute to this goal. ECV products on soil moisture, forestry, lakes, also contribute to this goal. |

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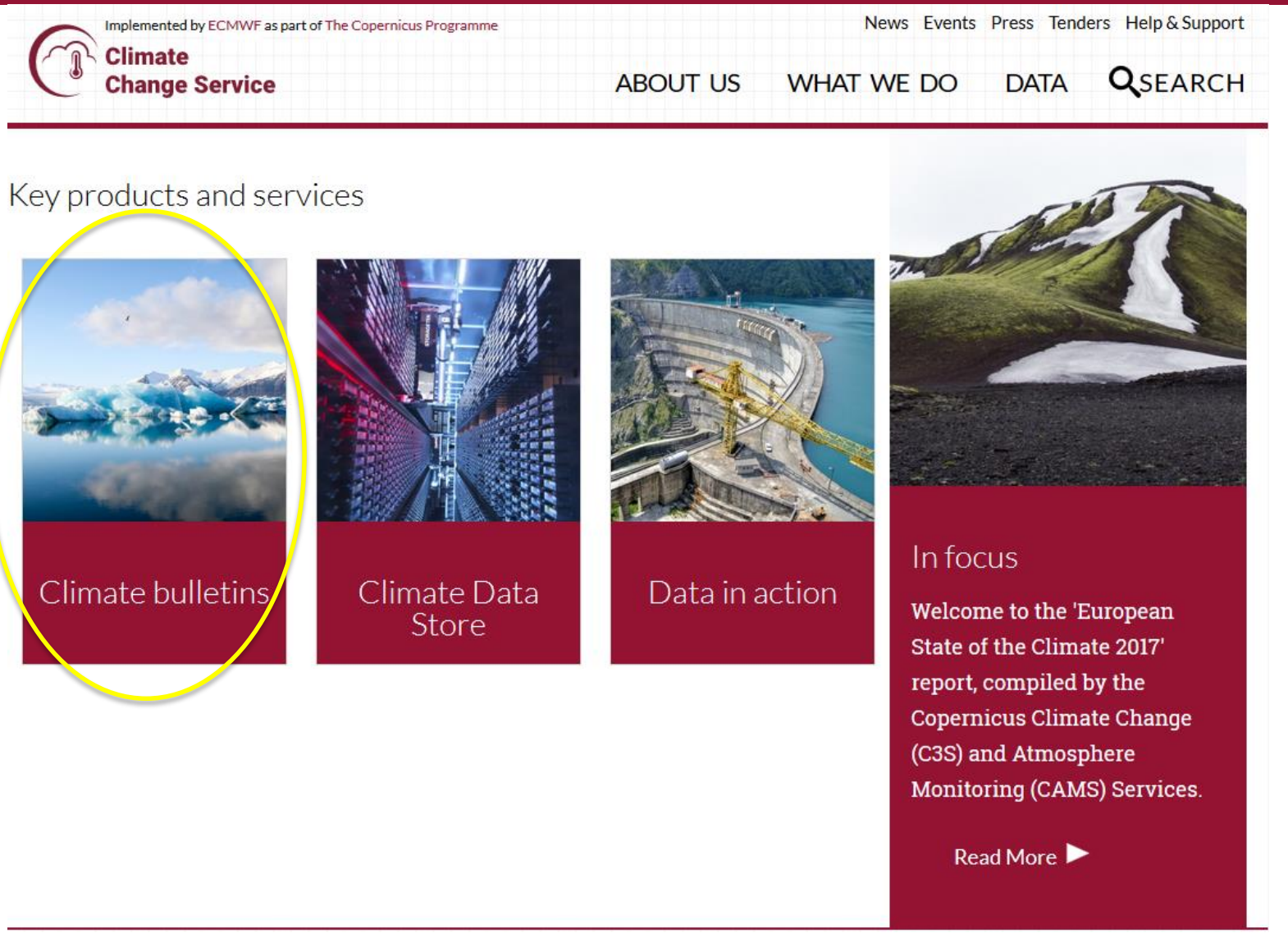
# https://climate.copernicus.eu/

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# Monthly Climate Bulletin

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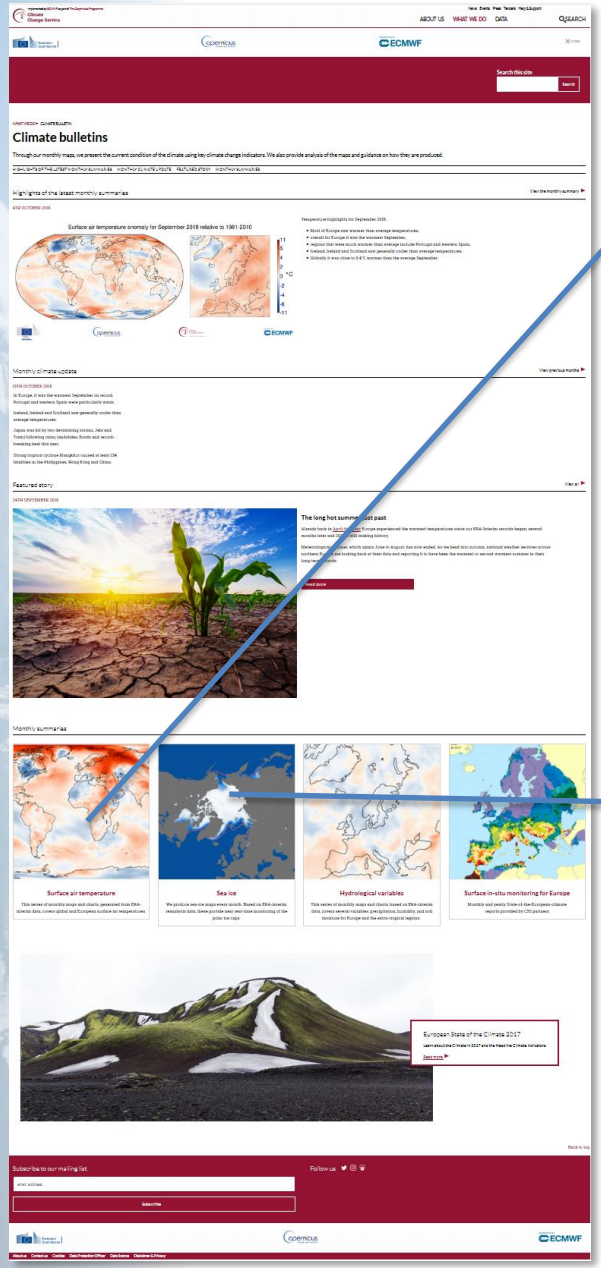
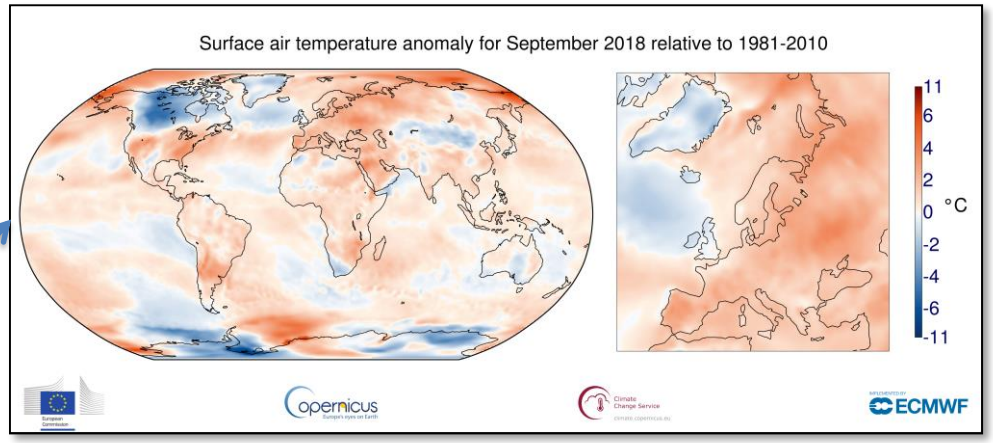
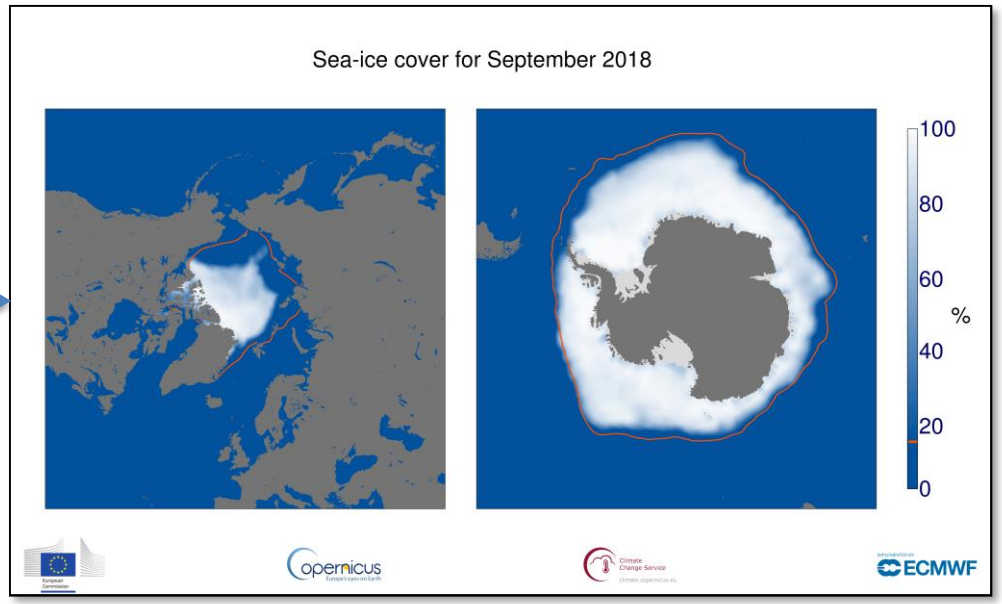



