



Climate Change

# Copernicus Climate Change Service

## Climate Change and the Urban Environment





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## Outline

1. The Copernicus Climate Change Service (C3S)
  - What is it?
  - Products and Services
  - Applications
2. Climate Change and the Urban Environment
  - Urban Sectorial Information System (SIS) Demonstrator Project



Climate Change

# Copernicus Climate Change Service (C3S)





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## The C3S mission

To support European adaptation and mitigation policies by:

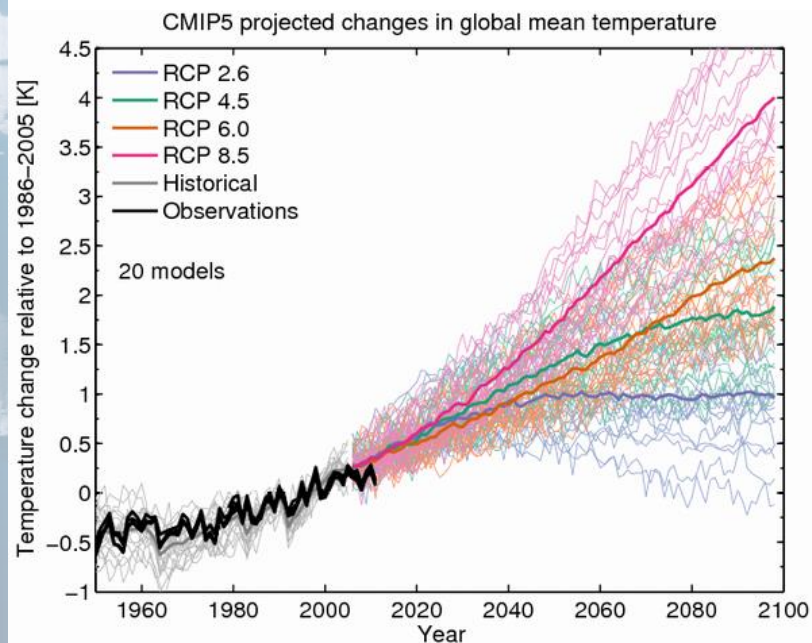
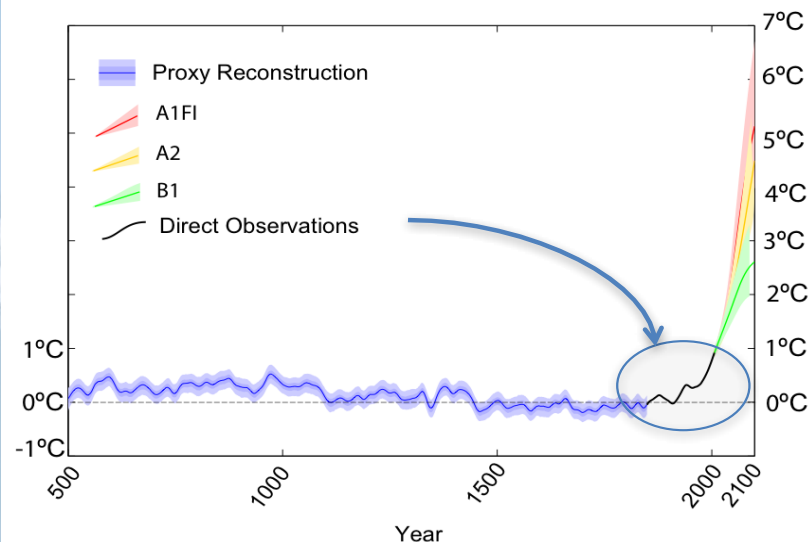
- Providing consistent and authoritative information about climate
- Building on existing capabilities and infrastructures (nationally, in Europe and worldwide)
- Stimulating the market for climate services in Europe





# 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?

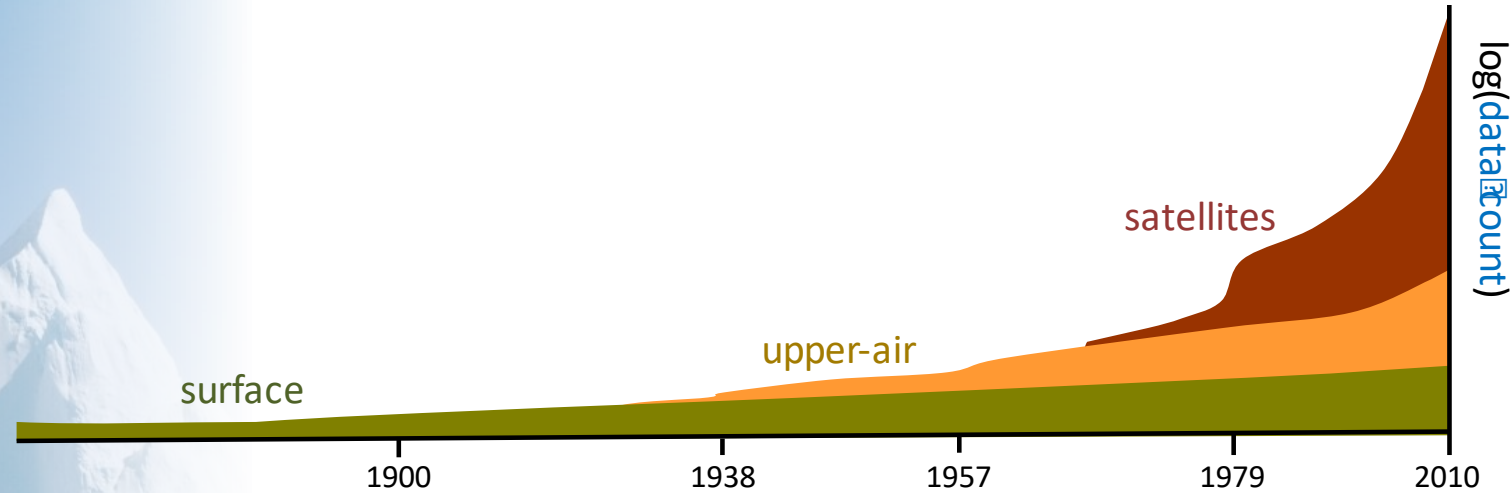






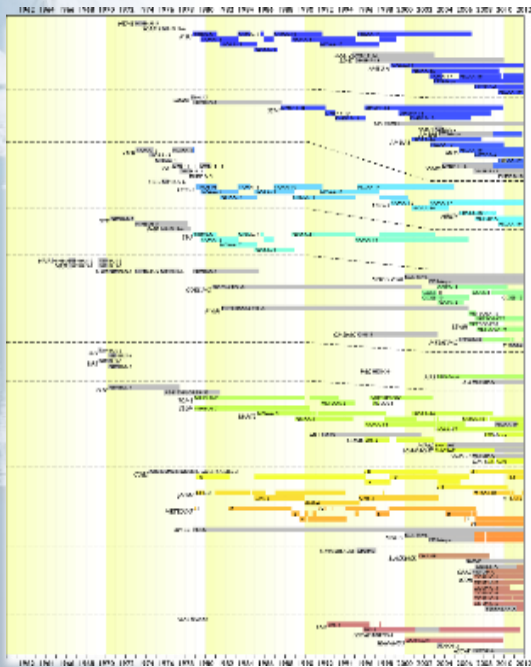
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# Past, present and future climate information

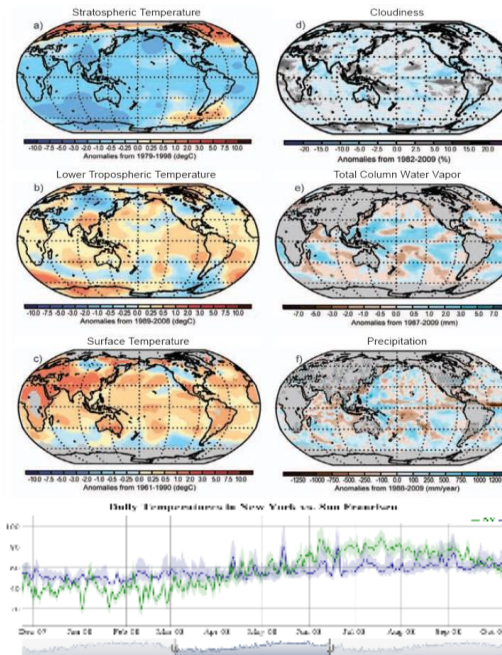


## Past Observations

- 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.



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# Past, present and future climate information

The screenshot shows the Copernicus Climate Change Service (C3S) website. The header includes the Copernicus logo, the C3S logo, and a search bar. The main navigation menu lists: ABOUT C3S, NEWS & MEDIA, EVENTS, TENDERS, PRODUCTS, SERVICES, and HELP & SUPPORT. The page title is "Seasonal forecasts". Below the title, there is a breadcrumb trail: home » products. The main content area features four maps: a line graph showing a sharp increase in temperature, a world map with color-coded temperature anomalies, a world map with color-coded precipitation anomalies, and a map of Europe with color-coded temperature anomalies. To the right of the maps is a list of products: AVERAGE SURFACE AIR TEMPERATURE MONTHLY MAPS, MONTHLY SEA-ICE MAPS, HYDROLOGICAL CLIMATE VARIABLES, CLIMATE REANALYSIS, and SEASONAL FORECASTS. Below the products list is a "NEWS" section with four articles: "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", and "26 Jan 2017 Copernicus at the 4th International Conference on Energy & Meteorology (ICEM)". Below the news section is an "EVENTS" section with one article: "13 Nov 2017 Report Reassesses Variations in Global Warming".

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

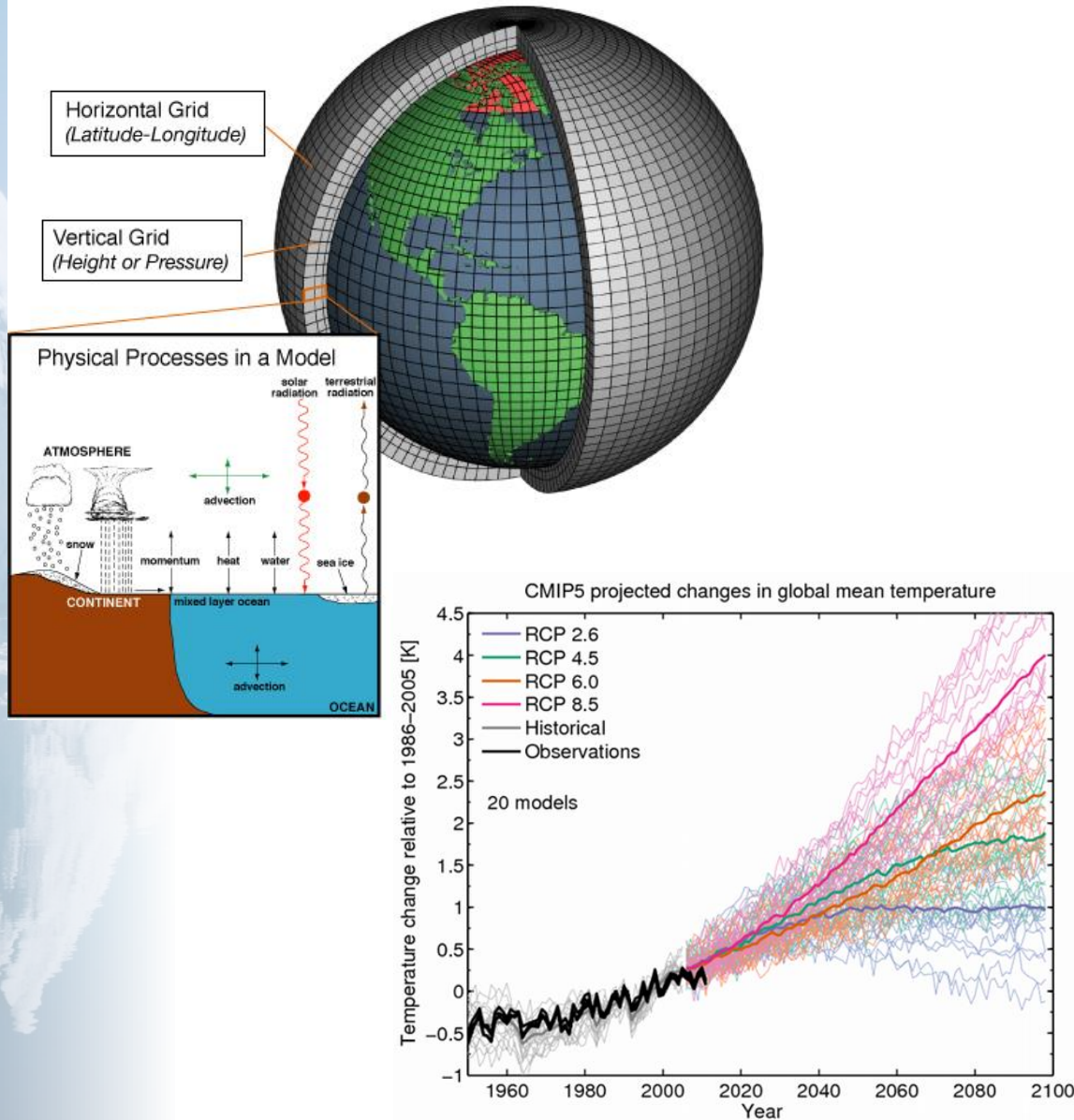
## Seasonal Forecasts

- 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).





