



Climate Change

ERA5 and introduction to the Climate Data Store

Cornel Soci

with contribution from Hans Hersbach, Cedric Bergeron
and many colleagues





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Background





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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 featuring a view of Earth from space with a satellite in orbit. The text 'FULL, FREE AND OPEN ACCESS TO DATA' is positioned above a list of monitoring areas. The Copernicus logo and tagline 'Europe's eyes on Earth' are at the bottom.

FULL, FREE AND OPEN
ACCESS TO DATA

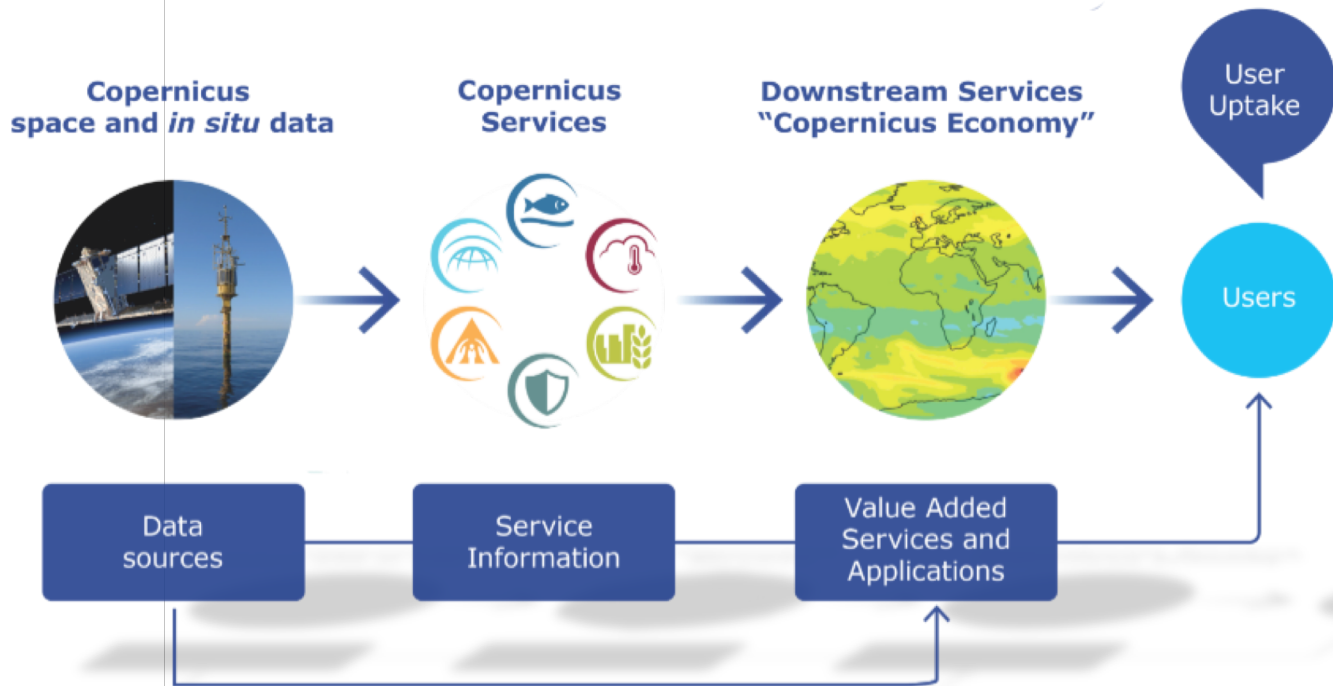
- ATMOSPHERE MONITORING
- MARINE ENVIRONMENT MONITORING
- LAND MONITORING
- CLIMATE CHANGE
- EMERGENCY MANAGEMENT
- SECURITY

opernicus
Europe's eyes on Earth



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COPERNICUS





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COPERNICUS

The European Commission has **entrusted** ECMWF with the implementation of the **Copernicus Climate Change Service (C3S)** and **Copernicus Atmospheric Monitoring Service (CAMS)**





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The C3S mission

To support European adaptation and mitigation policies by:

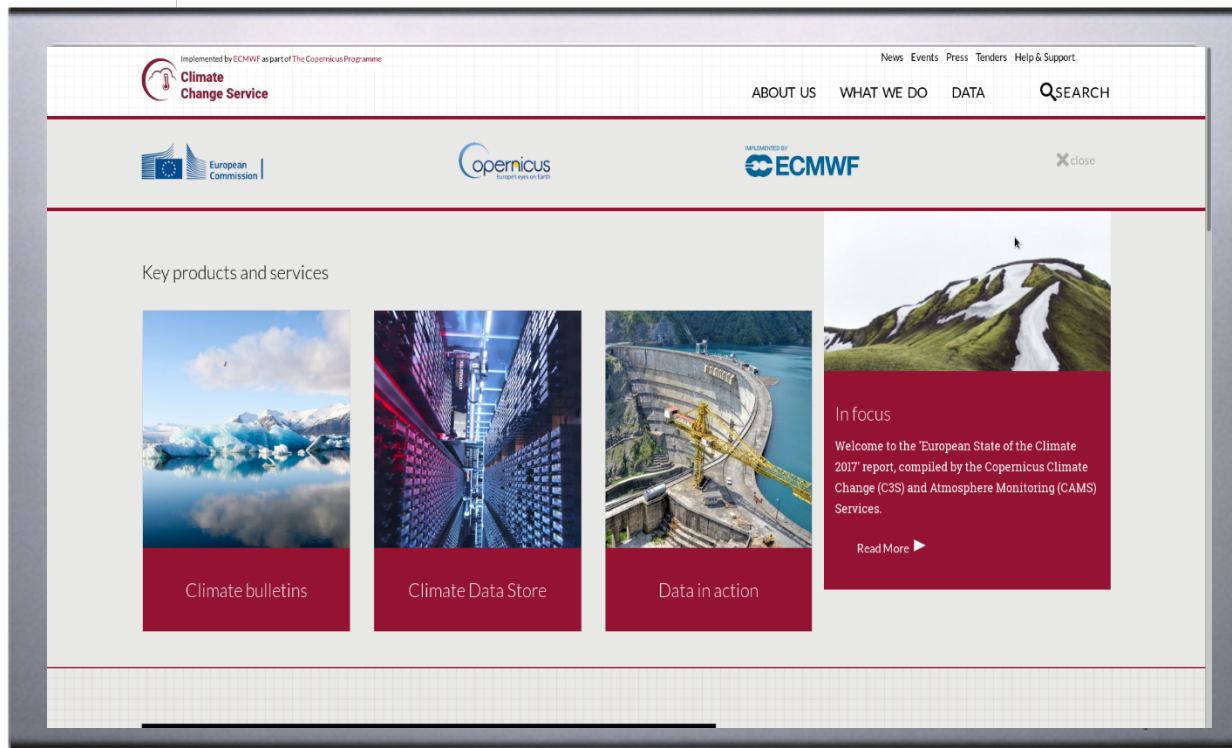
- Providing consistent and authoritative information about climate
- Building on existing capabilities and infrastructures (nationally, in Europe and worldwide)
- Stimulating the market for climate services in Europe





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https://climate.copernicus.eu





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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

Implemented by ECMWF as part of The Copernicus Programme

Climate Change Service

News Events Press Tenders Help & Support

ABOUT US WHAT WE DO DATA QSEARCH

European Commission


copernicus

ECMWF

close

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.

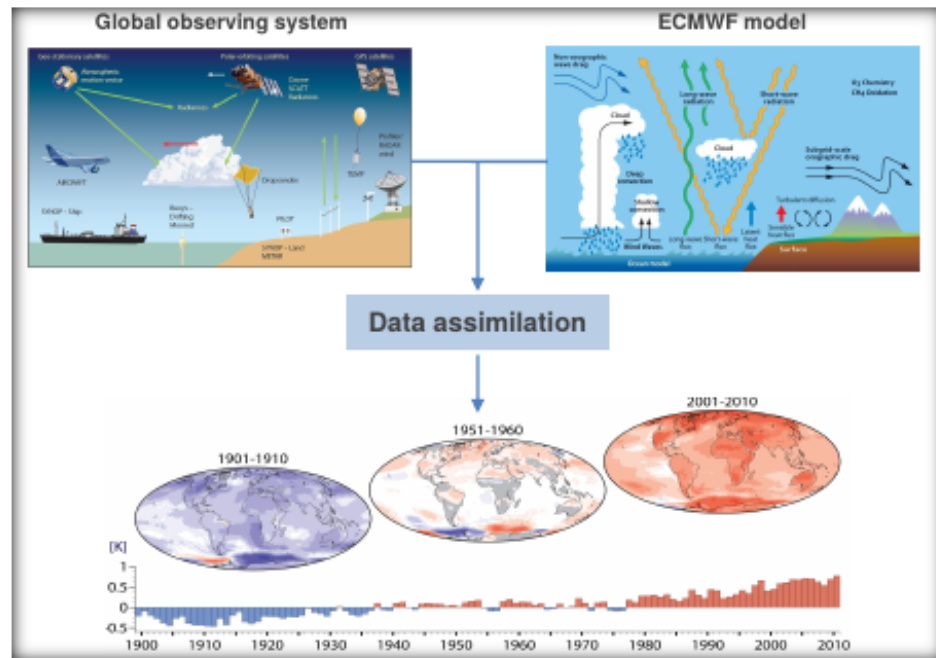
[Read more](#)



Why Reanalysis?