- Globally it was close to 0.4°C warmer than the average September.
- Overall for Europe it was the warmest September.
- Scotland saw generally cooler than average temperatures.




- The pink line denotes the climatological ice edge for September for the period 1981-2010.
- Arctic sea-ice extended much less to the south than is normal for September.

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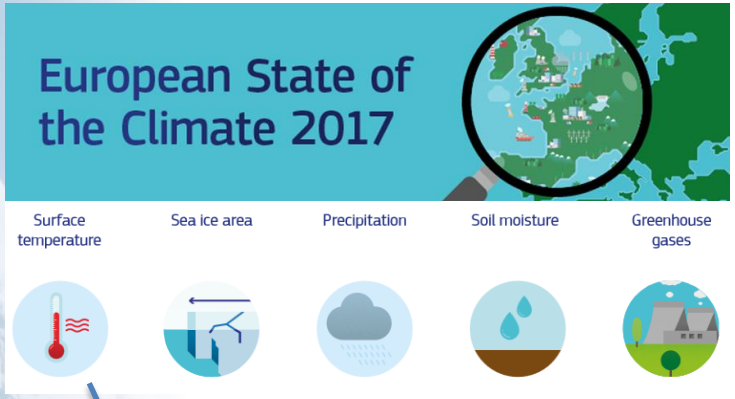
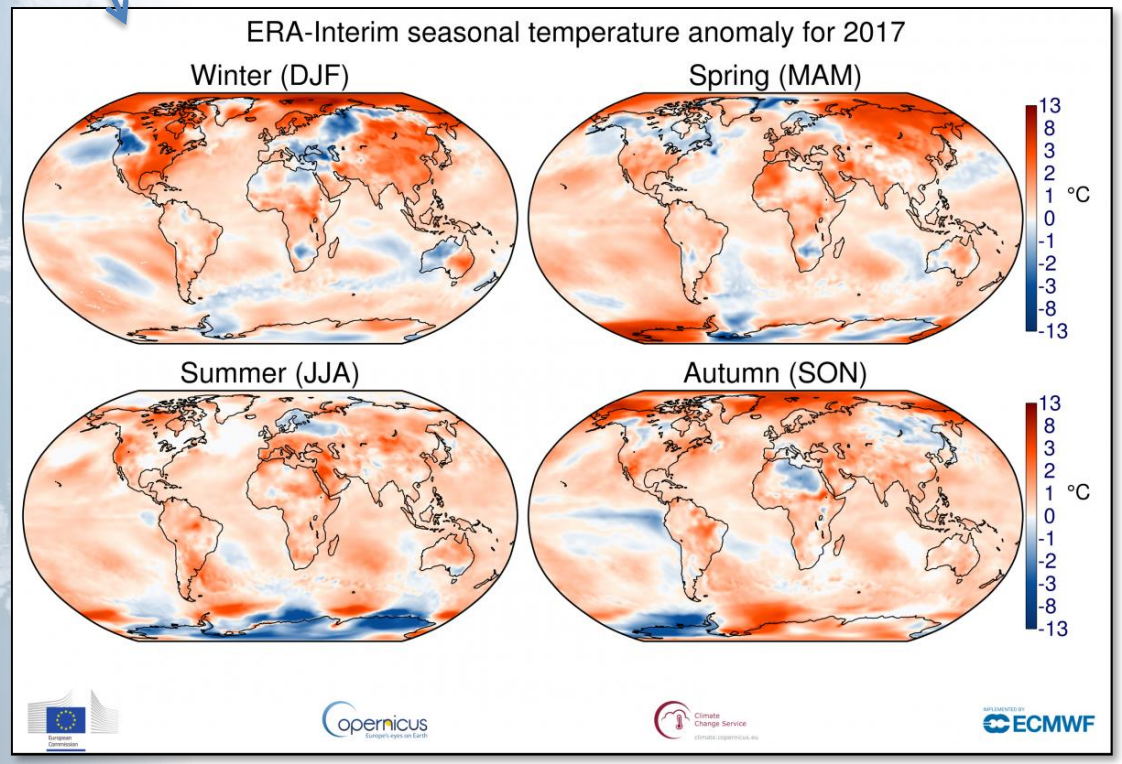
# Annual Climate Bulletin




The European State of the Climate 2017 covers two main themes

- The Climate in 2017 and
- Headline Climate Indicators.


- Surface air temperatures for 2017 were higher than the average for 1981-2010 over most areas of land and ocean.
- They were most above the 1981-2010 average in the Arctic but were also well above average over much of North America, south-western Europe, the Middle East, north-western and central Africa, eastern and southern Asia, and offshore of West Antarctica.