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# Essential Climate Variables

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



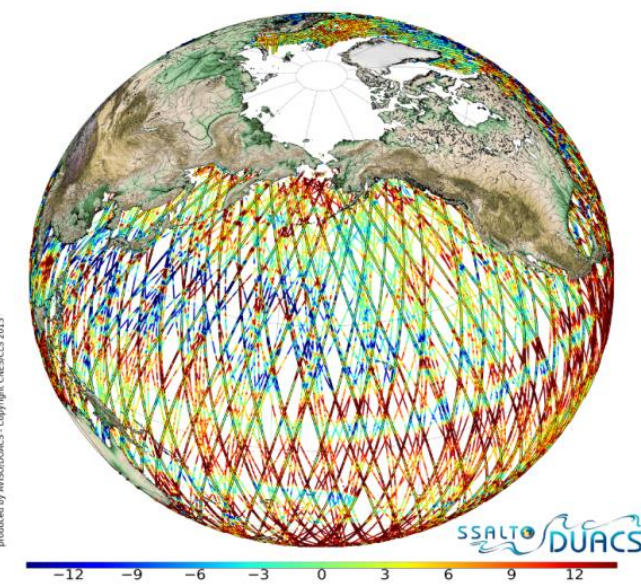
## ECVs supported by C3S contracts

		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



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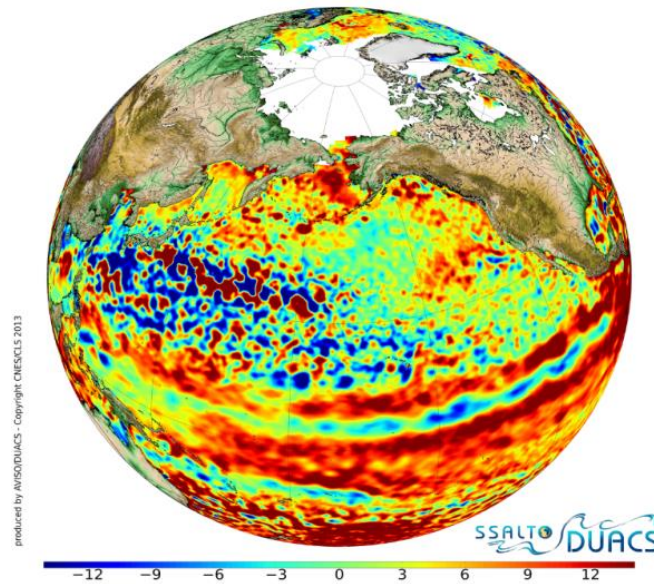
# Example: Sea Level ECV production service



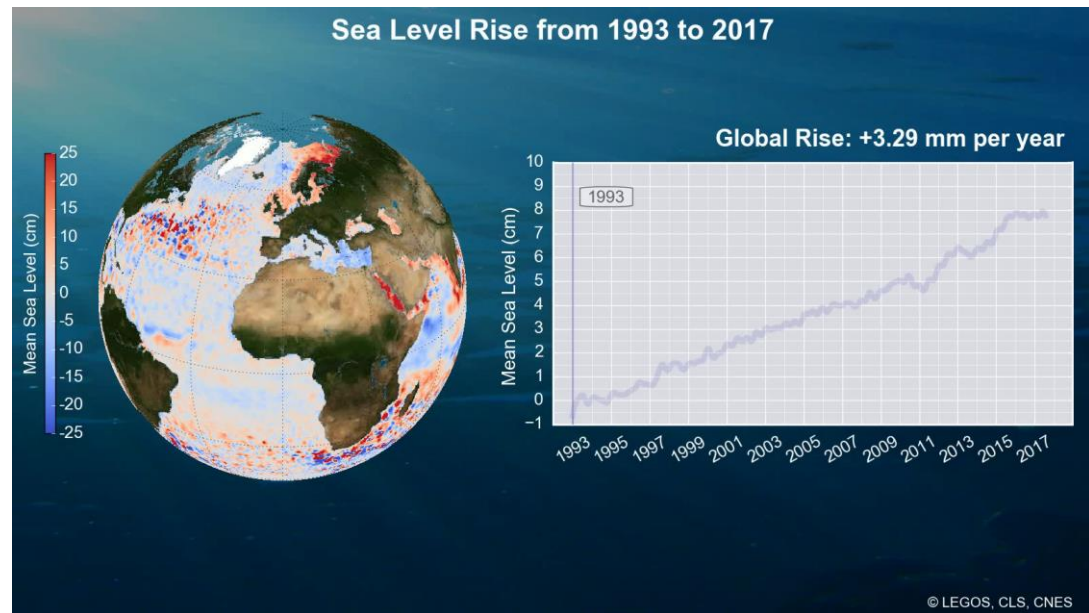
From satellite along-track altimetry measurements...



... to sea level gridded maps...



... to derive  
Ocean  
Monitoring  
Indicators



European  
Commission







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## C3S and UNFCCC Sustainable Development Goals

### C3S contribution to SDGs

C3S SIS addresses agriculture, and some of the global services will focus on food security

C3S SIS addresses health, providing relevant climate change indicators

Two Proof-of-concept SIS projects in C3S dedicated to water management. A urban PoC SIS is also addressing this SDG at city level.

Two proof-of-concept SIS projects in C3S dedicated to the Energy Sector. Reanalyses (produced by C3S) are also highly relevant.

C3S activities contribute indirectly to this SDG insofar that the energy climate impact indicators (see goal 7) are relevant.

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

C3S SIS related to urban aspects of climate change, as well as health and infrastructure aspects, contribute indirectly to this SDG. Reanalysis products too.

C3S SIS products and indicators on water management are directly relevant for this goal.

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

Some of the ECV products generated by C3S (including reanalysis ORAS5) are ocean relevant. This is done in coordination with CMEMS.

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.

11 SUSTAINABLE CITIES AND COMMUNITIES



12 RESPONSIBLE CONSUMPTION AND PRODUCTION



13 CLIMATE ACTION



14 LIFE BELOW WATER



15 LIFE ON LAND







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



Implemented by ECMWF as part of The Copernicus Programme

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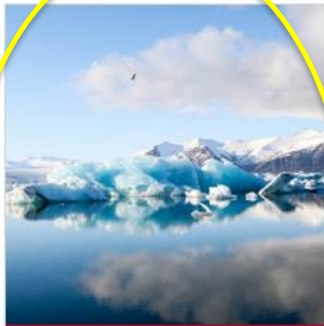
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## Key products and services



Climate bulletins



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Data in action



### In focus

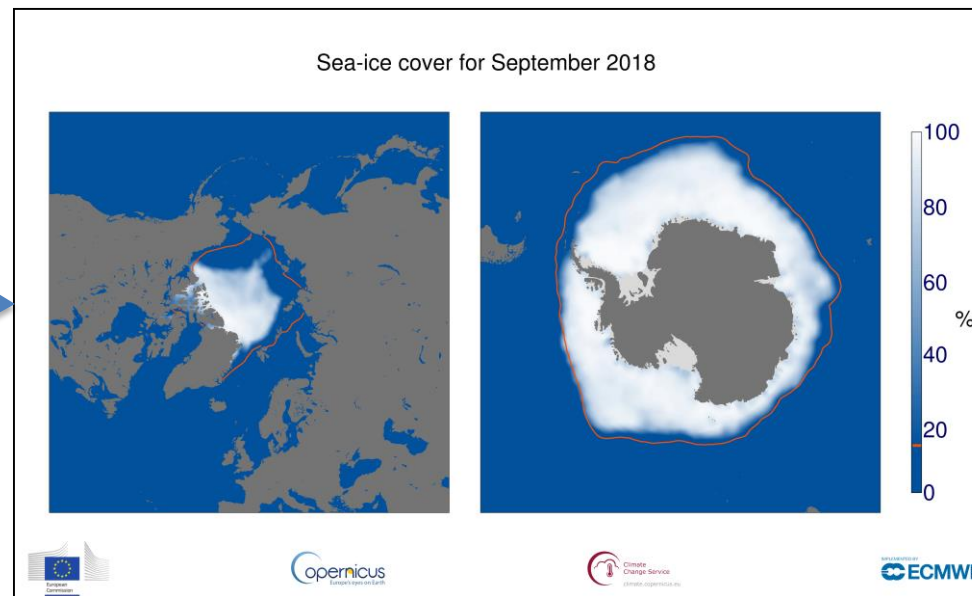
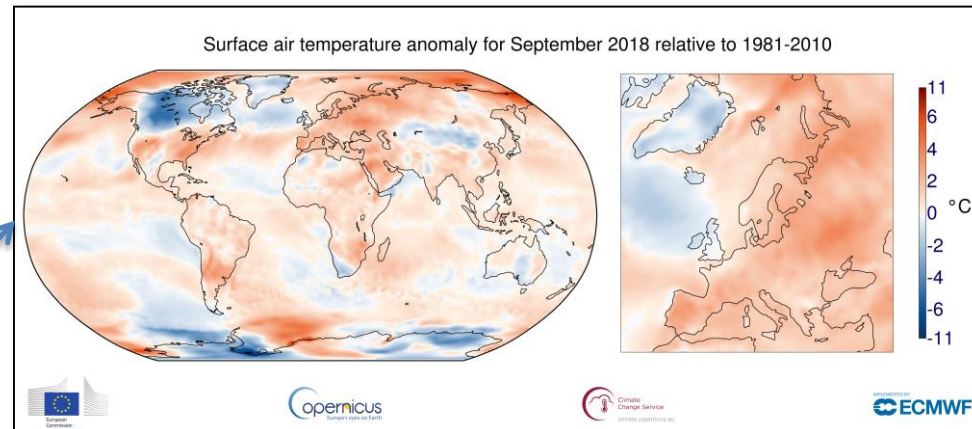
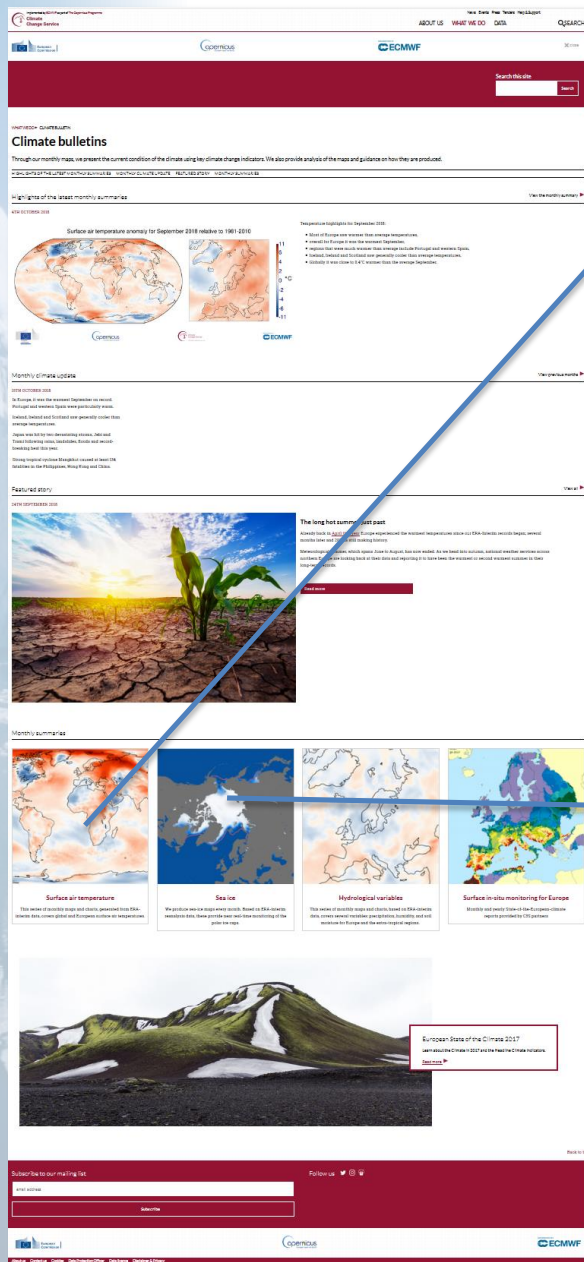
Welcome to the 'European State of the Climate 2017' report, compiled by the Copernicus Climate Change (C3S) and Atmosphere Monitoring (CAMS) Services.

