CDS & ADS Training

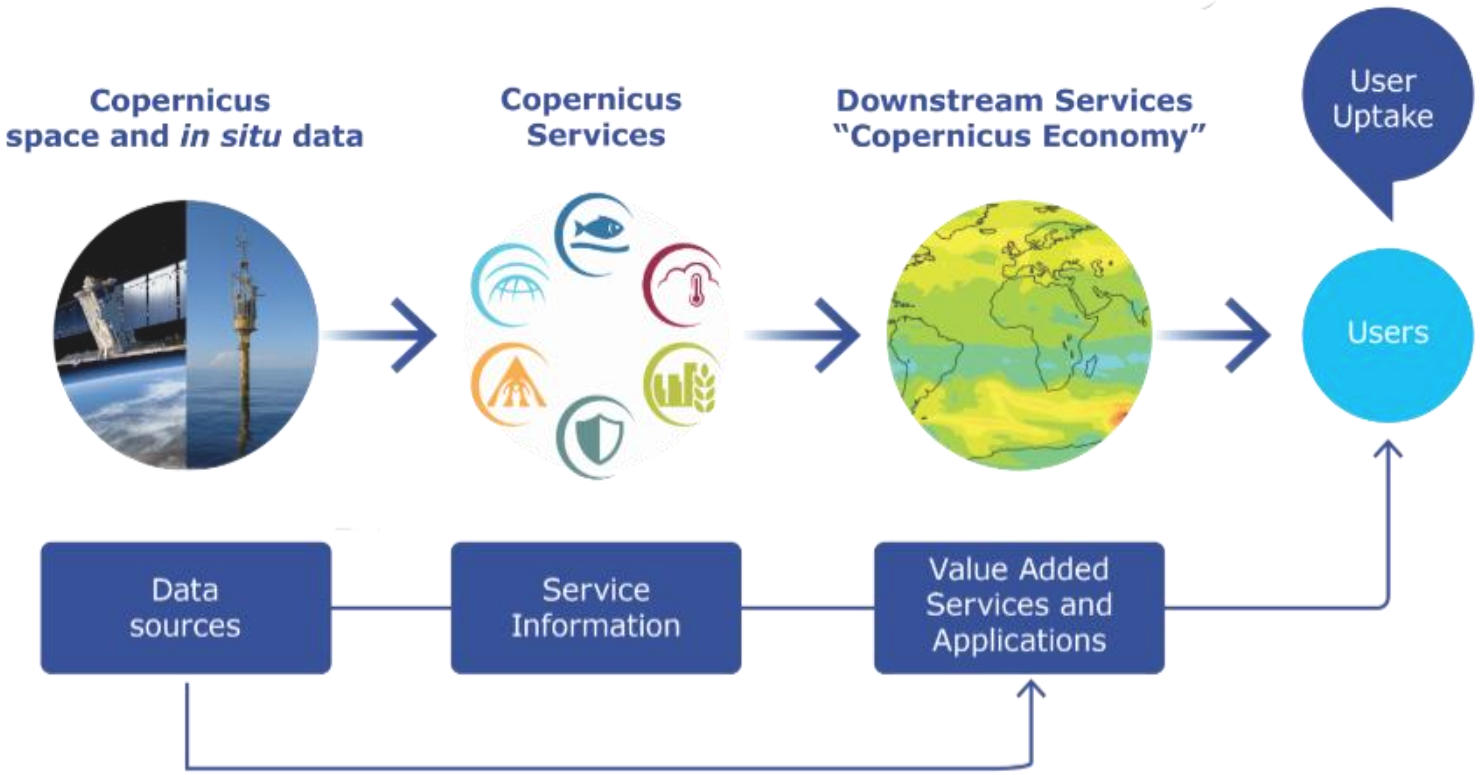
CADS Team – ECMWF

cds-team@ecmwf.int
angel.alos@ecmwf.int

PROGRAMME OF THE EUROPEAN UNION

opernicus Europe's eyes on Earth

IMPLEMENTED BY ECMWF



https://www.copernicus.eu/

Copernicus is the **European Union's Earth Observation Programme**

Combines **satellite** observations and **in-situ** measurements.