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# Climate Indicators

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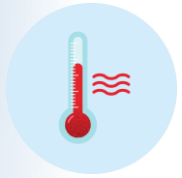


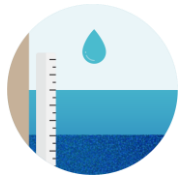
↑ Surface Air Temperature

↑ Greenhouse Gases

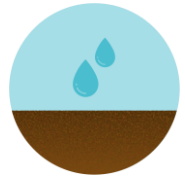
— Rain

↓ Sea Ice

↓ Glaciers



↑ Sea Level



↓ Soil Moisture

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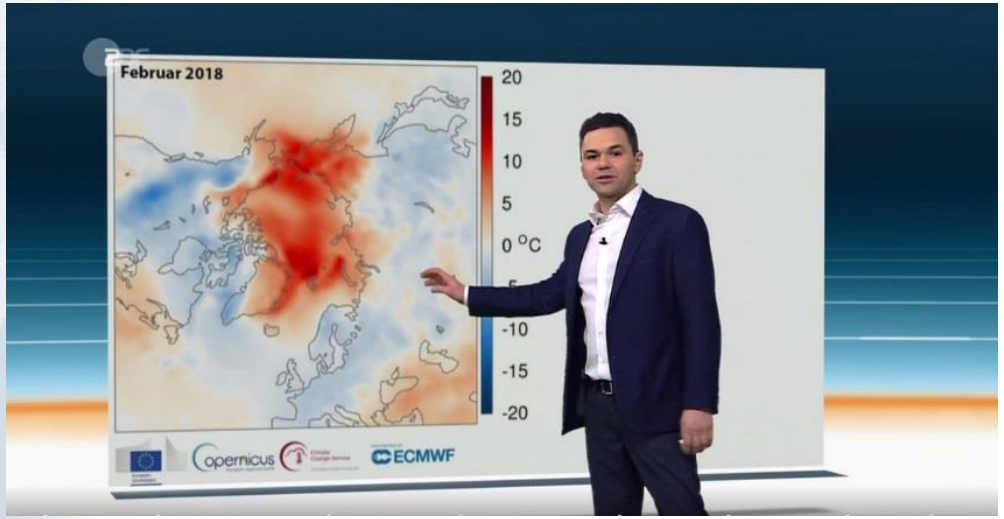
# Examples of user uptake by media


- Standard C3S monthly products
- “Bespoke” C3S products




Credit: ZDF, Özden Terli, C3S


BBC, July 2018

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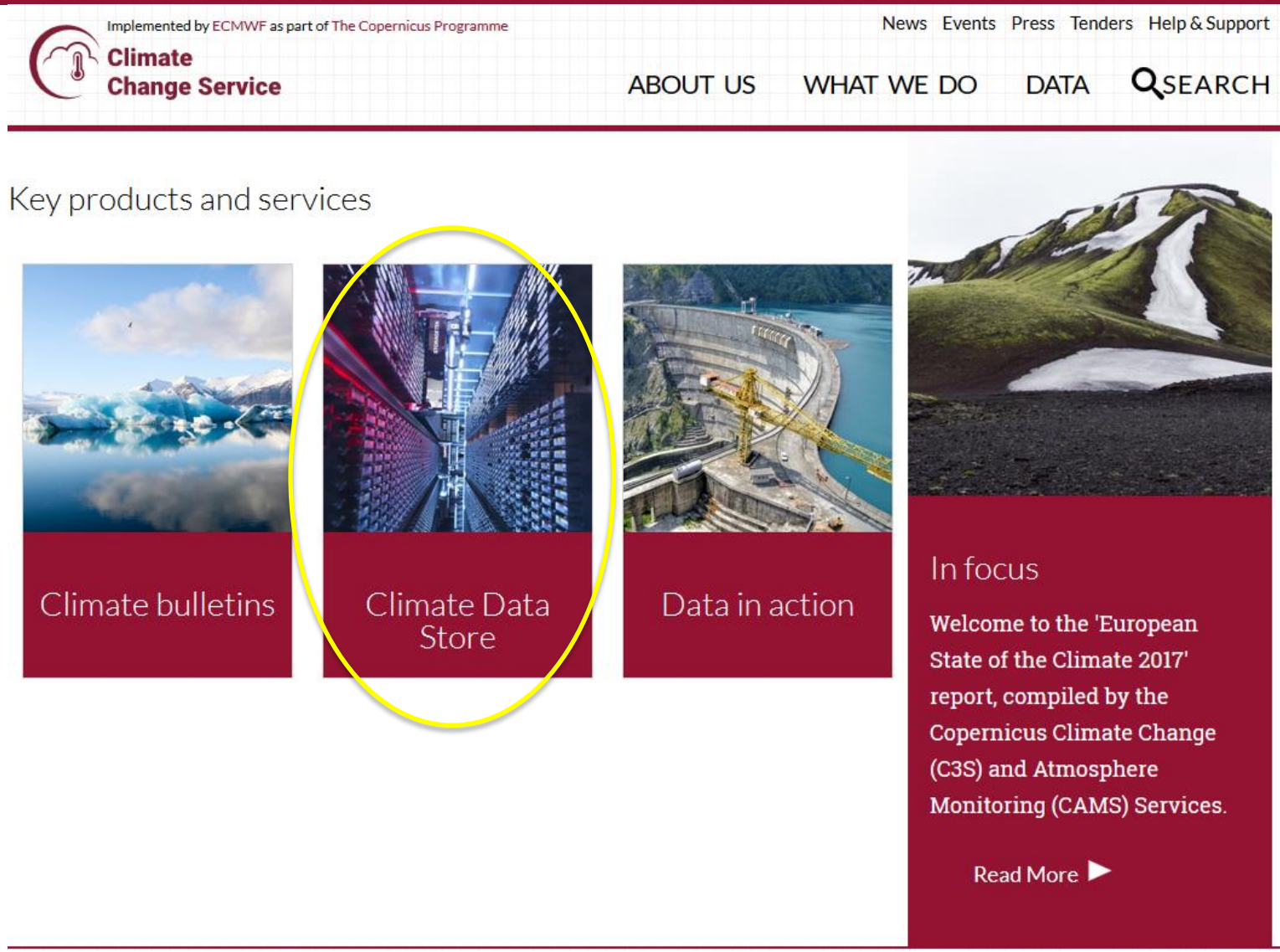


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# Climate Data Store

- We have built a store
- The door opened to customers  in June 2018
- We continuously put products on the shelves
- Open and free data

