



Climate Change

# Copernicus Climate Change Service (C3S)





Climate  
Change

## 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

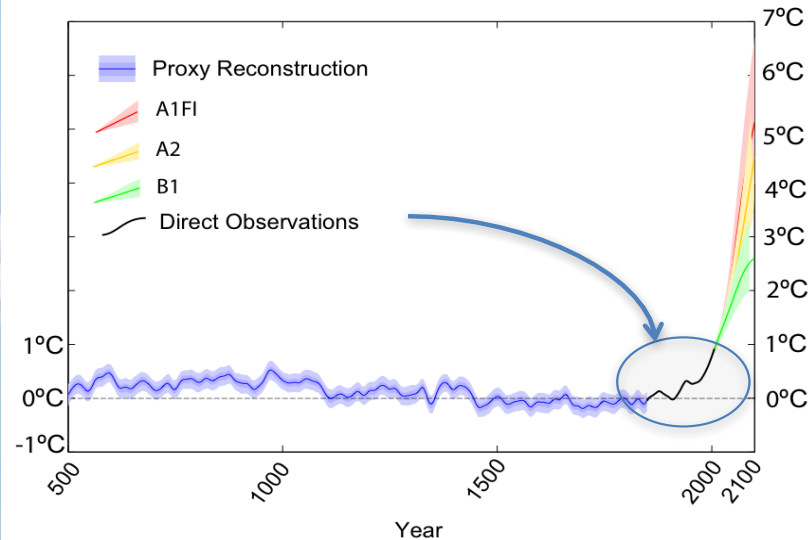




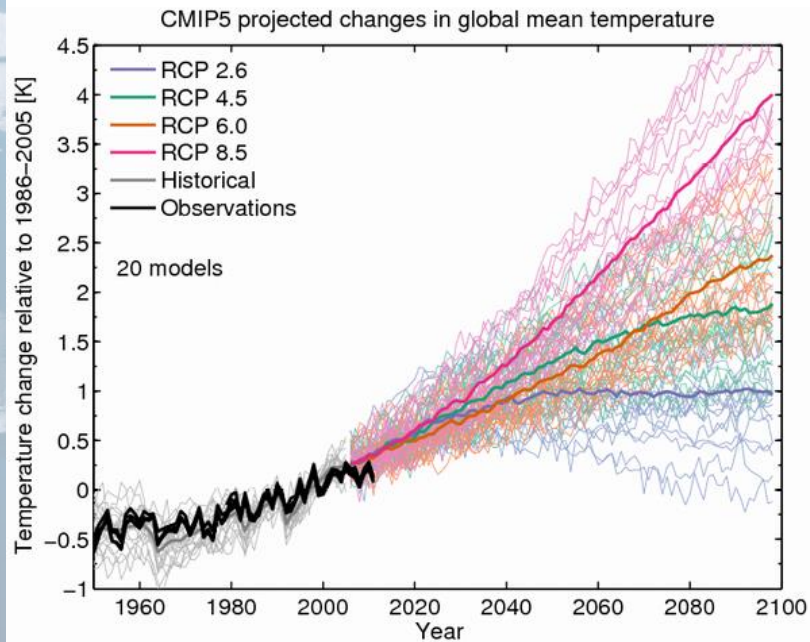
Climate  
Change

# Climate Change Service: Solutions

Global Temperature Relative to 1800-1900 (°C)



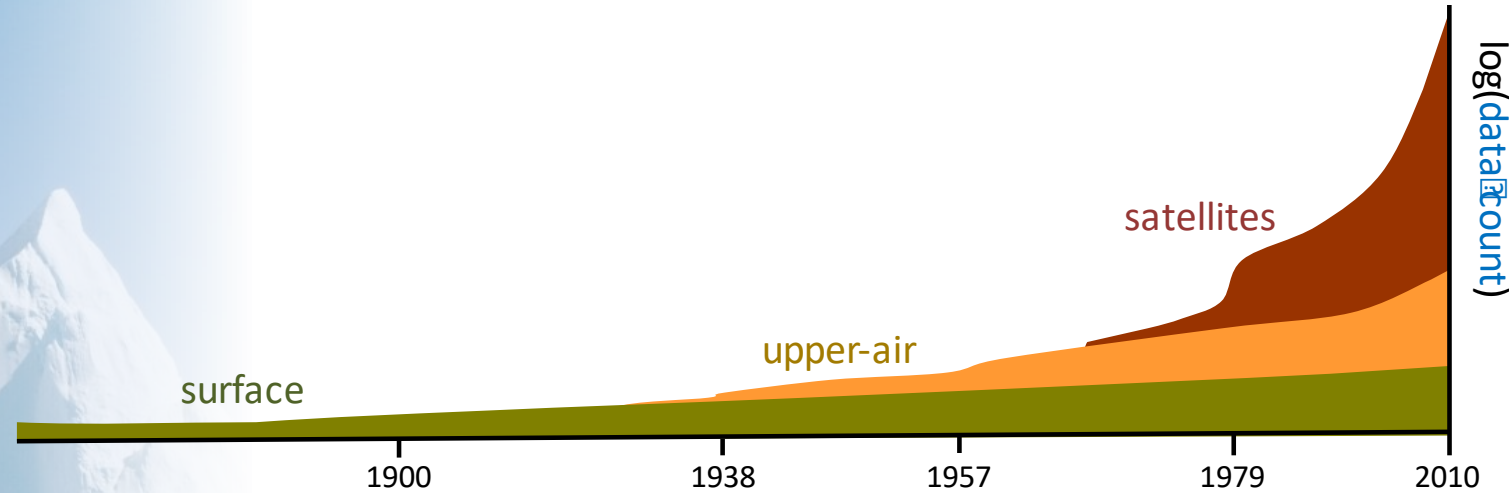
- How is the climate changing?
- How will it change in future?
- How will it impact society?





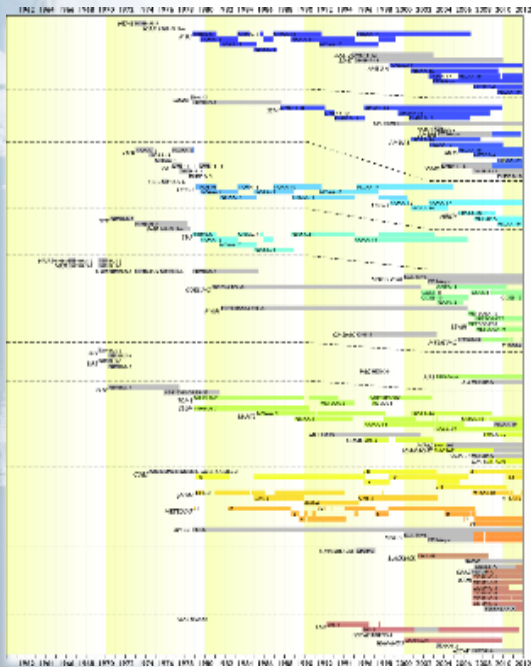
Climate  
Change

# Past, present and future climate information

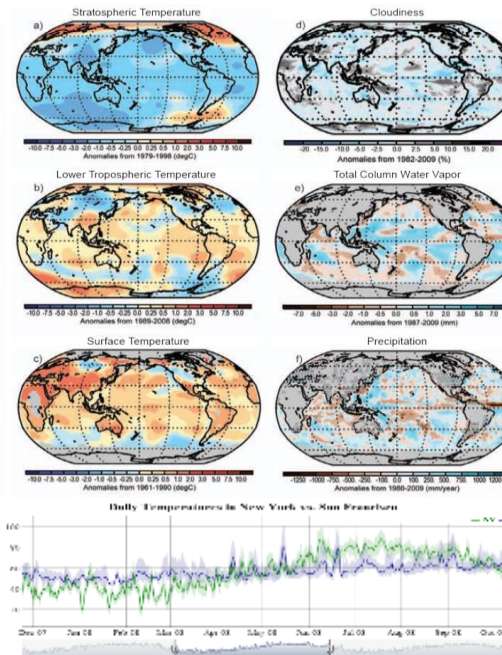


## Past Observations

- Exponential increase
- EO data since 1979



Earth system models



## Climate Reanalysis

e.g. ERA-5.

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





Climate  
Change

# Past, present and future climate information

The screenshot displays the Copernicus Climate Change Service (C3S) website. At the top, the Copernicus logo and 'Europe's eyes on Earth' tagline are visible, along with the 'Climate Change Service' logo. A navigation bar includes links for 'ABOUT C3S', 'NEWS & MEDIA', 'EVENTS', 'TENDERS', 'PRODUCTS', 'SERVICES', and 'HELP & SUPPORT'. A search bar and social media icons are also present. The main content area is titled 'Seasonal forecasts' and features a breadcrumb trail 'home » products'. Below this, there are four graphical elements: a line graph showing a sharp increase in a red line, a world map with green and yellow shading, a world map with orange and yellow shading, and a map of Europe with a yellow sun icon. To the right of these graphics is a list of product categories: 'AVERAGE SURFACE AIR TEMPERATURE MONTHLY MAPS', 'MONTHLY SEA-ICE MAPS', 'HYDROLOGICAL CLIMATE VARIABLES', 'CLIMATE REANALYSIS', and 'SEASONAL FORECASTS'. Below this list is a 'NEWS' section with three entries: '16 Jul 2017 C3S releases powerful new climate change "encyclopaedia" for public use', '03 Mar 2017 #OpenDataHack @ECMWF - explore creative uses of open data', and '03 Mar 2017 C3S holds its inaugural General Assembly'. A 'More News' button is located below the news entries. At the bottom of the page is an 'EVENTS' section with one entry: '13 Nov 2017'.

home » products

The Copernicus Climate Change Service (C3S) is developing seasonal forecast products, with a target publication date of 15<sup>th</sup> of each month. These products are based on data from several state-of-the-art seasonal prediction systems.