Reanalysis offers a detailed overview of the past atmosphere (and other components)

- **Complete:** combining vast amounts of observations into (global) fields
- **Consistent:** use the same physical model and DA system throughout
- **State-of-the-art:** use the best available observations and model at highest feasible resolution
- *Reanalysis allows for a close monitoring of the Earth's climate system also where direct observations are sparse.*





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Reanalyses Produced at ECMWF

Atmosphere/land

1) 1979 - 1981
FGGE

2) 1994 - 1996
ERA-15

3) 2001 - 2003
ERA-40

4) 2006 - ...
ERA-Interim



5) 2016 - ...
ERA5

including ocean waves

Ocean

2006
ORAS3

2010 - ...
ORAS4

2016 - ...
ORAS5

including sea ice



Centennial

2013 - 2015
ERA-20CM/20C

2016
CERA-20C

2017
CERA-SAT

Coupled

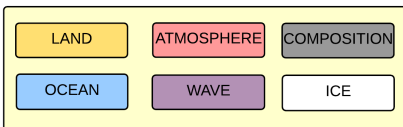
Enhanced land

2012
ERA-Int/Land

2014
ERA-20C/Land

Copernicus
Europe's eyes on Earth
ERA5L

Towards a coupled earth system



Atmospheric composition

2008 - 2009
GEMS

2010 - 2011
MACC

Copernicus
Europe's eyes on Earth
2017 - ...
CAMS

WVF



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ERA-Interim users worldwide

ERA-Interim had more than 33,000 unique users in Jan 2016- Apr 2018 alone.

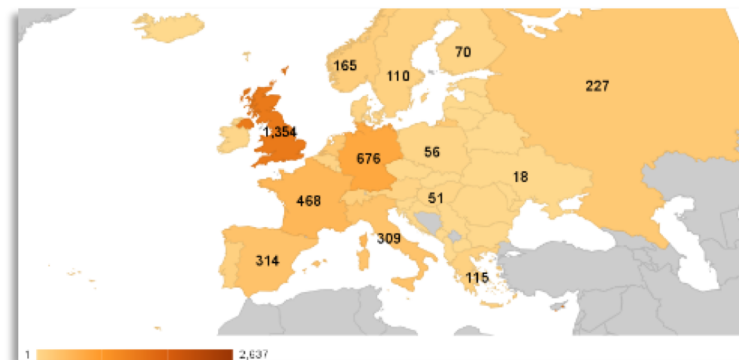
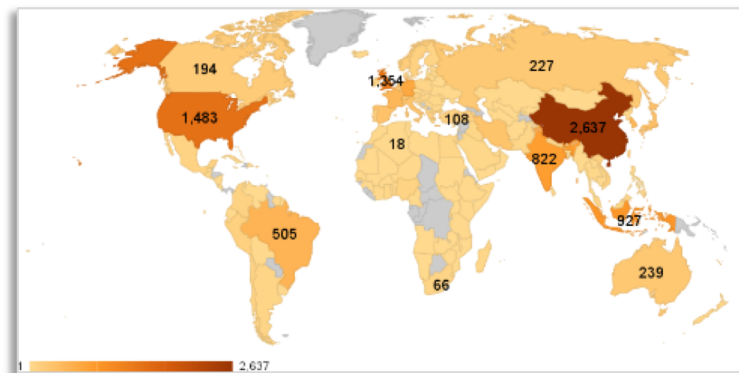
Users and stakeholders:

- Climate monitoring & provision of climatologies
- ECMWF member states
- Research and education, over 10,000 citations
- Public sector
- Space agencies
- Commercial applications

However, ERA-Interim is 10 years old and needs replacement.

Transition from ERA-Interim to ERA5 in progress.

Unique registered users in 2016





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ERA5 Configuration and Performance





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What is new in ERA5?

	ERA-Interim	ERA5
Period	1979 – present	1950 – present , produced in 2 phases
Availability behind real time	2-3 months	2-3 months (final product) 2-5 days (ERA5T)
Assimilation system	2006 (31r2), 4D-Var	2016 (41r2), 4D-Var, hybrid EDA providing B
Model input (radiation and surface)	As in operations, (inconsistent SST and sea ice)	Appropriate for climate , e.g., evolution greenhouse gases, volcanic eruptions, sea surface temperature and sea ice
Spatial resolution	79 km globally 60 levels to 10 Pa	31 km globally 137 levels to 1 Pa
Uncertainty estimate		from 10-member EDA at 62 km
Output frequency	6-hourly Analysis fields	Hourly (three-hourly for the ensemble), Extended list of parameters ~ 9 Peta Byte (1950 - timely updates)
Extra Observations	Mostly ERA-40, GTS	Various reprocessed CDRs, latest instruments
Variational Bias control radiosondes	Satellite radiances, RAOBCORE	Also ozone, aircraft, surface pressure, RISE
Land downscaling product	ERA-Interim land, 79km	ERA5L, 9km (forced by ERA5)



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ERA5 observing system

Over 200 report types

Reprocessed data sets

Radiances: SSM/I brightness temp from CM-SAF
MSG from EUMETSAT

Atmospheric motion vector winds: METEOSAT, GMS/GOES-9/MTSAT,
GOES-8 to 15, AVHRR METOP and NOAA

Scatterometers: ASCAT-A (EUMETSAT),
ERS 1/2 soil moisture (ESA)

Radio Occultation: COSMIC, CHAMP, GRACE, SAC-C, TERRASAR-x (UCAR)

Ozone: NIMBUS-7, EP TOMS, ERS-2 GOME, ENVISAT SCIAMACHY, Aura
MLS, OMI, MIPAS, SBUV

Wave Height: ERS-1,ERS-2, Envisat, Jason

Latest instruments

IASI, ASCAT, ATMS, Cris, MWHS, ...

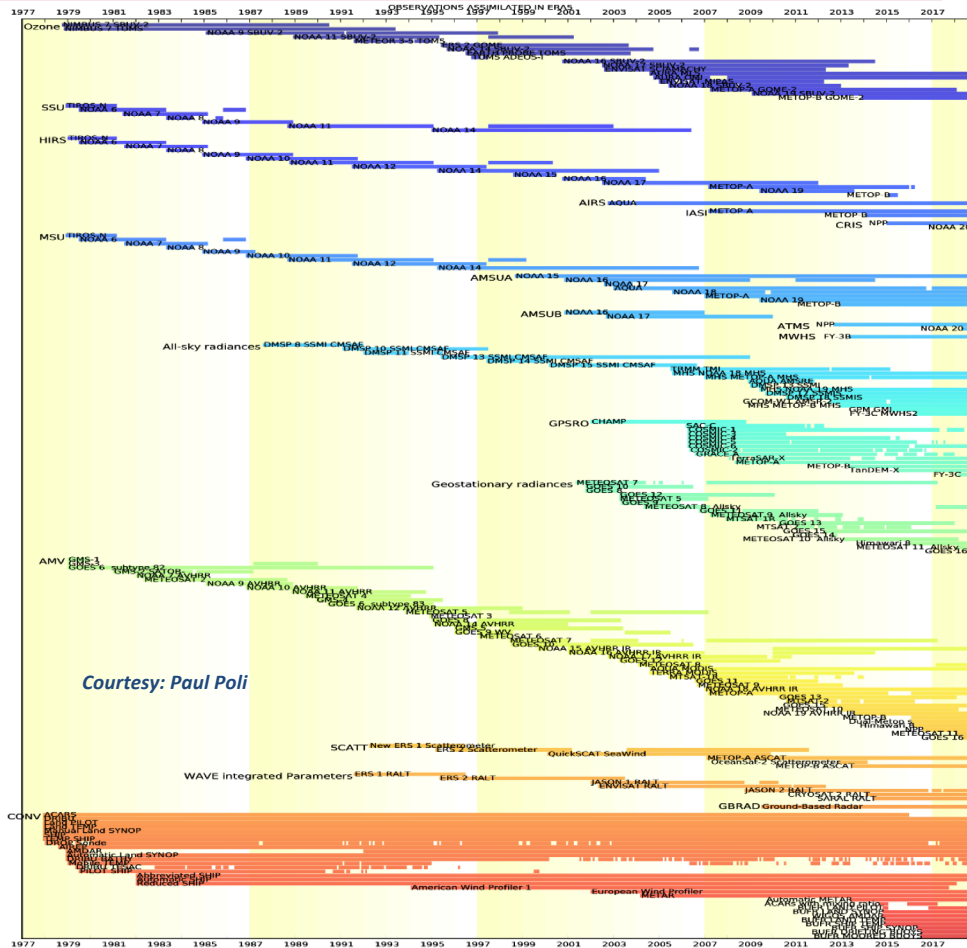
Latest Satellites

MET-11, Himawari, NOAA-20, GOES-16

Improved data usage

all-sky vs clear-sky assimilation,
latest radiative transfer function, corrections,
extended variational bias control

How to monitor all this?