cds.climate.copernicus.eu

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# Climate Data Store

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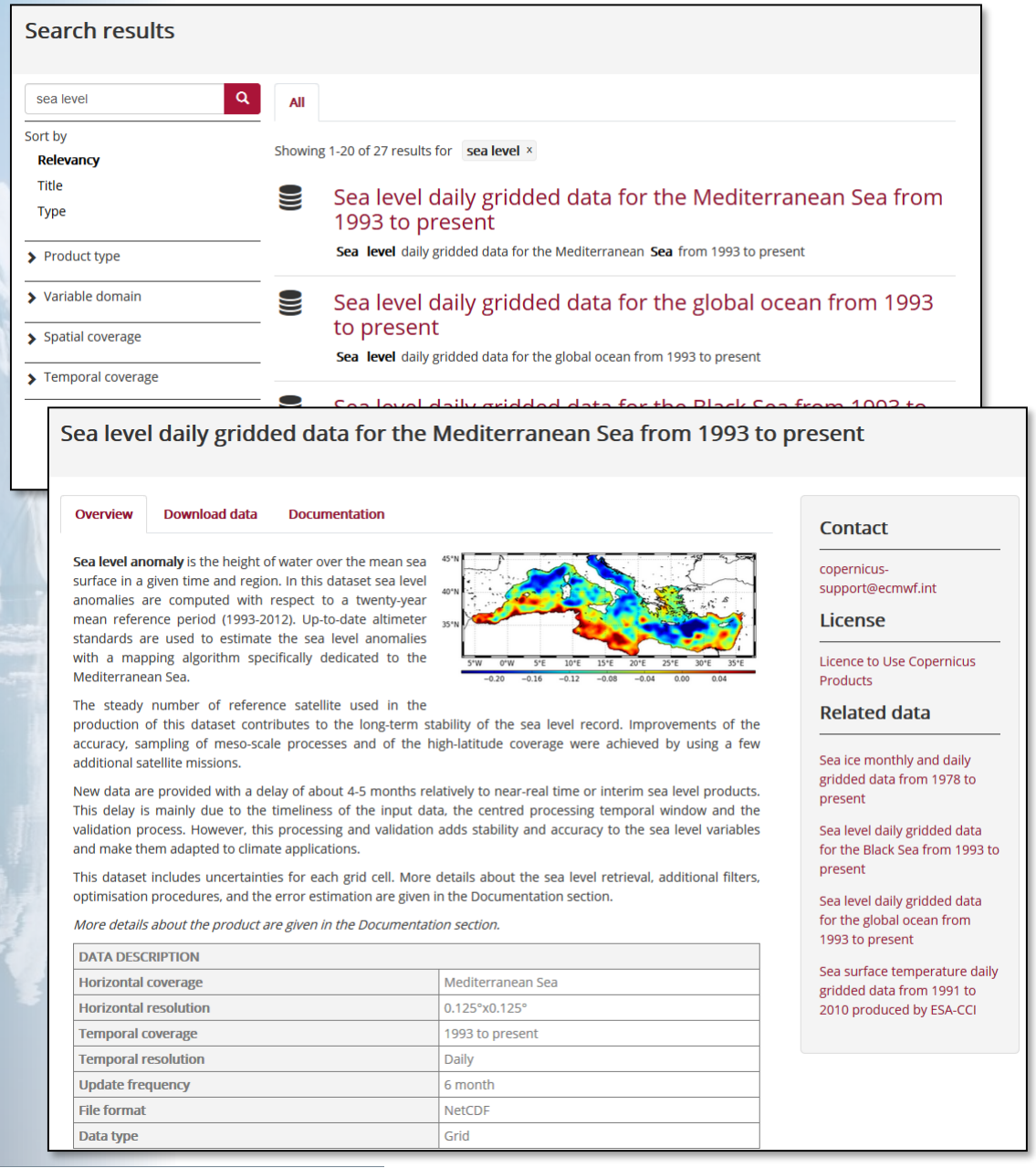


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- Search on Keywords
- Filter on Facets
- Data Products and Applications
- Browse Overview
- Access Full Documentation
- Accept Licence
- Download Data

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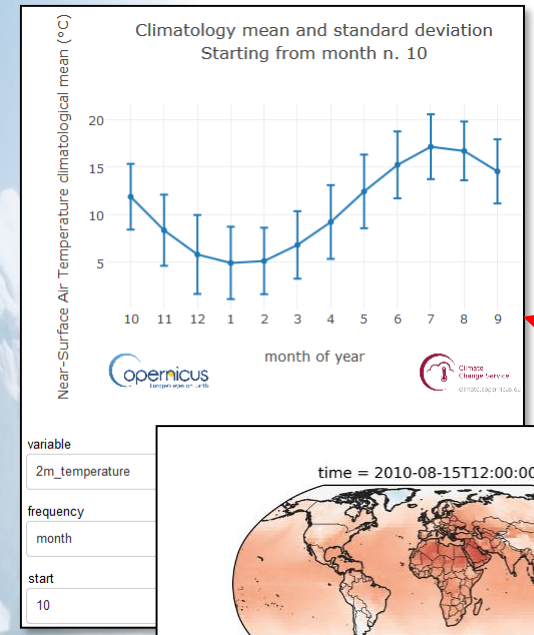
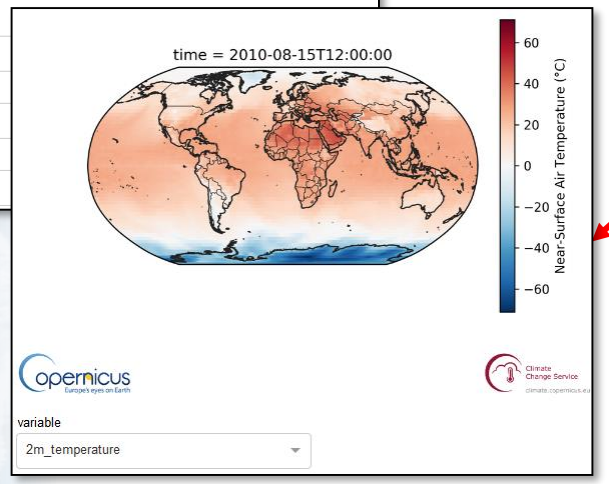
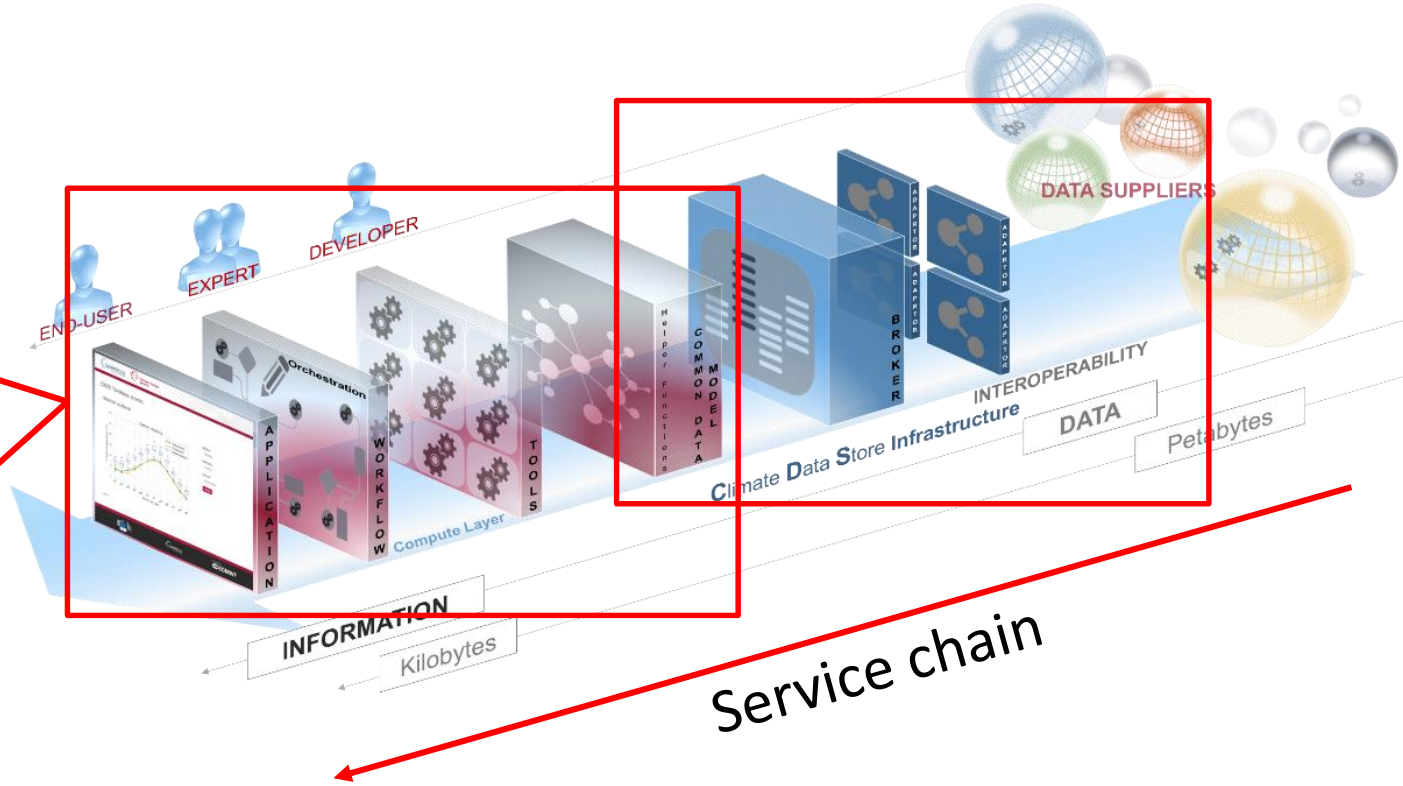
# Data, tools, workflows and applications




Quality Assured information and tools for users ranging from scientists to practitioners and policy makers.