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# 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.





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# Annual Climate Bulletin

## European State of the Climate 2017



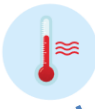
Surface temperature

Sea ice area

Precipitation

Soil moisture

Greenhouse gases



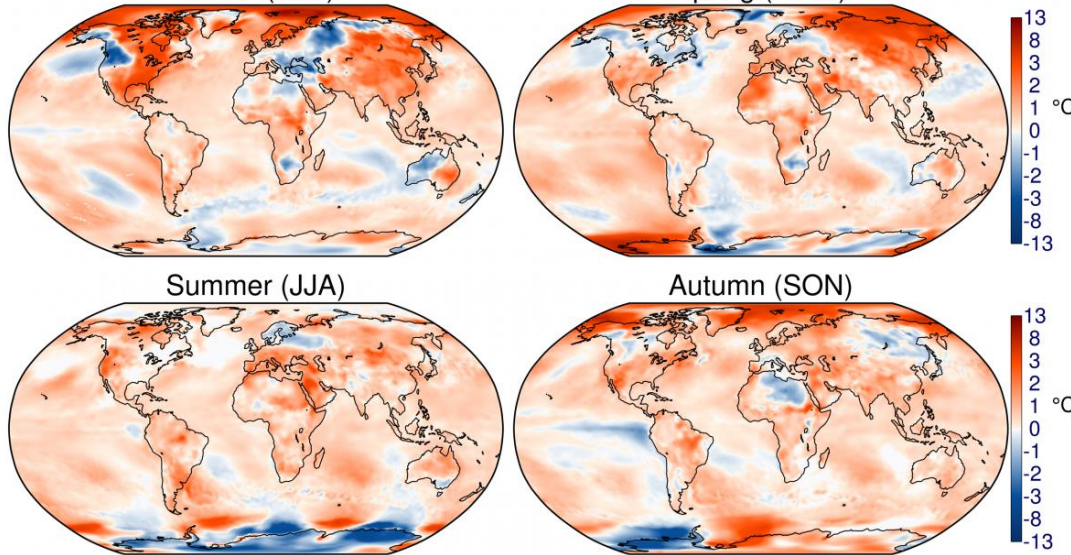
ERA-Interim seasonal temperature anomaly for 2017

Winter (DJF)

Spring (MAM)

Summer (JJA)

Autumn (SON)



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.

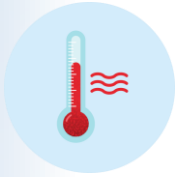






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## Climate Indicators



Surface Air Temperature



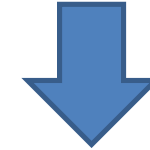
Greenhouse Gases



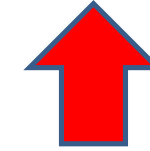
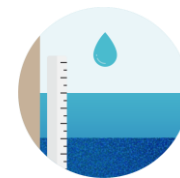
Rain



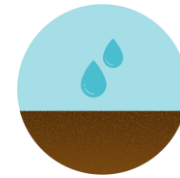
Sea Ice



Glaciers



Sea Level



Soil Moisture

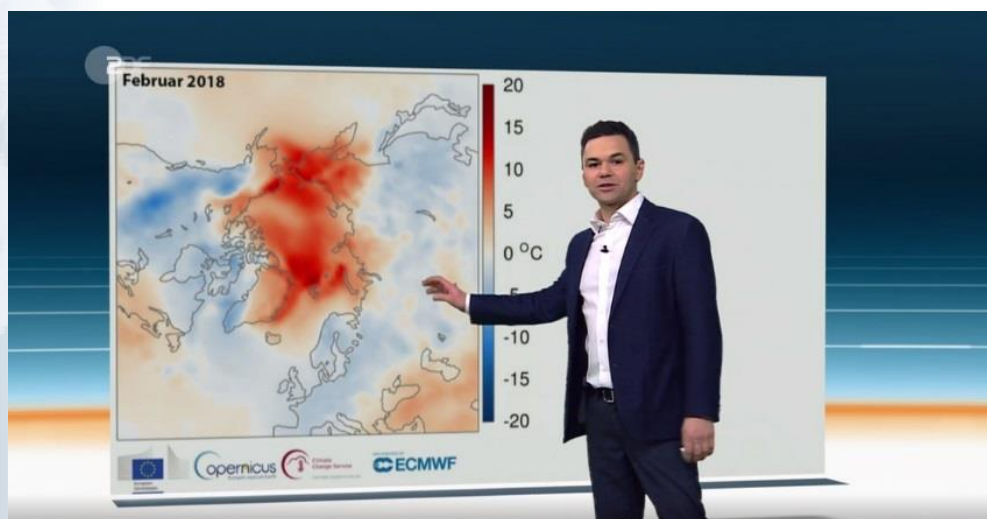


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## Examples of user uptake by media



- Standard C3S monthly products
- “Bespoke” C3S products



Credit: ZDF, Özden Terli, C3S

**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**

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
- TSB boss to step down after IT fiasco
- Famed cystic fibrosis activist dies at 21

**Features**

- Movels of the deep and their superpowers
- Why does the battle for Idlib matter?

BBC, July 2018





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## Key products and services



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### In focus

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





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# Climate Data Store



cds.climate.copernicus.eu

Search results

sea level

Q

All

Sort by

Relevancy

Title

Type

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

Overview

Download data

Documentation

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

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

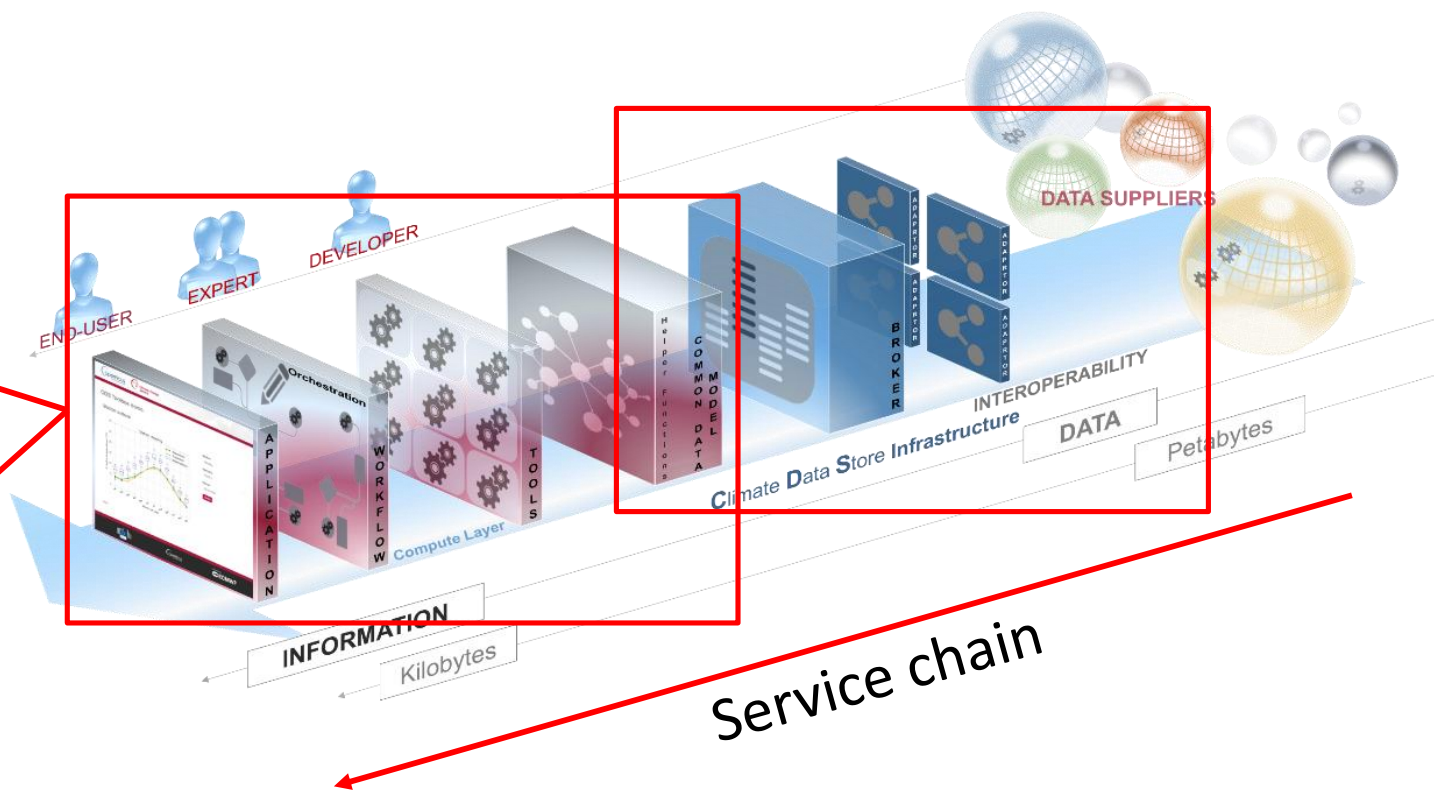
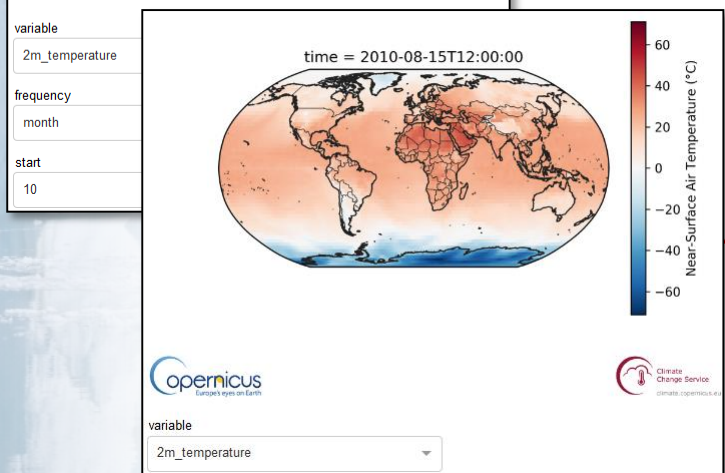
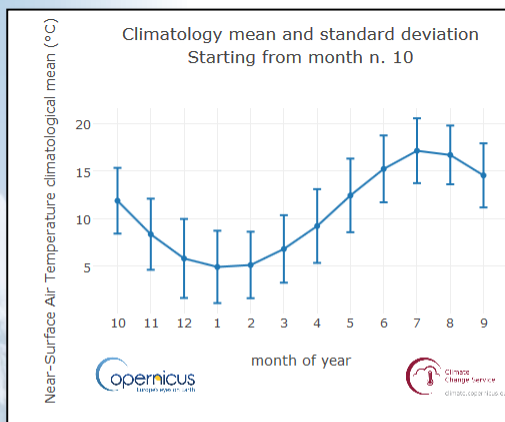
Sea surface temperature daily gridded data from 1991 to 2010 produced by ESA-CCI

