C3S: El Servicio de Cambio Climático de Copernicus

Joaquín Muñoz Sabater
European Centre for Medium-Range Weather Forecasts (ECMWF)

Climate Change

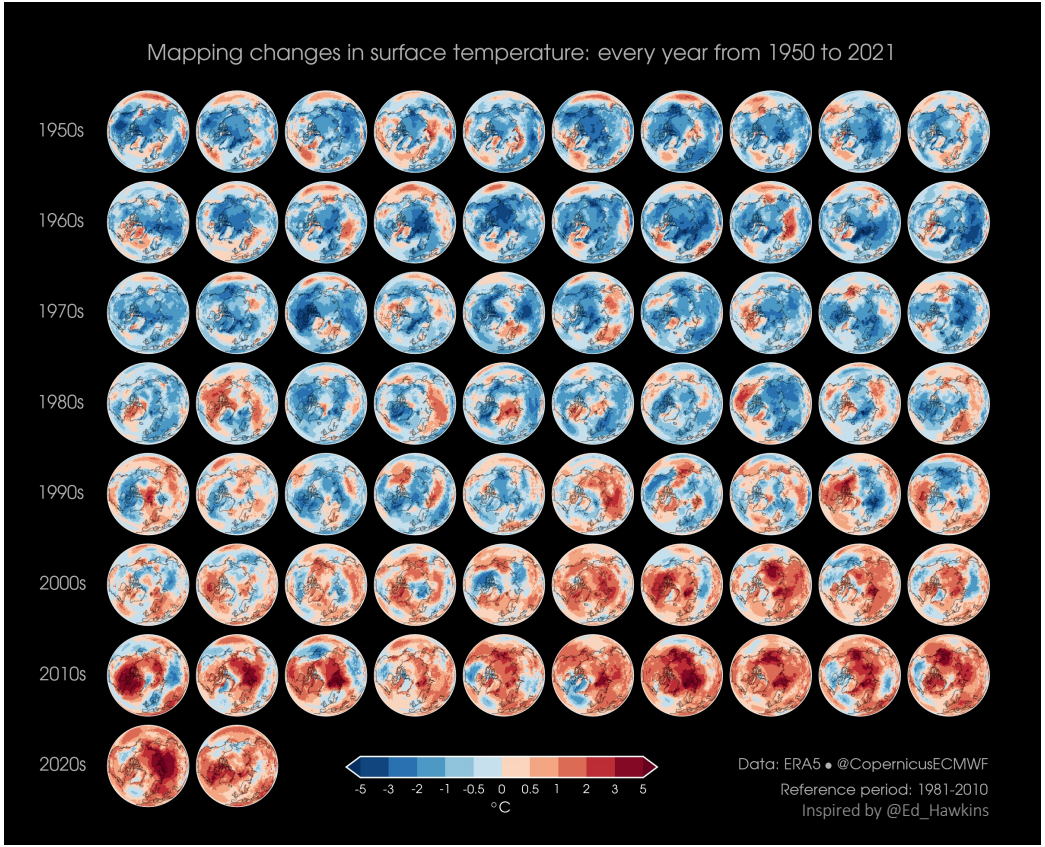
Introducción a los servicios climáticos – Universidad Politécnica de Valencia, 11 July 2022

Copernicus Europe's eyes on Earth | European Commission | ECMWF

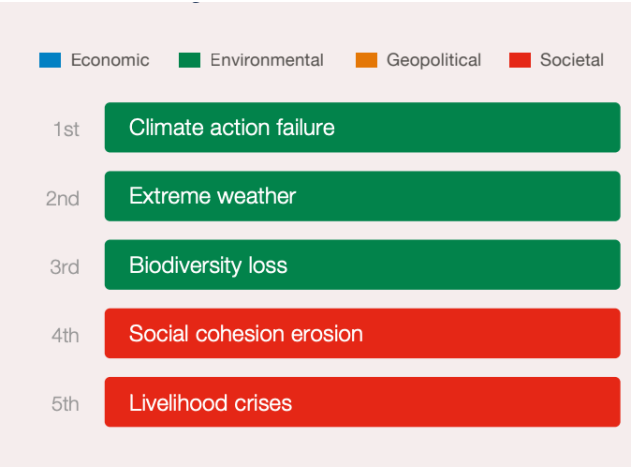
@j_munoz_sabater

Climate Change

Climate insights have never been more important



World Economic Forum 2022: Global Risks Report: "most severe risks on a global scale over the next 10 years"



There are more climate related disasters now than ever before. Improving our ability to describe then and predict them would equip our society to better manage them.

Climate Change

Outline

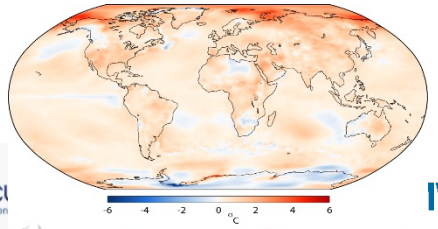
¿ Qué es el Servicio Europeo de Cambio Climático (C3S) ?

¿ Qué productos se ofrecen ?

¿Cómo acceder a los productos de C3S y qué herramientas de apoyo existen ?

¿ Para qué sirven los Sistemas de Información Sectorial (SIS) ?

¿ Algún otro componente en C3S ?



IWF

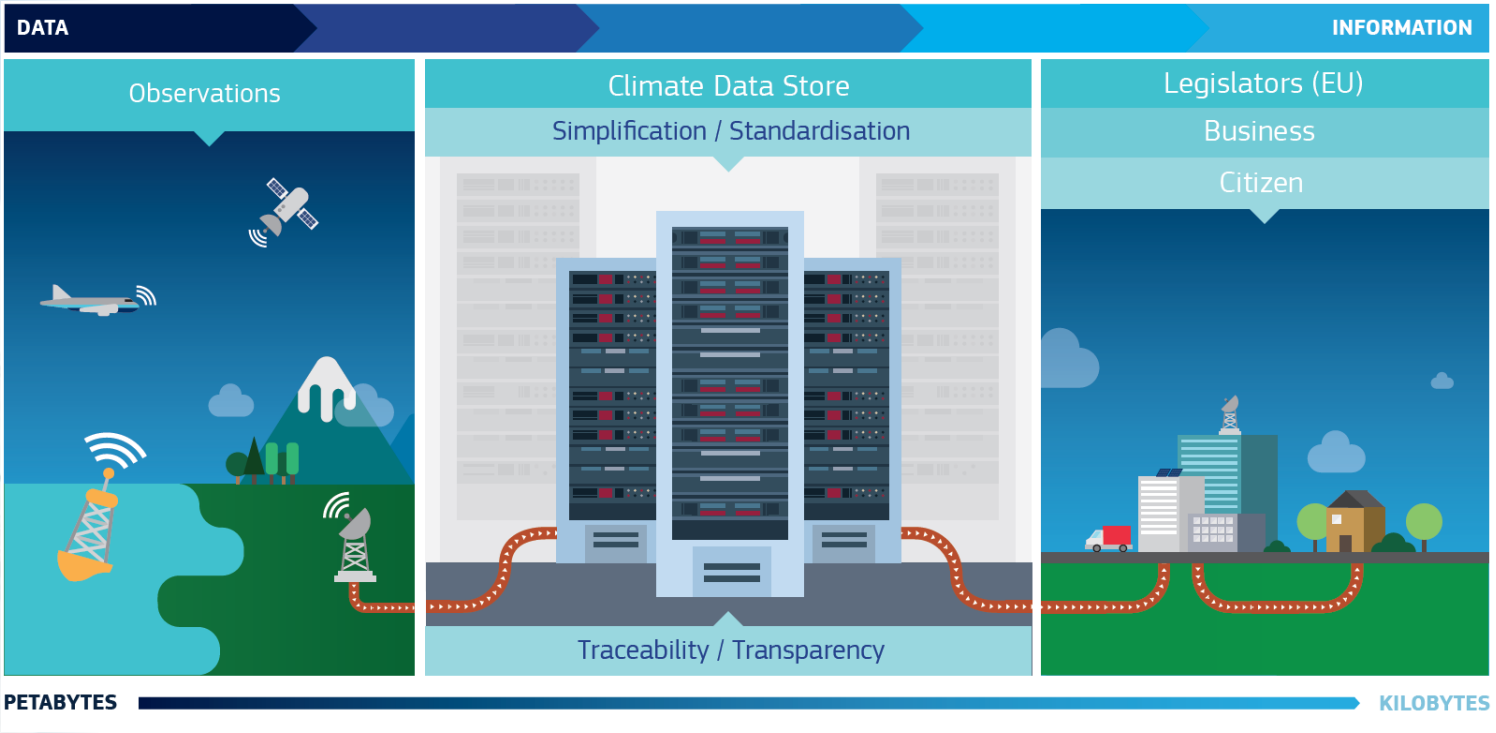
Abierto, completo, gratuito

1st MFF (2014-2020): ~ 4300 M€

2nd MFF (2021-2027): ~ 5420 M€

Climate Change

What is the Copernicus Climate Change Service (C3S)?



authoritative quality-controlled data and information based on Earth Observation about the past, present and future climate;

tools to inform climate change mitigation and adaptation strategies by policy makers and businesses;

examples of best practice in the use of climate information.

Copernicus | European Commission | ECMWF

Estructura de C3S

Climate Change

European commission
e.g.,FP7 Space call, H2020

EU estados miembros, ESA, EUMETSAT, EEA, WMO..

Evaluación & Control Calidad

Garantía de calidad
Integridad del Servicio
Necesidades de usuarios

Climate Data Store

Sistemas de Información Sectorial

ENERGY · WATER MANAGEMENT · INSURANCE · AGRICULTURE & FORESTRY · INFRASTRUCTURE

Divulgación & difusión

Usuarios & stakeholders

Copernicus · European Commission · ECMWF

Outline

Climate Change

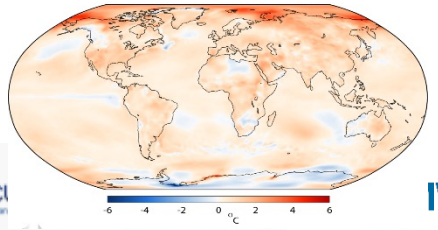
¿ Qué es el Servicio Europeo de Cambio Climático (C3S) ?

¿ Qué productos se ofrecen ?

¿Cómo acceder a los productos de C3S y qué herramientas de apoyo existen ?

¿ Para qué sirven los Sistemas de Información Sectorial (SIS) ?