Services transform this raw data into value-added geo-information products.

ECMWF entrusted to implement **Climate Change** (C3S) and **Atmosphere Monitoring** (CAMS) services.

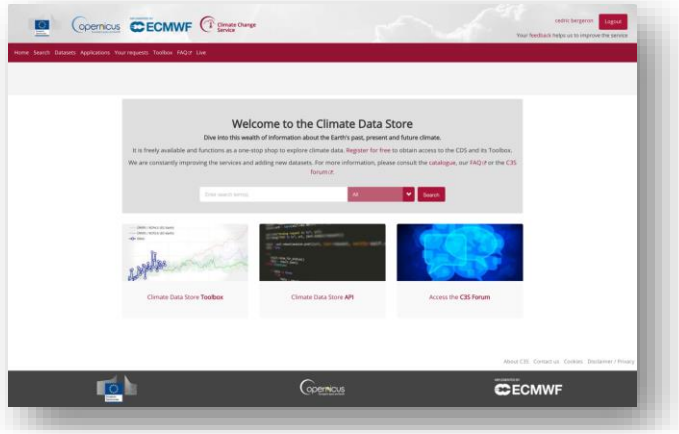
Together with EUMETSAT, Mercator and EEA, **ECMWF** also implements the **DIAS** platform **WEkEO**

Climate and Atmosphere Data Stores (CDS/ADS)

The **Climate Data Store (CDS)**, is **an online open and free service supporting** the **implementation** of **Climate Change Service (C3S)**.

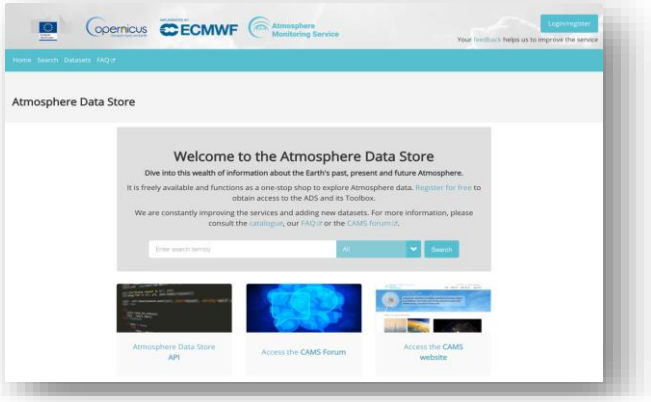
- Wide range of climate **datasets** and **applications** via a searchable catalogue.
- **CDS** catalogue also include a set of datasets from Copernicus Emergency and Management Service (CEMS)
- **Toolbox** allows users to interact with the data and **build** their own applications, maps and graphs.
- **Evaluation and Quality Control (EQC)** function

https://climate.copernicus.eu/



https://cds.climate.copernicus.eu

https://atmosphere.copernicus.eu/



https://ads.atmosphere.copernicus.eu

The **Atmosphere Data Store (ADS)** is replacing the CAMS Catalogue as the main point of access to **Atmosphere Monitoring Service (CAMS)** data

- **Shared** underlaying **infrastructure (CADS)**,
- **Supporting teams and work methodologies**.