One-stop shop for data from multiple suppliers, all harmonised to a common data model and interoperable.

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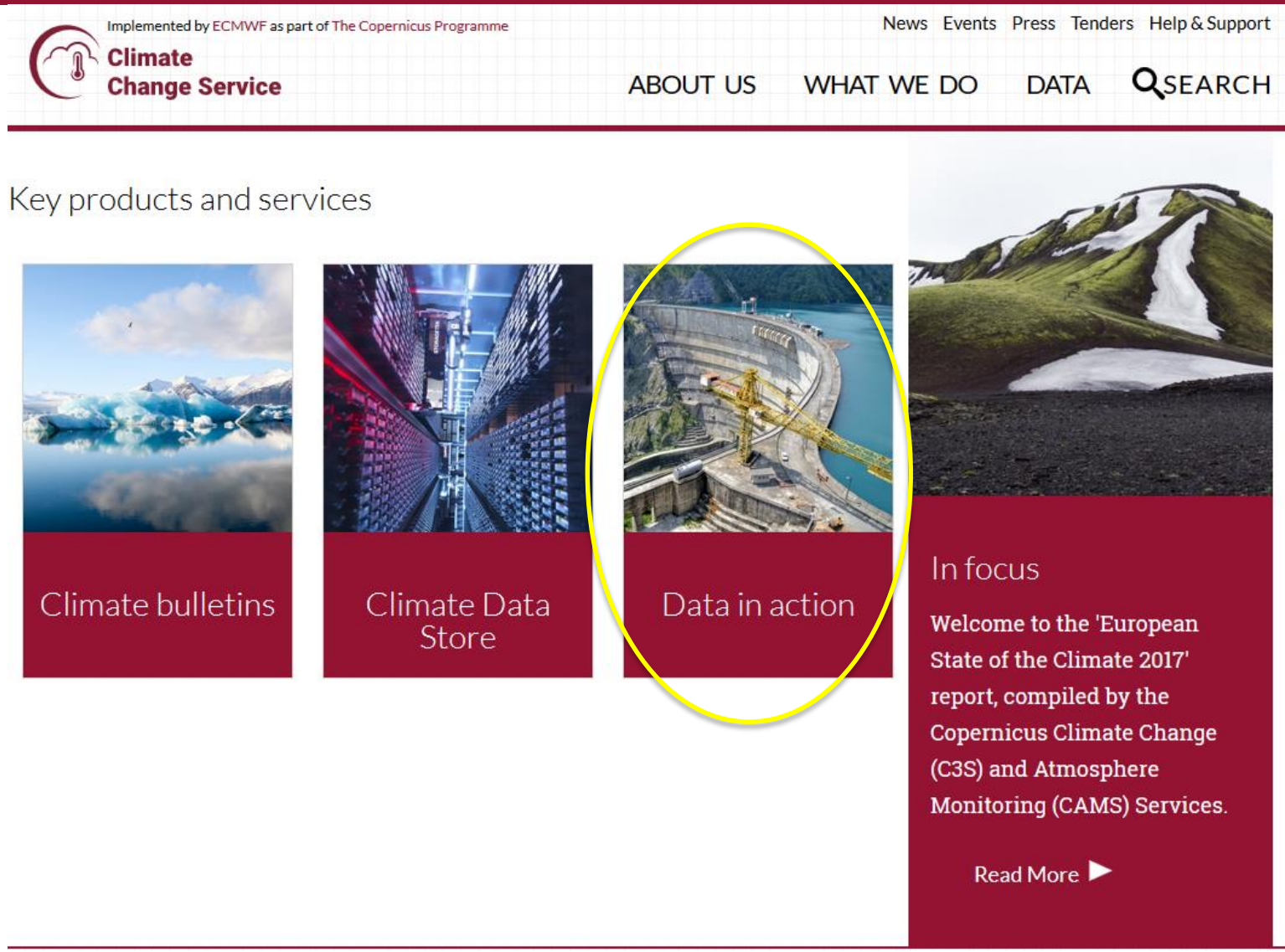


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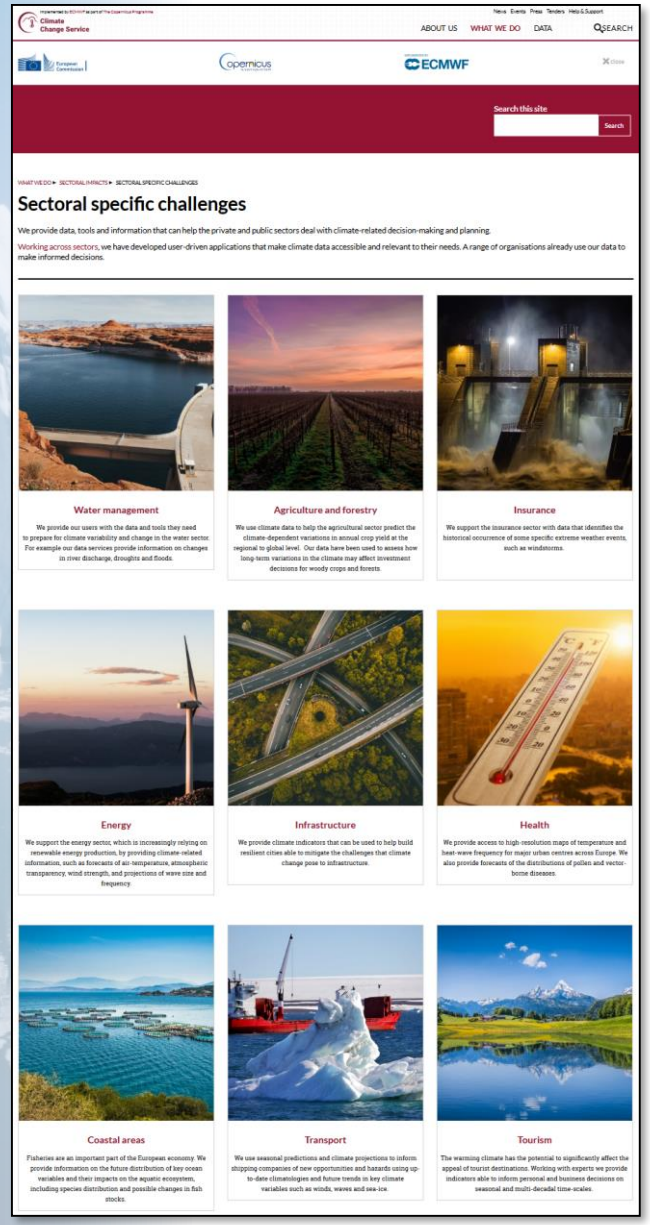
# Sectorial Impacts




C3S has developed a number of case studies and applications – known as Sectorial Information Systems (SIS).

These demonstrate how climate data can be accessed, transformed and made relevant to address specific contexts.

- Water management
- Agriculture and forestry
- Insurance
- Energy
- Infrastructure
- Health
- Coastal areas
- Transport
- Tourism

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# Case Study: Viticulture in Buzet, SW France

The case study considered 4 key stages in grape vine phenology:

1. Bud Break
2. Flowering
3. Veraison
4. Maturity

Using data from historical observations, a mathematical model was developed to correlate the Day of Year (DOY) reaching each stage, with the accumulated temperature, measured in Growing Degree Days. Then, using simulated future daily weather from climate projections, it was possible to predict how the DOY of each stage might change in future.