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



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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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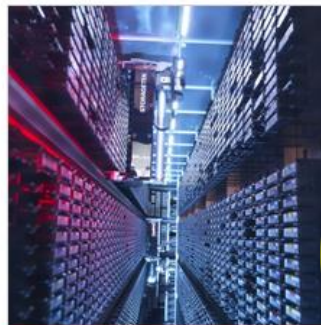
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## Key products and services



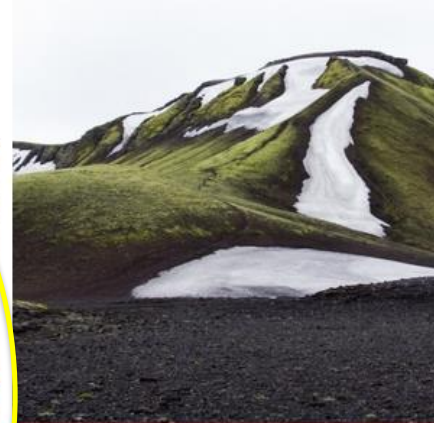
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### In focus

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Europe's eyes on Earth

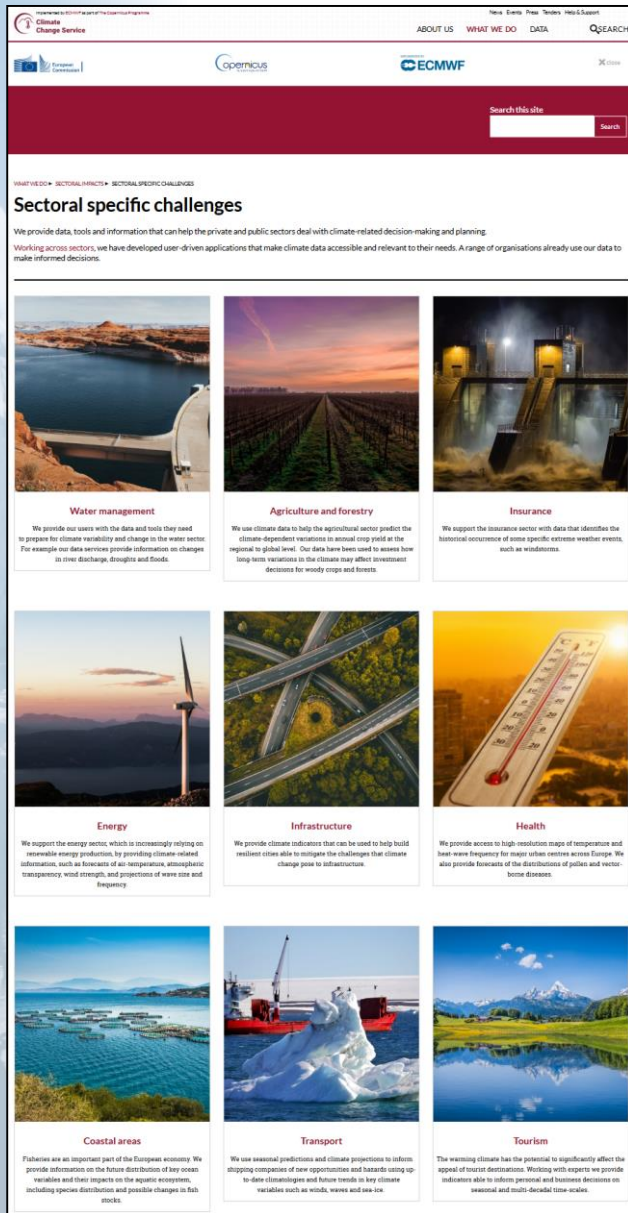
 **European  
Commission**

 **ECMWF**



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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

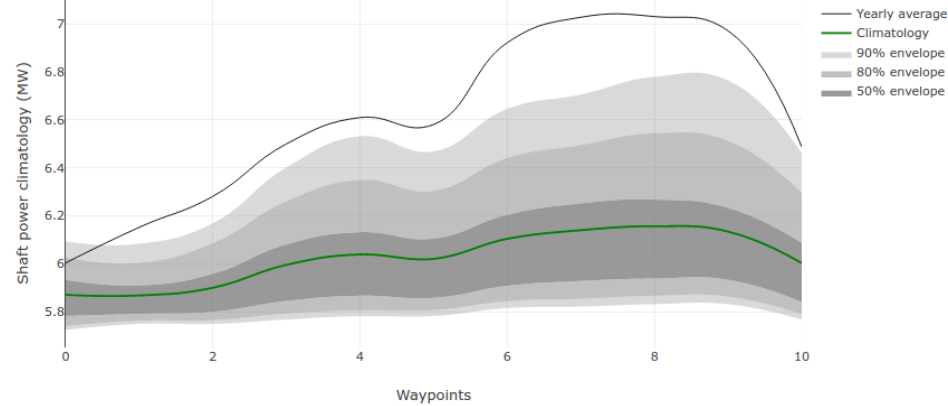


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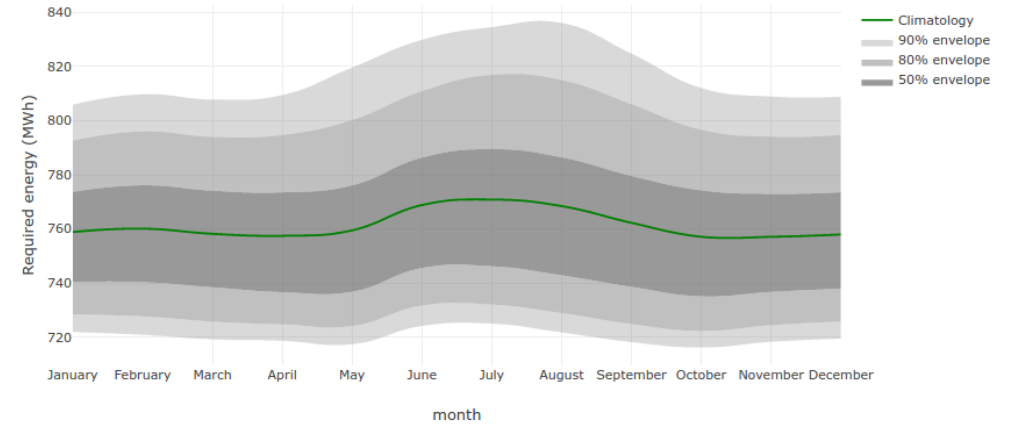
# Examples: Climate indicators related to Shipping

Which part of the route/season is most likely to lead to overconsumption ?

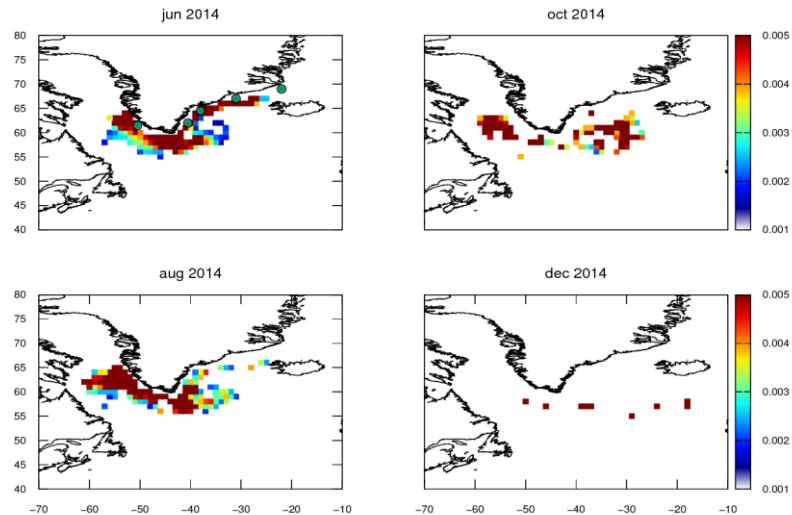
Shaft power climatology in July



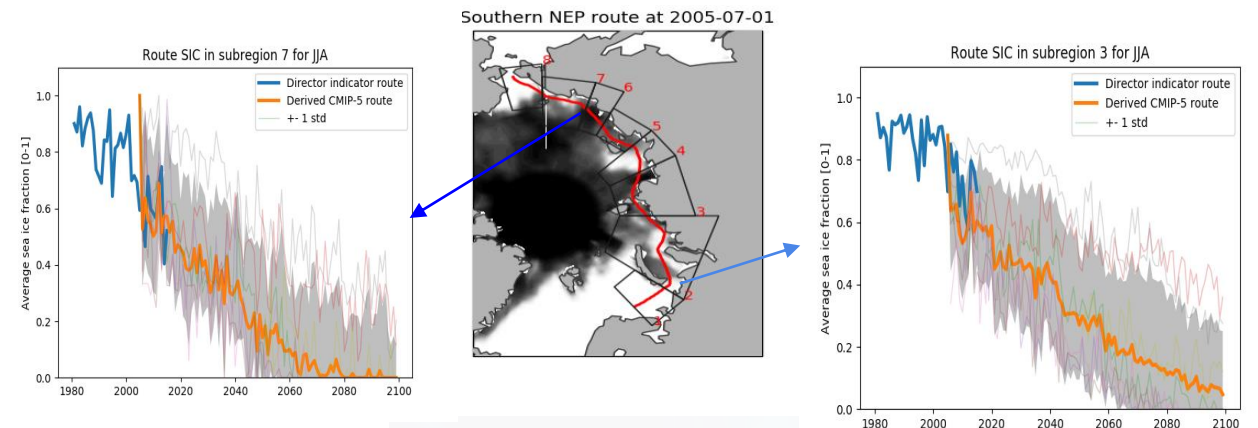
Yearly climatology of required energy



Where/when will I find icebergs ?



When will the Arctic route become commercially viable?