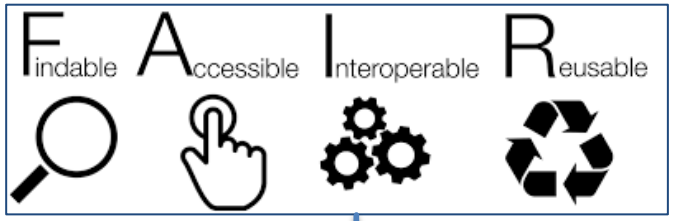
PROGRAMME OF THE EUROPEAN UNION

Europe's eyes on Earth

IMPLEMENTED BY ECMWF

CADS Architecture & FAIR Principles

Fully extensible, configurable, plug-in infrastructure



Driven by a **FAIR***est platform vision*

ECMWF *co-chairs* ***OGC*** *Climate Resilience DWG*

Distributed Data Sources

WPS
URL
MARS
Opendap
APIs
CADS Observations Repository
Others …

Adaptors

APIs

User - Profiles
Catalogue
Broker - QoS
Schedule, Compute,Ccache
User Interfaces

CIM-EQC

CADS API

Standard Services
OGC, INSPIRE, WMO, ..
CSW, WMS, WFS, API

Serverless ARCO Service
Data (OGC Zarr) & Metadata (STAC)

WMTS

EarthKit

Jupyter Labs

Web Portals
(CDS, ADS)