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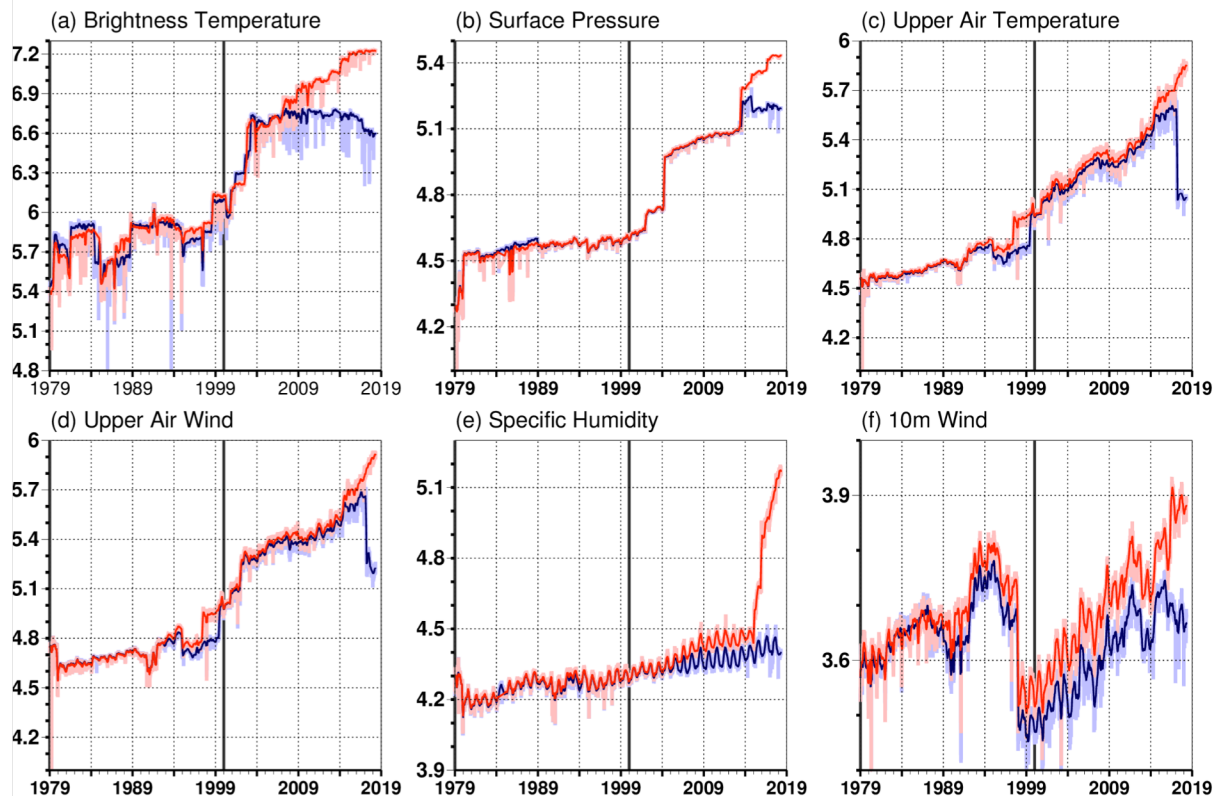
ERA5 data usage compare to ERA-Interim

ERA5 data usage has increased from 0.75 million/day (1979) to 21 million/day (2018)

ERA-Interim is progressively getting outdated. It is not able to:

- use the latest instruments
- respond to changes in data format (like the ongoing transition to BUFR format for conventional data)

*Number of used observations per day (10log scale) for **ERA5** and **ERA-Interim***





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ERA5 Performance and Status

Improvement of forecast skill: up to one day gain with respect to ERA-Interim

Publicly available in the C3S Climate Data Store:

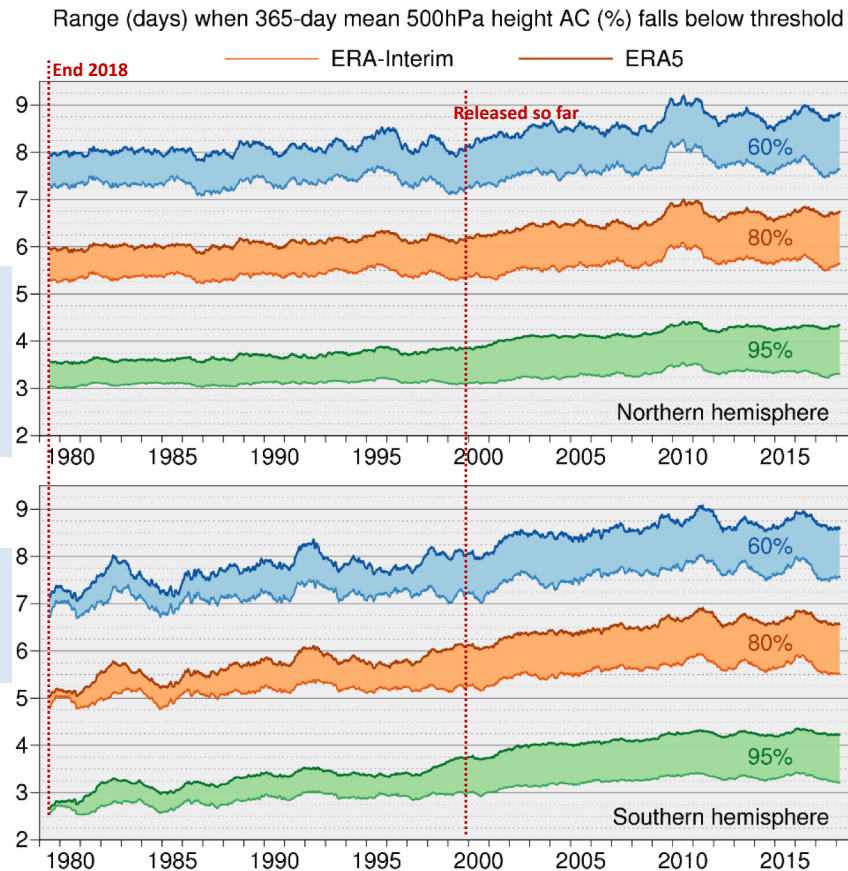
Currently: 2000 onwards, 2-3 months behind real time

By end 2018: 1979-1999, and ERA5T

Back-extension from 1950 to 1978: has already started.

ERA5 land already in production.

Note: ERA-Interim production will not be supported after mid 2019





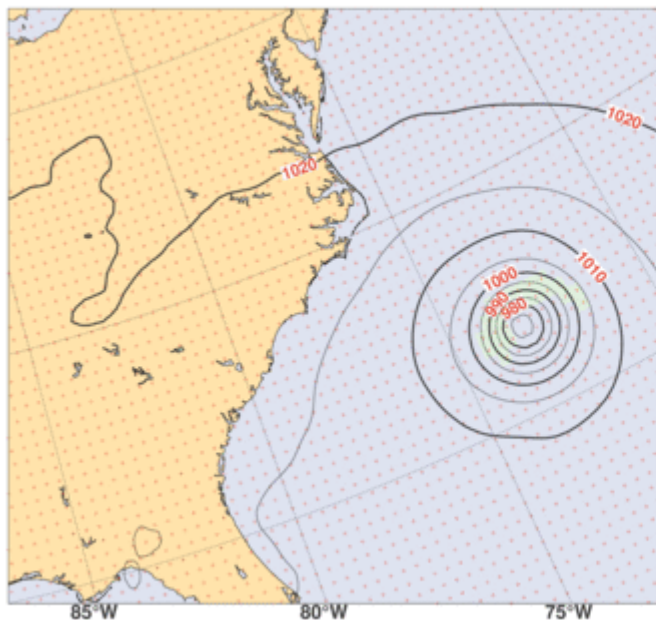
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Horizontal resolution and depiction of tropical cyclones

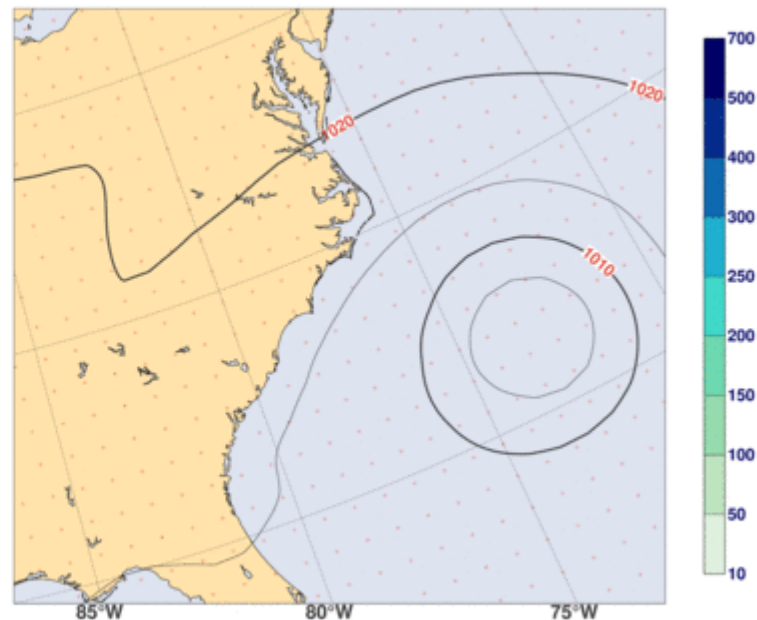
Better model, better and more observations, higher resolution