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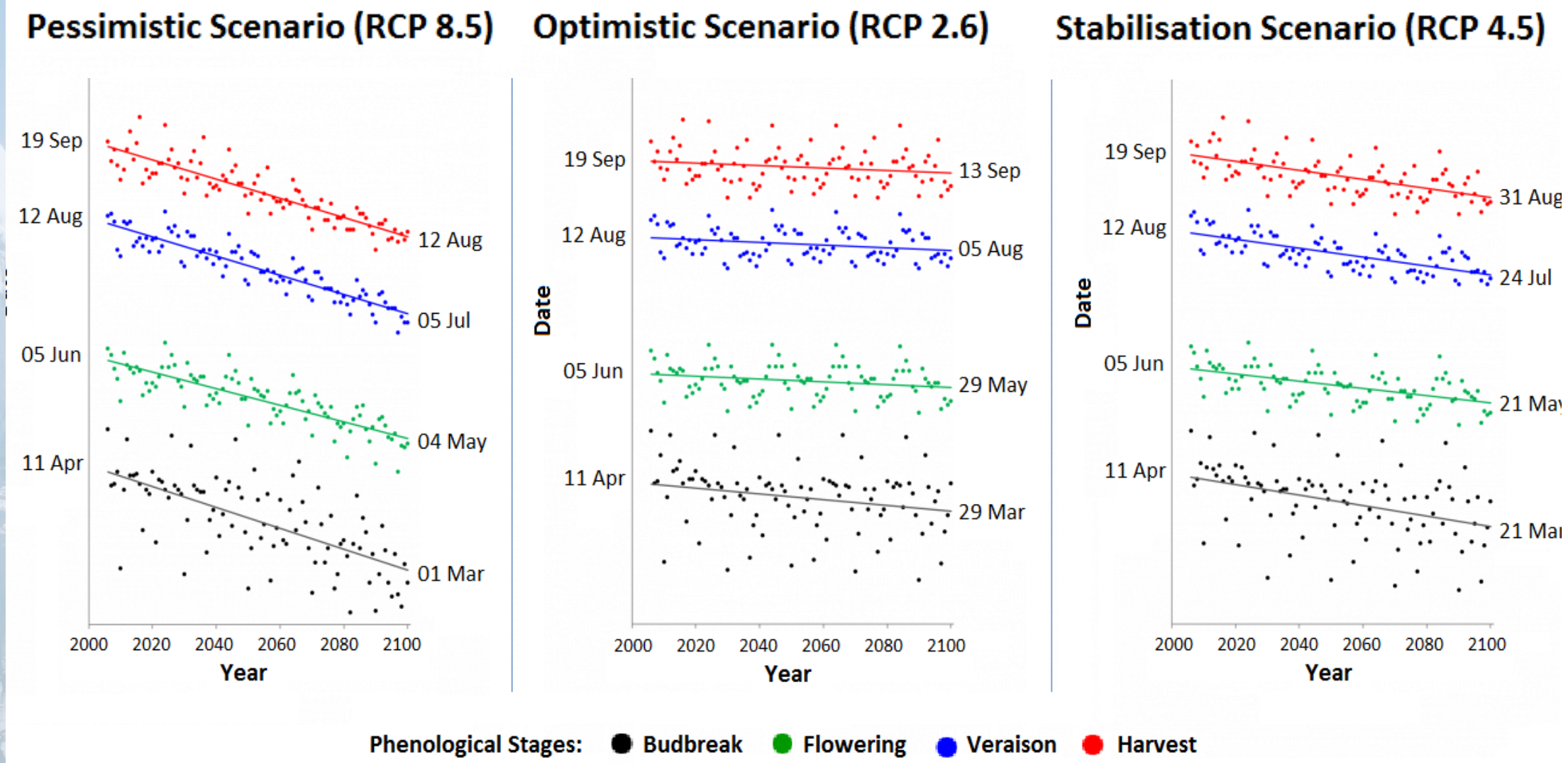
# Case Study: Viticulture in Buzet, SW France



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# Example: Huglin Index for Grape Varieties

| Huglin-Index H | Selected varieties of grapevine which are worth cultivating |
|---|---|
| H < 1500 | Not recommended for cultivation |
| 1500 < H < 1600 | Müller-Thurgau |
| 1600 < H < 1700 | Pinot blanc, Gamay noir |
| 1700 < H < 1800 | Riesling, Chardonnay, Sylvaner, Sauvignon blanc, Pinot noir |
| 1800 < H < 1900 | Cabernet franc |
| 1900 < H < 2000 | Chinon blanc, Cabernet sauvignon, Merlot |
| 2000 < H < 2100 | Ugni blanc |
| 2100 < H < 2200 | Grenache, Syrah |
| 2200 < H < 2300 | Carignan |
| 2300 < H < 2400 | Aramon |

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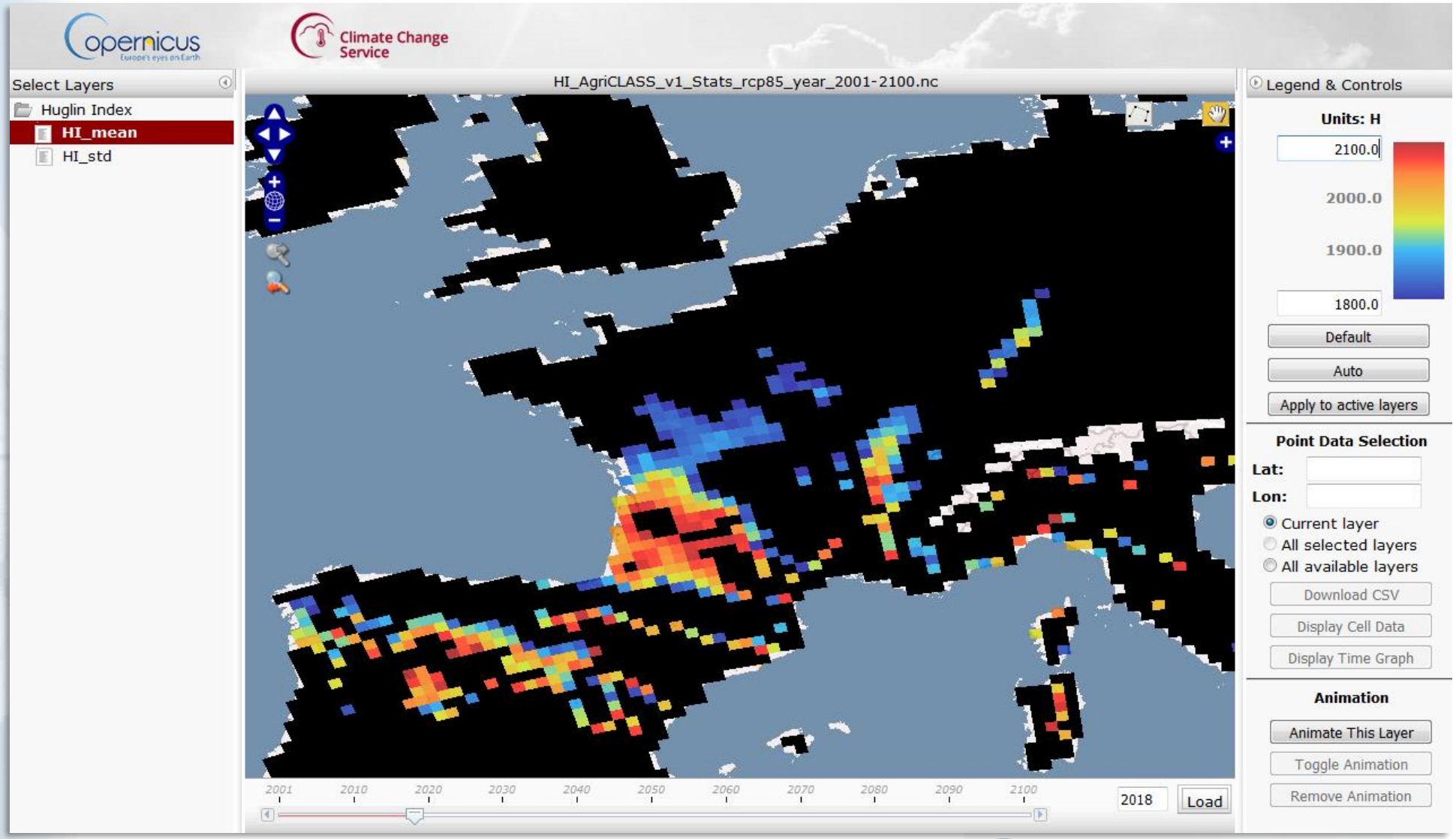
# Example: Huglin Index for Grape Varieties (2018)