External Platforms

WEkEO by COPERNICUS

Climate ADAPT — SHARING ADAPTATION KNOWLEDGE FOR A CLIMATE-RESILIENT EUROPE

Users

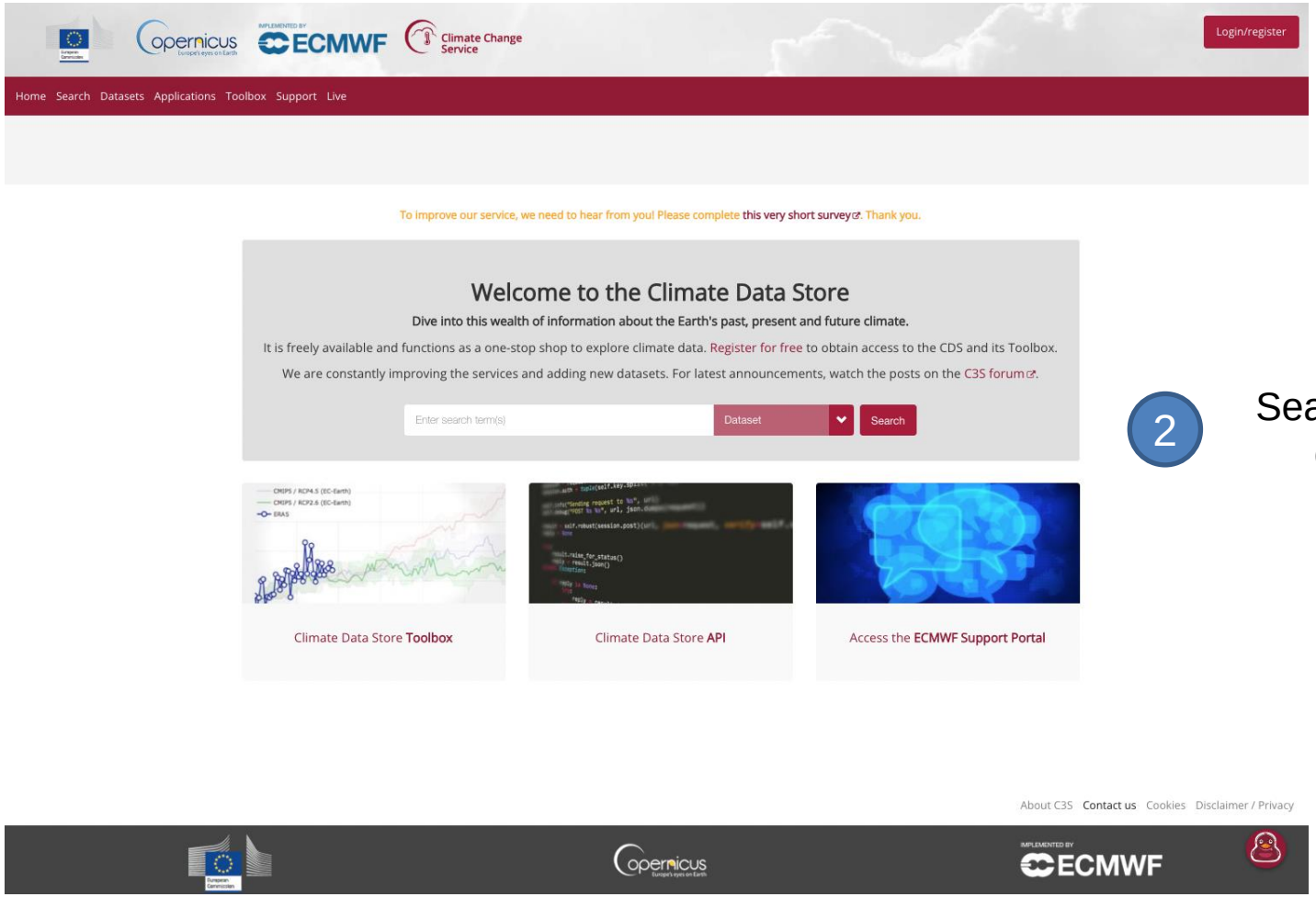
Internal & External

PROGRAMME OF THE EUROPEAN UNION

Europe's eyes on Earth

IMPLEMENTED BY ECMWF

Home and registration

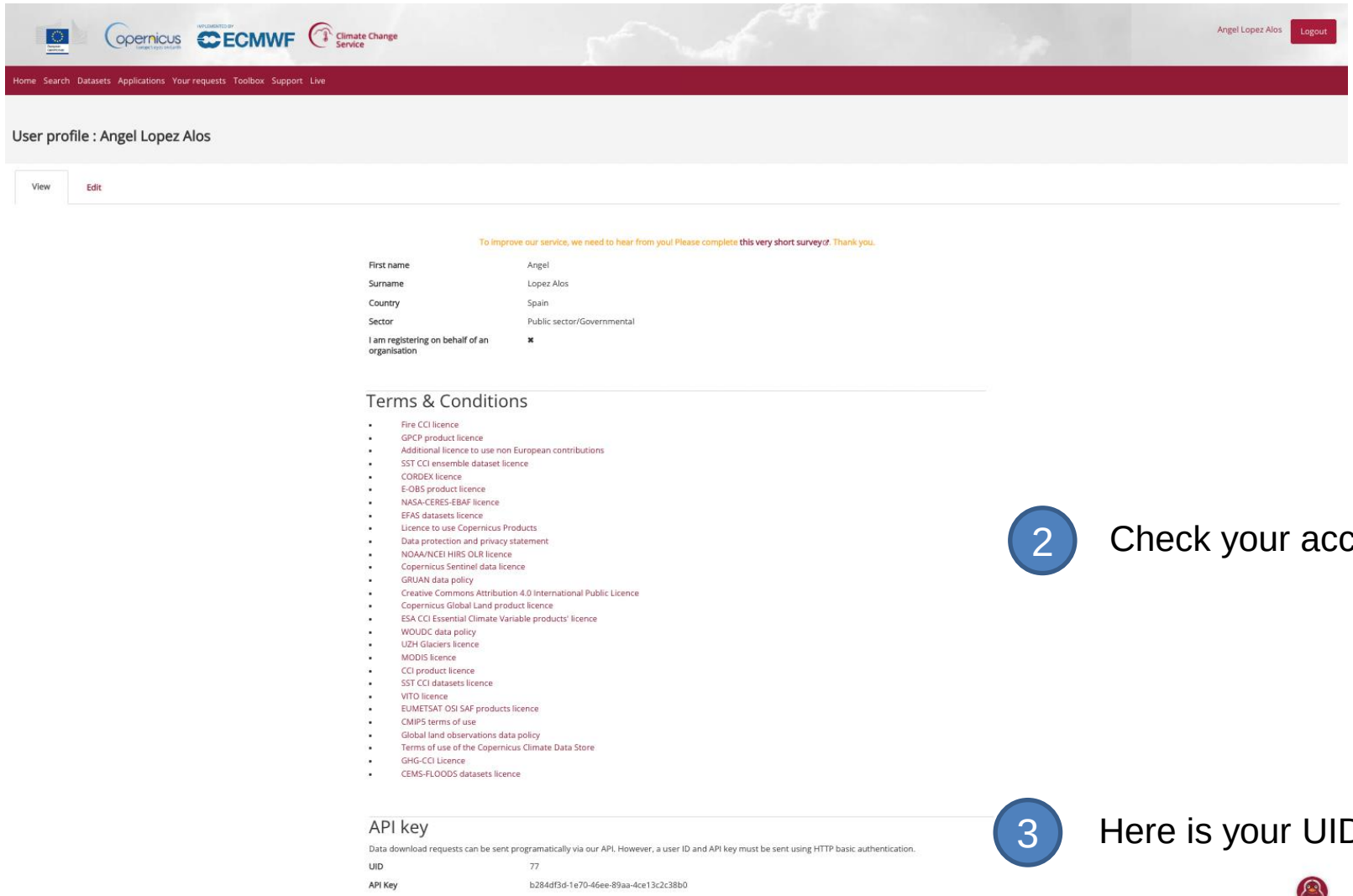


1. Log-in or create an account in case not yet registered

2. Search and discover the catalogue of datasets and applications

3. Consult the Knowledge Duck whenever required

Profile



1 Access your profile

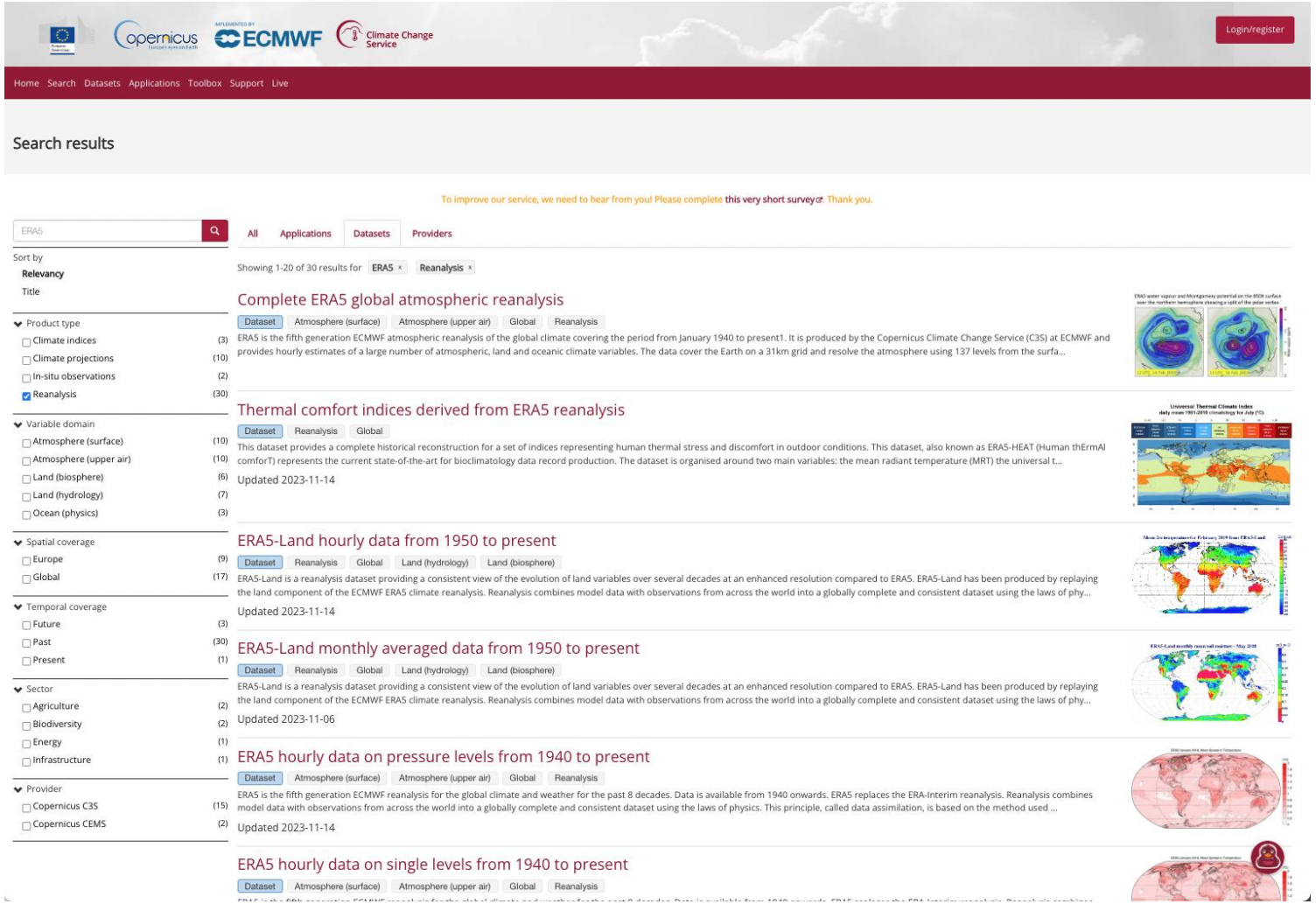
2 Check your accepted T&C

3 Here is your UID and API Token

Discover the catalogue

Search and filter 1

Reanalysis is split in several catalogue entrances 2



PROGRAMME OF THE EUROPEAN UNION

Europe's eyes on Earth

IMPLEMENTED BY ECMWF

Dataset overview

Copernicus ECMWF Climate Change Service

Angel Lopez Alos Logout

Home Search Datasets Applications Your requests Toolbox Support Live

ERA5 hourly data on pressure levels from 1940 to present