New: hourly output

Florence Thu 13 Sep 2018, 01 UTC for ERA5



Florence Thu 13 Sep 2018, 01 UTC for ERA-Interim

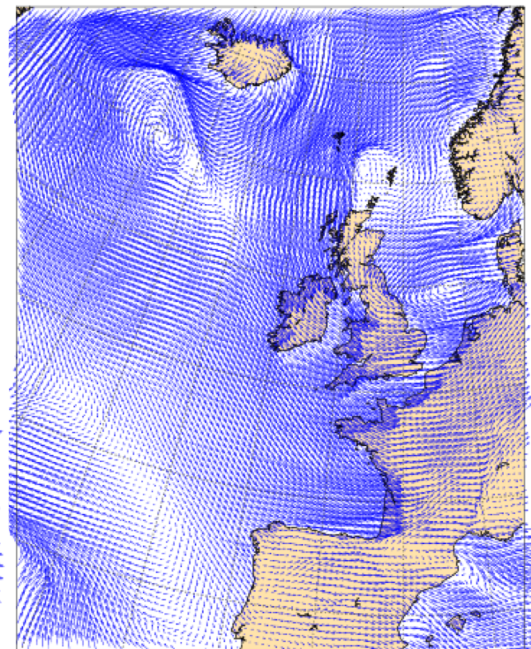
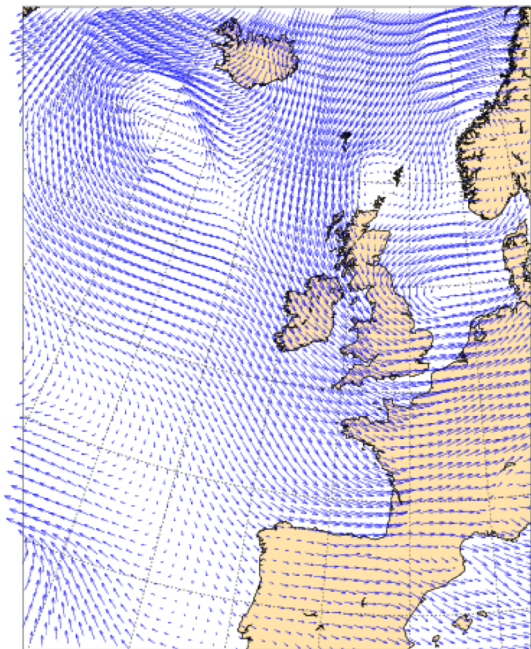




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Comparison with Merra-2

	Merra-2	ERA5
<i>Spatial resolution</i>	<i>0.5 x 0.625 degrees 72 levels to 1 Pa</i>	<i>0.28125 x 0.28125 degrees 137 levels to 1 Pa</i>
<i>Assimilation system</i>	<i>3D-Var FGAT, 6-hour window</i>	<i>4D-Var, 12-hour window</i>
<i>Output frequency</i>	<i>Hourly</i>	<i>Hourly</i>



ECMWF



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Concluding Remarks





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Concluding Remarks!

ERA5 will replace ERA-Interim.

As part of the Copernicus Climate Service, at ECMWF, the production of ERA5 is well underway:

- 31km global resolution, from 1950, hourly output, uncertainty estimate.
- **To date ERA5 2000-2018 is publicly available**
- Release of other periods will be done in stages; data access via the **Climate Data Store**.
- By end 2018: 1979 onwards.
- C3S User service Desk, Knowledge Base, FAQ's, user support.

The performance of ERA5 is very promising in the troposphere.

- improved global hydrological and mass balance;
- reduced biases in precipitation;
- refinement of the variability and trends of surface air temperature.

In parallel, at ECMWF reanalysis activities are focused towards a coupled Earth system

- Benefit to reanalysis (ERA6)
- and the ECMWF system as a whole



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The Climate Data Store (CDS)





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Data access before the CDS...

ESGF Portal at CEDA

Home About Us Contact Us

Enter Text: Search Reset Display 10 3 results per page [More Search Options]

1. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
Data Node: [corsea-ouput.cdm](#)
Version: 20140604
Total Number of Files (for all variables): 5
[Show Metadata] [Show Files] [THEOSIS Catalog] [WGI]

2. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
Data Node: [corsea-ouput.cdm](#)
Version: 20140604
Total Number of Files (for all variables): 5
[Show Metadata] [Show Files] [THEOSIS Catalog] [WGI]

3. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
Data Node: [corsea-ouput.cdm](#)
Version: 20140604
Total Number of Files (for all variables): 5
[Show Metadata] [Show Files] [THEOSIS Catalog] [WGI]

4. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
Data Node: [corsea-ouput.cdm](#)
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5. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
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6. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
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7. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
Data Node: [corsea-ouput.cdm](#)
Version: 20140604
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[Show Metadata] [Show Files] [THEOSIS Catalog] [WGI]

8. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
Data Node: [corsea-ouput.cdm](#)
Version: 20140604
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[Show Metadata] [Show Files] [THEOSIS Catalog] [WGI]

9. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
Data Node: [corsea-ouput.cdm](#)
Version: 20140604
Total Number of Files (for all variables): 5
[Show Metadata] [Show Files] [THEOSIS Catalog] [WGI]

10. [corsea-ouput.AFR-64.DMI.ECMWF-ERNAI-Evaluation.v1514](#)
Data Node: [corsea-ouput.cdm](#)
Version: 20140604
Total Number of Files (for all variables): 5
[Show Metadata] [Show Files] [THEOSIS Catalog] [WGI]



ECMWF

Public Datasets Select dataset Current activity Help

ERA Interim/LAND

Select a month

Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Analysis	1979												1980											
Forecast	1981												1982											
	1983												1984											
	1985												1986											
	1987												1988											
	1989												1990											
	1991												1992											
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	1997												1998											
	1999												2000											
	2001												2002											
	2003												2004											
	2005												2006											
	2007												2008											
	2009												2010											

Select step

3 6 9 12 18 24

Select All or Clear

Forecasts are integrated daily, from 00:00UTC, for +step hours.

Select parameter

Evaporation Forecast albedo Snowfall
 Snowcover Sub-surface runoff Surface latent heat flux
 Surface net solar radiation Surface net thermal radiation Surface runoff
 Surface sensible heat flux Total precipitation

Select All or Clear

View the MARS request Retrieve GRIB Retrieve NetCDF

EUMETSAT OSISAF OCEAN AND SEA ICE

ABOUT OSISAF PRODUCTS DOCUMENTATION COMMUNITY

Search Home / List of products

List of products

Domain: Sea Ice

Thumbnail	Title	Identifier	Status	Satellite	Level	Frequency	Timeliness	Spatial coverage	Spatial sampling
	Global Sea Ice Concentration (SSM/I)	OSI-401-b	Operational	DMP5/SSM/I	L3	1 per day	5 h	Global	10 km
	Global Sea Ice Edge	OSI-402-c	Operational	DMP5/SSM/I and Metop/ASCAT	L3	1 per day	5 h	global	10 km
	Global Sea Ice Type	OSI-403-c	Operational	DMP5/SSM/I, Metop/ASCAT and GCOM-W/AMSR-2	L3	1 per day	5 h	global	10 km
	Global Sea Ice Emissivity	OSI-404	Operational	DMP5/SSM/I	L3	1 per day	5 h	global	10 km
	Global Low Resolution Sea Ice Drift	OSI-405-c	Operational	DMP5/SSM/I and GCOM-W/AMSR-2	L3	1 per day	6 h	Global	62.5 km
	Medium Resolution Sea Ice Drift	OSI-407	Operational	Metop/AVHRR	L3	2 per day	6 h	Northern Hemisphere	20 km

ssh.cds@cds-test.climate.copernicus.eu -- 117 x 34

ssh.cds-test.climate.copernicus.eu

Product	Frequency	Timeliness	Spatial coverage	Spatial sampling
408 Oct 6 13:25 dt_med-twosst_phy14_20051202.nc.gz	1 per day	5 h	global	10 km
189 Oct 6 13:25 dt_med-twosst_phy14_20051203.nc.gz	1 per day	5 h	global	10 km
897 Oct 6 13:25 dt_med-twosst_phy14_20051204.nc.gz	1 per day	5 h	global	10 km
879 Oct 6 13:25 dt_med-twosst_phy14_20051205.nc.gz	1 per day	5 h	global	10 km
78 Oct 6 13:25 dt_med-twosst_phy14_20051207.nc.gz	1 per day	5 h	global	10 km
421 Oct 6 13:25 dt_med-twosst_phy14_20051208.nc.gz	1 per day	5 h	global	10 km
878 Oct 6 13:25 dt_med-twosst_phy14_20051209.nc.gz	1 per day	5 h	global	10 km
405 Oct 6 13:25 dt_med-twosst_phy14_20051210.nc.gz	1 per day	5 h	global	10 km
753 Oct 6 13:25 dt_med-twosst_phy14_20051211.nc.gz	1 per day	5 h	global	10 km
19 Oct 6 13:25 dt_med-twosst_phy14_20051212.nc.gz	1 per day	5 h	global	10 km
418 Oct 6 13:25 dt_med-twosst_phy14_20051213.nc.gz	1 per day	5 h	global	10 km
693 Oct 6 13:25 dt_med-twosst_phy14_20051214.nc.gz	1 per day	5 h	global	10 km
878 Oct 6 13:25 dt_med-twosst_phy14_20051215.nc.gz	1 per day	5 h	global	10 km
827 Oct 6 13:25 dt_med-twosst_phy14_20051216.nc.gz	1 per day	5 h	global	10 km
704 Oct 6 13:25 dt_med-twosst_phy14_20051217.nc.gz	1 per day	5 h	global	10 km
435 Oct 6 13:25 dt_med-twosst_phy14_20051218.nc.gz	1 per day	5 h	global	10 km
466 Oct 6 13:25 dt_med-twosst_phy14_20051219.nc.gz	1 per day	5 h	global	10 km
468 Oct 6 13:25 dt_med-twosst_phy14_20051220.nc.gz	1 per day	5 h	global	10 km
437 Oct 6 13:25 dt_med-twosst_phy14_20051221.nc.gz	1 per day	5 h	global	10 km
405 Oct 6 13:25 dt_med-twosst_phy14_20051222.nc.gz	1 per day	5 h	global	10 km
118 Oct 6 13:25 dt_med-twosst_phy14_20051223.nc.gz	1 per day	5 h	global	10 km
894 Oct 6 13:25 dt_med-twosst_phy14_20051224.nc.gz	1 per day	5 h	global	10 km
62 Oct 6 13:25 dt_med-twosst_phy14_20051225.nc.gz	1 per day	5 h	global	10 km
791 Oct 6 13:25 dt_med-twosst_phy14_20051226.nc.gz	1 per day	5 h	global	10 km
437 Oct 6 13:25 dt_med-twosst_phy14_20051227.nc.gz	1 per day	5 h	global	10 km
443 Oct 6 13:25 dt_med-twosst_phy14_20051228.nc.gz	1 per day	5 h	global	10 km
587 Oct 6 13:25 dt_med-twosst_phy14_20051229.nc.gz	1 per day	5 h	global	10 km
437 Oct 6 13:25 dt_med-twosst_phy14_20051230.nc.gz	1 per day	5 h	global	10 km
227 * 61-c3s/Products/SEALEVEL/regional-merg-td-grids-two-merged/phy/2005/ is the current directory	1 per day	5 h	global	25 km