## 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



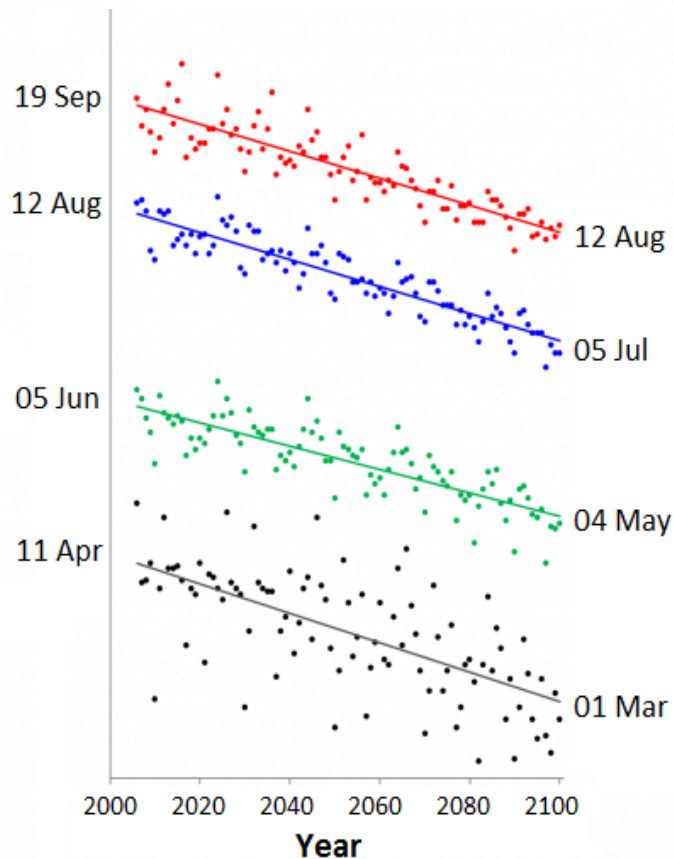
Using data from historical observations, a mathematical model was developed to correlate the Day of Year (DOY) reaching each stage, with the accumulated temperature, measured in Growing Degree Days. Then, using simulated future daily weather from climate projections, it was possible to predict how the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



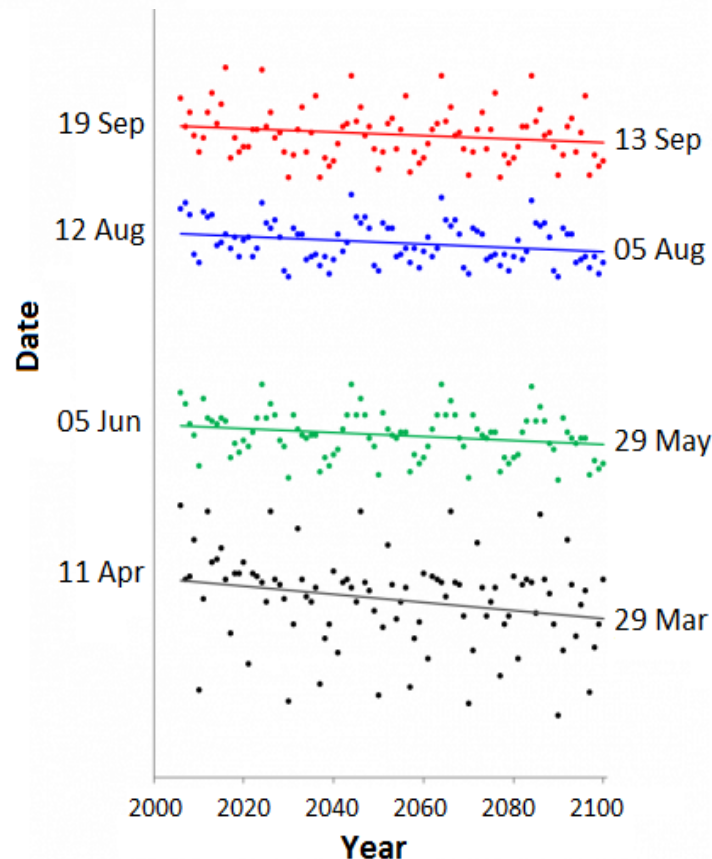
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## Case Study: Viticulture in Buzet, SW France

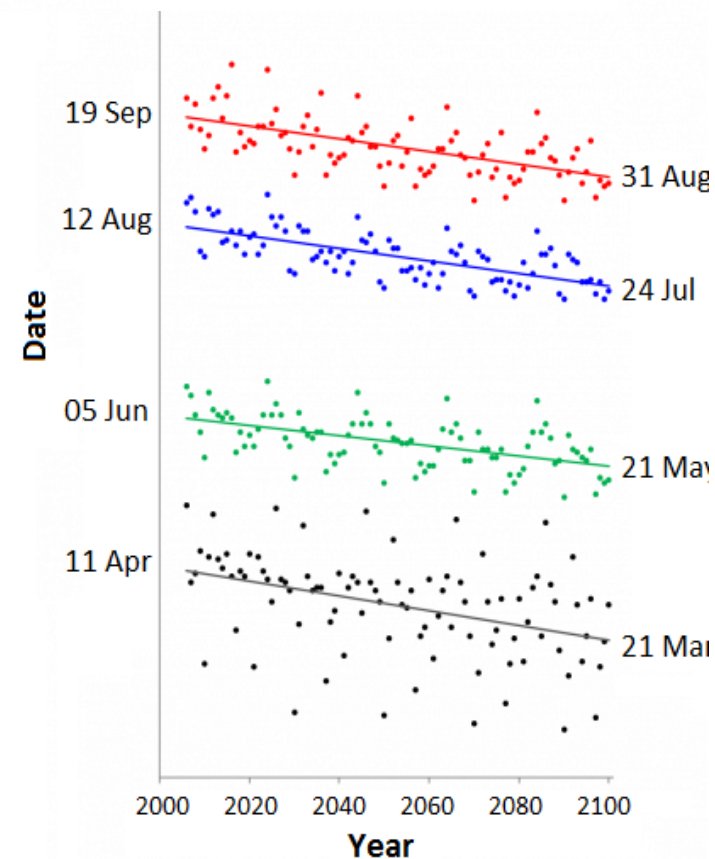
### Pessimistic Scenario (RCP 8.5)



### Optimistic Scenario (RCP 2.6)



### Stabilisation Scenario (RCP 4.5)



Phenological Stages: ● Budbreak ● Flowering ● Veraison ● Harvest



## Example: Huglin Index for Grape Varieties

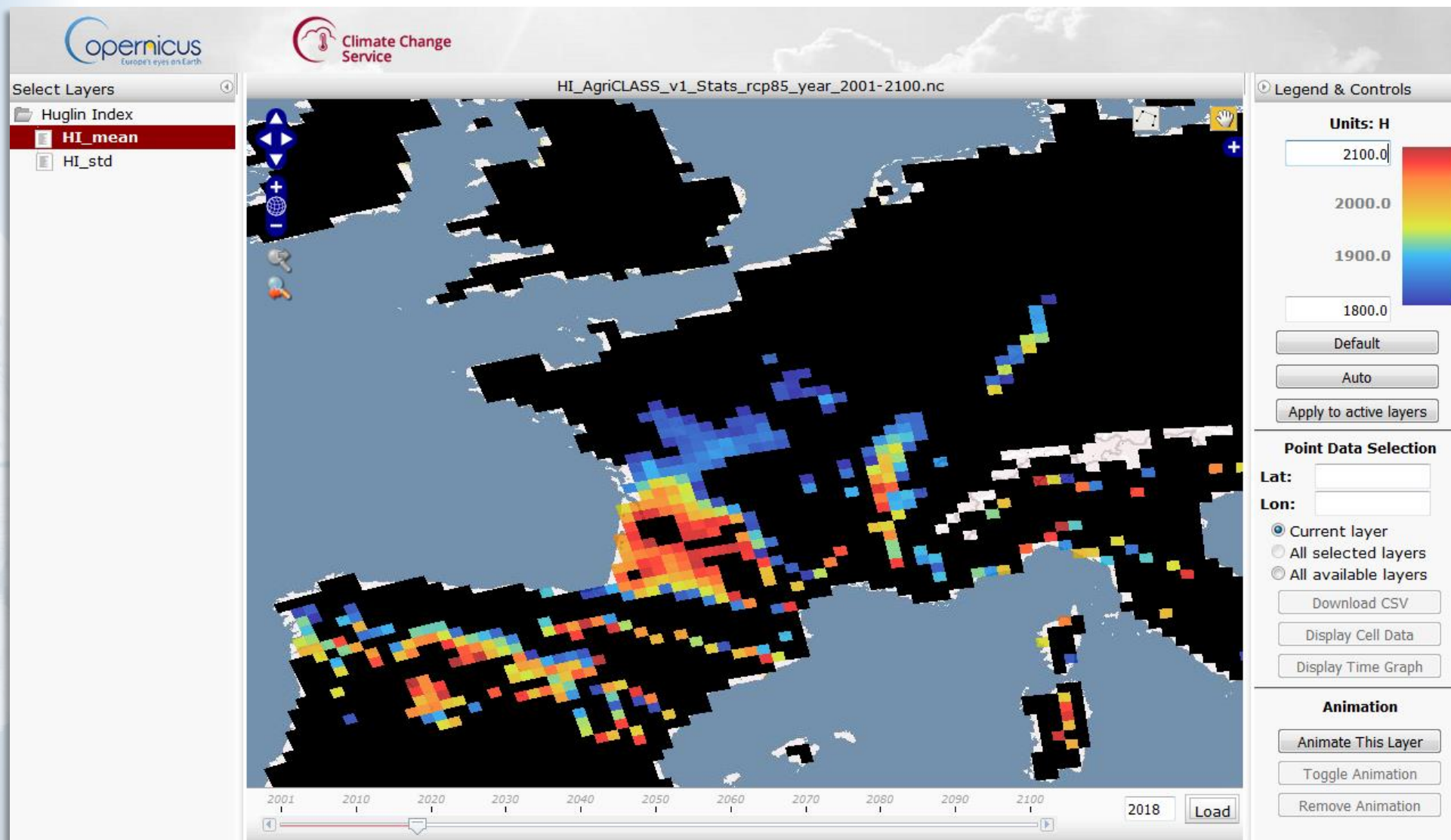
Huglin-Index H	Selected varieties of grapevine which are worth cultivating
$H < 1500$	Not recommended for cultivation
$1500 < H < 1600$	Müller-Thurgau
$1600 < H < 1700$	Pinot blanc, Gamay noir
$1700 < H < 1800$	Riesling, Chardonnay, Sylvaner, Sauvignon blanc, Pinot noir
$1800 < H < 1900$	Cabernet franc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