To improve our service, we need to hear from you! Please complete this very short survey. Thank you.

Overview Download data Metadata Quality assessment Documentation

ERA5 is the fifth generation ECMWF reanalysis for the global climate and weather for the past 8 decades. Data is available from 1940 onwards. ERA5 replaces the ERA-interim reanalysis.

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 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.

ERA5 provides hourly estimates for a large number of atmospheric, ocean-wave and land-surface quantities. An uncertainty estimate is sampled by an underlying 10-member ensemble at three-hourly intervals. Ensemble mean and spread have been pre-computed for convenience. Such uncertainty estimates are closely related to the information content of the available observing system which has evolved considerably over time. They also indicate flow-dependent sensitive areas. To facilitate many climate applications, monthly-mean averages have been pre-calculated too, though monthly means are not available for the ensemble mean and spread.

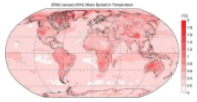
ERA5 is updated daily with a latency of about 5 days. In case that serious flaws are detected in this early release (called ERA5T), this data could be different from the final release 2 to 3 months later. In case that this occurs users are notified.

The data set presented here is a regridded subset of the full ERA5 data set on native resolution. It is online on spinning disk, which should ensure fast and easy access. It should satisfy the requirements for most common applications.

An overview of all ERA5 datasets can be found in this article. Information on access to ERA5 data on native resolution is provided in these guidelines.

Data has been regridded to a regular lat-lon grid of 0.25 degrees for the reanalysis and 0.5 degrees for the uncertainty estimate (0.5 and 1 degree respectively for ocean waves). There are four main sub sets: hourly and monthly products, both on pressure levels (upper air fields) and single levels (atmospheric, ocean-wave and land surface quantities).

The present entry is "ERA5 hourly data on pressure levels from 1940 to present".