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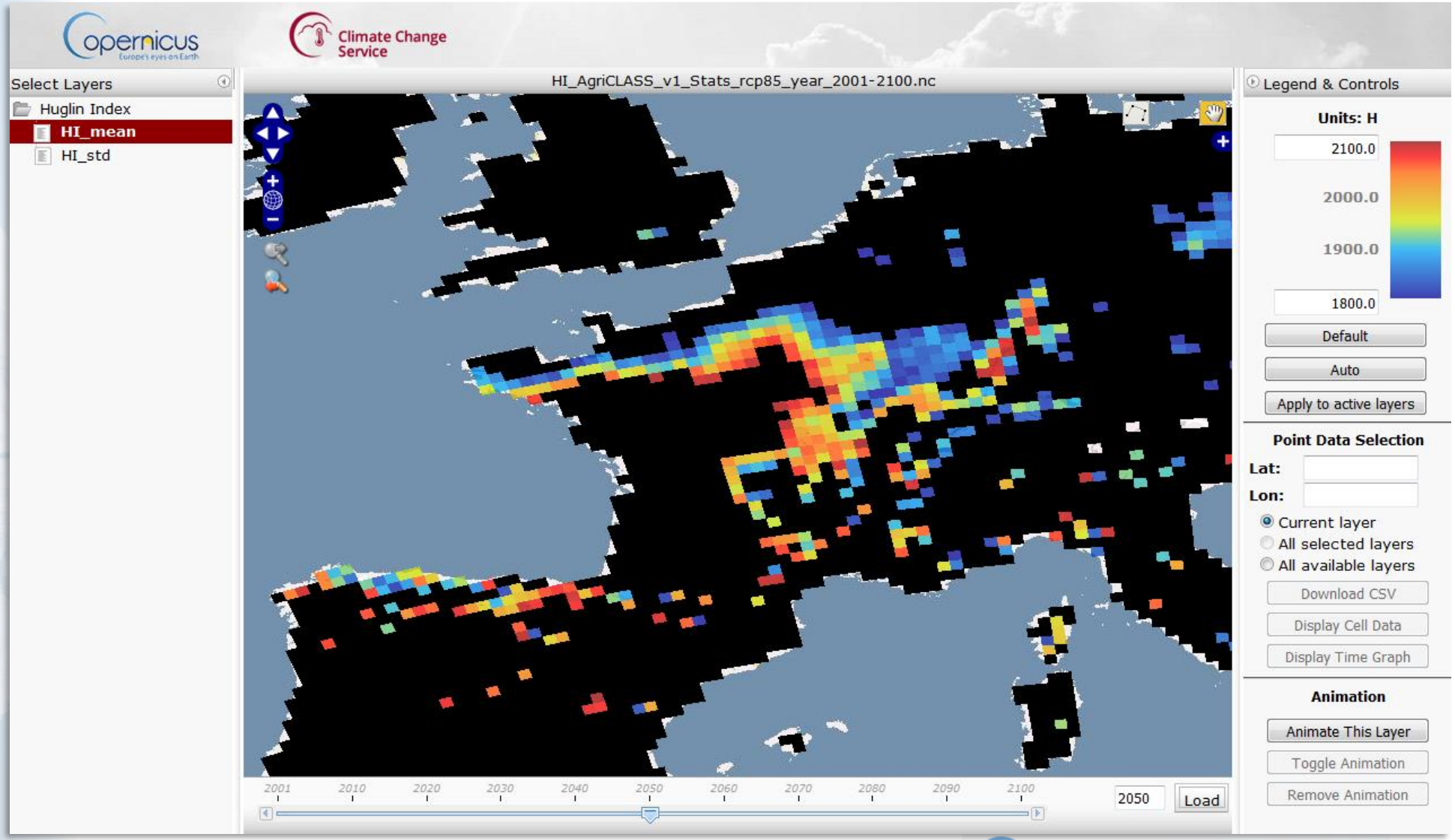
# Example: Huglin Index for Grape Varieties (2050, RCP8.5)



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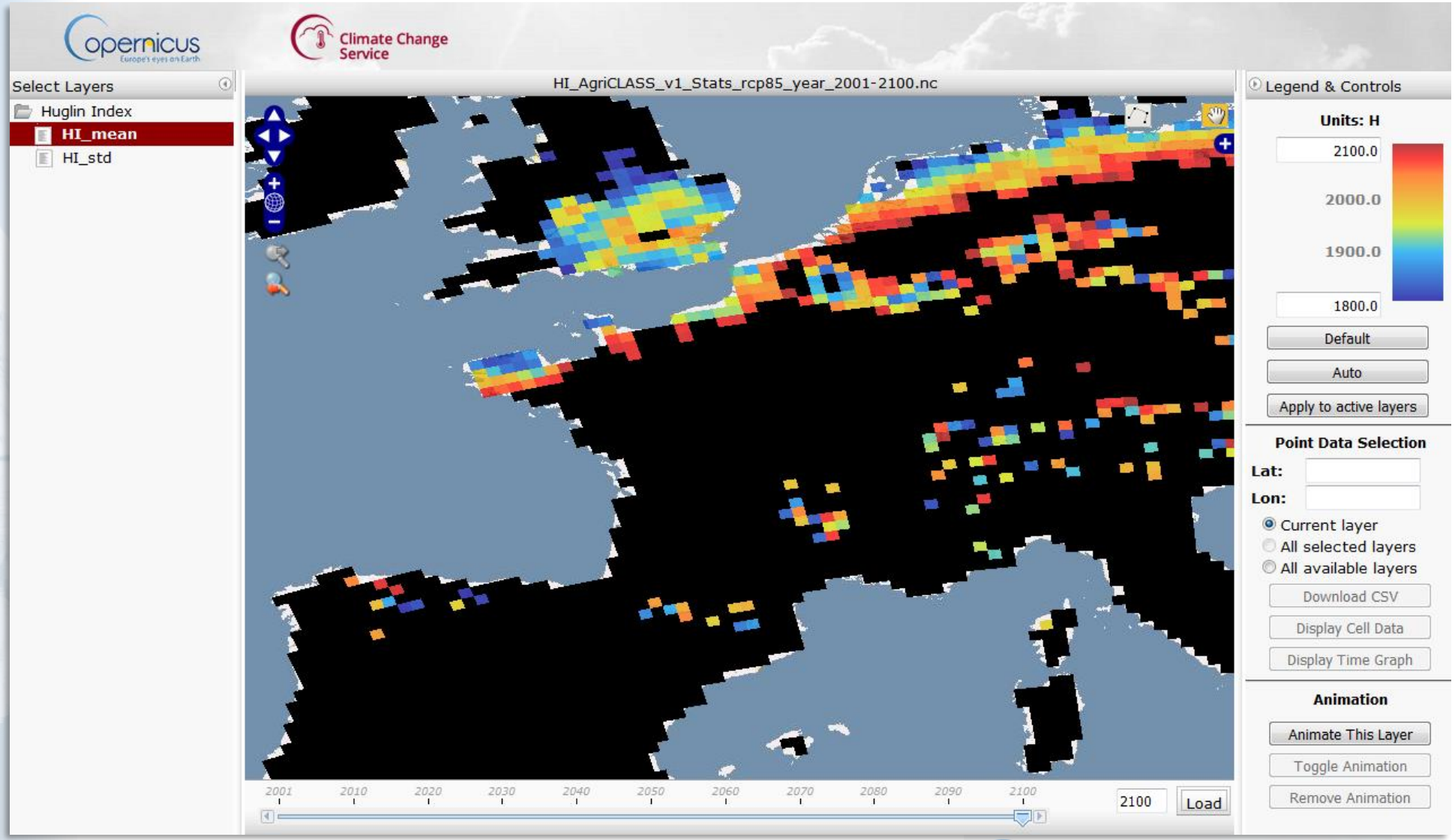
# Example: Huglin Index for Grape Varieties (2100, RCP8.5)