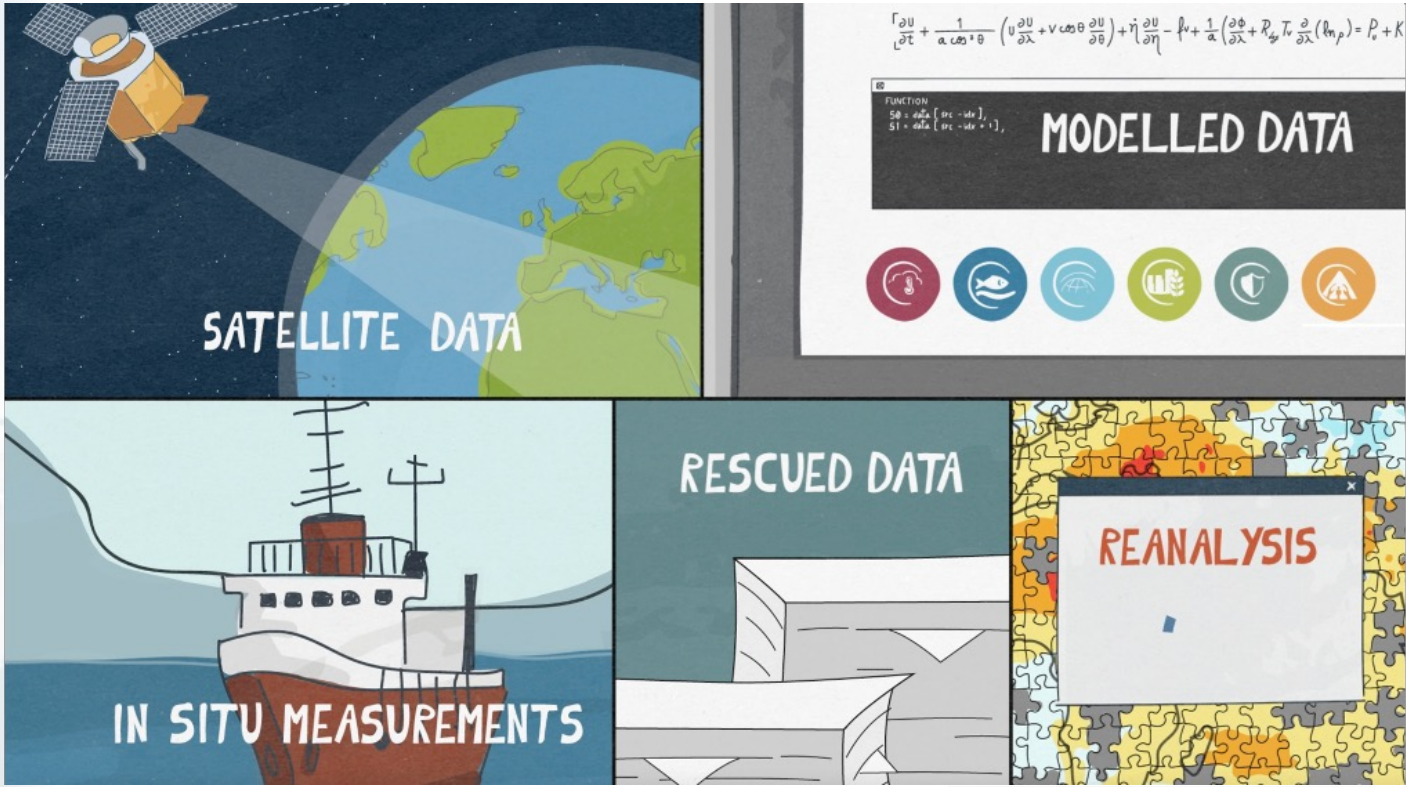
¿ Algún otro componente en C3S ?



IWF

Climate Change

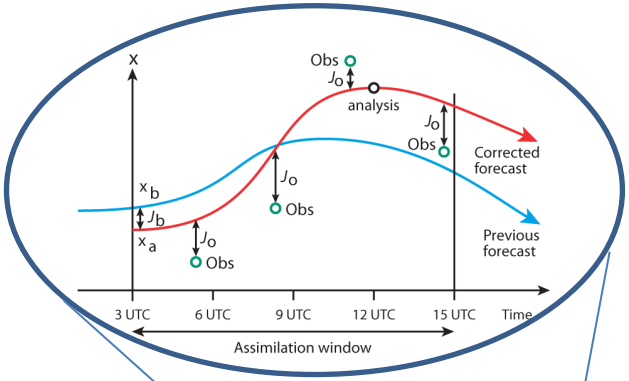
The Climate Data Store – ‘A one stop shop for climate data’

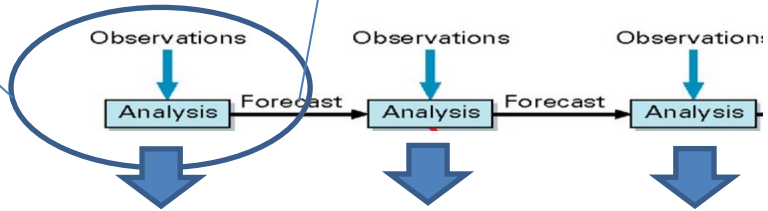


Copernicus Europe's eyes on Earth | European Commission | ECMWF

Climate Change

What is the reanalysis?





Data assimilation & reanalysis
Combining information from observations and models to provide an estimate of weather and climate over multi-decadal timescales

PROGRAMME OF THE EUROPEAN UNION

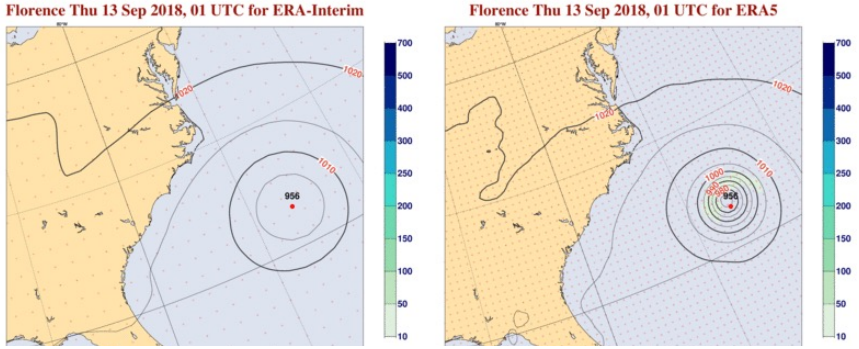
Copernicus Europe's eyes on Earth

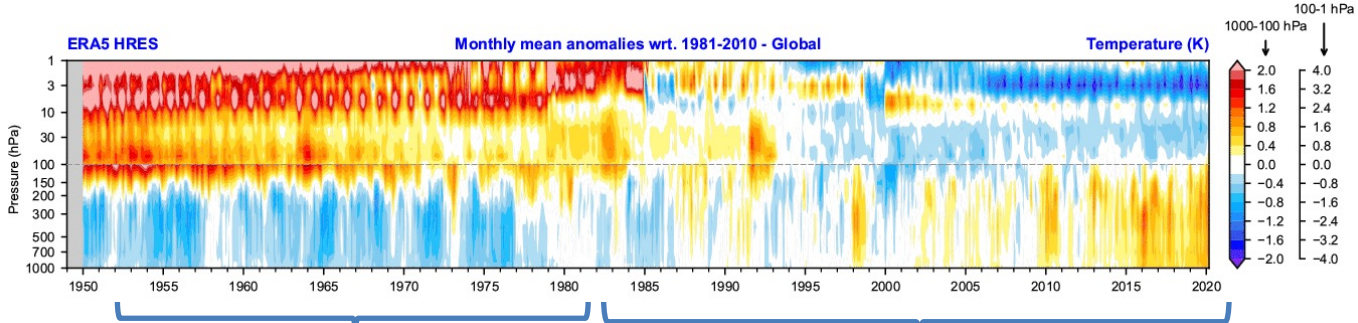
implemented by ECMWF

Climate Change

Maps without gaps: global atmospheric reanalysis ERA5

ERA5:
Spatial resolution: 31 km
Temporal resolution: hourly
Period: 1950-present





1950 – 1979
Preliminary (published end 2020)

1979 – present
Complete. NRT stream runs RT – 1 day

Hersbach et al., 2020 (Quart. J. Roy. Met. Soc.),
https://doi.org/10.1002/qj.3803

Copernicus | European Commission | ECMWF

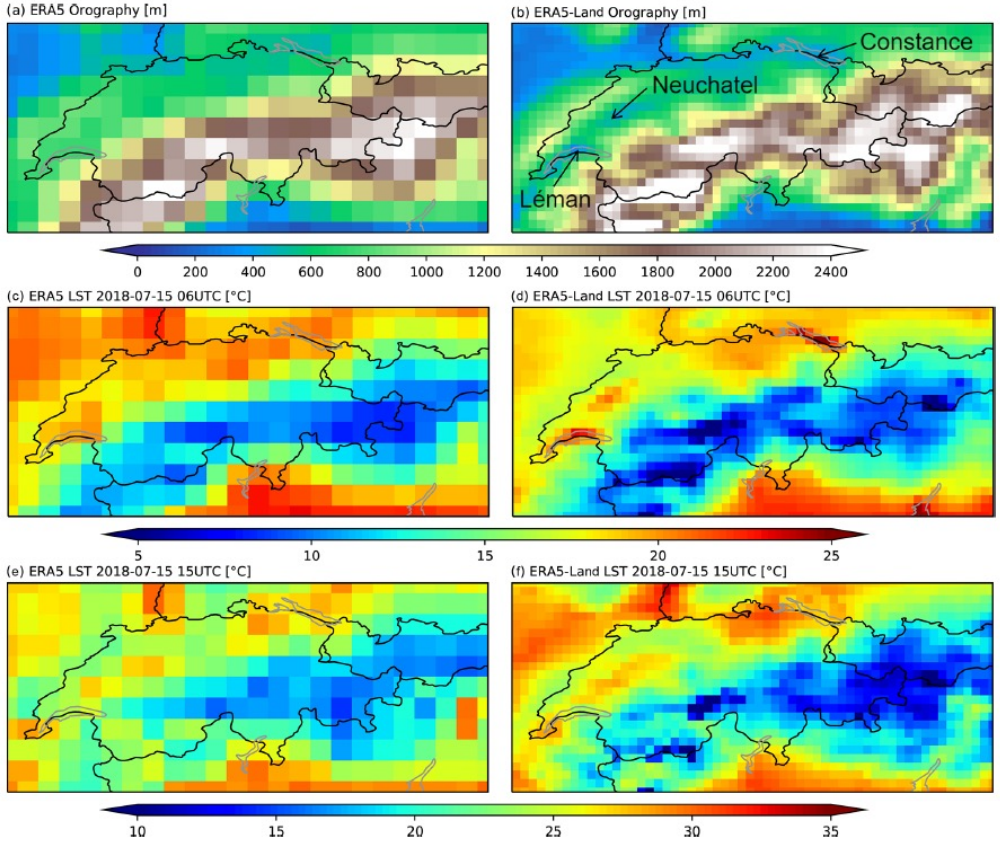
Climate Change

High-resolution and consistency for the land evolution: ERA5-Land (1950-present)

orography

Soil Temperature (15 July 2018 06UTC)

Soil Temperature (15 July 2018 15UTC)



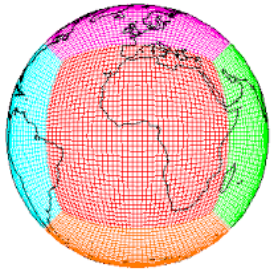
ERA5-Land:
Spatial resolution: 9 km
Temporal resolution: hourly
Period: 1950-present
Land consistency

Muñoz-Sabater et al., 2021 (Earth Syst. Sc. Data), https://doi.org/10.5194/essd-13-4349-2021

Copernicus European Commission ECMWF

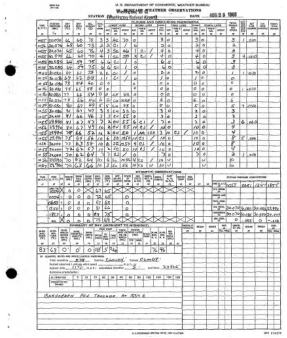
Regional reanalyses

Climate Change



Global reanalyses

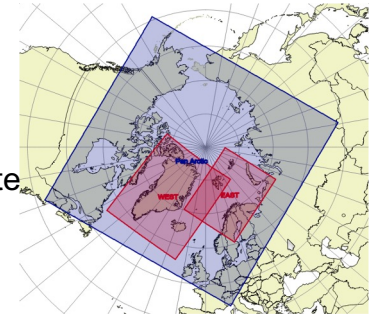
+



local observations

Regional models at higher horizontal resolution

- 2.5 km in the Arctic or 5.5 km for Europe
- Wind field better account for to the local orography
- More detailed description of extreme events.