The current proof-of-concept phase includes **graphical forecast products** for a number of variables (air and sea-surface temperature, atmospheric circulation and precipitation); the forecasts are updated every month and cover a time range of 6 months. The interface to the list of products offers links to maps or timeseries for the forecast variables, and the facility to navigate the full set of graphics. Multi-system combinations, as well as predictions from the individual component systems, are available.

The centres currently providing forecasts to C3S are ECMWF, The Met Office and Météo-France; at a later stage Deutscher Wetterdienst and Centro Euro-Mediterraneo sui Cambiamenti Climatici will be added to the list.

- AVERAGE SURFACE AIR TEMPERATURE MONTHLY MAPS
- MONTHLY SEA-ICE MAPS
- HYDROLOGICAL CLIMATE VARIABLES
- CLIMATE REANALYSIS
- SEASONAL FORECASTS

**NEWS**

16 Jul 2017  
C3S releases powerful new climate change "encyclopaedia" for public use

03 Mar 2017  
#OpenDataHack @ECMWF - explore creative uses of open data

03 Mar 2017  
C3S holds its inaugural General Assembly

26 Jan 2017  
Copernicus at the 4th International Conference on Energy & Meteorology (ICEM)

06 Dec 2016  
Report Reassesses Variations in Global Warming

[More News](#)