DATA DESCRIPTION	
Data type	Gridded
Projection	Regular latitude-longitude grid.
Horizontal coverage	Global
Horizontal resolution	Reanalysis: 0.25° x 0.25° Mean, spread and members: 0.5° x 0.5°
Vertical coverage	1000 hPa to 1 hPa
Vertical resolution	37 pressure levels
Temporal coverage	1940 to present
Temporal resolution	Hourly
File format	GRIB

MAIN VARIABLES		
Name	Units	Description
Divergence	s^{-1}	This parameter is the horizontal divergence of velocity. It is the rate at which air is spreading out horizontally from a point, per square metre. This parameter is positive for air that is spreading out, or diverging, and negative for the opposite, for air that is concentrating, or converging (convergence).
Fraction of cloud cover	Dimensionless	This parameter is the proportion of a grid box covered by cloud (liquid or ice) and varies between zero and one. This parameter is available on multiple levels through the atmosphere.
Geopotential	$m^2 s^{-2}$	This parameter is the gravitational potential energy of a unit mass, at a particular location, relative to mean sea level. It is also the amount of work that would have to be done, against the force of gravity, to lift a unit mass to that location from mean sea level. The geopotential height can be calculated by dividing the geopotential by the Earth's gravitational accelleration, g (=9.80665 m s-2). The geopotential height plays an important role in synoptic meteorology (analysis of weather patterns). Charts of geopotential height plotted at constant pressure levels (e.g., 300, 500 or 850 hPa) can be used to identify weather systems such as cyclones, anticyclones, troughs and ridges. At the surface of the Earth, this parameter shows the variations in geopotential (height) of the surface, and is often referred to as the orography.
Ozone mass mixing ratio	$kg\ kg^{-1}$	This parameter is the mass of ozone per kilogram of air. In the ECMWF Integrated Forecasting System (IFS), there is a simplified representation of ozone chemistry (including representation of the chemistry which has caused the ozone hole). Ozone is also transported around in the atmosphere through the motion of air. Naturally occurring ozone in the stratosphere helps protect organisms at the surface of the Earth from the harmful effects of ultraviolet (UV) radiation from the Sun. Ozone near the surface, often produced because of pollution, is harmful to organisms. Most of the IFS chemical species are archived as mass mixing ratios [kg kg-1].
Potential vorticity	$K\ m^2\ kg^{-1}\ s^{-1}$	Potential vorticity is a measure of the capacity for air to rotate in the atmosphere. If we ignore the effects of heating and friction, potential vorticity is conserved following an air parcel. It is used to look for places where large wind storms are likely to originate and develop. Potential vorticity increases strongly above the tropopause and therefore, it can also be used in studies related to the stratosphere and stratosphere-troposphere exchanges. Large wind storms develop when a column of air in the atmosphere starts to rotate. Potential vorticity is calculated from the wind, temperature and pressure across a column of air in the atmosphere.
Relative humidity	%	This parameter is the water vapour pressure as a percentage of the value at which the air becomes saturated (the point at which water vapour begins to condense into liquid water or deposition into ice). For temperatures over 0°C (273.15 K) it is calculated for saturation over water. At temperatures below -23°C it is calculated for saturation over ice. Between -23°C and 0°C this parameter is calculated by interpolating between the ice and water values using a quadratic function.
Specific cloud ice water content	$kg\ kg^{-1}$	This parameter is the mass of cloud ice particles per kilogram of the total mass of moist air. The 'total mass of moist air' is the sum of the dry air, water vapour, cloud liquid, cloud ice, rain and falling snow. This parameter represents the average value for a grid box. Water within clouds can be liquid or ice, or a combination of the two. Note that 'cloud frozen water' is the same as 'cloud ice water'.
Specific cloud liquid water content	$kg\ kg^{-1}$	This parameter is the mass of cloud liquid water droplets per kilogram of the total mass of moist air. The 'total mass of moist air' is the sum of the dry air, water vapour, cloud liquid, cloud ice, rain and falling snow. This parameter represents the average value for a grid box. Water within clouds can be liquid or ice, or a combination of the two.