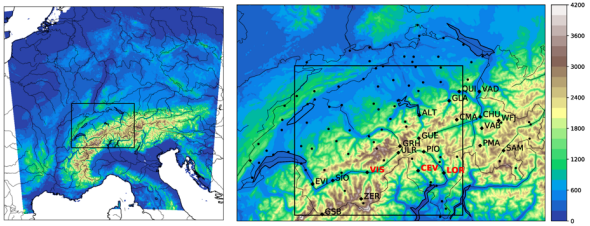


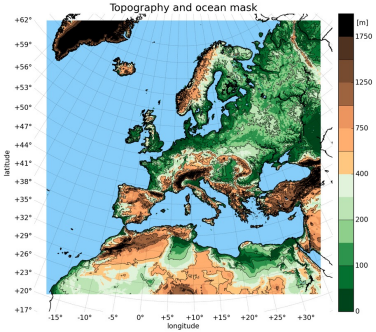
Additional (local) observations

- Local surface observations and slightly different treatment of satellite data where possible

Better description of surface characteristics

- Sea surface temperature, sea ice concentration, glacier albedo, snow cover for the Arctic
- Additionally, orography and soil information and vegetation on 1 km resolution for Europe

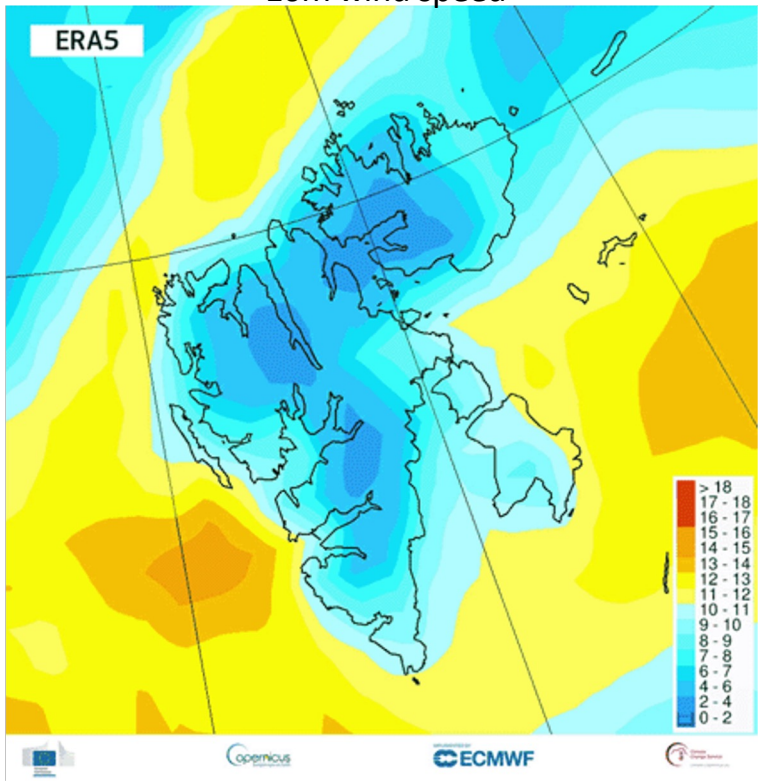




Climate Change

Regional reanalysis for the Arctic region (CARRA)

10m wind speed

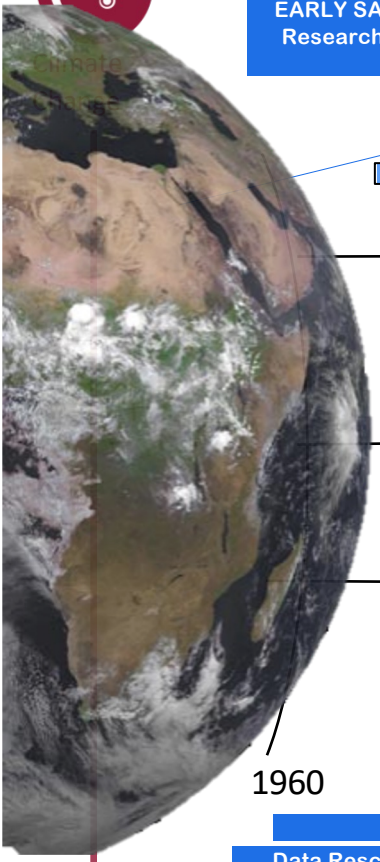


Copernicus Arctic Regional Reanalysis (CARRA)

- Driven by ERA5
- Two subdomains of the European Arctic @2.5 km (non-hydrostatic) horizontal resolution
- Improved orography and land-use
- Additional local observations assimilated
- Now available on the CDS for the period September 1990 - June 2021

Copernicus European Commission ECMWF

Satellite data rescue



EARLY SATELLITE ERA (pre-1979)
Research satellites (NIMBUS 1-7, NOAA)

MODERN ERA (1979-2000)
operational Satellites (NOAA, DMSP, GOES, METEOSAT)

Data not yet assimilated

Data assimilated in ERA5

1979

THIR /N4-7
HRIR/N1-3
MRIR /N2-3
SCR/N4-5
HIRS/1/N 6
SIRS/N3-4
PMR/N
IRIS/N3-4
VTPR/NOAA2-5
SSH/DMSP F1-F4
ITPR/N5
NEMS/N5
SCAMS/N 6
ATS
SMS-1,2
SSU/TIROS_N/NOAA 6-14
HIRS/2-4
IMG/ADEOS
SMMIS/DMSP F16-19
MSU/TIROS-N-NOAA6-14
SSM/T-2/DMSP F11-15
SSM/T-1/DMSP F4, F7-F15
SMMR/SEASAT-N7
SSM/I/DMSP F4, F7-F15
MVIRI+SEVIRI
GMS
AVHRR/POES
GOES 1-15

1960 1970 1980 1990 2000

Infrared Imagers

Infrared Sounders

Microwave Sounders/ Imagers

Geostationary + Atmospheric Motion Vecto

Reprocessing (recalibration, navigation, ...), quality assessment

Data Rescue: decoding original data, reformatting, archiving & QC

PROGRAMME OF THE EUROPEAN UNION

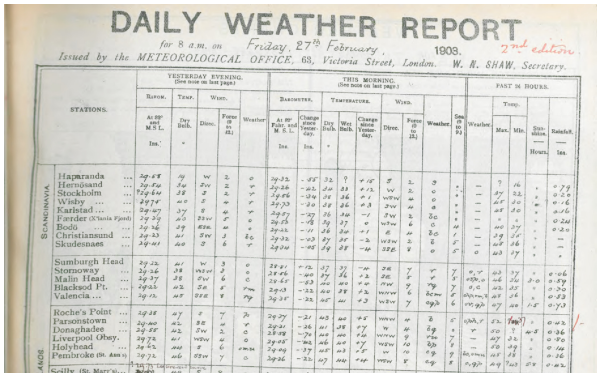
Copernicus Europe's eyes on Earth

implemented by ECMWF

Climate Change

Importance of data rescue

GREAT STORM, FEBRUARY 27, 1903.
Phœnix Park—2,948 Trees blown down (1,242 Forest Trees, 1,706 Thorns).



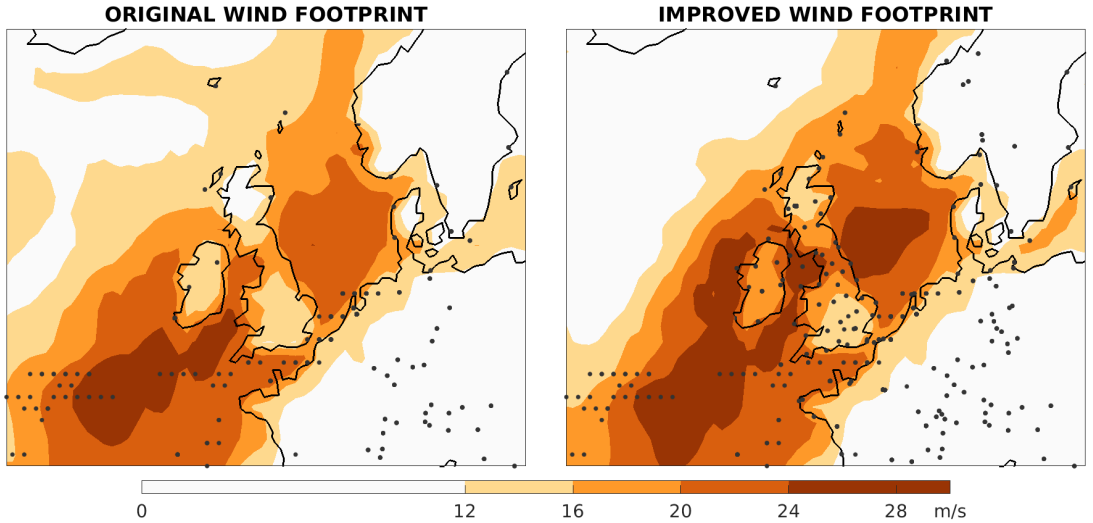
DAILY WEATHER REPORT

for 8 a.m. on Friday, 27th February, 1903. 2nd edition

Issued by the METEOROLOGICAL OFFICE, 63, Victoria Street, London. W. N. SHAW, Secretary.

'Ulysses' windstorm of February 1903, which hit Ireland and UK

- Data for many European locations rescued from paper.



- Wind footprint in a reanalysis of the event was not severe enough to cause known damage. Adding rescued data (new black dots) produced a credible reanalysis of the storm.

PROGRAMME OF THE EUROPEAN UNION
Copernicus Europe's eyes on Earth
implemented by ECMWF

Climate Change

What is the climate system?