**EVENTS**

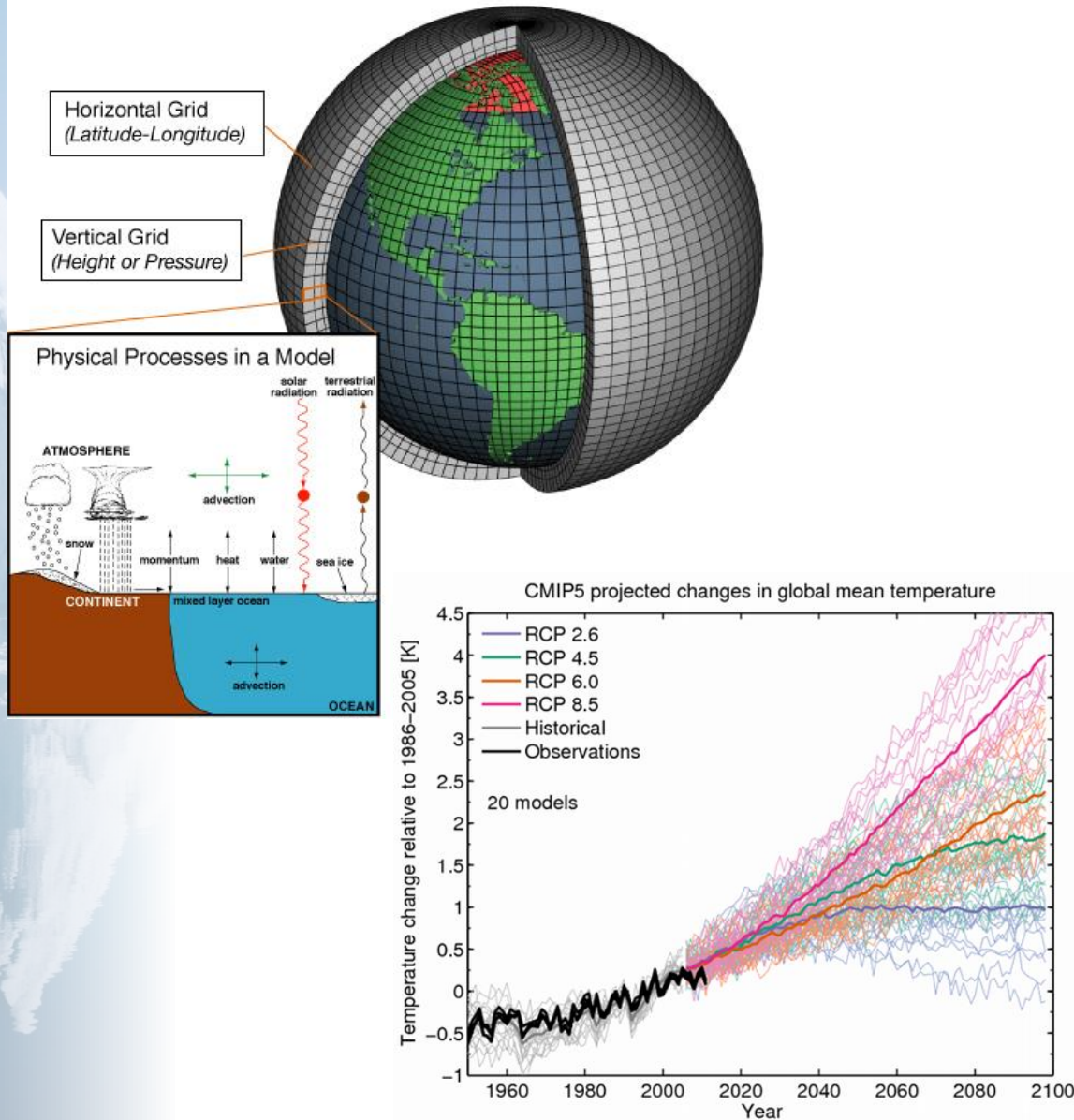
13 Nov 2017

## 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).

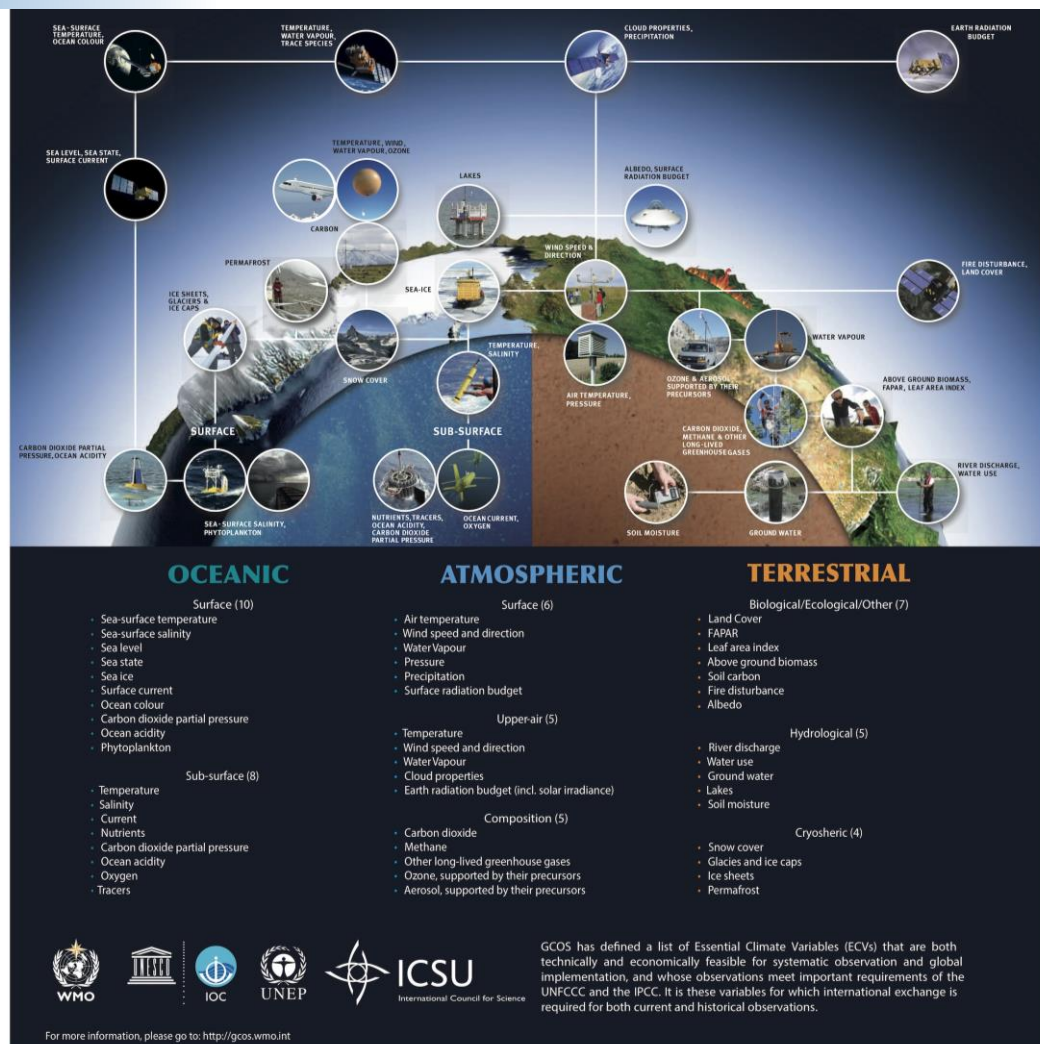




Climate  
Change

# Essential Climate Variables

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



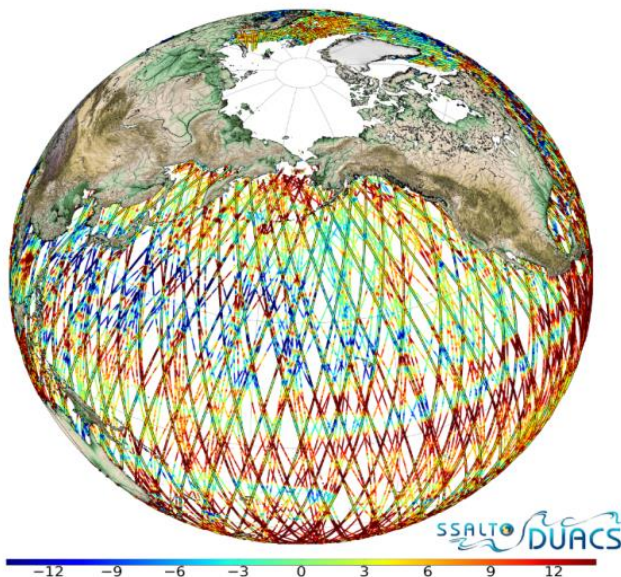
## ECVs supported by C3S contracts

		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



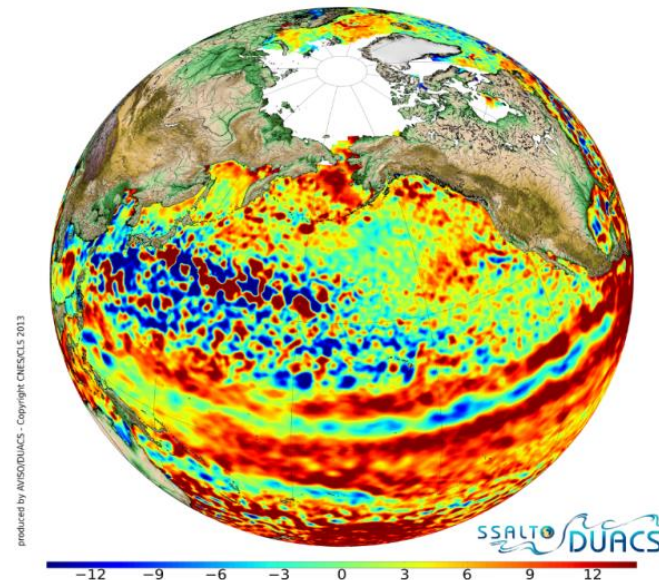
Climate  
Change

## Example: Sea Level ECV production service

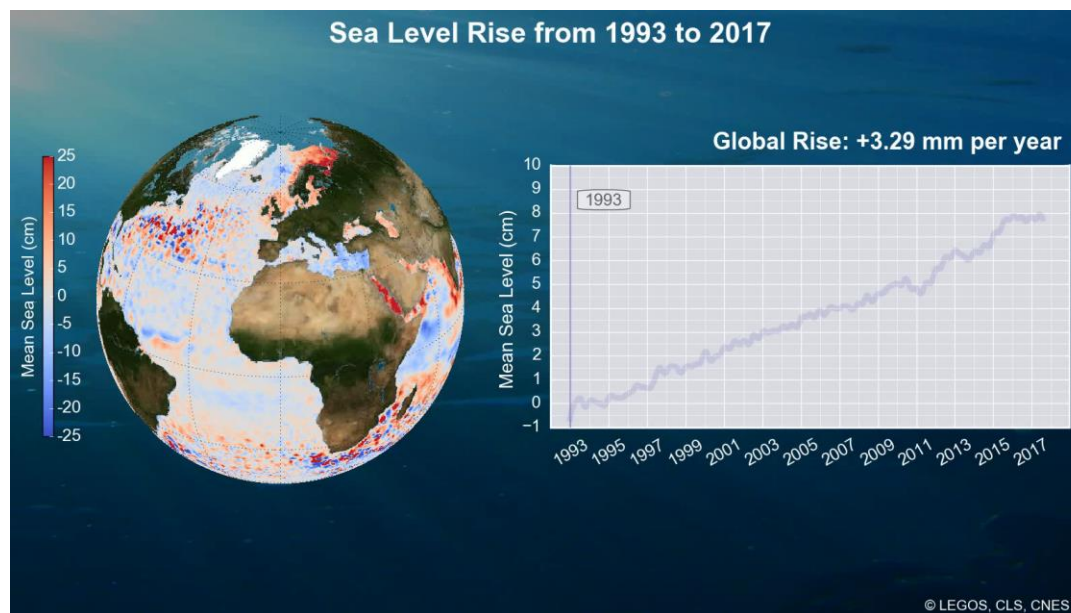


From satellite along-track altimetry measurements...

... to sea level gridded maps...



... to derive  
Ocean  
Monitoring  
Indicators



European  
Commission

ECMWF





Climate

## C3S and UNFCCC Sustainable Development Goals

### C3S contribution to SDGs

<b>2</b> ZERO HUNGER 	C3S SIS addresses agriculture, and some of the global services will focus on food security
<b>3</b> GOOD HEALTH AND WELL-BEING 	C3S SIS addresses health, providing relevant climate change indicators
<b>6</b> 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.
<b>7</b> 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.
<b>8</b> DECENT WORK AND ECONOMIC GROWTH 	C3S activities contribute indirectly to this SDG insofar that the energy climate impact indicators (see goal 7) are relevant.
<b>9</b> 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

<b>11</b> 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.
<b>12</b> RESPONSIBLE CONSUMPTION AND PRODUCTION 	C3S SIS products and indicators on water management are directly relevant for this goal.
<b>13</b> 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
<b>14</b> LIFE BELOW WATER 	Some of the ECV products generated by C3S (including reanalysis ORAS5) are ocean relevant. This is done in coordination with CMEMS.
<b>15</b> 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.



Climate  
Change

<https://climate.copernicus.eu/>



Implemented by ECMWF as part of The Copernicus Programme

**Climate  
Change Service**

[News](#) [Events](#) [Press](#) [Tenders](#) [Help & Support](#)

[ABOUT US](#)

[WHAT WE DO](#)

[DATA](#)

[SEARCH](#)

## 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.

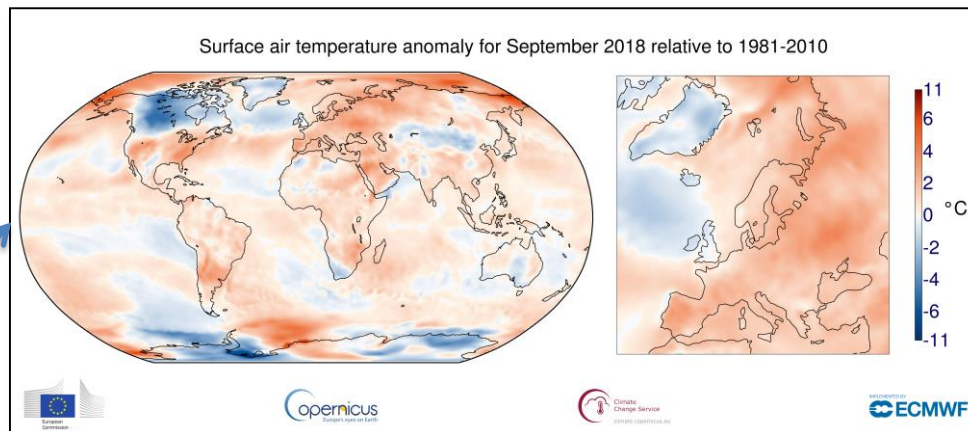
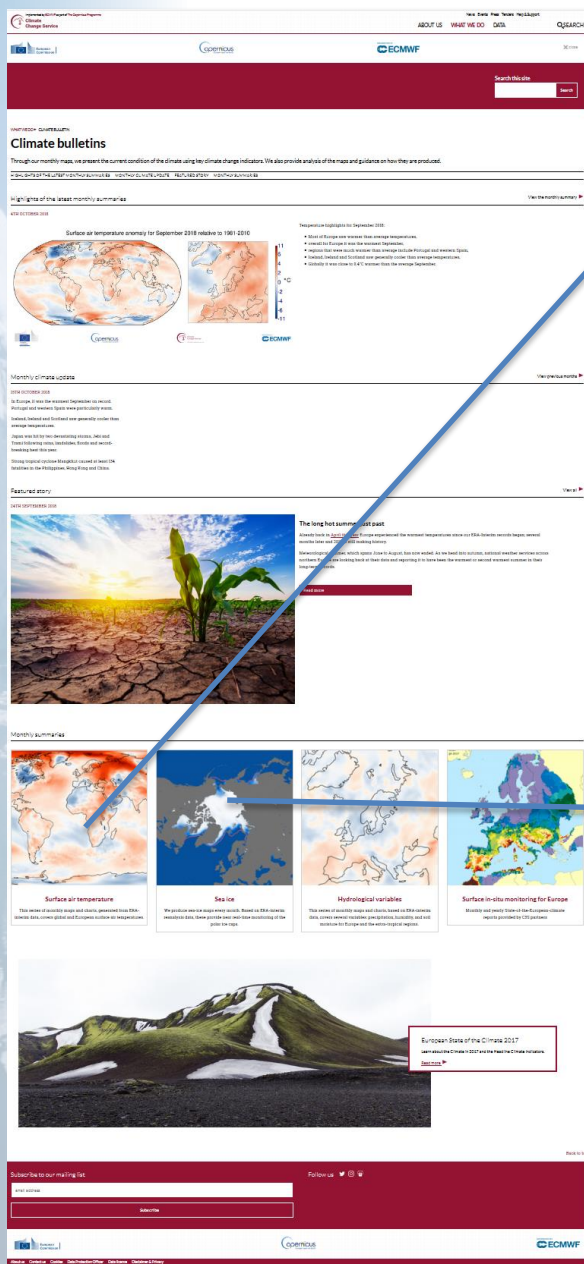
[Read More](#) ▶