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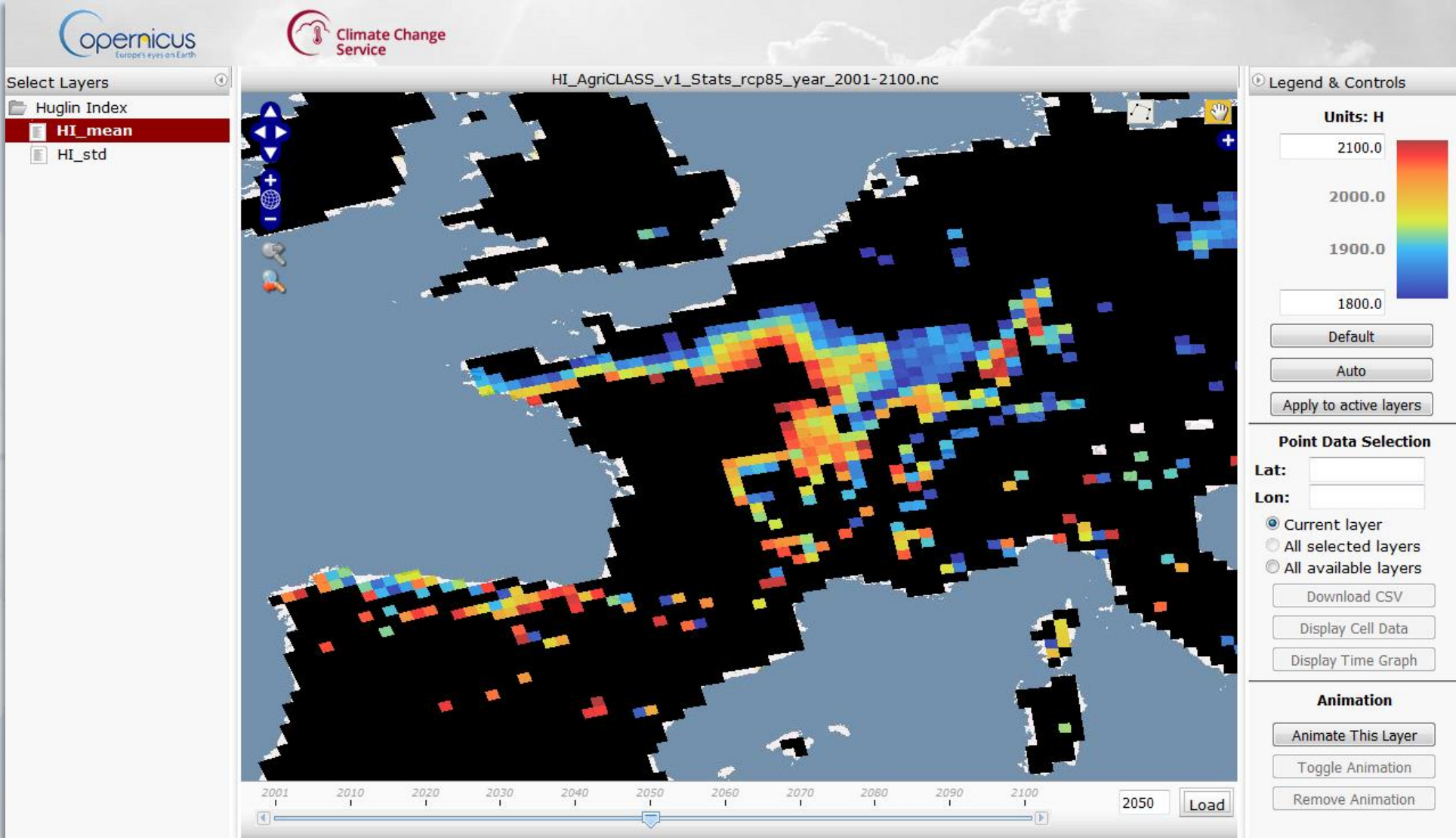
## Example: Hugin Index for Grape Varieties (2018)





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

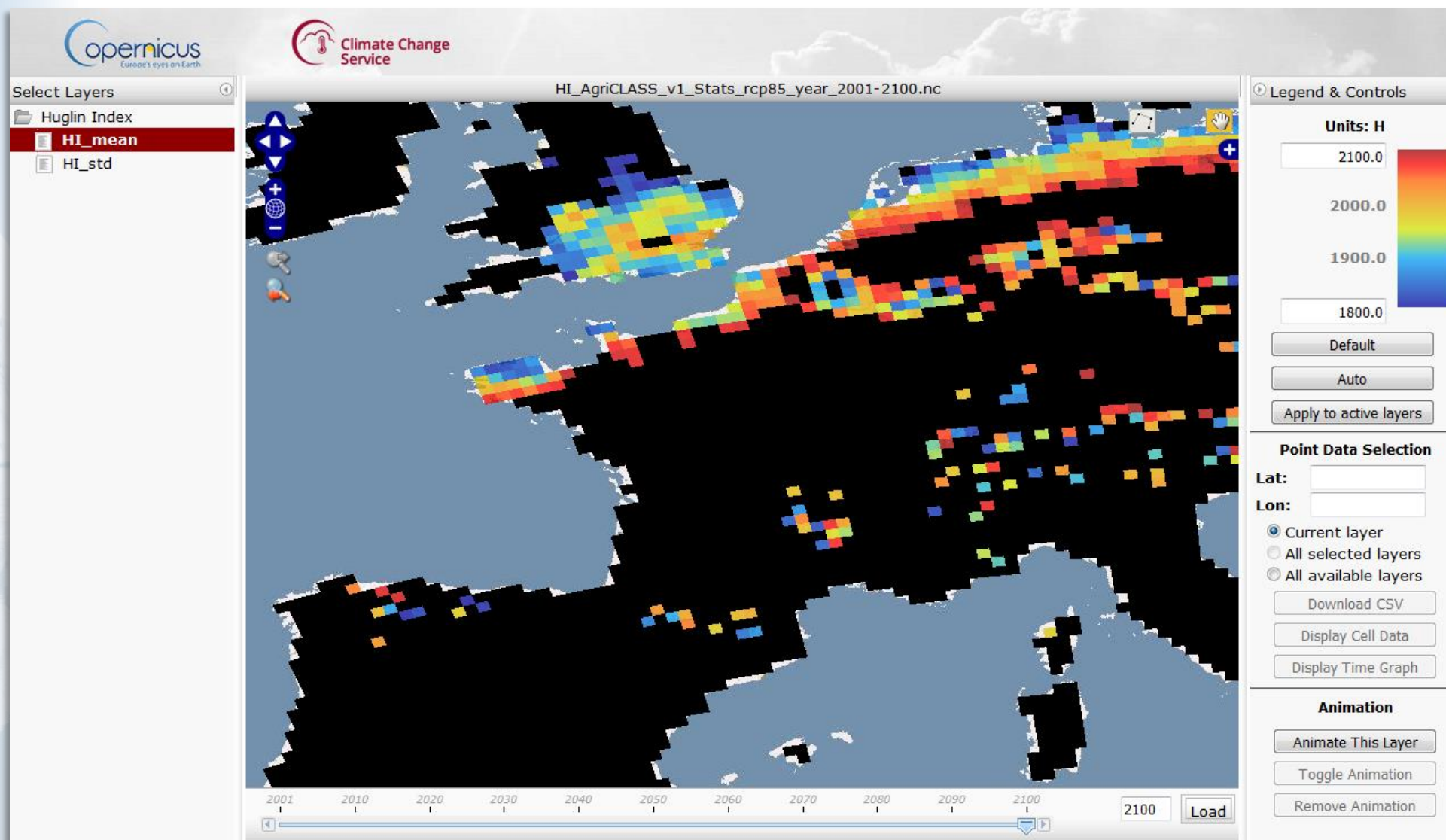






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## Example: Hugin Index for Grape Varieties (2100, RCP8.5)







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# Evaluation and Quality Control (EQC)

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Copernicus Europe's eyes on Earth

Climate Change Service B E T A

## 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.

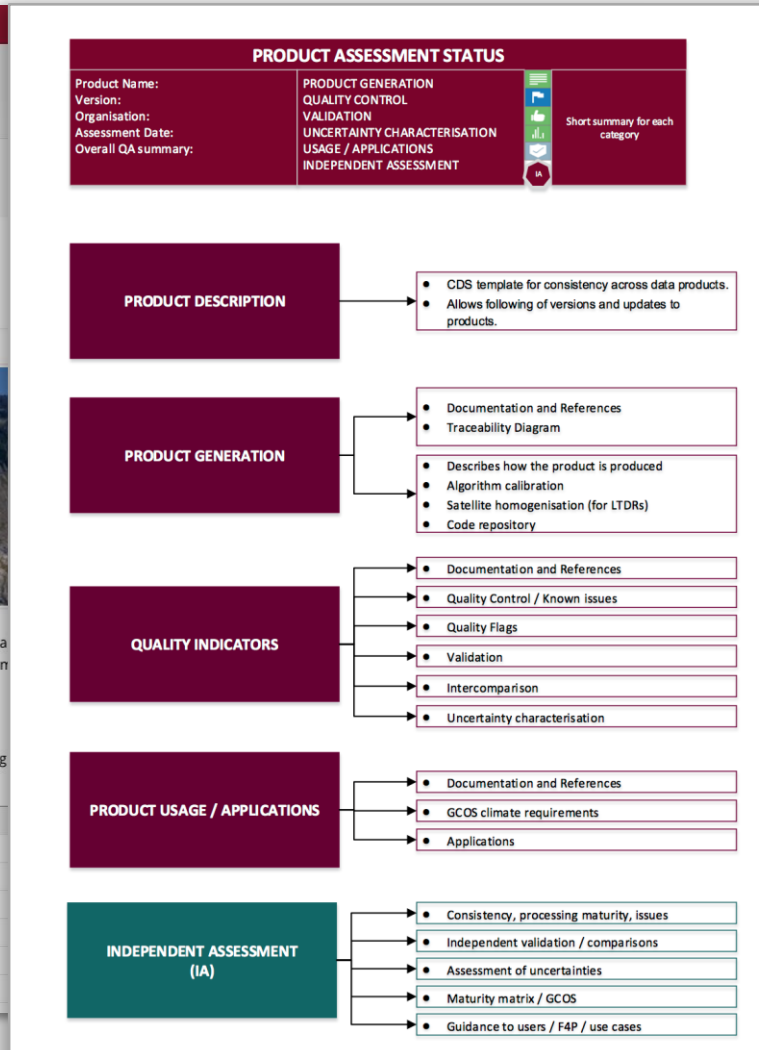
Both subsets are provided as **ESRI shapefiles** containing the location of the glacier label point in geographic coordinates (longitude and latitude in degrees), which are referenced to the WGS84 datum, and some general statistic information about the glacier. Both shapefiles come with one ancillary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



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# C3S and the ecosystem



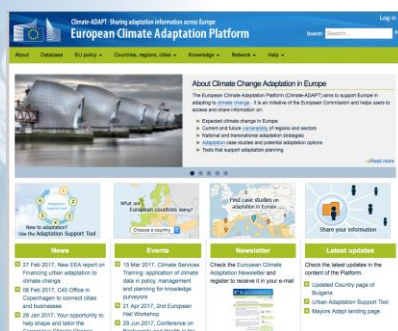
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etc...



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



NOAA:

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



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





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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.