COP1

- = satellite ECVs
- = ECVs from reanalysis

CRYOSPHERE

- Snow
- Ice Sheets and Ice Shelves
- Glaciers
- Permafrost

SURFACE ATMOSPHERE

- Surface Radiation Budget
- Surface Pressure
- Surface Temperature
- Surface Water Vapour
- Surface Wind Speed and Direction
- Precipitation

UPPER-AIR ATMOSPHERE

- Upper-air Temperature
- Upper-air Water Vapour
- Upper-air Wind Speed and Direction
- Lightning
- Earth Radiation Budget
- Clouds

ATMOSPHERIC COMPOSITION

- Precursors for Aerosols and Ozone
- Aerosols
- CO_2, CH_4, and other GHGs
- Ozone

SURFACE OCEAN PHYSICS

- Surface Currents
- Surface Stress
- Sea Surface Temperature
- Sea Ice
- Ocean Surface Heat Flux
- Sea Level
- Sea Surface Salinity
- Sea State

SUBSURFACE OCEAN PHYSICS

- Subsurface Temperature
- Subsurface Currents
- Subsurface Salinity

OCEAN BIOLOGY / ECOSYSTEMS

- Plankton
- Marine Habitats

OCEAN BIOGEOCHEMISTRY

- Ocean Colour
- Transient Tracers
- Inorganic Carbon
- Oxygen
- Nitrous Oxide (N_2O)
- Nutrients

HYDROSPHERE

- Soil Moisture
- Lakes
- Groundwater
- River Discharge
- Evaporation from Land

ANTHROPOSPHERE

- Anthropogenic Water Use
- Anthropogenic Greenhouse Gas Fluxes

BIOSPHERE

- Soil Carbon
- Albedo
- Fire
- FAPAR*
- Leaf Area Index (LAI)
- Land Surface Temperature
- Above-ground Biomass
- Land Cover

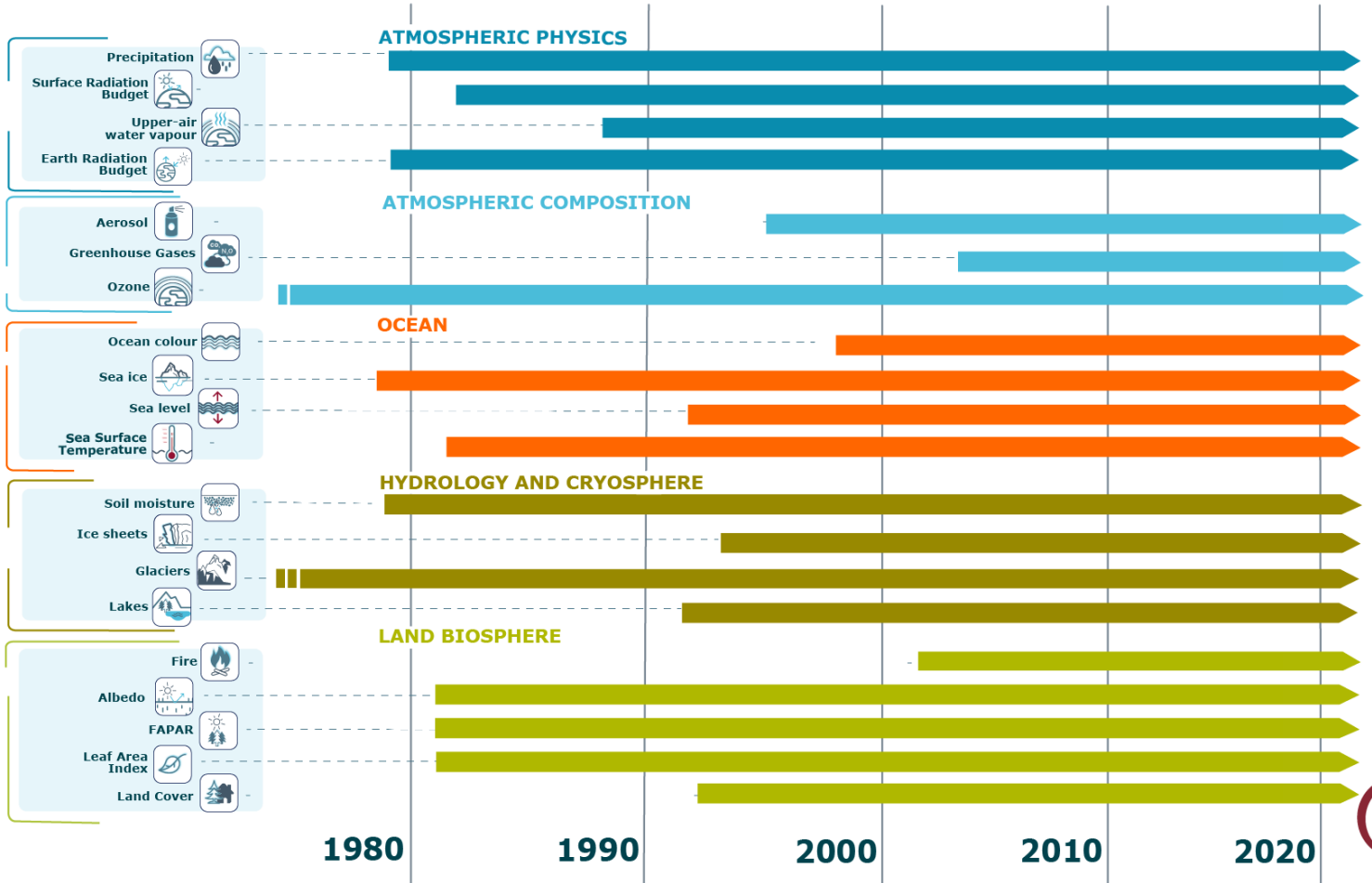
*Fraction of Absorbed Photosynthetically Active Radiation

Climate Change Service

climate.copernicus.eu

Climate Change

Satellite ECV data records



IN COLLABORATION with more than **50** organisations.

EUMETSAT

esa

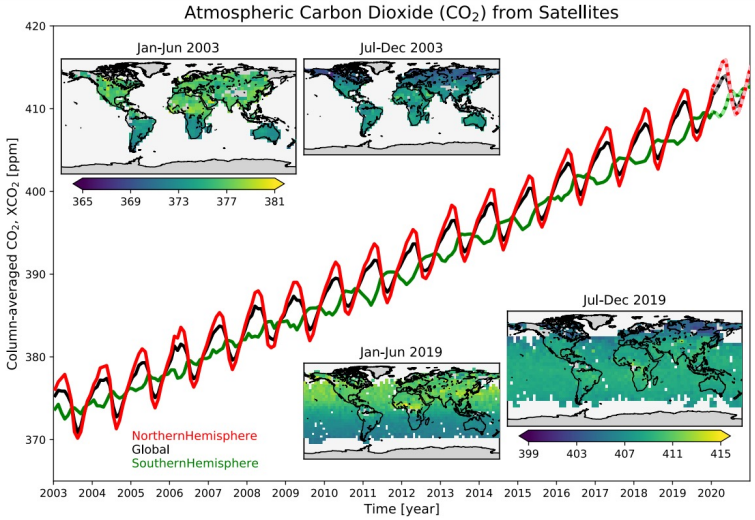
Mainly use **Sentinel-3** data

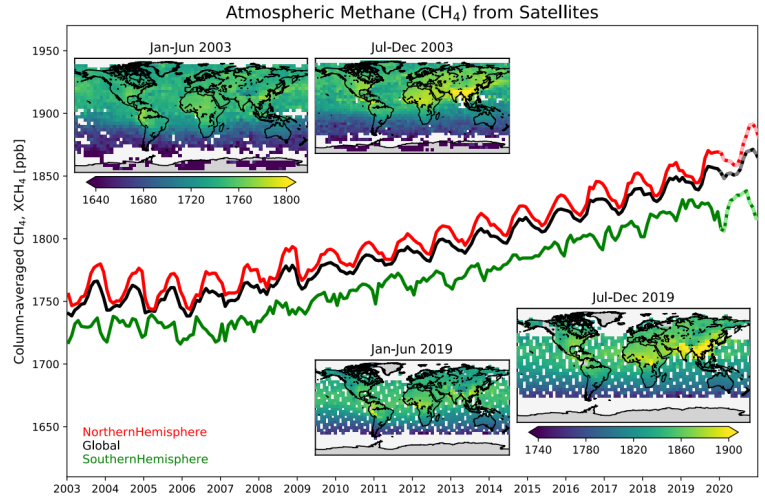
Future use of other Sentinel data

Climate Change Service

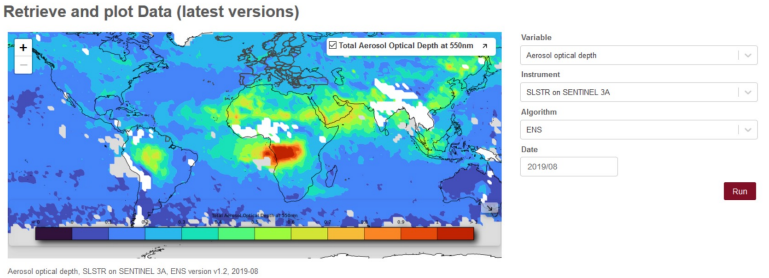
climate.copernicus.eu

Generation of key information for policy makers, published in the ESOTC





- New toolbox applications/viewers to be implemented in 2022,



Copernicus Europe's eyes on Earth | European Commission | ECMWF

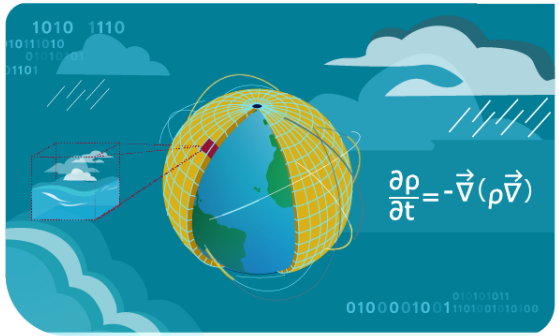
Climate Change

What is a climate prediction?

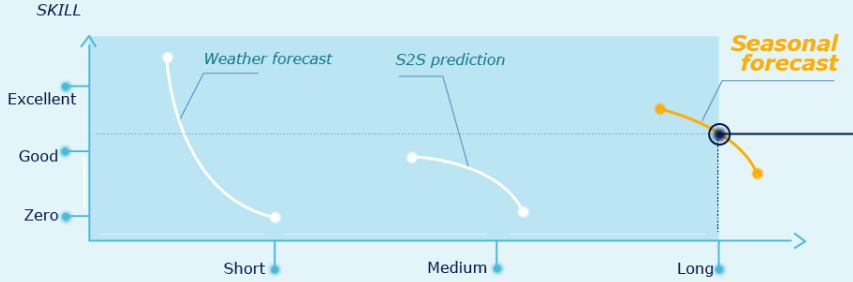
OBSERVATIONS OF THE CURRENT STATE OF THE CLIMATE

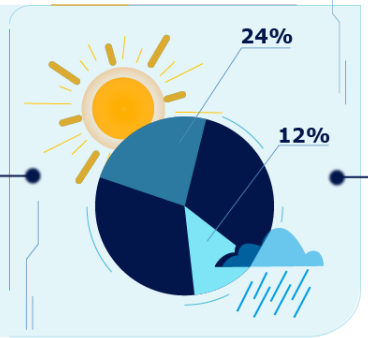
+

CLIMATE MODELS



PREDICTIONS





EARLY WARNING FOR:

C3S seasonal predictions: components

Climate Change

DATA PRODUCTS

http://cds.climate.copernicus.eu

Datasets available in the Climate Data Store:

- Daily and subdaily data (6h, 12h, 24h)
- Monthly statistics
  (mean, max., min. and standard deviation)
- Bias corrected data (monthly anomalies)