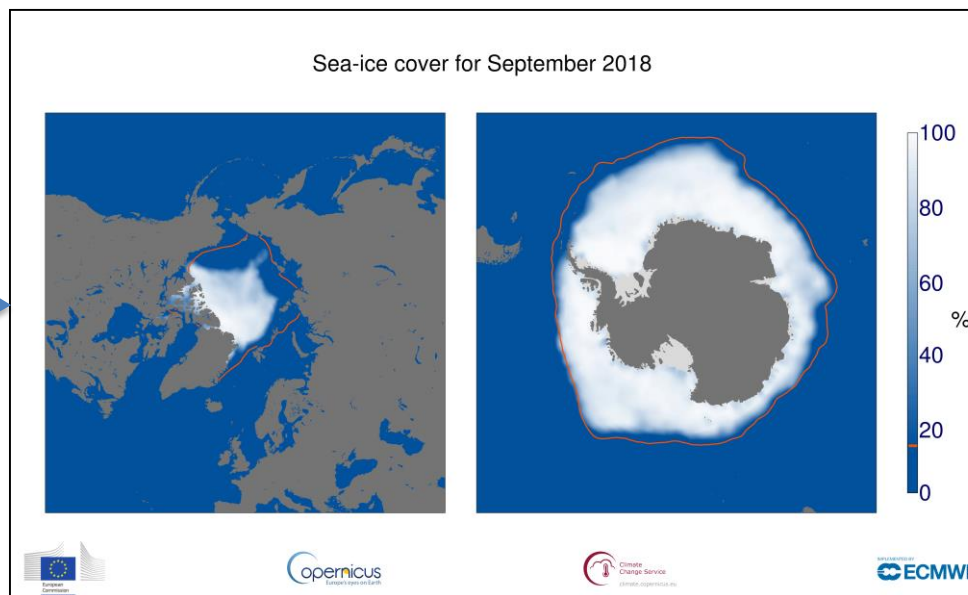


Climate  
Change

# Monthly Climate Bulletin



- Globally it was close to  $0.4^{\circ}\text{C}$  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.



Climate  
Change

# Annual Climate Bulletin



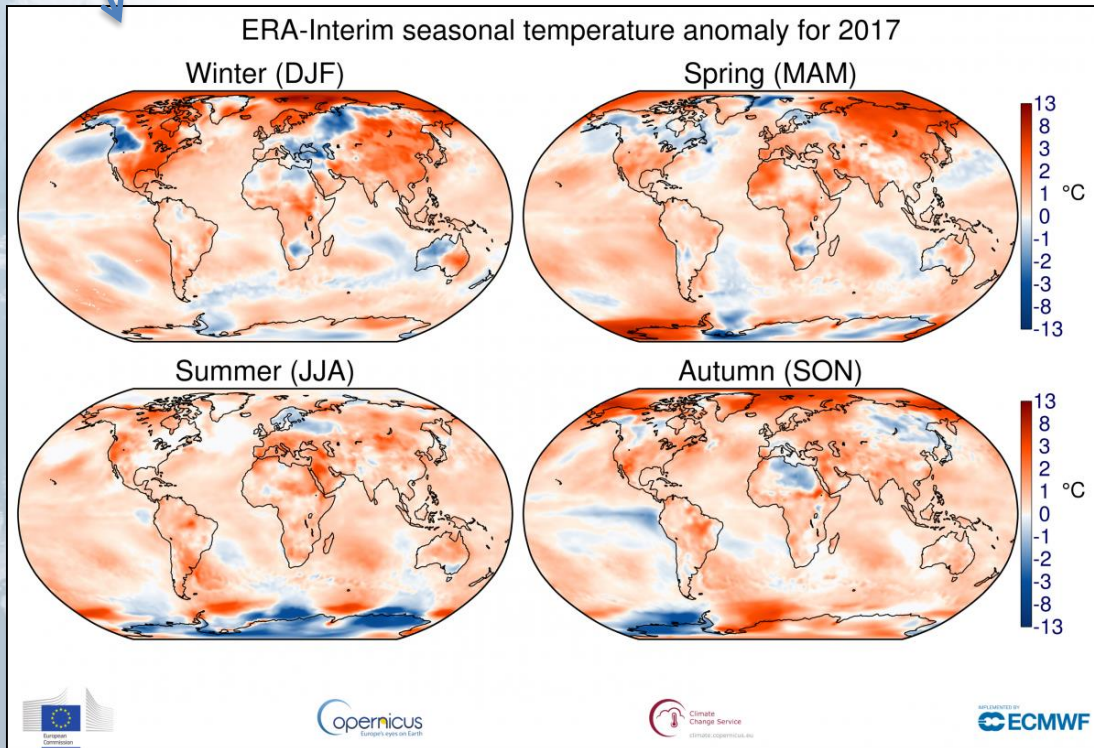
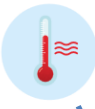
Surface  
temperature

Sea ice area

Precipitation

Soil moisture

Greenhouse  
gases



The European State of the Climate 2017 covers two main themes

- The Climate in 2017 and
- Headline Climate Indicators.



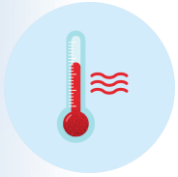
- Surface air temperatures for 2017 were higher than the average for 1981-2010 over most areas of land and ocean.
- They were most above the 1981-2010 average in the Arctic but were also well above average over much of North America, south-western Europe, the Middle East, north-western and central Africa,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





Climate  
Change

## Climate Indicators



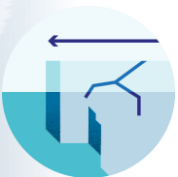
Surface Air Temperature



Greenhouse Gases



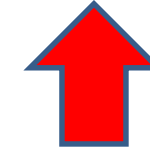
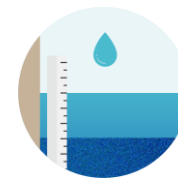
Rain



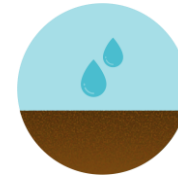
Sea Ice



Glaciers



Sea Level



Soil Moisture

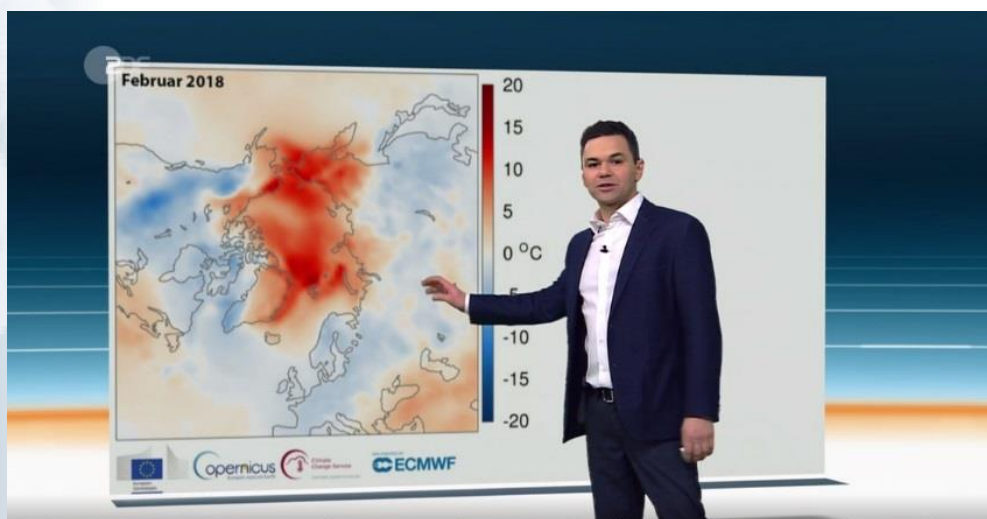


Climate  
Change

## Examples of user uptake by media



- Standard C3S monthly products
- “Bespoke” C3S products



Credit: ZDF, Özden Terli, C3S

**BBC** Sign in News Sport Weather iPlayer TV Radio More Search

# NEWS

Home UK World Business Politics Tech Science Health Family & Education Entertainment & Arts More

World Africa Asia Australia Europe Latin America Middle East US & Canada

## Reality Check: Mapping the global heatwave

24 July 2018

UK heatwave

### Where in the world temperatures are above and below average for 1-20 July

°C

14 6 4 2 0 -2 -4 -6 -8 -10 -12 -14

TEMPERATURES ARE MEASURED AGAINST THE AVERAGE FOR THE PERIOD 1981-2010

SOURCE: COPERNICUS CLIMATE CHANGE SERVICE, EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

COUNTRIES ACROSS THE WORLD HAVE BEEN FACING EXTREMELY HIGH TEMPERATURES THIS SUMMER.