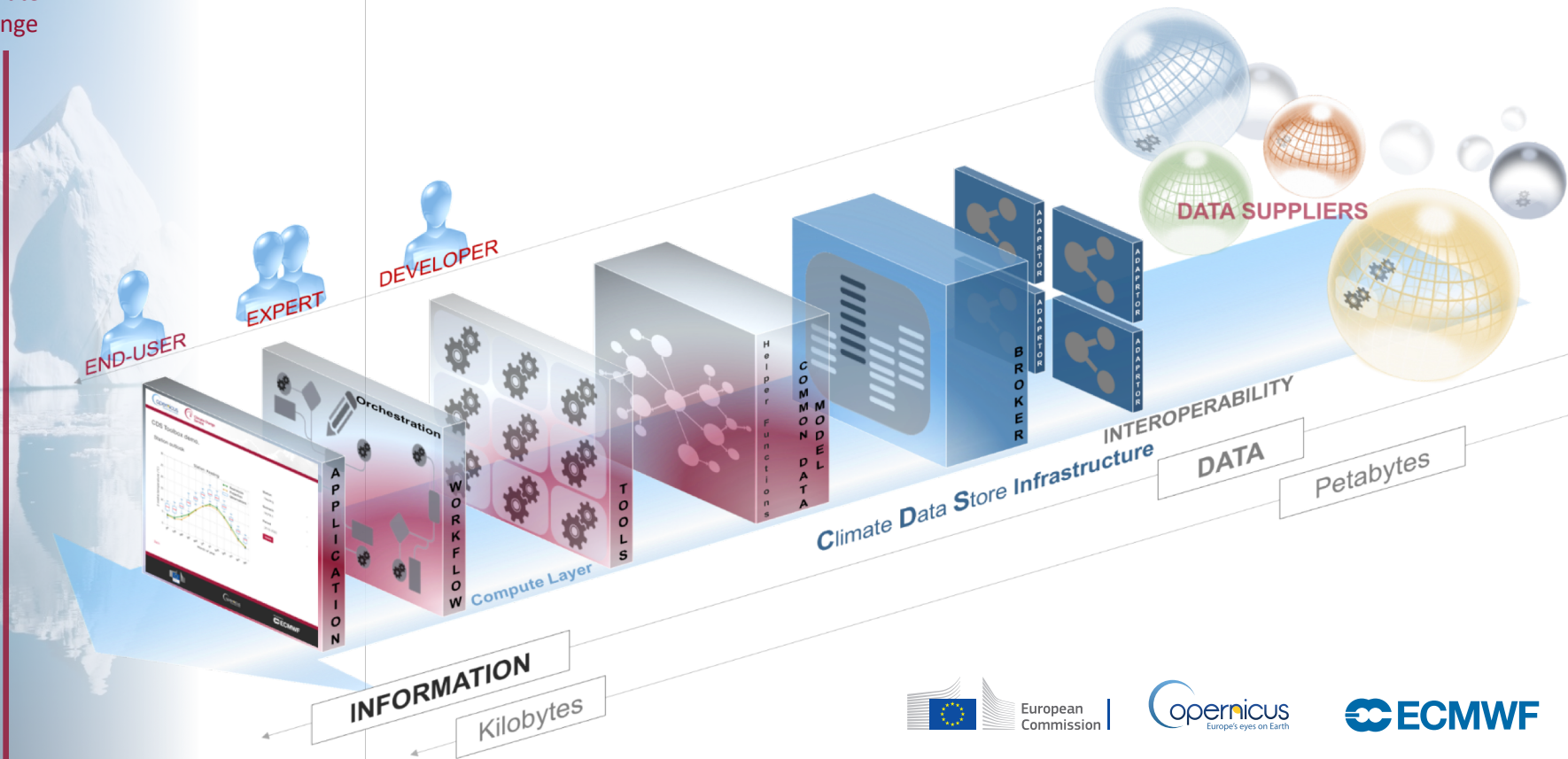
```

-ferret - 1 Ferret ocean
226 Transfer complete
ftp> pwd
227 *61-c3s/Products/SEALEVEL/regional-merg-td-grids-two-merged/phy/2005/ is the current directory
ftp>
  
```



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Concept





Climate Change

CDS inventory



Scientific basis:

- Essential Climate Variables as defined by GCOS
- GCOS Status Report and Implementation Plan
- IPCC, CMIP

Observations

Global estimates of ECVs from satellite and in-situ observations

Reprocessed CDRs, reference observations

Support for data rescue, climate data collections

Climate reanalysis

Global atmosphere, ocean, land

Regional reanalyses for Europe and Arctic

Coupled climate reanalysis for 100 years

Model output

Multi-model seasonal forecast products

Access to CMIP data and products, global and regional

Reference set of climate projections for Europe

Climate Indicators



European Commission





Climate
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Climate Data Store

3,300
users

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**.

The screenshot shows the Climate Data Store website. At the top, there are logos for the European Commission, Copernicus, ECMWF, and Climate Change Service. Below the logos is a navigation bar with links for Home, Search, Datasets, Toolbox, and Help & support. The main content area features a welcome message: "Welcome to the Climate Data Store. Dive into this wealth of information about the Earth's past, present and future climate. It is freely available and functions as a one-stop shop to explore climate data. Register for free to obtain access to the CDS and its Toolbox. We are constantly improving the services and adding new datasets. For more information, please consult our catalogue roadmap and our FAQ." Below the text is a search bar with the placeholder "Enter search term(s)", a dropdown menu set to "All", and a "Search" button. At the bottom, there are three featured sections: "Climate Data Store Toolbox" with a line graph, "Climate Data Store API" with a code snippet, and "Access climate reanalysis (ERA5)" with a map of Europe.





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Catalogue

Copernicus Europe's eyes on Earth

Climate Change Service BETA Login/register

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Search Results

Search dataset

All Dataset Site

Sort by
Relevancy
Title

Product type
Variable domain
Spatial coverage
Temporal coverage

- Mediterranean delayed-time sea surface heights and derived variables**
This Mediterranean sea dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by ECMWF Copernicus Climate Change Service (C3S) and produced by t...
- Global delayed-time sea surface heights and derived variables**
This global sea dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by ECMWF Copernicus Climate Change Service (C3S) and produced by the CLS/...
- Black sea delayed-time sea level anomalies and derived variables**
This Black sea dataset is a Level-4 Essential Climate Variable (ECV) product and Climate Data Record (CDR). It was brokered by ECMWF Copernicus Climate Change Service (C3S) and produced by the CLS/C...
- Southern hemisphere sea ice concentration from satellites for the period 2015 onwards**
This sea ice concentration dataset is a Level-3 Essential Climate Variable (ECV) product and Interim Climate Data Record (ICDR) produced by EUMETSAT OSI SAF using passive microwave data (PMW) from t...
- Northern hemisphere sea ice thickness for the period 2002-2017**
The sea ice thickness dataset is a Level-3 Essential Climate Variable (ECV) product and Climate Data Record (CDR) brokered by ECMWF Copernicus Climate Change Service (C3S). The sea ice thickness is ...
- Northern hemisphere sea ice edge for the period 1979-2015**
This sea ice edge dataset is a Level-3 Essential Climate Variable (ECV) product and Climate Data Record (CDR) brokered by