CDS Toolbox

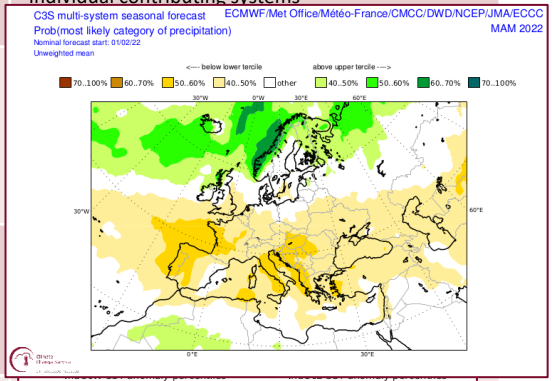
```
import cdsapi

c = cdsapi.Client()

c.retrieve(
    'seasonal-monthly-single-levels',
    {   'format':'grib',
        'originating_centre':'meteo_france',
        'variable':'total_precipitation',
        'product_type':[
            'ensemble_mean','hindcast_climate_mean'
        ],
        'year':'2018',
        'month':'09',
        'leadtime_month':['1','2','3','4','5','6'] },
    'cds_seasonal_output.grib')
```

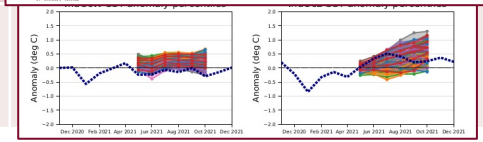
CDS API

GRAPHICAL PRODUCTS

https://climate.copernicus.eu/charts/c3s_seasonal/

Source	Individual contributing systems
Variables	
2D Maps - Global - Predefined regions	
Time series - SST NINO regions - SST Indian Ocean - Wind at 10hPa	





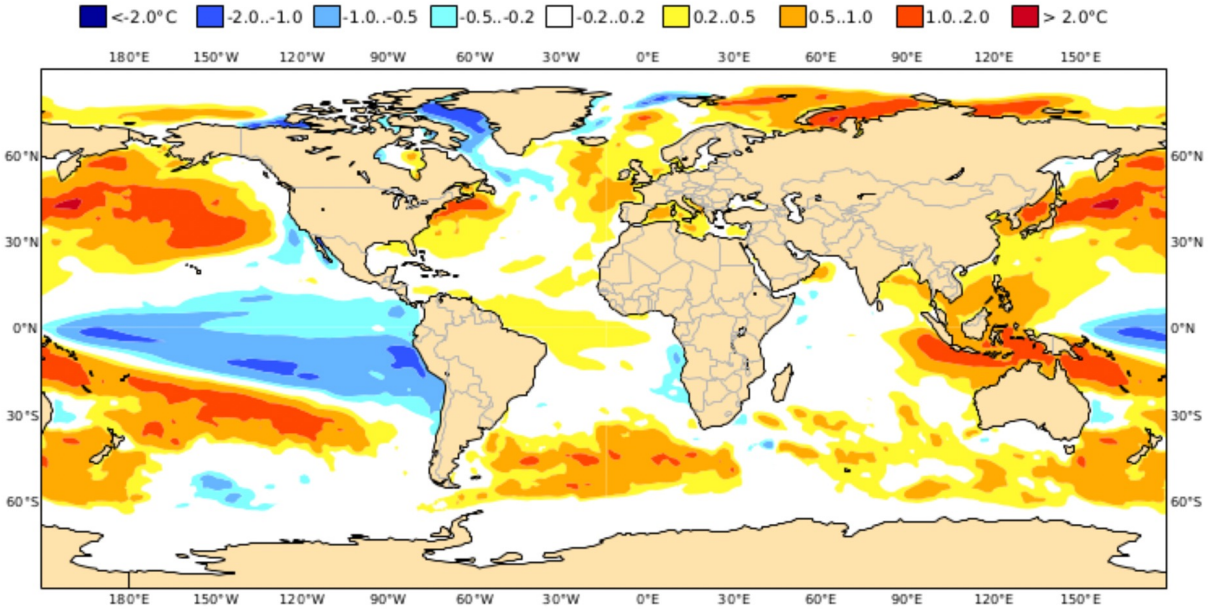
Copernicus · European Commission · ECMWF

Climate Predictions – Seasonal Forecasts

Climate Change

C3S multi-system seasonal forecast
Mean SST anomaly
Nominal forecast start: 01/06/22
Variance-standardized mean

ECMWF/Met Office/Météo-France/CMCC/DWD/NCEP/JMA/ECCC
JAS 2022



cmcc · DWD · ECMWF · Canada · Climate Change Service · 気象庁 Japan Meteorological Agency · METEO FRANCE · Met Office · NOAA

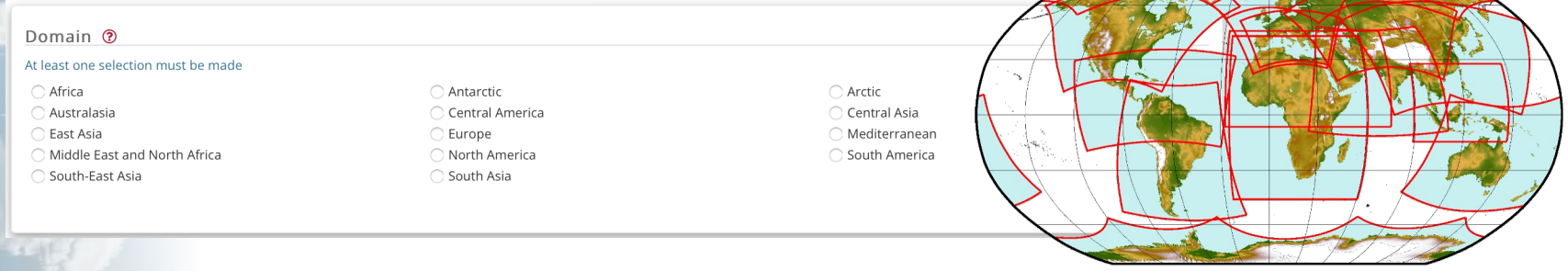
Copernicus · European Commission · ECMWF

Climate Change

C3S Climate Projections

- **CMIP5 simulations:** in the Climate Data Store (CDS) since 2018
- **CMIP6 simulations:** published in CDS in March 2021
  - **New functionality** to improve handling of data **web-processing services**

- **World-wide CORDEX simulations:** European region in the CDS since 2019; continual update with data for other regions



Climate Change

Outline

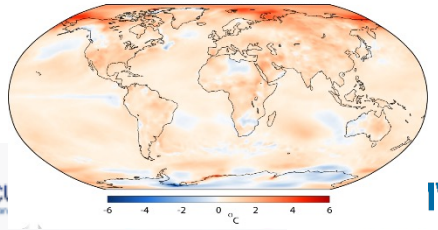
¿ Qué es el Servicio Europeo de Cambio Climático (C3S) ?

¿ Qué productos se ofrecen ?

¿Cómo acceder a los productos de C3S y qué herramientas de apoyo existen ?

¿ Para qué sirven los Sistemas de Información Sectorial (SIS) ?

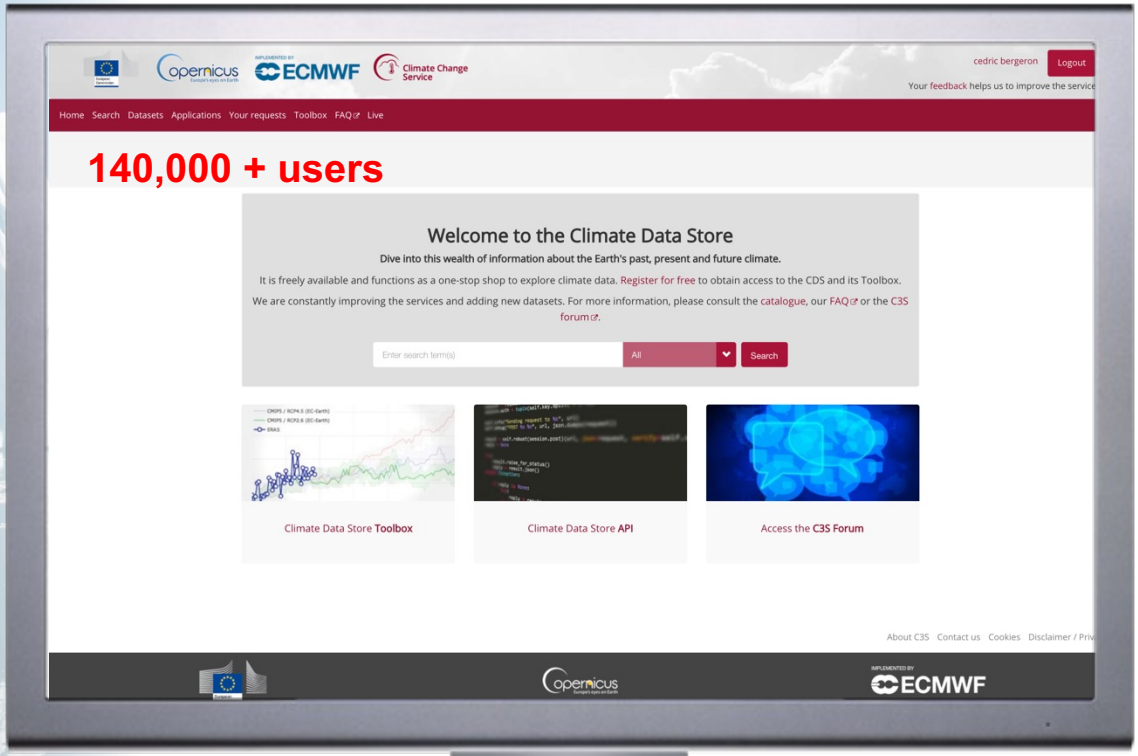
¿ Algún otro componente en C3S ?



IWF

The Climate Data Store

Climate Change



https://cds.climate.copernicus.eu

The **Climate Data Store** also called CDS, is **an online open and free service**.

It allows users to browse and access the wide range of climate datasets via a searchable catalogue…

… It allows users to build their own applications, maps and graphs

Copernicus Europe's eyes on Earth | European Commission | ECMWF

Climate Change

… and a consistent and simple meta(data) access

Download form

Overview

EQC Information

Documentation

Login/register

Your feedback helps us to improve the service

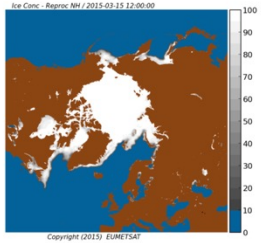
Home Search Datasets Applications Toolbox FAQ Live

Sea ice monthly and daily gridded data from 1978 to present derived from satellite sensors

Overview | Download data | Quality assessment | Documentation

This dataset provides daily values for sea ice **concentration**, sea ice **edge** and sea ice **type** and monthly values for sea ice **thickness**. These four variables are important markers for climate change studies since sea ice greatly influences the surface albedo and exchanges of energy, moisture and carbon. The sea-ice distribution, including polynyas and margins, also has an important influence on marine ecosystems. Changes in the distribution of sea ice affect these ecosystems and a number of activities such as shipping, logistic and tourist operations.

Sea ice edge, sea ice concentration and sea ice type were computed from satellite passive microwave brightness temperatures from the series of SMMR, SSM/I and SSMIS sensors. Sea ice thickness were computed from Ku-Band radar altimeter measurements collected during the Envisat and CryoSat-2 satellite missions. Ice thicknesses from Envisat satellite (October 2002 to October 2010) have less coverage and higher uncertainty than thicknesses from CryoSat-2 satellite (November 2010 - March 2015), however the combined dataset provides a valuable unique observational record of sea ice variability.