FROM THE UK, ACROSS TO SCANDINAVIA AND JAPAN, THE HOT WEATHER IS EXPECTED TO CONTINUE FOR THE REST OF THE MONTH. JAPAN HAS JUST DECLARED A NATURAL DISASTER, WITH HIGH TEMPERATURES LEADING TO THOUSANDS BEING ADMITTED TO HOSPITAL WITH HEAT STROKE.

VARIOUS TEMPERATURE RECORDS FOR JULY WERE BROKEN IN SOUTHERN CALIFORNIA, EASTERN CANADA, ALGERIA AND NORWAY.

### Top Stories

**Met chief calls for quick Facebook access**  
A suspect in the murder of Lucy McHugh, 13, was jailed for withholding his Facebook password.  
3 hours ago

**TSB boss to step down after IT fiasco**  
4 hours ago

**Famed cystic fibrosis activist dies at 21**  
3 hours ago

### Features

**Movels of the deep and their superpowers**

**Why does the battle for Idlib matter?**

BBC, July 2018







Climate  
Change

<https://climate.copernicus.eu/>



Implemented by ECMWF as part of The Copernicus Programme

**Climate  
Change Service**

[News](#) [Events](#) [Press](#) [Tenders](#) [Help & Support](#)

[ABOUT US](#)

[WHAT WE DO](#)

[DATA](#)

[SEARCH](#)

## 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](#) ▶



Climate  
Change

## 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](https://cds.climate.copernicus.eu)







Climate  
Change

# Climate Data Store



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

### Search results

Q

All

Sort by

Relevancy

Title

Type

Product type

Variable domain

Spatial coverage

Temporal coverage

Showing 1-20 of 27 results for sea level x

Sea level daily gridded data for the Mediterranean Sea from 1993 to present

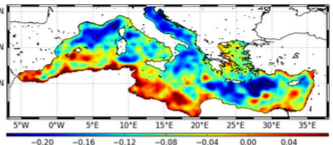
Sea level daily gridded data for the global ocean from 1993 to present

Sea level daily gridded data for the Black Sea from 1993 to present

### Sea level daily gridded data for the Mediterranean Sea from 1993 to present

OverviewDownload dataDocumentation

**Sea level anomaly** is the height of water over the mean sea surface in a given time and region. In this dataset sea level anomalies are computed with respect to a twenty-year mean reference period (1993-2012). Up-to-date altimeter standards are used to estimate the sea level anomalies with a mapping algorithm specifically dedicated to the Mediterranean Sea.



The steady number of reference satellite used in the production of this dataset contributes to the long-term stability of the sea level record. Improvements of the accuracy, sampling of meso-scale processes and of the high-latitude coverage were achieved by using a few additional satellite missions.

New data are provided with a delay of about 4-5 months relatively to near-real time or interim sea level products. This delay is mainly due to the timeliness of the input data, the centred processing temporal window and the validation process. However, this processing and validation adds stability and accuracy to the sea level variables and make them adapted to climate applications.

This dataset includes uncertainties for each grid cell. More details about the sea level retrieval, additional filters, optimisation procedures, and the error estimation are given in the Documentation section.

*More details about the product are given in the Documentation section.*

DATA DESCRIPTION	
Horizontal coverage	Mediterranean Sea
Horizontal resolution	0.125°x0.125°
Temporal coverage	1993 to present
Temporal resolution	Daily
Update frequency	6 month
File format	NetCDF
Data type	Grid

#### Contact

[copernicus-support@ecmwf.int](mailto:copernicus-support@ecmwf.int)

#### License

Licence to Use Copernicus Products

#### Related data

- Sea ice monthly and daily gridded data from 1978 to present
- Sea level daily gridded data for the Black Sea from 1993 to present
- Sea level daily gridded data for the global ocean from 1993 to present
- Sea surface temperature daily gridded data from 1991 to 2010 produced by ESA-CCI

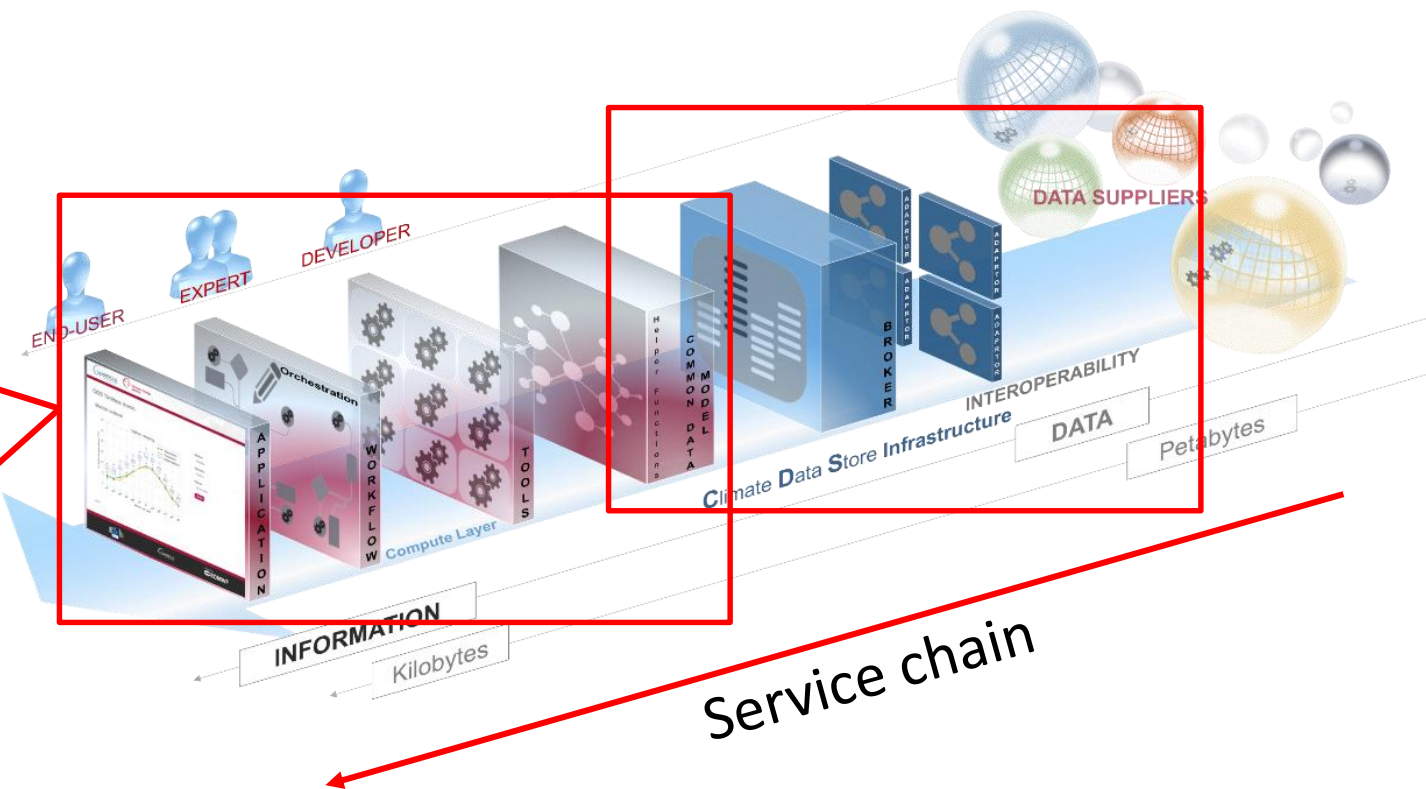
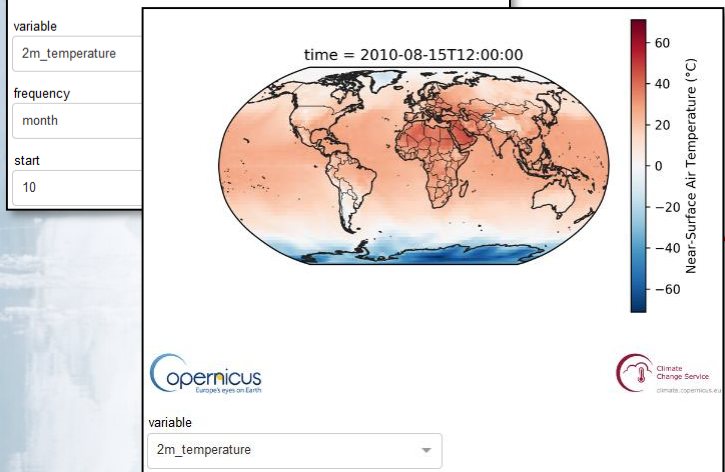
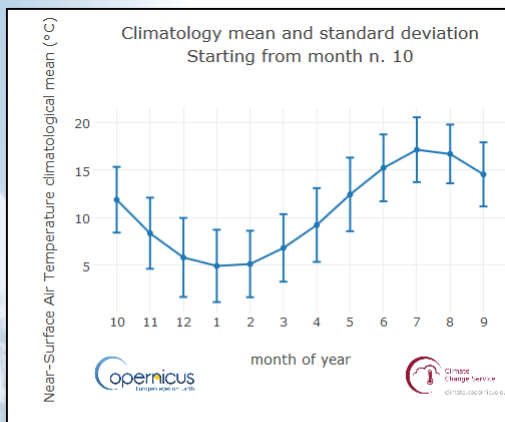
- Search on Keywords
- Filter on Facets
- Data Products and Applications
- Browse Overview
- Access Full Documentation
- Accept Licence
- Download Data