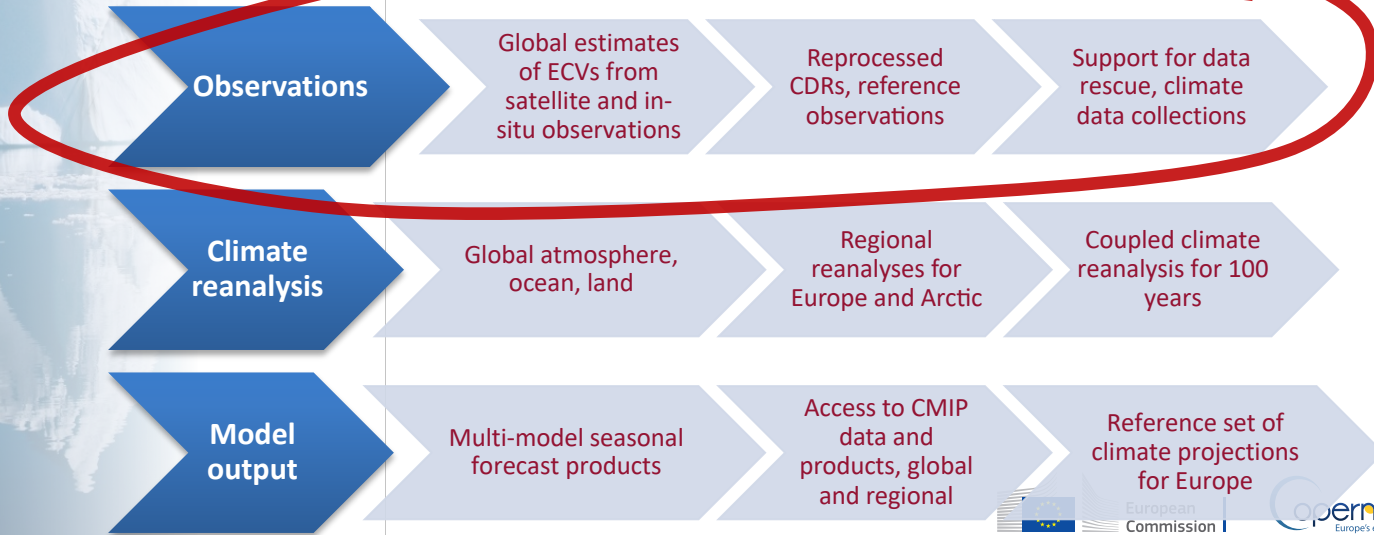
Climate Change

CDS inventory



Scientific basis:

- Essential Climate Variables as defined by GCOS
- GCOS Status Report and Implementation Plan
- IPCC, CMIP



European Commission

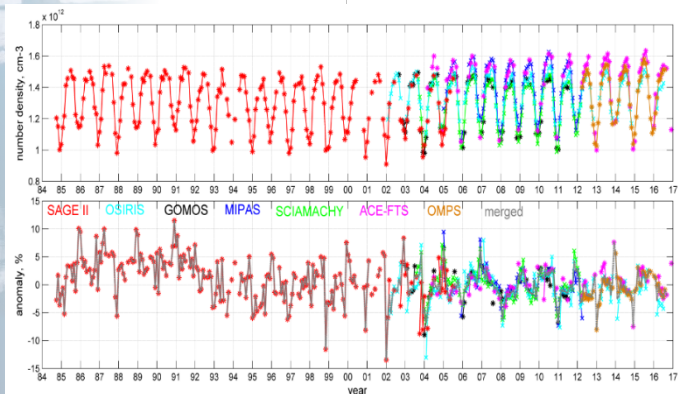
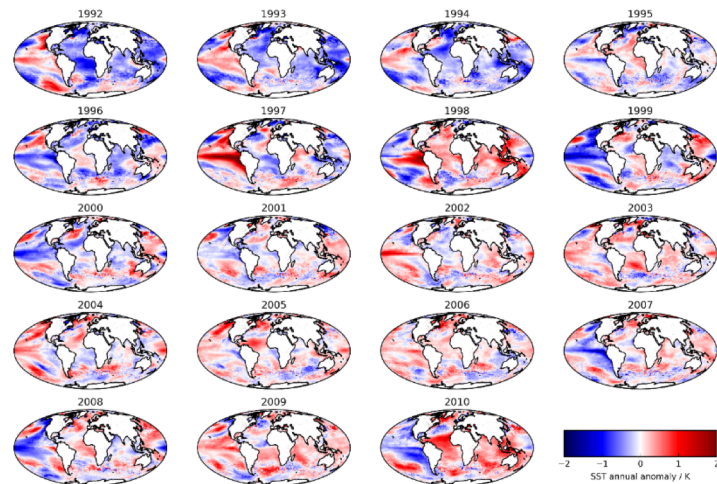




ECV products: What is in CDS

Sea Surface Temperature (TVUK)

- **Ready now:** daily 1991-2010 at 0.05 deg resolution (CCI phase I)
- **Later:** CCI phase II, ICDR <5 days



Ozone (BIRA)

- **Ready now:** various CCI datasets, total column, profiles, single instr., merged
- **Later:** reprocessing, further back, ICDRs



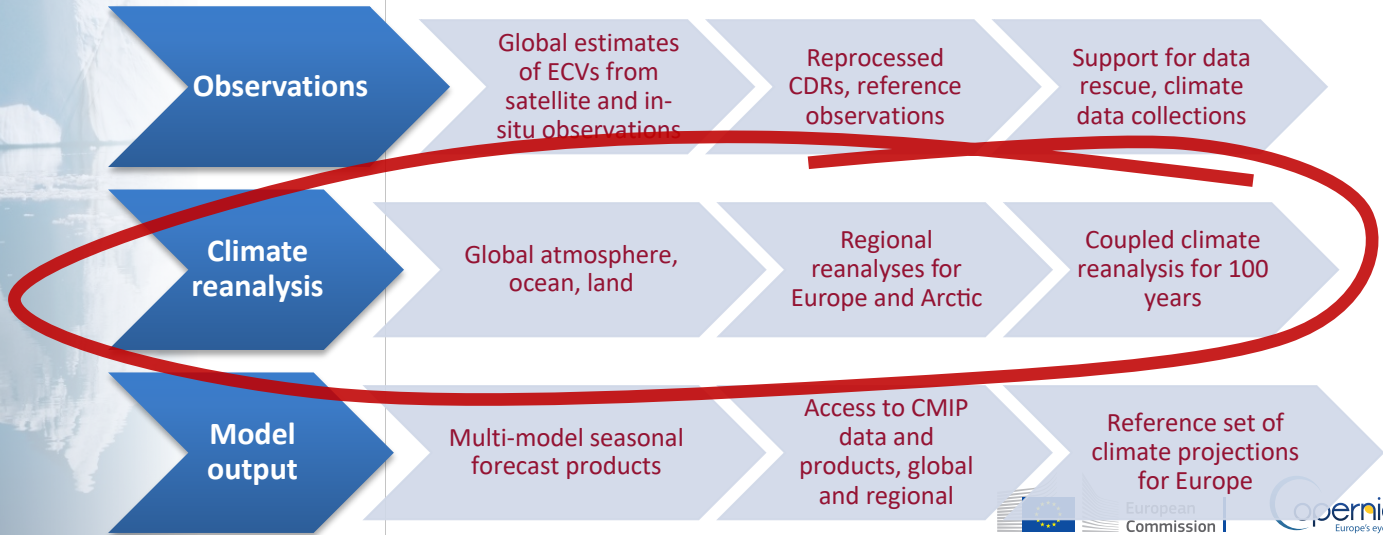
Climate Change

CDS inventory



Scientific basis:

- Essential Climate Variables as defined by GCOS
- GCOS Status Report and Implementation Plan
- IPCC, CMIP



Climate Indicators



European Commission





Climate Change

Data content: Global reanalysis data

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Search results

Search dataset All Datasets

Sort by **Relevancy**

Showing 1-2 of 2 results for **Reanalysis** x

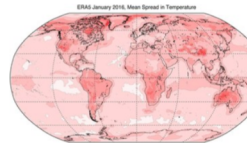
- Climate projections (4)
- Reanalysis (2)
- Satellite observations (11)
- Seasonal forecasts (6)
- Sectoral climate indices (2)

- Spatial coverage**
 - Global (2)
- Temporal coverage**
 - Past (2)

ERA5 hourly data on pressure levels from 2000 to present

Overview Download data Documentation

ERA5 is the fifth generation ECMWF atmospheric reanalysis of the global climate. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics. This principle, called data assimilation, is based on the method used by numerical weather prediction centres, where every so many hours (12 hours at ECMWF) a previous forecast is combined with newly available observations in an optimal way to produce a new best estimate of the state of the atmosphere, called analysis, from which an updated, improved forecast is issued. Reanalysis works in the same way, but at reduced resolution to allow for the provision of a dataset spanning back several decades. Reanalysis does not have the constraint of issuing timely forecasts, so it is more time to collect observations, and when going further back in time, to allow for the ingestion of improvements of the original observations, which all benefit the quality of the reanalysis product.



The assimilation system is able to estimate biases between observations and to sift good-quality data from poor. The laws of physics allow for estimates at locations where data coverage is low, such as for surface temperature Arctic. The provision of estimates at each grid point around the globe for each regular output time, over a long period always using the same format, makes reanalysis a very convenient and popular dataset to work with.

The observing system has changed drastically over time, and although the assimilation system can resolve data from the initially much sparser networks will lead to less accurate estimates. For this reason, ERA5 includes an uncer-

ERA5 hourly data on pressure levels from 2000 to present

ERA5 is the fifth generation ECMWF atmospheric reanalysis of the global climate. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset...

ERA5 hourly data on single levels from 2000 to present

ERA5 is the fifth generation ECMWF atmospheric reanalysis of the global climate. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset...