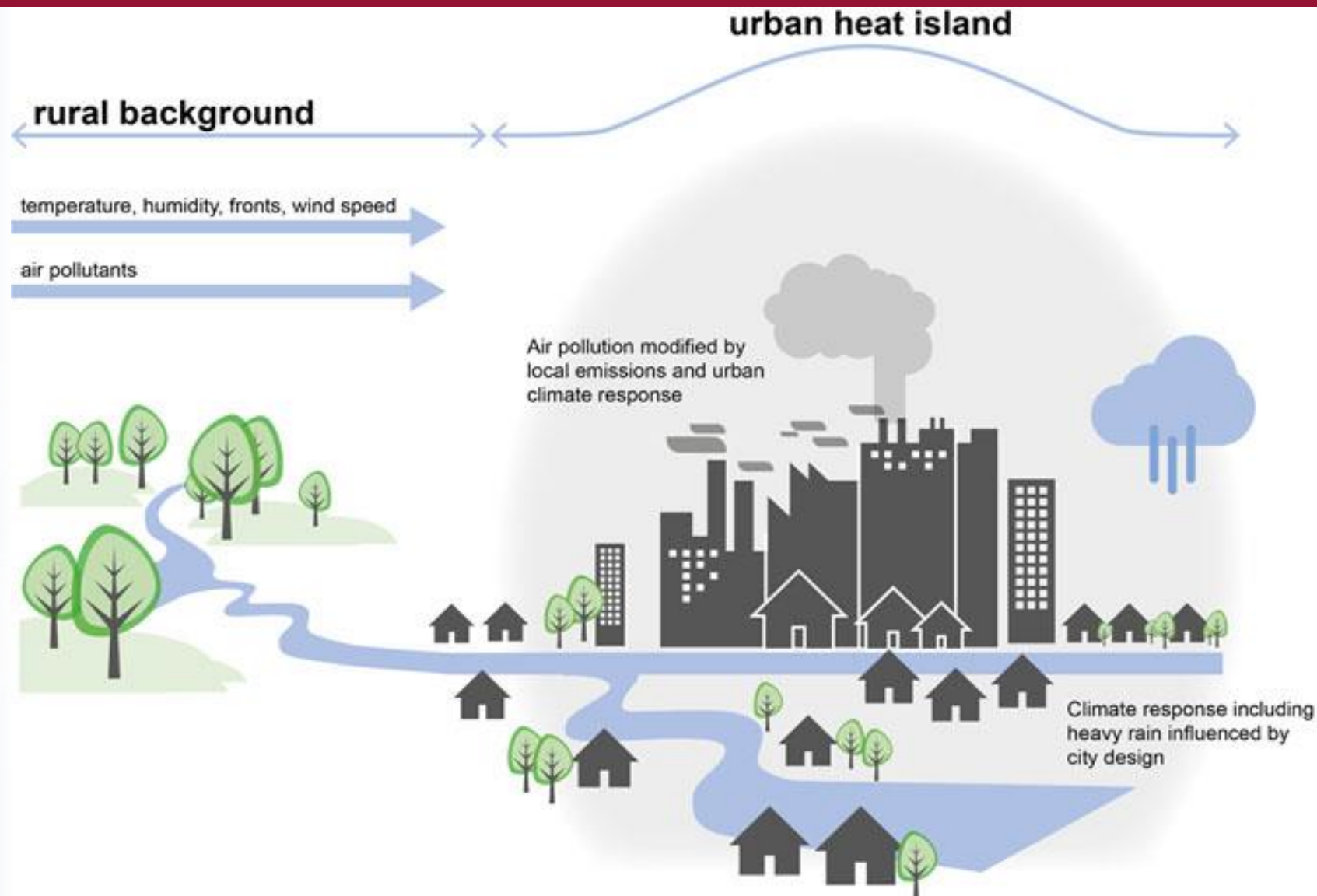
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# Climate Change and the Urban Environment





# Climate Impacts





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# Urban SIS Project

**Urban SIS**

**Urban SIS: Climate Information for European Cities** is a project funded by Copernicus. The goal of the project is to provide a proof-of-concept of a service offering Essential Climate Variables (ECV) and impact indicators based on temperature and other climatic variables together with air pollutant concentrations.

This information will bring more consistent and useful data to different sectors operating in urban areas, e.g. related to infrastructure and health. Note also that ozone and aerosols are part of the atmospheric ECVs, as defined by GCOS.

Currently, Essential Climate Variables information over Europe, such as the re-analysis of historical periods and regionally downscaled climate projections, are offered on spatial scales that does not take into account the specific conditions of individual cities.

Improved understanding of physical processes, as well as the development of computer power have allowed models to operate at the kilometer-scale resolutions required to represent urban areas and their impact on the local weather and climate.

An overview of the project is given in our [Urban SIS flyer](#).

## Urban Sectorial Information System (Urban SIS)

A demonstrator project from the proof of concept phase of the C3S programme

Active: Oct 2015 – Dec 2017

### Project Partners

- Swedish Meteorological and Hydrological Institute (SMHI)
- University of Reading,
- University of Umea, SE
- ARPA
- University of Bologna
- WSP
- Veryday

<http://urbansis.climate.copernicus.eu/>







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## Target Users

Advanced end users (consultants, urban engineers, modellers):

- improved input data to run local impact models
- consistent ECV variables, dynamically downscaled
- both historical periods and future climate projections (climate adaptation required also today!)
- generation of city-specific impact indicators
- possibility for an extended commercial market of local assessments

Urban planners in general:

- the spatial perspective (maps) allow identification of “hot spots”
- possibility to compare and prioritize different climate-related threats to a specific city and a specific sector
- possibility to compare impact indicators from one city to another
- possibility to discuss problems and solutions across different sectors (different indicators based on the same ECVs)



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## Aims

- Provide **city-specific** climate data and impact indicators to support the infrastructure and health sectors operating in cities.
- Develop, demonstrate and test a method to **downscale** climate and impact indicators to the urban scale ( $\sim 1 \times 1 \text{ km}^2$ )
- Deliver the information in such **format** that it is directly useful for consultants and urban engineers/scientists as input to specific/local models or dimensional calculations
- Concerning in particular the following urban **hazards**:
  - Intense rainfall
  - Heat waves
  - Extreme air pollution levels



HEALTH



INFRASTRUCTURE



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## Sectorial Indicators

### Health Sector

#### Heat Stress

- Number of hot days
- Heat wave duration
- Heat induced mortality

#### Discomfort

- Thom Discomfort Index
- Universal Thermal Climate Index
- Frequency of tropical nights

#### Air Quality

- EU limit values: concentration
- EU limit values: concentration
- Mortality long-term exposure
- Mortality short-term exposure

### Infrastructure Sector

#### Flooding

- Short duration extreme precipitation
- Short duration extreme precipitation intensity/duration

#### Green infrastructure

- Growing season length

#### Transport infrastructure

- Frost days
- Ice days
- Zero-crossings

### Energy Sector

#### Energy consumption

- Heating degree days
- Cooling degree days

#### Solar energy

- Shortwave solar insolation





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# Essential Climate Variables (ECV)

## Temperature

- Air temperature
- Urban air temperature
- Nature air temperature
- Higher layer air temperature

## Hydrology

- Discharge
- Runoff
- Surface runoff
- Soil moisture
- Evapotranspiration
- Snow cover

## Precipitation

- Precipitation
- Snowfall

## Air quality

- NO<sub>2</sub>
- O<sub>3</sub>
- PM<sub>10</sub>
- PM<sub>2.5</sub>

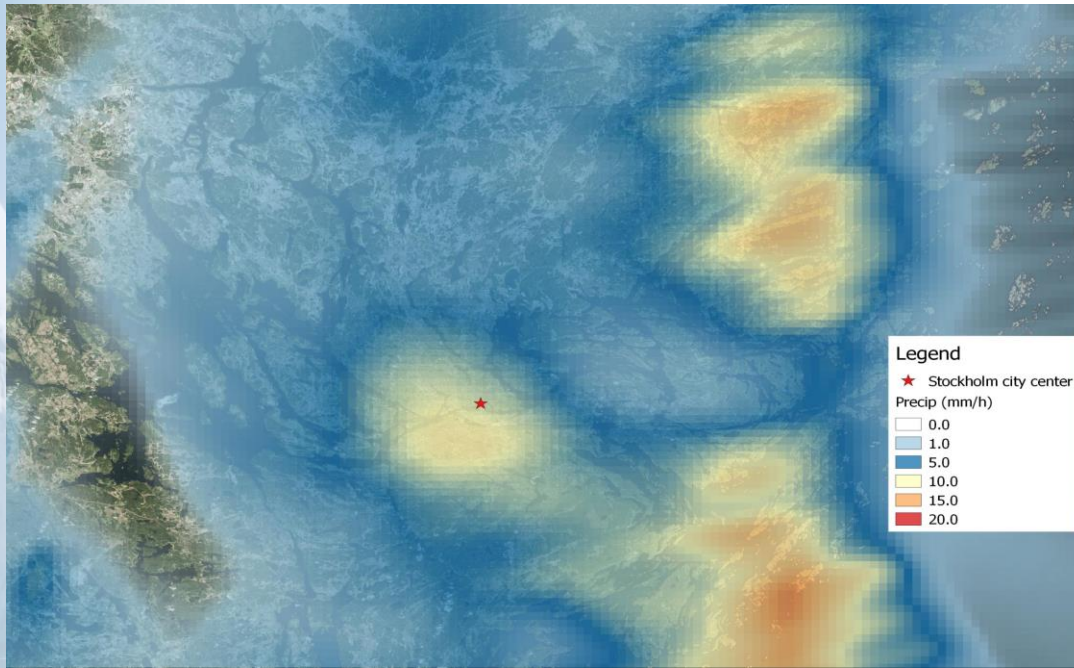
## Other meteorological variables

- Wind
- Boundary layer height
- Total Cloud Cover
- Relative Humidity
- Global Radiation
- Direct shortwave radiation
- Diffuse shortwave radiation



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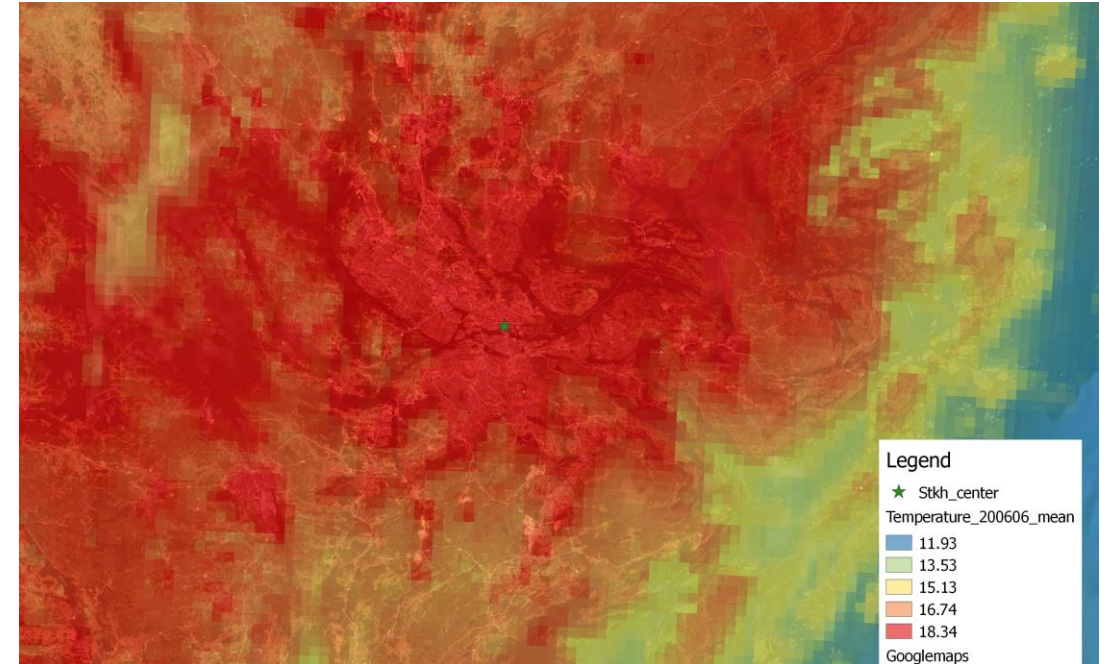
## Spatial and Temporal Resolution



Stockholm: Intense Rainfall

Climate datasets are available over Europe, but these are currently at low spatial resolution, suitable for regional scale analysis, but less informative for individual cities.

Higher resolution (km) datasets are required to represent urban areas and understand their impact on local weather and climate.