From 1978 up to April 2015 the data records provided by this dataset have sufficient length, consistency, and continuity to detect climate variability and change. From April 2015 onwards, satellite data were processed using the same algorithms and processing environment but consistency and continuity have not been extensively verified.

This dataset is produced on behalf of C3S, with the exception of sea ice concentration which is produced at the EUMETSAT Satellite Application Facility on Ocean and Sea Ice (OSI SAF).

DATA DESCRIPTION	
Data type	Gridded
Horizontal coverage	Sea ice concentration and edge: global ocean split in Northern and Southern hemisphere (Lambert EA projection). Sea ice thickness and type: northern hemisphere (Lambert EASE2 projection).
Horizontal resolution	Sea ice concentration and edge: 12.5 km grid resolution (true spatial resolution is about 40-50 km a respectively). Sea ice thickness and type: 25 km grid resolution (true spatial resolution is about 1-10 km and 4 respectively).
Temporal coverage	Sea ice concentration: 1978 to present. Sea ice thickness: 2002 to present. Sea ice edge: 1979 to present. Sea ice type: 1979 to present.
Temporal resolution	Sea ice concentration, edge and type: daily (every second day in the period 1978-1987). Sea ice thickness: monthly (Arctic winter months from October - April).

Contact

copernicus-support@ecmwf.int

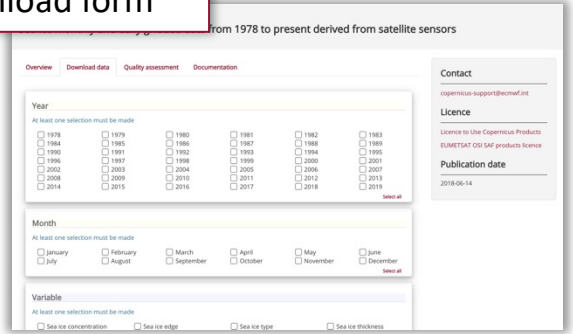
Licence

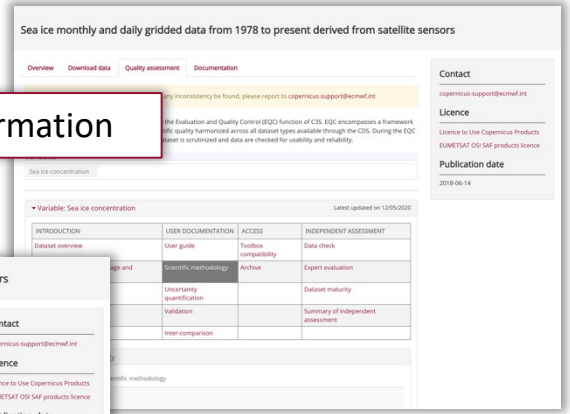
Licence to Use Copernicus Products

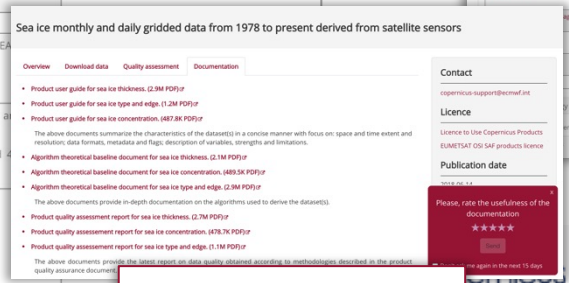
EUMETSAT OSI SAF products licence

Publication date

2018-06-14





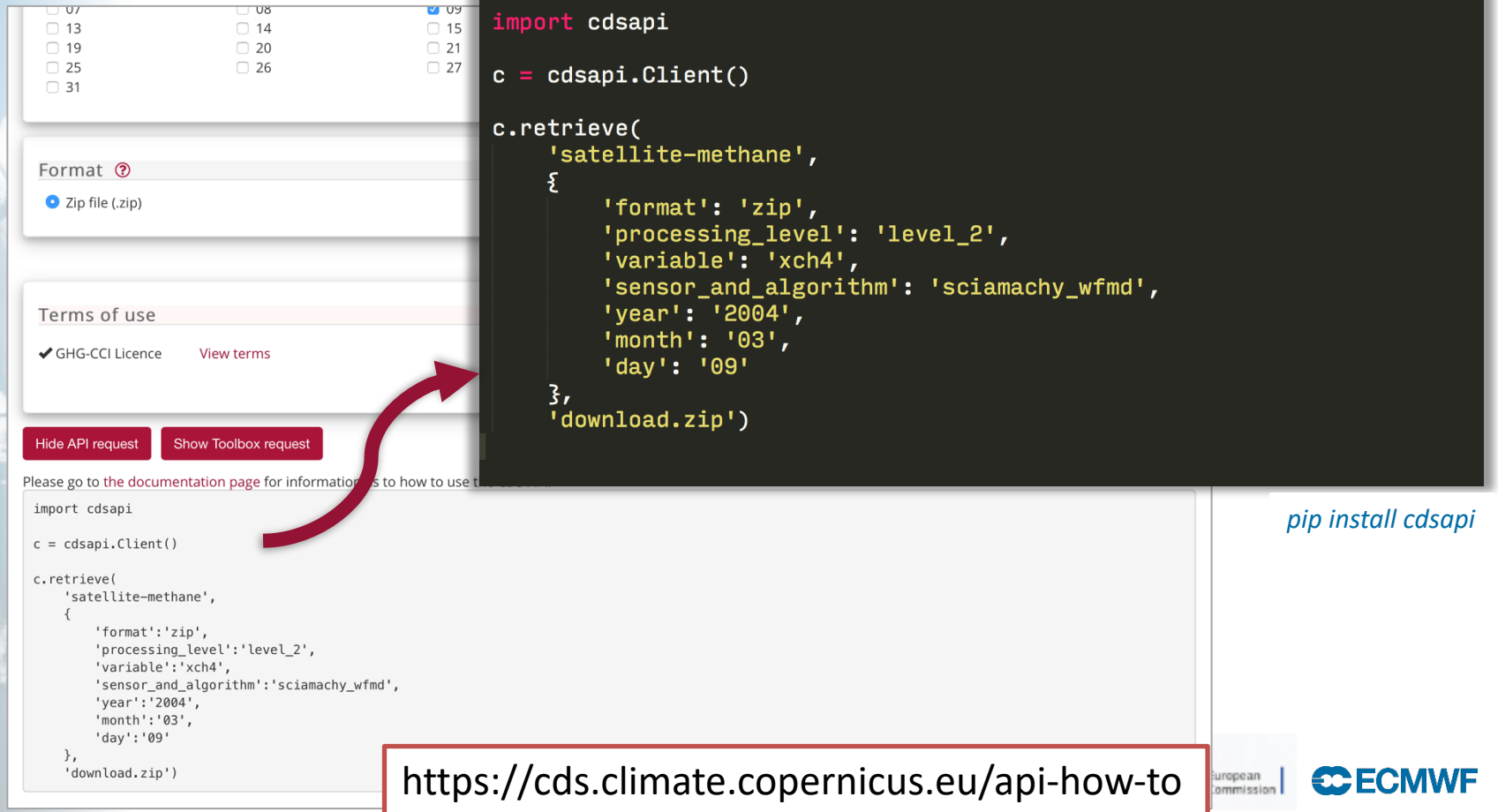


European Commission