ERA5 hourly data on pressure levels from 2000 to present

Overview Download data Documentation

Variable

At least one selection must be made

- | | | |
|---|--|--|
| <input type="checkbox"/> Divergence | <input type="checkbox"/> Fraction of cloud cover | <input type="checkbox"/> Geopotential |
| <input type="checkbox"/> Ozone mass mixing ratio | <input type="checkbox"/> Potential vorticity | <input type="checkbox"/> Relative humidity |
| <input type="checkbox"/> Specific cloud ice water content | <input type="checkbox"/> Specific cloud liquid water content | <input type="checkbox"/> Specific humidity |
| <input type="checkbox"/> Specific snow water content | <input type="checkbox"/> Temperature | <input type="checkbox"/> Specific rain water content |
| <input type="checkbox"/> V-component of wind | <input type="checkbox"/> Vertical velocity | <input type="checkbox"/> U-component of wind |
| | | <input type="checkbox"/> Vorticity (relative) |
- [Select all](#)

Pressure level

At least one selection must be made

- | | | |
|-----------------------------------|----------------------------------|----------------------------------|
| <input type="checkbox"/> 1 hPa | <input type="checkbox"/> 2 hPa | <input type="checkbox"/> 3 hPa |
| <input type="checkbox"/> 5 hPa | <input type="checkbox"/> 7 hPa | <input type="checkbox"/> 10 hPa |
| <input type="checkbox"/> 20 hPa | <input type="checkbox"/> 30 hPa | <input type="checkbox"/> 50 hPa |
| <input type="checkbox"/> 70 hPa | <input type="checkbox"/> 100 hPa | <input type="checkbox"/> 125 hPa |
| <input type="checkbox"/> 150 hPa | <input type="checkbox"/> 175 hPa | <input type="checkbox"/> 200 hPa |
| <input type="checkbox"/> 225 hPa | <input type="checkbox"/> 250 hPa | <input type="checkbox"/> 300 hPa |
| <input type="checkbox"/> 350 hPa | <input type="checkbox"/> 400 hPa | <input type="checkbox"/> 450 hPa |
| <input type="checkbox"/> 500 hPa | <input type="checkbox"/> 550 hPa | <input type="checkbox"/> 600 hPa |
| <input type="checkbox"/> 650 hPa | <input type="checkbox"/> 700 hPa | <input type="checkbox"/> 750 hPa |
| <input type="checkbox"/> 775 hPa | <input type="checkbox"/> 800 hPa | <input type="checkbox"/> 825 hPa |
| <input type="checkbox"/> 850 hPa | <input type="checkbox"/> 875 hPa | <input type="checkbox"/> 900 hPa |
| <input type="checkbox"/> 925 hPa | <input type="checkbox"/> 950 hPa | <input type="checkbox"/> 975 hPa |
| <input type="checkbox"/> 1000 hPa | | |
- [Select all](#)

Product type

- Reanalysis Ensemble members Ensemble mean
- Ensemble spread
- [Select all](#) [Clear all](#)

Year

At least one selection must be made

- | | | |
|-------------------------------|-------------------------------|-------------------------------|
| <input type="checkbox"/> 2000 | <input type="checkbox"/> 2001 | <input type="checkbox"/> 2002 |
| <input type="checkbox"/> 2003 | <input type="checkbox"/> 2004 | <input type="checkbox"/> 2005 |
| <input type="checkbox"/> 2006 | <input type="checkbox"/> 2007 | <input type="checkbox"/> 2008 |





Climate
Change

C3S_322 Lot 1: Regional reanalysis for Europe

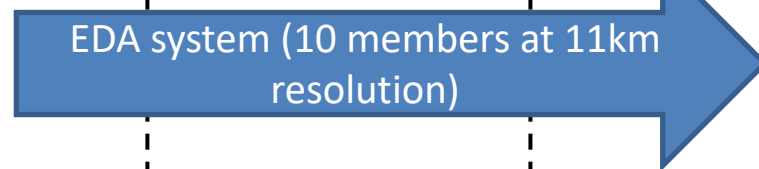
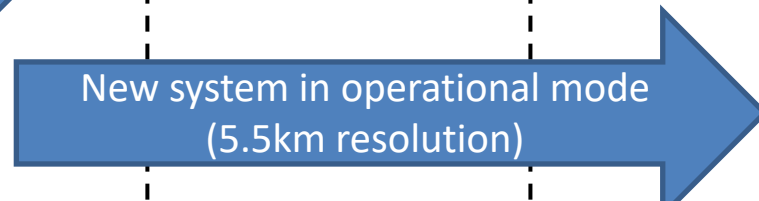
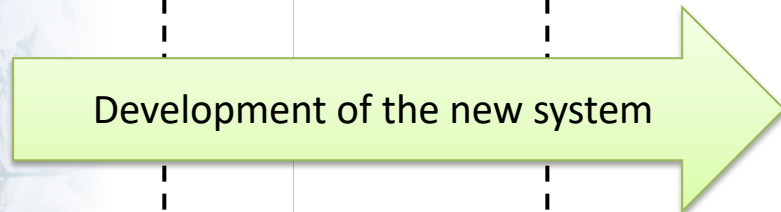
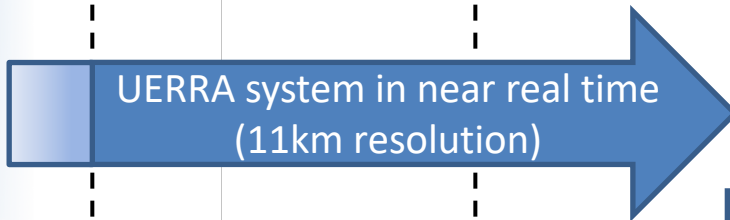
2017

2018

2019

2020

2021



- 11 km (500x500 grid points), 65 levels
- Surface downscaling analysis 5.5 km (MESCAN)
- Start in 1961 and operational from 2/2018

- 5.5 km (1100x1050 grid points), 100 levels
- Surface analysis at 5.5 km
- Plus 10 ensemble members at 11km
- Will start in the early 1980s



C3S_322 Lot 1: Regional reanalysis for Europe



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This is a new service – your feedback will help us to improve it **B E T A**

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UERRA regional reanalysis on pressure levels from 1961 to present

Overview Download data Documentation

The UERRA-HARMONIE regional reanalysis of the climate in Europe combines model data with observations from across the world into a complete and consistent dataset using the laws of physics. This principle, called data assimilation, is based on the method used by numerical weather prediction centres, where every so many hours (6 hours in the UERRA-HARMONIE system) a previous forecast is combined with newly available observations in an optimal way to produce a new best estimate of the state of the atmosphere, called analysis, from which an updated, improved forecast is issued. Reanalysis works in the same way, but at reduced resolution to allow for the provision of a dataset spanning back several decades. Reanalysis does not have the constraint of issuing timely forecasts, so there is more time to collect observations, and when going further back in time, to allow for the ingestion of improved versions of the original observations, which all benefit the quality of the reanalysis product.

The assimilation system is able to estimate biases between observations and to sift good-quality data from poor data. The laws of physics allow for estimates at locations where data coverage is low. The provision of estimates at each grid point in Europe for each regular output time, over a long period, always using the same format, makes reanalysis a very convenient and popular dataset to work with.

The observing system has changed drastically over time, and although the assimilation system can resolve data holes, the initially much sparser networks will lead to less accurate estimates. UERRA-HARMONIE data is available from 1961 and is updated once a month with a delay to real-time of 3-4 months. The system provides four analyses per day at 0 UTC, 6 UTC, 12 UTC, and 18 UTC. Between the analyses, forecasts of the system are available with hourly resolution. Hence, estimates of the status of the atmosphere are available for every hour since 1961. Moreover, forecasts up to 30 hours are available from the analyses at 0 UTC and 12 UTC though the output is not stored hourly after forecast hour 6 but only every third (sixth) hour.

In addition to observations in the model domain, a regional reanalysis needs information at its lateral boundaries. For the UERRA-HARMONIE system, this information is taken ERA40 (until the end of 1978) and ERA-Interim (from 1979). The improvement over global products comes with the higher horizontal resolution that allows incorporating topography. Moreover, it enables the system even to consider more observations at places with dense observation networks. The UERRA-HARMONIE regional reanalysis is resolution of 11km.

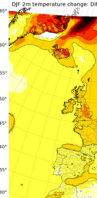
Variables are produced at the surface and on model levels (65 levels) but are also interpolated to two other level types: pressure levels (24 levels between 1000-10hPa), and height levels (15m-500m). The output of height levels were introduced with special focus on the

wind energy sector and their needs. The number of available parameters varies between the different level types.

In order to make data access more manageable, the UERRA-HARMONIE dataset has been split into 5 records. The present record is the UERRA-HARMONIE regional reanalysis to present.