Climate  
Change

## 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.





Climate  
Change

<https://climate.copernicus.eu/>



Implemented by ECMWF as part of The Copernicus Programme

**Climate  
Change Service**

[News](#) [Events](#) [Press](#) [Tenders](#) [Help & Support](#)

[ABOUT US](#)

[WHAT WE DO](#)

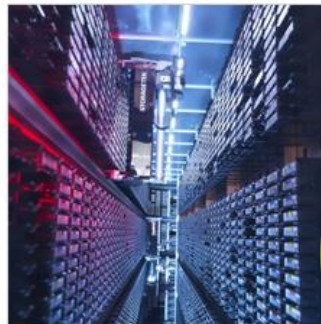
[DATA](#)

[SEARCH](#)

## Key products and services



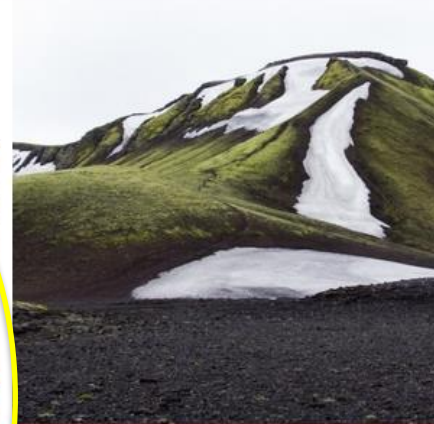
Climate bulletins



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](#) ▶

 **Copernicus**  
Europe's eyes on Earth

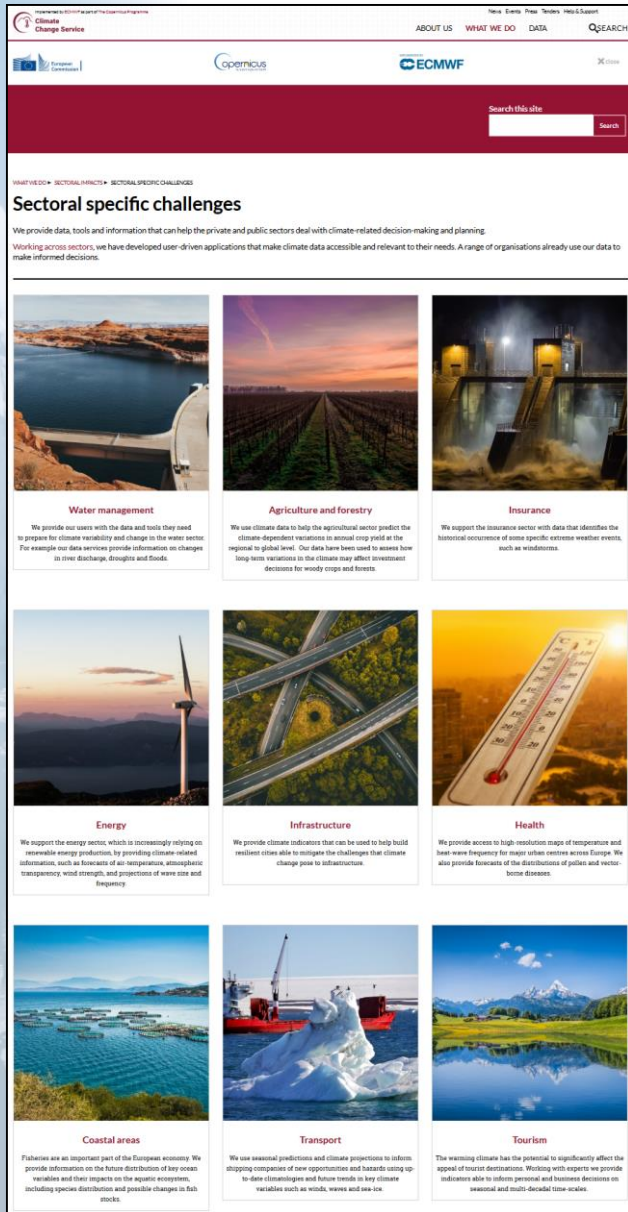
 **European  
Commission**

 **ECMWF**



Climate  
Change

# 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





## 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



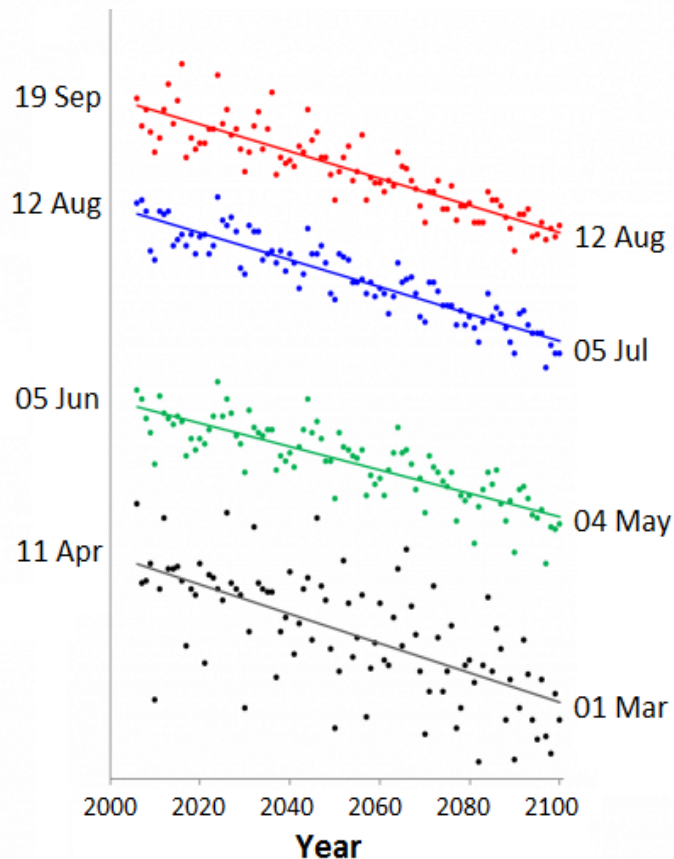
Using data from historical observations, a mathematical model was developed to correlate the Day of Year (DOY) reaching each stage, with the accumulated temperature, measured in Growing Degree Days. Then, using simulated future daily weather from climate projections, it was possible to predict how the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