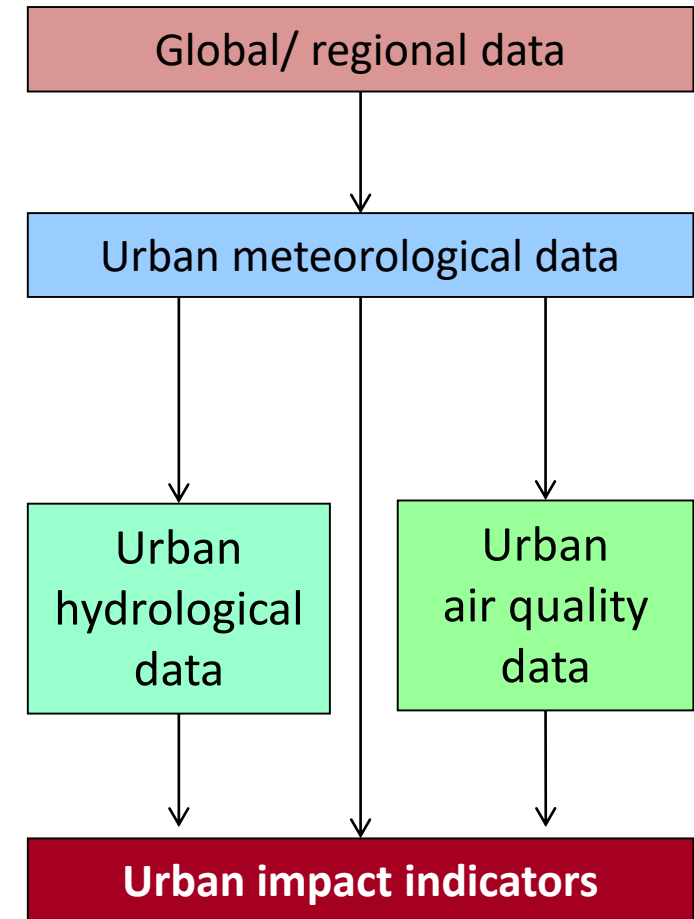
Stockholm: Urban Heat island

This project aims to downscale Essential Climate Variables (ECVs) and impact indicators to the urban scale (1km<sup>2</sup>)



## Data Production

- ECV data downscaled over cities (150 - 200km<sup>2</sup>)
- Climate data and local data combined with climate scenarios and advanced models
- Output data as hourly 1 x 1km grids, for 5 - 10 year windows, for past, present and future conditions
- Downscaled ECVs validated with historical datasets
- Statistical processing of ECVs to generate city-specific Urban Impact Indicators to show the impact of climate change on urban sectors
- Indicators tailored to meet requirements from modellers and end-users
- Urban Impact Indicators have been chosen based on their relevance to urban areas, through workshops and interviews with stakeholders.







## Pilot Studies

Three pilot studies were run to assess the usefulness of project datasets on a local scale:

- Stockholm  
Use case: urban flooding
- Bologna  
Use cases: urban flooding; urban heat; urban air quality
- Amsterdam-Rotterdam  
No formal use case. Validation of downscaled ECVs and Impact Indicators, to demonstrate the scalability of datasets

This project could be extended in the future to cover additional European cities.

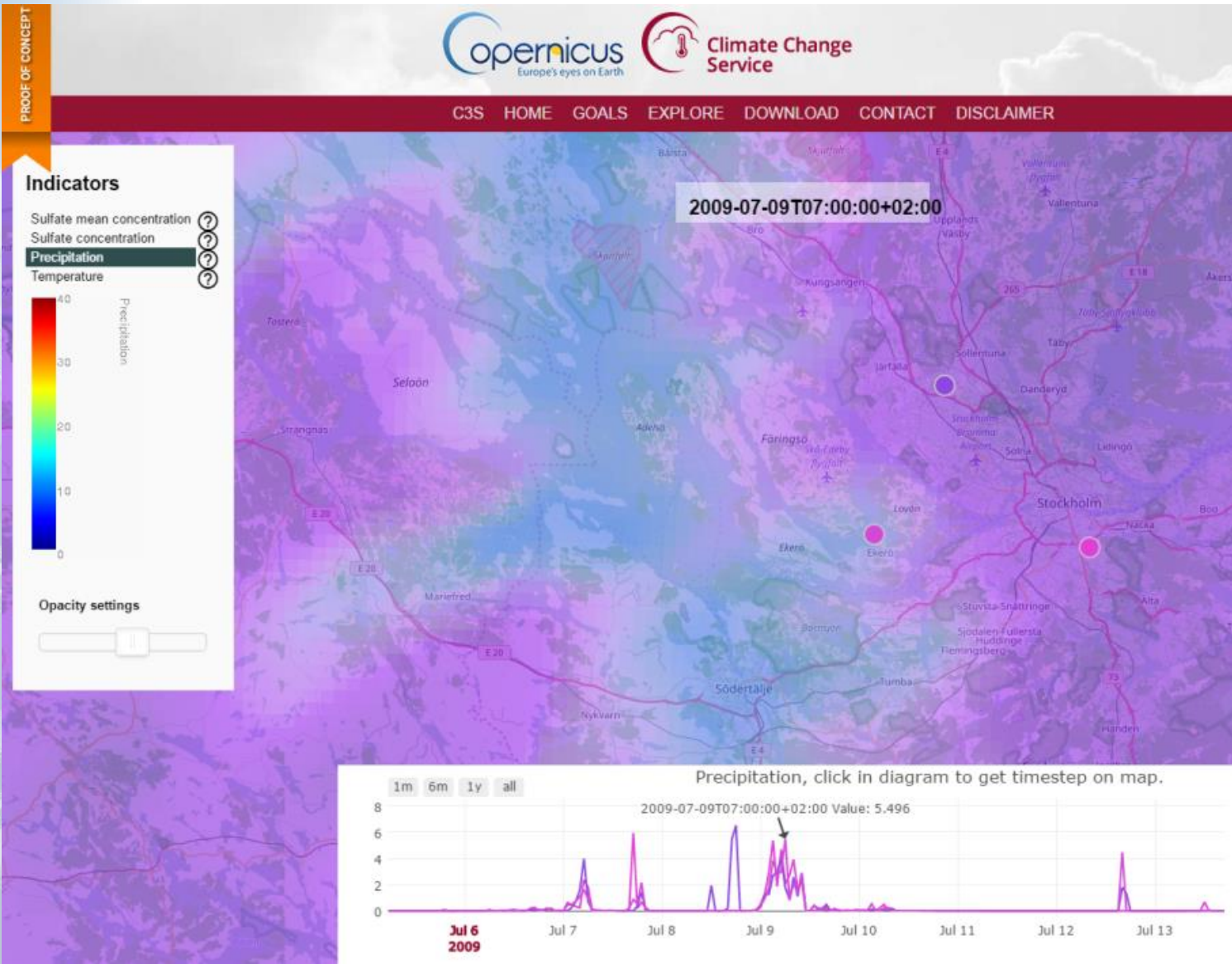
Technical Reports are available to download at

<http://urbansis.climate.copernicus.eu/goals/>





# Urban SIS Data Portal



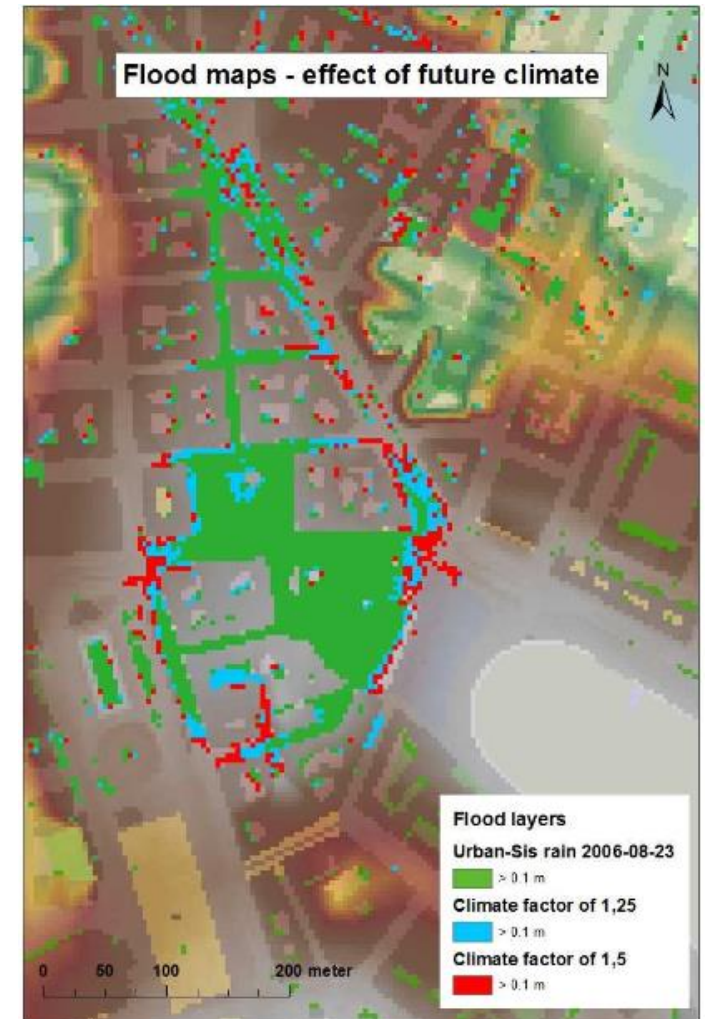
The interactive data portal tool allows you to select, visualise and download the Urban Impact Indicators from the case study sites.





## Pilot Study: Urban Flooding (Stockholm)

- Built-up urban areas are vulnerable to pluvial flooding especially in low point areas
- Hourly gridded ECV data used to assess historical, present & future risk of intense rainfalls
- HARMONIE meteorological model run for historical (UERRA) and future climate scenarios (RCP8.5) with detailed land-use characteristics from EEA Urban Atlas
- HYPE hydrological model used to simulate surface runoff per subcatchment and per different land uses (impervious, green etc).
- Impact indicators for heavy rainfall analysed in comparison with simulations made with other input data



Urban flooding effects in parts of the Berzelii Park using the Urban SIS rain event of August 23<sup>rd</sup> 2006 (green) and climate factors of 1,25 (blue) and 1,5 (red) respectively.





## Pilot Study: Urban Flooding (Bologna)

- Built-up urban areas are vulnerable to flooding (storms and fluvial)
- Hourly gridded ECV data used to assess historical, present & future risk of flash flooding after storms
- HARMONIE meteorological model run for historical (UERRA) and future climate scenarios (RCP8.5) with detailed land-use characteristics
- HYPE hydrological model used to simulate river discharge (Ravone & Reno), local runoff etc.
- Impact indicators for heavy rainfall analysed in comparison to large infrastructure projects



Bologna (en.wikipedia.org)



## Pilot Study: Urban Heat (Bologna)

- Extreme heat can present risks to human health
- Impact indicators derived to assess the impact of local climate changes on health sector, e.g.
  - Heat wave duration
  - Thom Discomfort Index (measure of human discomfort based on temperature & humidity)
- C3S climate data used as input to microclimate ENVIMET model
- Used to assess how specific buildings – existing and planned – respond to heat waves and heat island phenomena in the city



02/07/2015 (www.stirimeteo.com)





## Pilot Study: Urban Air Quality (Bologna)

- The Po Valley is heavily industrialised and densely populated
- In winter: particulate matter and NO<sub>2</sub> concentrations are particularly high
- In summer: O<sub>3</sub> concentration exceeds limits
- MATCH air quality model run with local emissions to obtain urban air pollution levels
- Study aims to assess the effectiveness of the multi-annual plan for air quality improvement (PAIR), when climate change and long-range pollution are taken into account



The Po Valley ([research.metoffice.gov.uk](http://research.metoffice.gov.uk))



Turin, Northern Italy ([www.thelocal.it](http://www.thelocal.it))





## Summary

- It is important to assess climate change impacts on urban areas to ensure sustainability in the future
- Existing climate data is available at a regional scale but less suitable to smaller scale urban studies
- C3S 'Proof of Concept' demonstrates the downscaling of ECVs to the city-scale (1km<sup>2</sup>) for 5 - 10 year windows for past, present & future conditions
- Modelling used to generate city-specific urban impact indicators
- Data provided in an easily accessible format for use by modellers, engineers and urban planners
- Demonstrates a potential service to bring climate experts and stakeholders together to discuss how best to tackle the challenges of climate change



Climate Change

# Thank You

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