# Evaluation and Quality Control (EQC)

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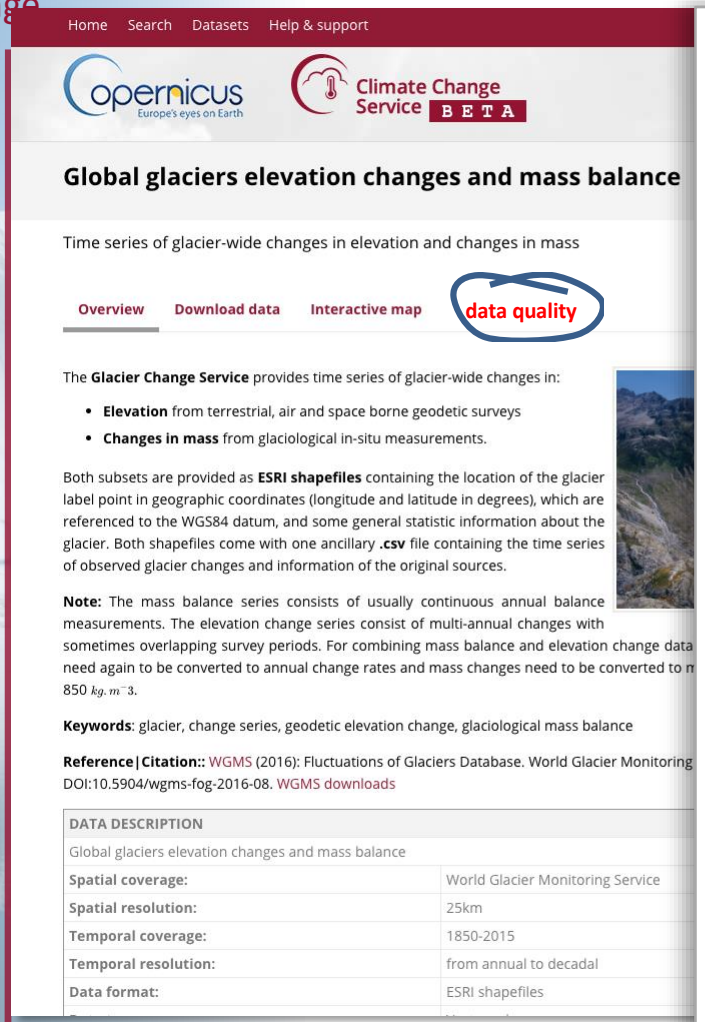


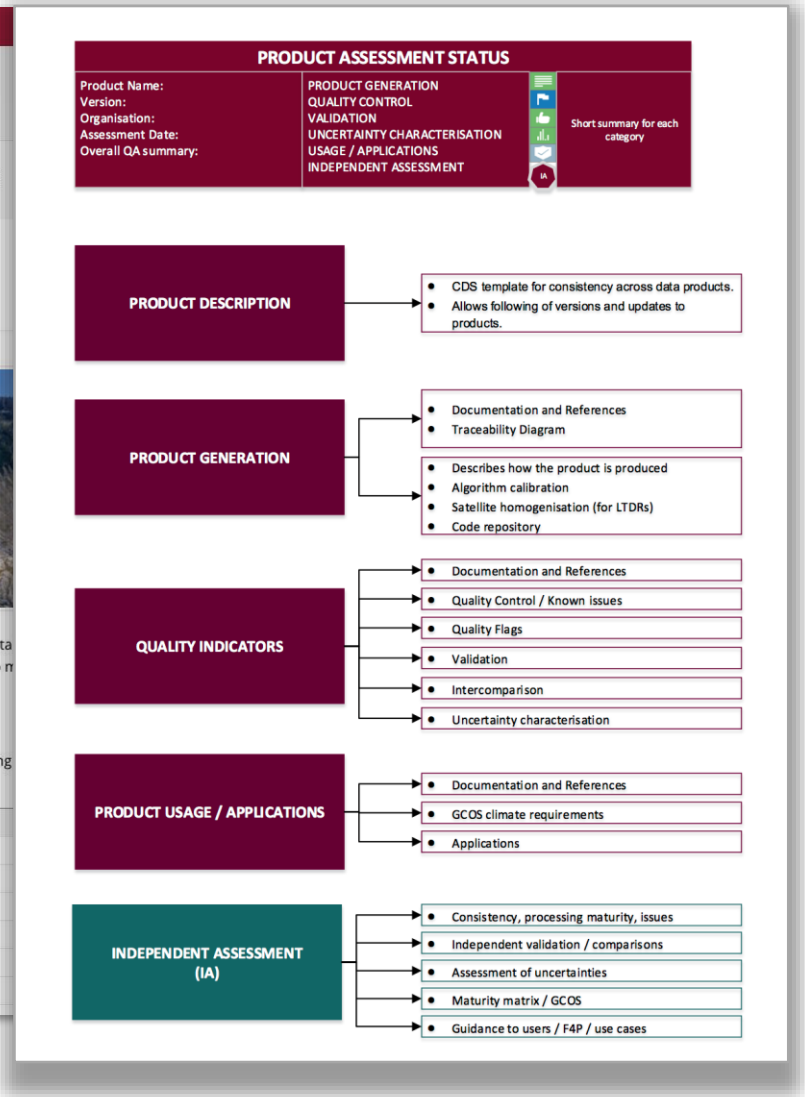


## Quality of data

- Assessments
- User guidance
- Gaps and limitations

## Quality of tools

- Fitness for purpose
- Best practices

## Quality of service

- Speed, responsiveness
- System availability, …

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# Conclusions

- C3S is still young and has recently entered its operational phase
- The service provides monthly and annual bulletins and occasional bespoke products
- Climate Data Store (CDS) is state-of-the-art cloud infrastructure for users to freely access an unprecedented range of quality-controlled climate data and information.
- CDS provides a compute layer allowing users to create and run their own applications / workflows on the cloud without downloading huge volumes of data.
- C3S includes a series of exemplar applications to show how the infrastructure can be used to address specific user needs: SIS (Europe, Global), Use Cases, Demonstrators, Downstream Services
- The Quality Assurance process within C3S is unique and absolutely critical
- C3S serves a wide range of European and worldwide users and bodies: EU DGs, WMO, GCOS, GFCS, EEA, etc.

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# Thank You

For questions contact:
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