ECMWF

Climate Change

… with a robust CDS API access



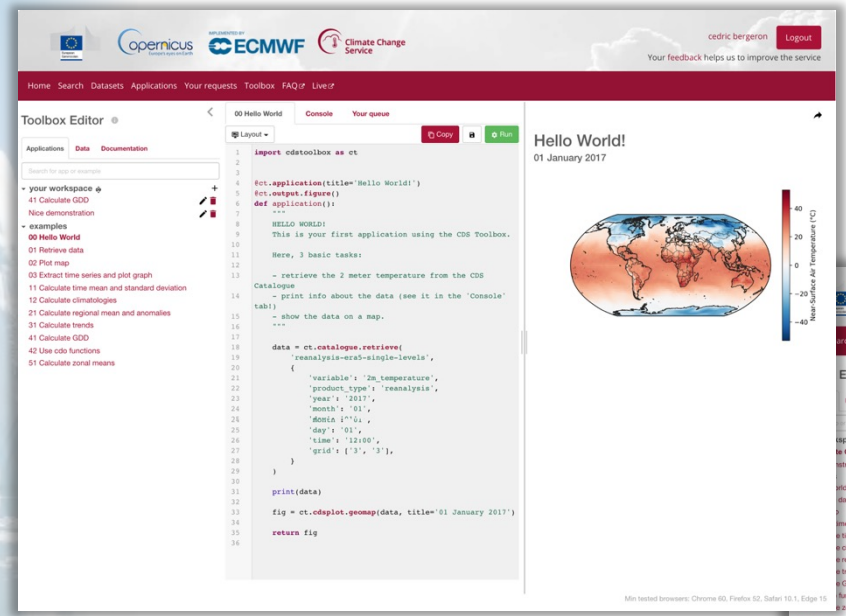
pip install cdsapi

https://cds.climate.copernicus.eu/api-how-to

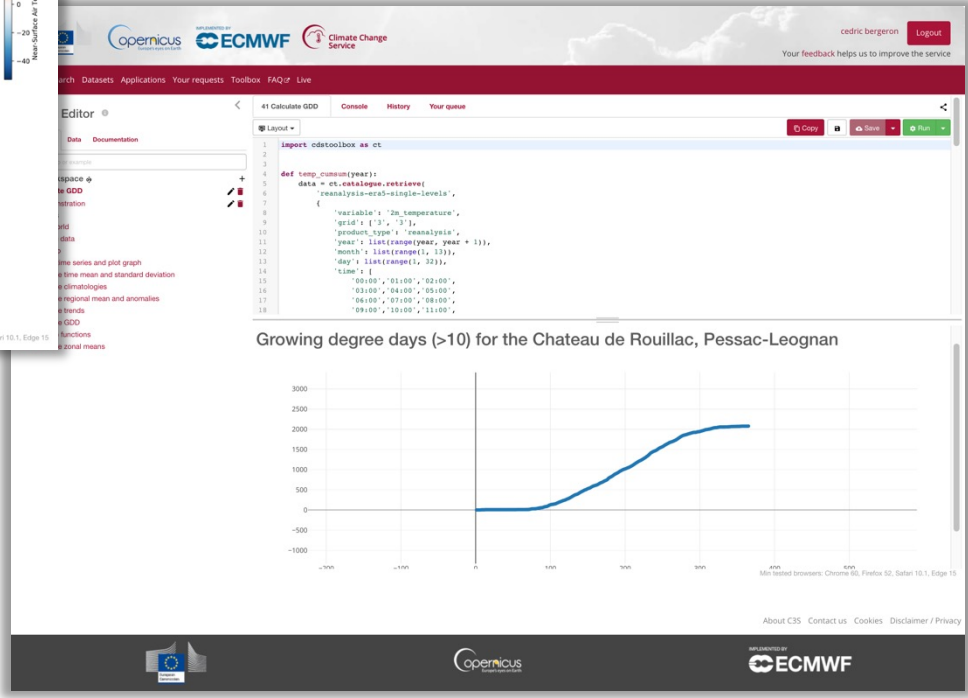
European Commission | ECMWF

Climate Change

… w i t h a w o r k f l o w e d i t o r

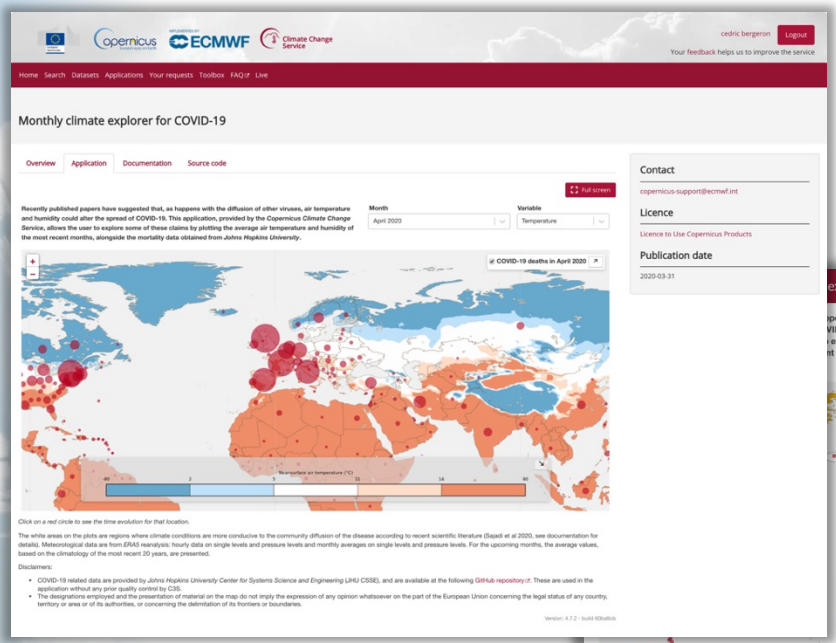


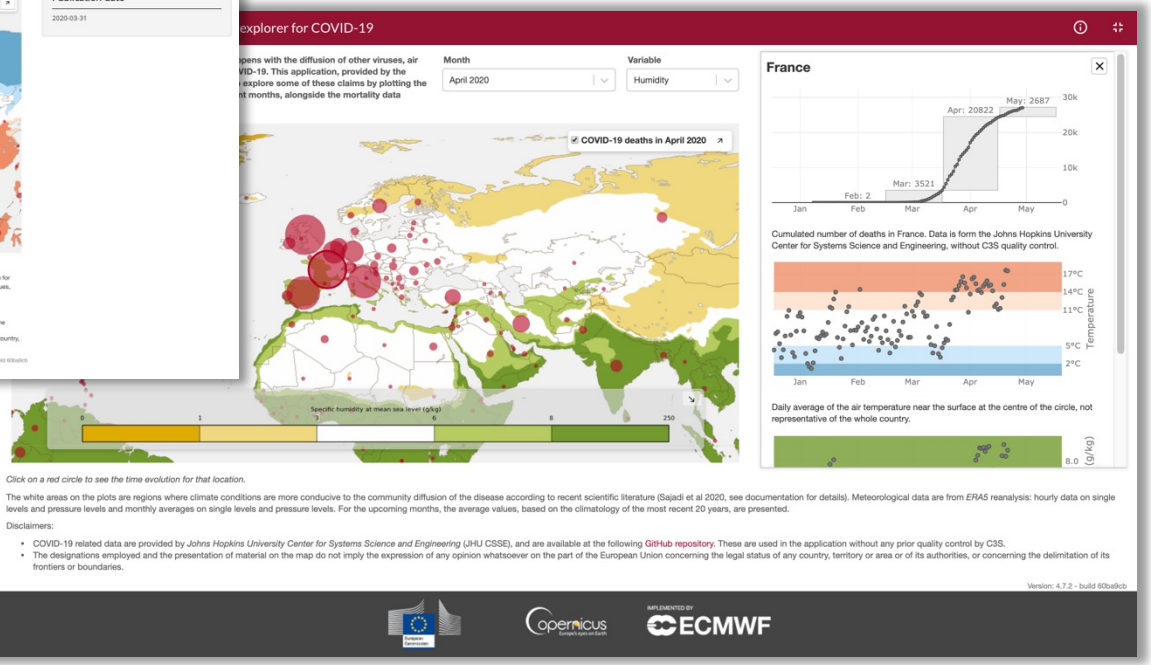
CDS Toolbox editor



Python based workflows

Fast Toolbox application development in the COVID-19 crisis context

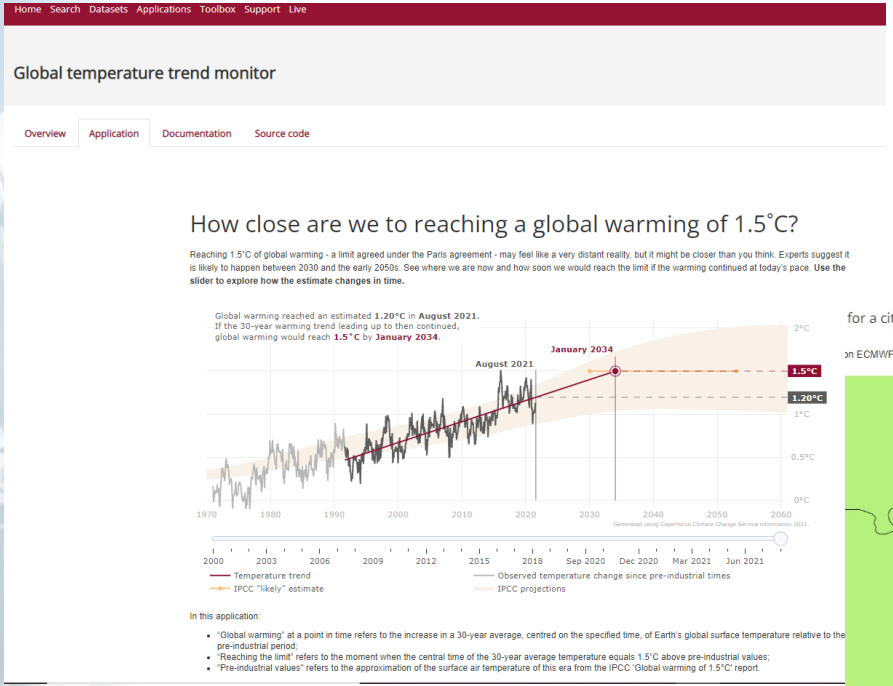




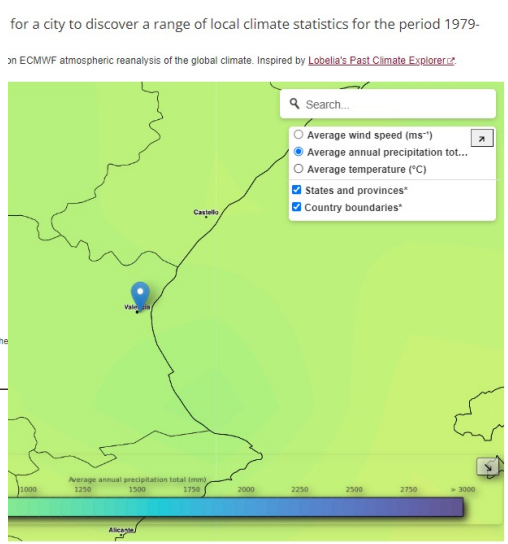
Improved visualisation tools and caching system
(for a very fast response time)

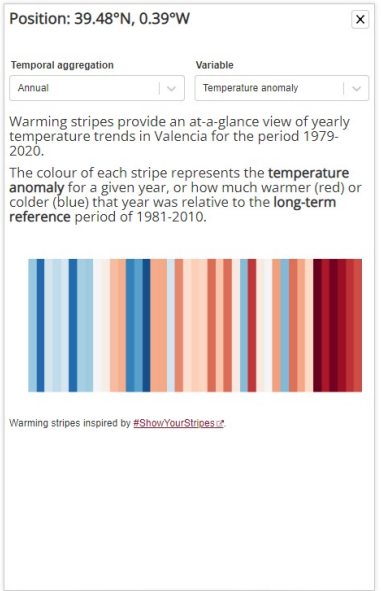
Climate Change

… transforming workflows into public applications



Datasets explorers





Outline

Climate Change

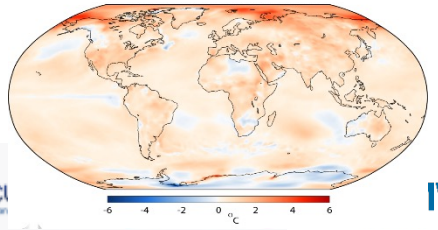
¿ Qué es el Servicio Europeo de Cambio Climático (C3S) ?

¿ Qué productos se ofrecen ?

¿Cómo acceder a los productos de C3S y qué herramientas de apoyo existen ?

¿ Para qué sirven los Sistemas de Información Sectorial (SIS) ?

¿ Algún otro componente en C3S ?



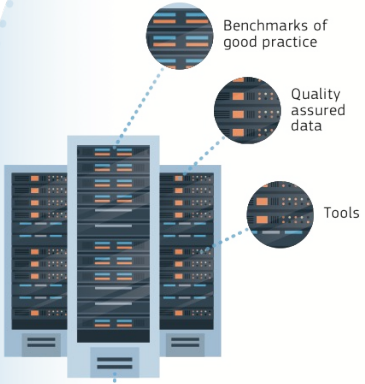
IWF

Climate Change

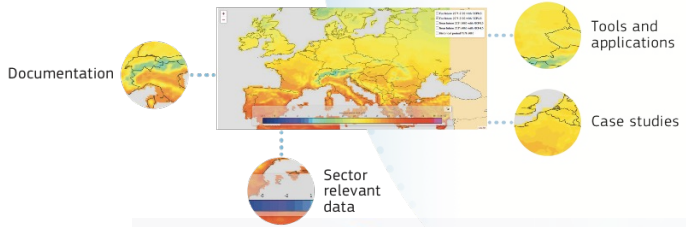
What is the SIS and how it works

USERS

CLIMATE DATA STORE



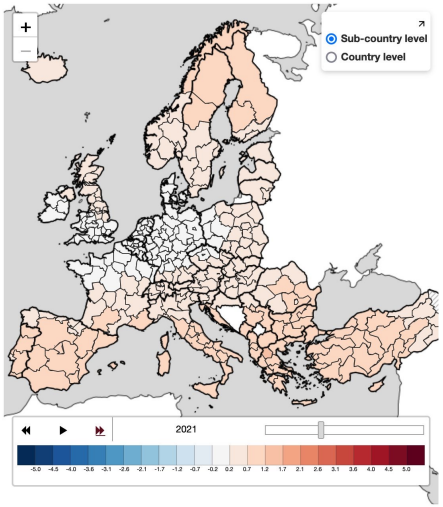
PRACTICAL EXAMPLES

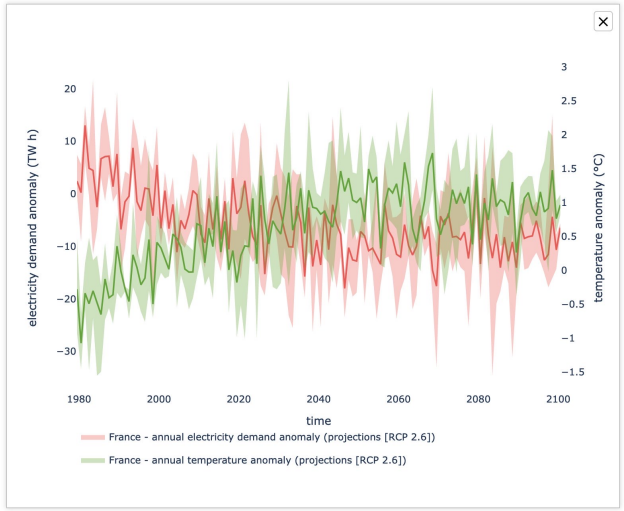


ECMWF Copernicus Europe's eyes on Earth European Commission

Climate Change

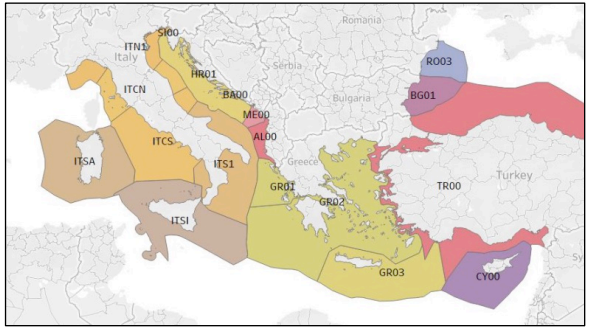
More complex sectoral applications: operational energy





What does it provide? Climate & energy variables from reanalyses, regional climate projections, and multi-model seasonal forecasts.