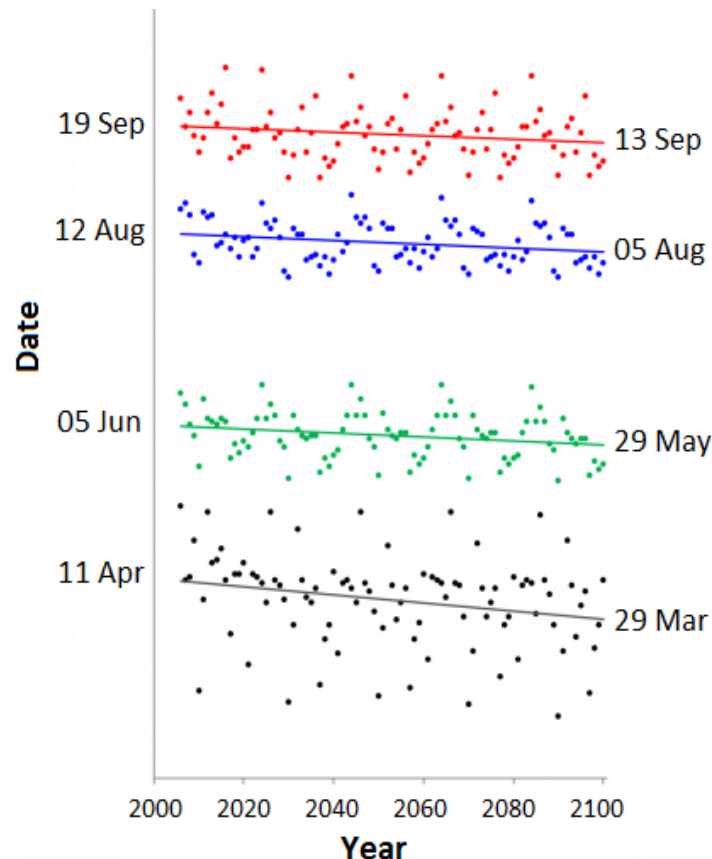
Climate  
Change

## Case Study: Viticulture in Buzet, SW France

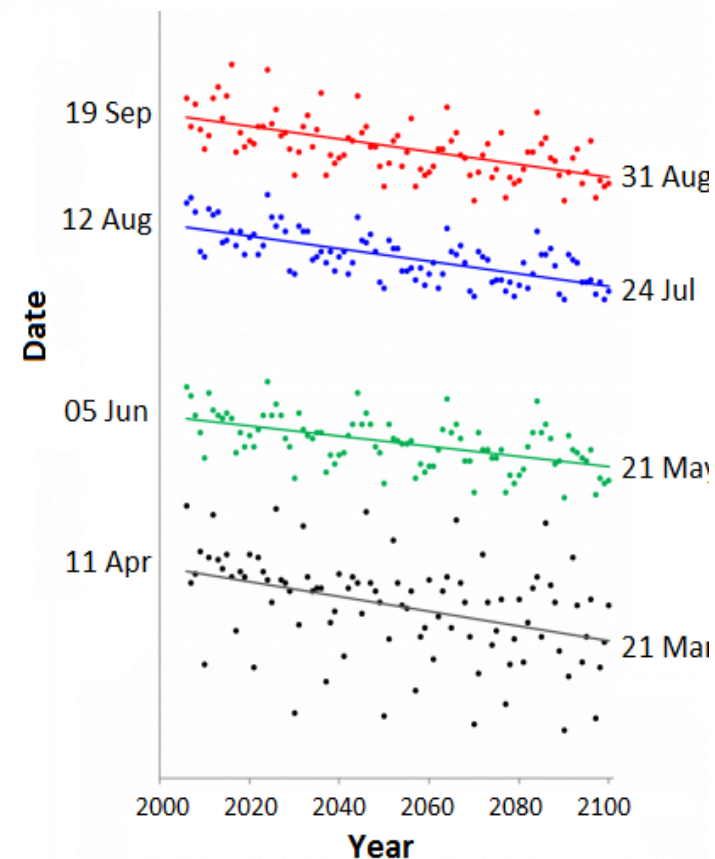
### Pessimistic Scenario (RCP 8.5)



### Optimistic Scenario (RCP 2.6)



### Stabilisation Scenario (RCP 4.5)



Phenological Stages: ● Budbreak ● Flowering ● Veraison ● Harvest





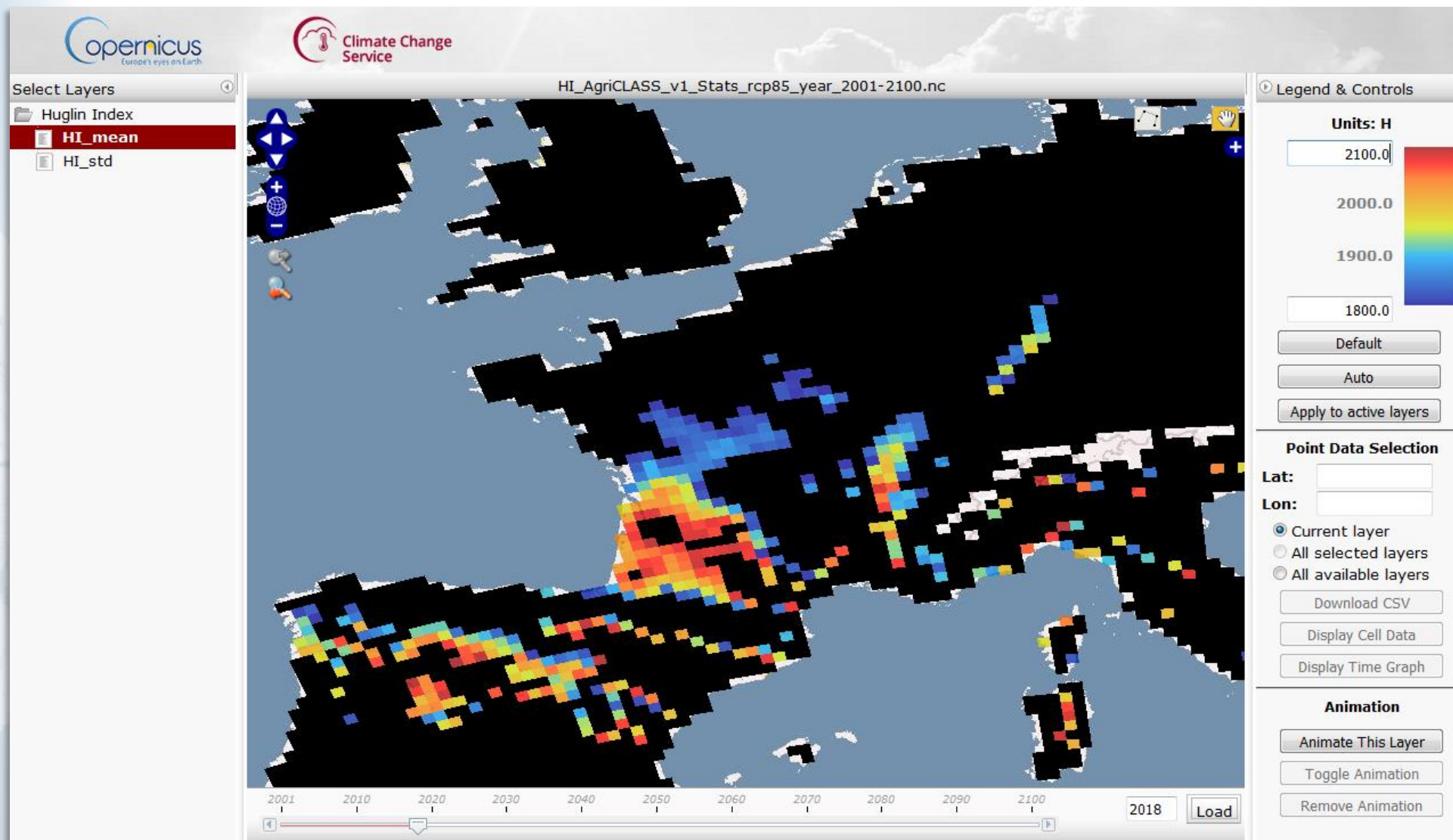
## Example: Huglin Index for Grape Varieties