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

DATA DESCRIPTION	
Horizontal coverage	Europe



Contact



This is a

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UERRA regional reanalysis on pressure levels from 1961 to present

Overview Download data Documentation

Variable

At least one selection must be made

- Geopotential
- Relative humidity
- U-component of wind
- Geopotential height
- Temperature
- V-component of wind

Select all

Pressure level

At least one selection must be made

- 10 hPa
- 20 hPa
- 30 hPa
- 50 hPa
- 70 hPa
- 100 hPa
- 150 hPa
- 200 hPa
- 250 hPa
- 300 hPa
- 400 hPa
- 500 hPa
- 600 hPa
- 700 hPa
- 750 hPa
- 800 hPa
- 825 hPa
- 850 hPa
- 875 hPa
- 900 hPa
- 925 hPa
- 950 hPa
- 975 hPa
- 1000 hPa

Select all

Year

At least one selection must be made

- 1961
- 1962
- 1963
- 1964
- 1965
- 1966
- 1967
- 1968
- 1969
- 1970
- 1971
- 1972
- 1973
- 1974
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- 1976
- 1977
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- 1999
- 2000
- 2001
- 2002

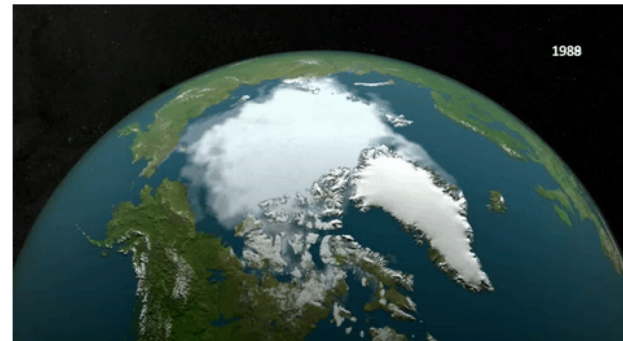


Climate
Change

C3S_322 Lot 2: Regional reanalysis for the Arctic

- Warming in the Arctic (observational records and future scenarios) roughly twice as high as global average
- Need for understanding and management of change processes
- Increased economic activity in the region

(Animated gif: NASA)



Coverage in two domains, main areas of interest in the European sector of the Arctic

High resolution (2,5 km) adds value to global products

Extensive use of satellite data

Use of local surface observation datasets available in the partner countries

Special emphasis on NWP schemes and observations for the handling of “cold surfaces”: Snow, sea ice, glaciers





Climate
Change



The Toolbox





Climate
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Documentation

Toolbox editor

Applications Data Documentation

Search for documentation

▼ **cdstoolbox**

application

▶ **input**

▶ **output**

▶ **catalogue**

▶ **cdsplot**

▶ **cdstools**

▶ **chart**

▼ **climate**

anomaly

apply_climatology

calibrate

climatology_mean

climatology_perc

climatology_std

compute_climatology_bias

daily_max

daily_mean

daily_min

daily_std

monthly_mean

monthly_std

normalize_to_climatology

season_select

▶ **cube**

▶ **eurostat**

▶ **geo**

The screenshot shows a documentation window titled "Climate and forecast tools" with version "0.8". It features a search bar and a table of contents with sections like "Cdo", "Heuristics", "Importer", "Input/Output", "Lonlat", "Matplotlib", "Plotly", "Season", "Stats", and "Udunits2". The main content area displays the documentation for the function `cftools.season.climatology_mean`, including its signature `cftools.season.climatology_mean(data: xr.DataArray, *args, **kwargs) → xr.DataArray` and a description: "Compute the mean of the climatology of the data between start and stop." It lists parameters: `data` (Xarray DataArray), `start` (start date), `stop` (end date), and `frequency` (grouping string). Below, it shows the signature for `cftools.season.climatology_perc` and its description: "Compute the standard deviation of the climatology of the data between start and stop."

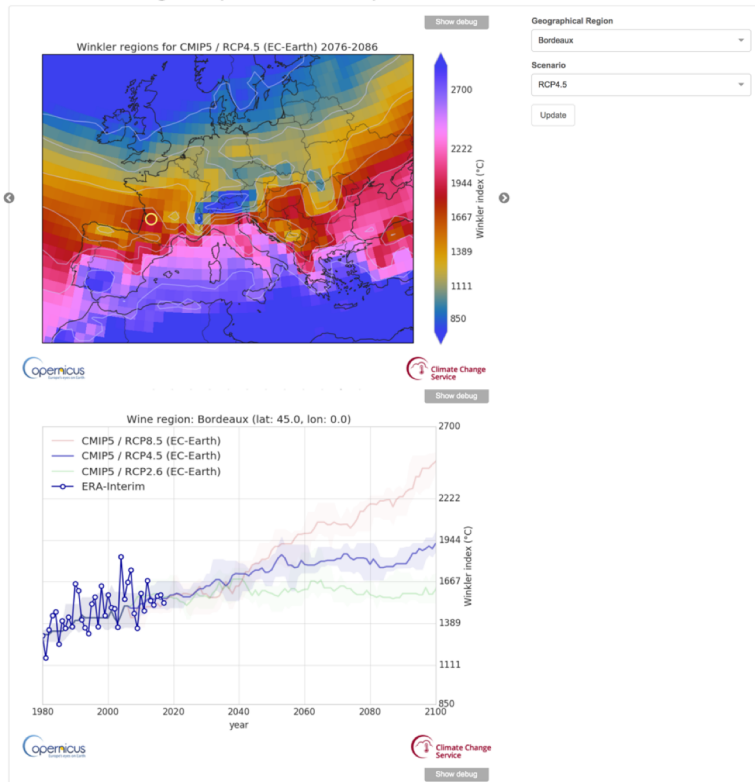


Climate
Change

Application



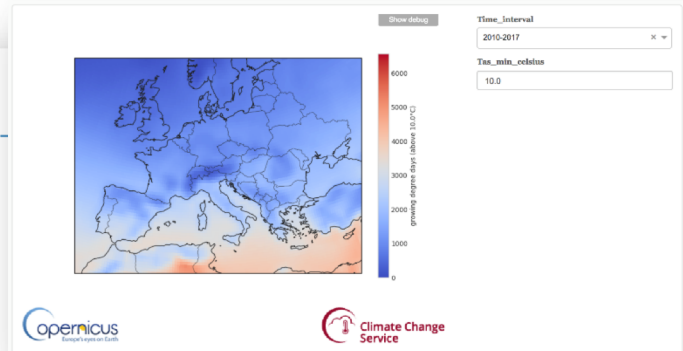
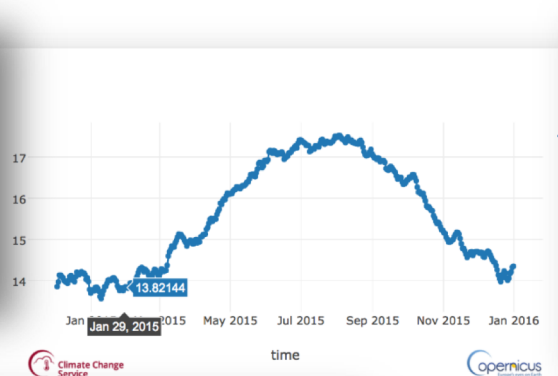
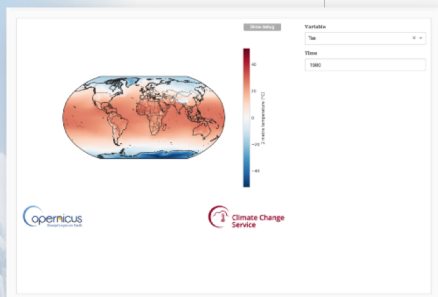
Climate change impact on wine production





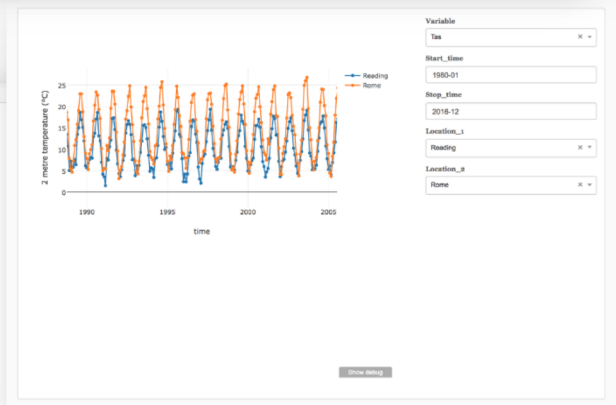
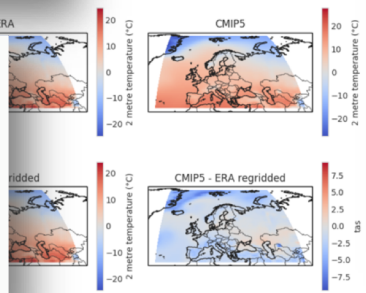
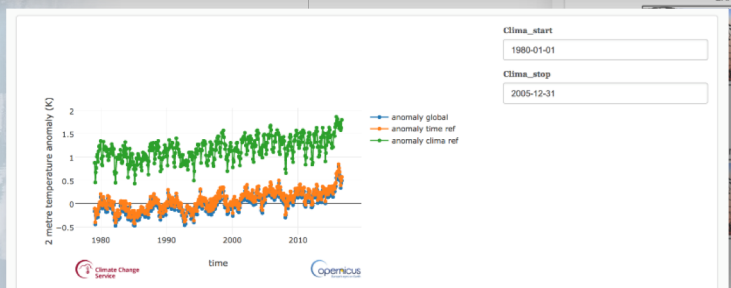
Climate Change

Plotting facilities



Download [d04fca38b270f51ec8f01d7599b57df64a4886-0.nc](https://api.opennicus.com/d04fca38b270f51ec8f01d7599b57df64a4886-0.nc) Show debug

Var:





Climate
Change

<https://climate.copernicus.eu>

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



Thank you