Who is it for? EU Agency for the Cooperation of Energy Regulators (ACER) and ENTSO-E (European network of transmission system operators for electricity).



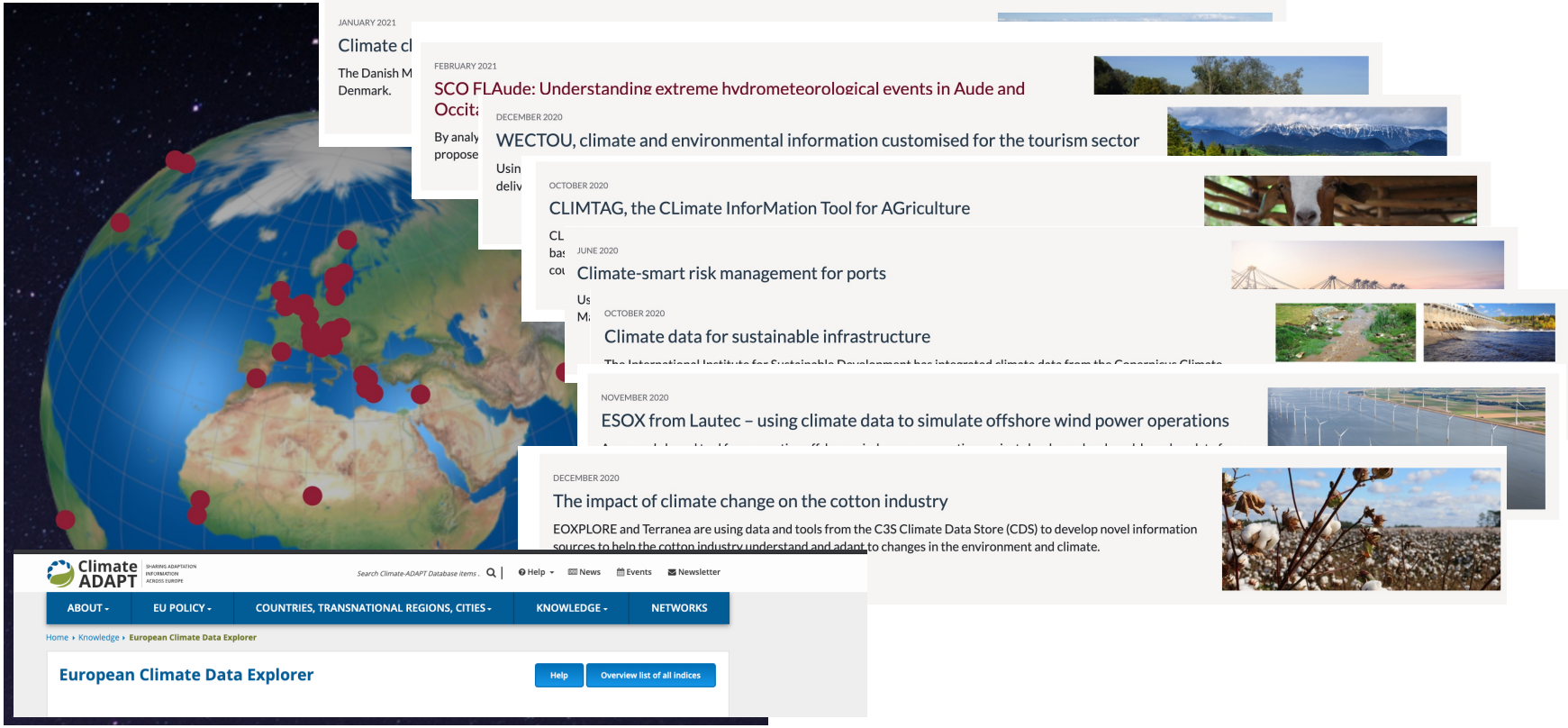
PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

implemented by ECMWF

Climate Change

Many examples of applications (more than can possibly be shown here)



PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

implemented by ECMWF

Climate Change

Outline

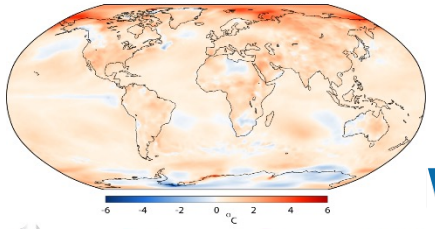
¿ Qué es el Servicio Europeo de Cambio Climático (C3S) ?

¿ Qué productos se ofrecen ?

¿Cómo acceder a los productos de C3S y qué herramientas de apoyo existen ?

¿ Para qué sirven los Sistemas de Información Sectorial (SIS) ?

¿ Algún otro componente en C3S ?



PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

WF

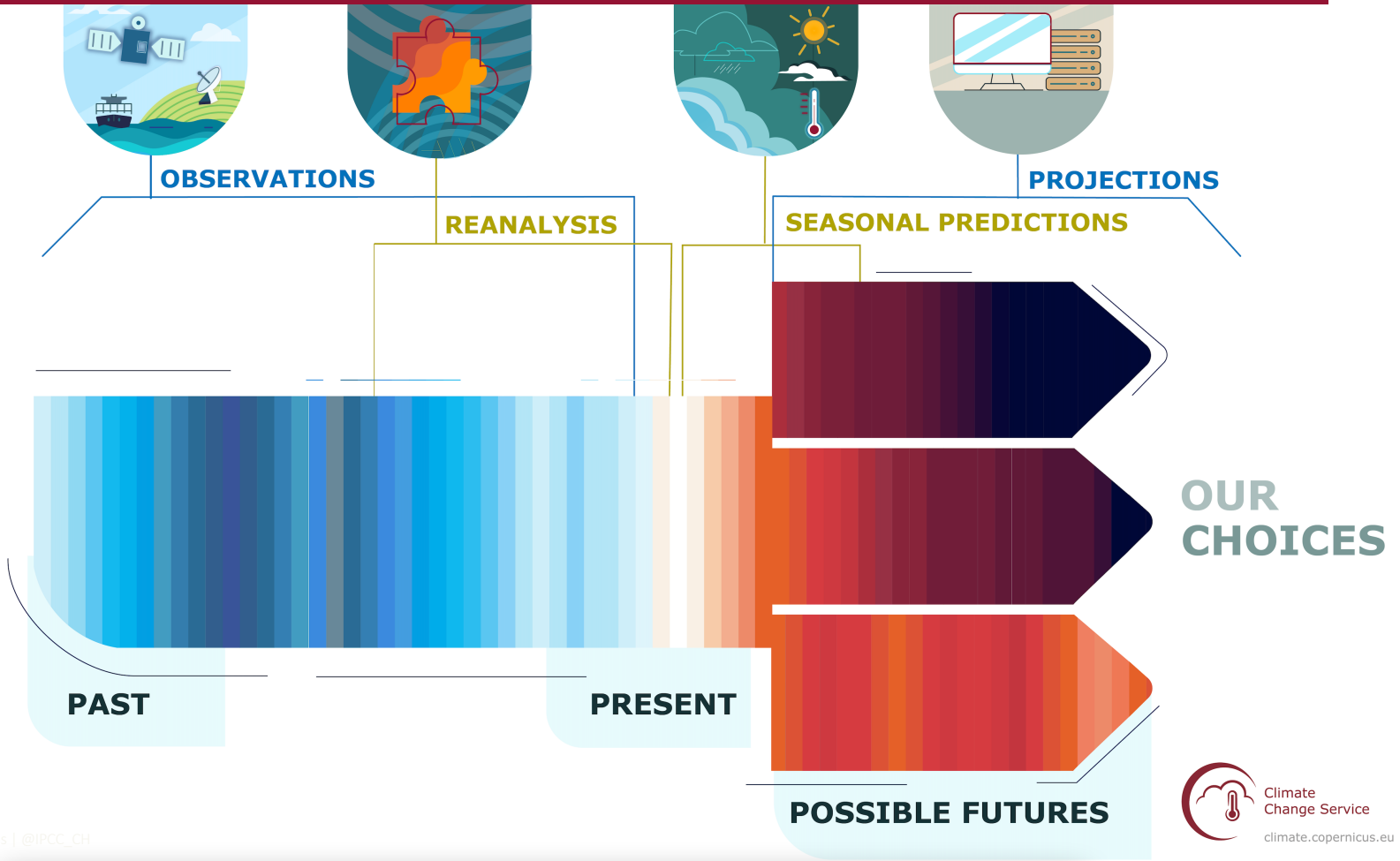
Climate Change

In summary…..

Copernicus
European Commission
ECMWF

Climate Change

Smart data for smart decisions



Inspired by @Ed_Hawkins | @IPCC_CH

Climate Change Service
climate.copernicus.eu

Implemented by ECMWF as part of The Copernicus Programme

News Events Press Tenders Help & Support Search

Copernicus Climate Change Service

About Us What we do Data

close

European Commission | Copernicus | IMPLEMENTED BY ECMWF

Climate Change

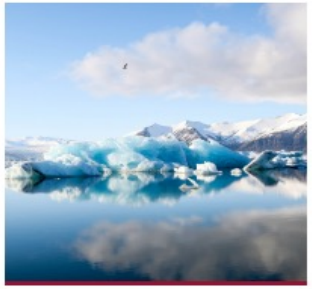
We provide authoritative information about the past, present and future climate, as w enable climate change mitigation an strategies by policy makers and busi

https://climate.copernicus.eu

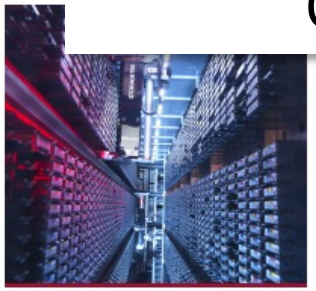
@j_munoz_sabater

@CopernicusECMWF

Key products and services



Climate bulletins



Climate Data Store

Data in action

The *European State of the Climate 2020*, an essential snapshot of the region and a useful benchmark for future assessments of the environment.

In focus