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



Climate  
Change

## Example: Hugin Index for Grape Varieties (2018)

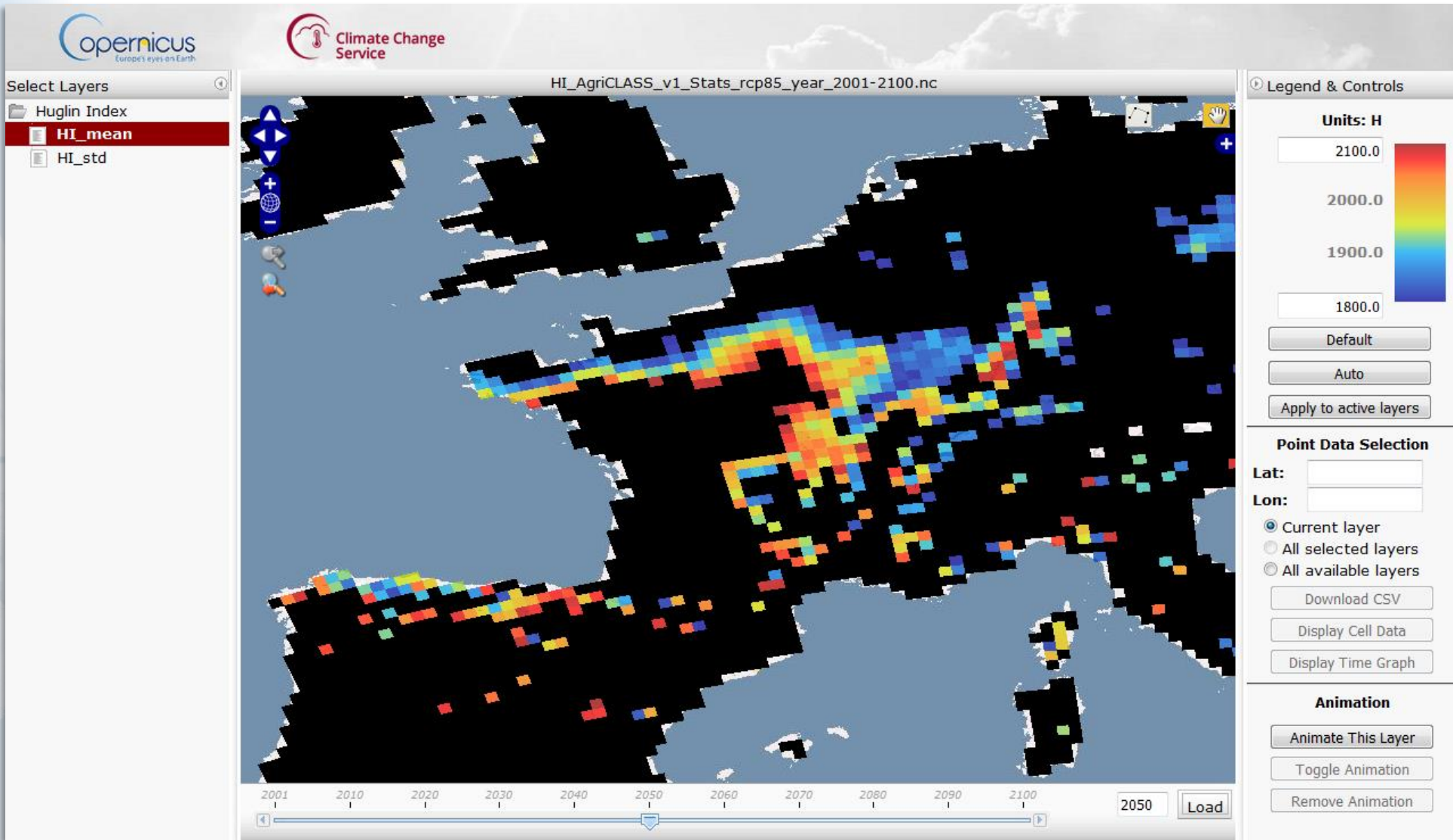






Climate  
Change

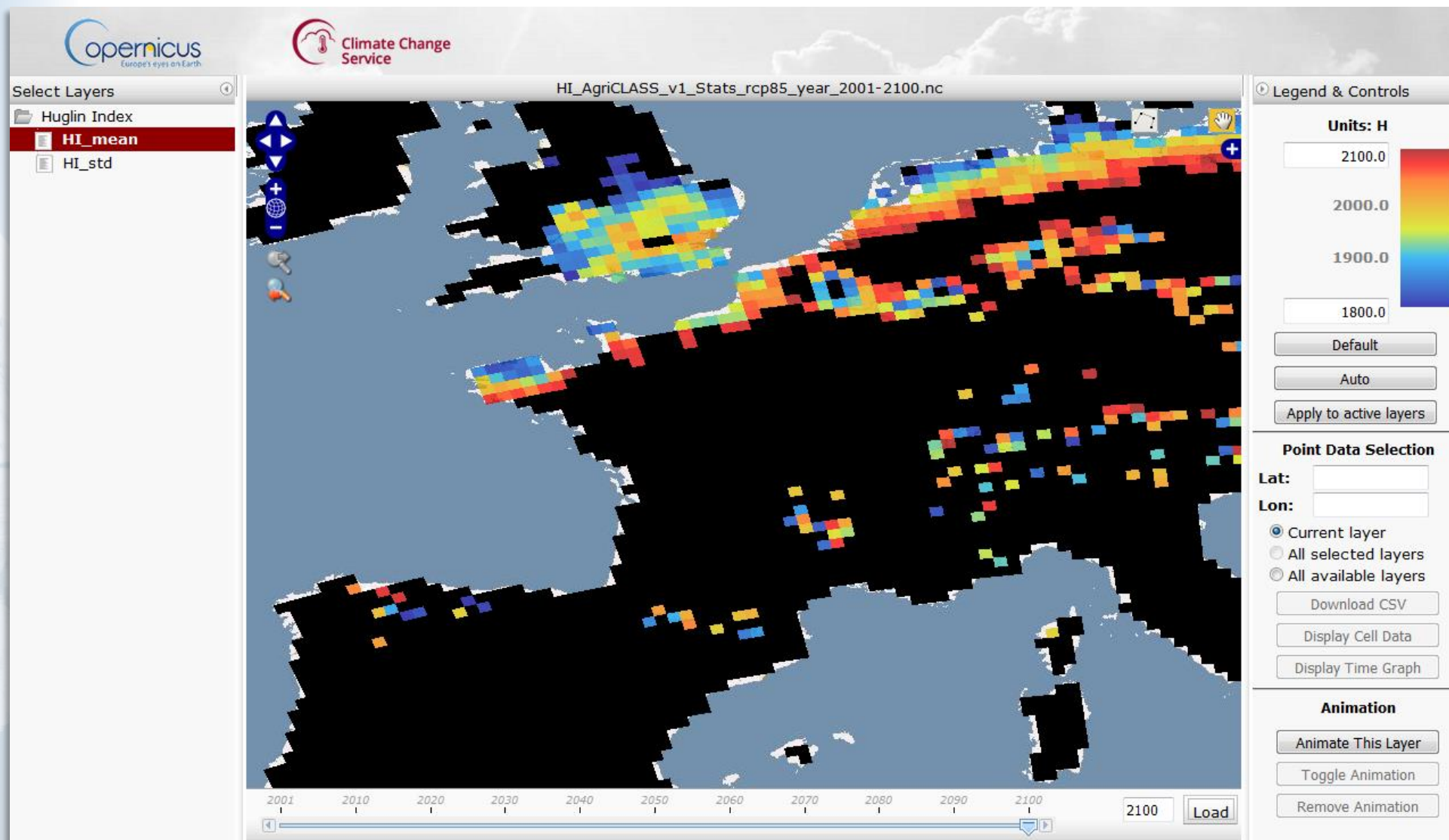
# Example: Hugin Index for Grape Varieties (2050, RCP8.5)





Climate  
Change

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







Climate  
Change

# Evaluation and Quality Control (EQC)

Home Search Datasets Help & support

Copernicus Europe's eyes on Earth

Climate Change Service BETA

## Global glaciers elevation changes and mass balance

Time series of glacier-wide changes in elevation and changes in mass

Overview Download data Interactive map **data quality**

The **Glacier Change Service** provides time series of glacier-wide changes in:

- **Elevation** from terrestrial, air and space borne geodetic surveys
- **Changes in mass** from glaciological in-situ measurements.

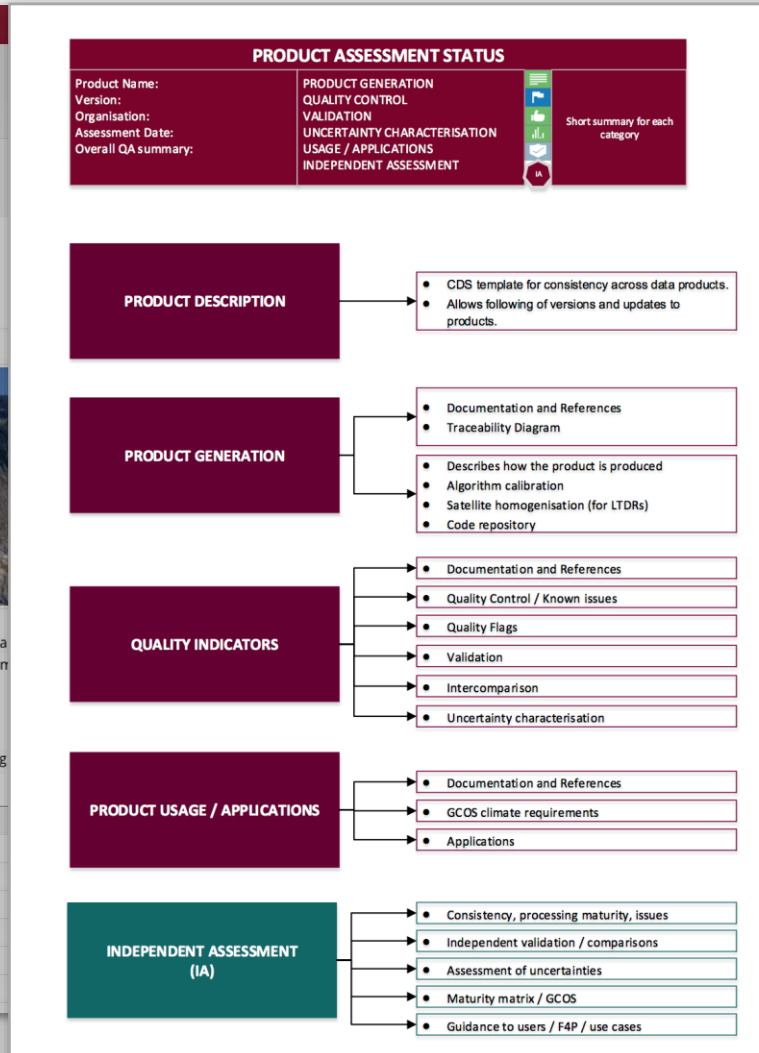
Both subsets are provided as **ESRI shapefiles** containing the location of the glacier label point in geographic coordinates (longitude and latitude in degrees), which are referenced to the WGS84 datum, and some general statistic information about the glacier. Both shapefiles come with one ancillary **.csv** file containing the time series of observed glacier changes and information of the original sources.

**Note:** The mass balance series consists of usually continuous annual balance measurements. The elevation change series consist of multi-annual changes with sometimes overlapping survey periods. For combining mass balance and elevation change data need again to be converted to annual change rates and mass changes need to be converted to  $850 \text{ kg} \cdot \text{m}^{-3}$ .

**Keywords:** glacier, change series, geodetic elevation change, glaciological mass balance

**Reference | Citation:** **WGMS** (2016): Fluctuations of Glaciers Database. World Glacier Monitoring DOI:10.5904/wgms-fog-2016-08. **WGMS downloads**

DATA DESCRIPTION	
Global glaciers elevation changes and mass balance	
Spatial coverage:	World Glacier Monitoring Service
Spatial resolution:	25km
Temporal coverage:	1850-2015
Temporal resolution:	from annual to decadal
Data format:	ESRI shapefiles



## Quality of data

- Assessments
- User guidance
- Gaps and limitations

## Quality of tools

- Fitness for purpose
- Best practices

## Quality of service

- Speed, responsiveness
- System availability, ...



Climate  
Change

# 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.





Climate Change

# Thank You

For questions contact:

Alex Farman, Telespazio VEGA UK Ltd

[alex.farman@telespazio.com](mailto:alex.farman@telespazio.com)