Specific humidity	$kg\ kg^{-1}$	This parameter is the mass of water vapour per kilogram of moist air. The total mass of moist air is the sum of the dry air, water vapour, cloud liquid, cloud ice, rain and falling snow.
Specific rain water content	$kg\ kg^{-1}$	The mass of water produced from large-scale clouds that is of raindrop size and so can fall to the surface as precipitation. Large-scale clouds are generated by the cloud scheme in the ECMWF Integrated Forecasting System (IFS). The cloud scheme represents the formation and dissipation of clouds and large-scale precipitation due to changes in atmospheric quantities (such as pressure, temperature and moisture) predicted directly by the IFS at spatial scales of a grid box or larger. The quantity is expressed in kilograms per kilogram of the total mass of moist air. The 'total mass of moist air' is the sum of the dry air, water vapour, cloud liquid, cloud ice, rain and falling snow. This parameter represents the average value for a grid box. Clouds contain a continuum of different sized water droplets and ice particles. The IFS cloud scheme simplifies this to represent a number of discrete cloud droplets/particles including cloud water droplets, raindrops, ice crystals and snow (aggregated ice crystals). The processes of droplet formation, phase transition and aggregation are also highly simplified in the IFS.
Specific snow water content	$kg\ kg^{-1}$	The mass of snow (aggregated ice crystals) produced from large-scale clouds that can fall to the surface as precipitation. Large-scale clouds are generated by the cloud scheme in the ECMWF Integrated Forecasting System (IFS). The cloud scheme represents the formation and dissipation of clouds and large-scale precipitation due to changes in atmospheric quantities (such as pressure, temperature and moisture) predicted directly by the IFS at spatial scales of a grid box or larger. The mass is expressed in kilograms per kilogram of the total mass of moist air. The 'total mass of moist air' is the sum of the dry air, water vapour, cloud liquid, cloud ice, rain and falling snow. This parameter represents the average value for a grid box. Clouds contain a continuum of different sized water droplets and ice particles. The IFS cloud scheme simplifies this to represent a number of discrete cloud droplets/particles including cloud water droplets, raindrops, ice crystals and snow (aggregated ice crystals). The processes of droplet formation, phase transition and aggregation are also highly simplified in the IFS.
Temperature	K	This parameter is the temperature in the atmosphere. It has units of kelvin (K). Temperature measured in kelvin can be converted to degrees Celsius (°C) by subtracting 273.15. This parameter is available on multiple levels through the atmosphere.
U-component of wind	$m\ s^{-1}$	This parameter is the eastward component of the wind. It is the horizontal speed of air moving towards the east. A negative sign indicates air moving towards the west. This parameter can be combined with the V component of wind to give the speed and direction of the horizontal wind.
V-component of wind	$m\ s^{-1}$	This parameter is the northward component of the wind. It is the horizontal speed of air moving towards the north. A negative sign indicates air moving towards the south. This parameter can be combined with the U component of wind to give the speed and direction of the horizontal wind.
Vertical velocity	$Pa\ s^{-1}$	This parameter is the speed of air motion in the upward or downward direction. The ECMWF Integrated Forecasting System (IFS) uses a pressure based vertical co-ordinate system and pressure decreases with height, therefore negative values of vertical velocity indicate upward motion. Vertical velocity can be useful to understand the large-scale dynamics of the atmosphere, including areas of upward motion/ascent (negative values) and downward motion/subsidence (positive values).
Vorticity (relative)	s^{-1}	This parameter is a measure of the rotation of air in the horizontal, around a vertical axis, relative to a fixed point on the surface of the Earth. On the scale of weather systems, troughs (weather features that can include rain) are associated with anticlockwise rotation (in the northern hemisphere), and ridges (weather features that bring light or still winds) are associated with clockwise rotation. Adding the effect of rotation of the Earth, the Coriolis parameter, to the relative vorticity produces the absolute vorticity.

Help

Get help

Licence

Licence to use Copernicus Products

Publication date

2018-06-14

Resource updated

2023-11-14

References

Citation

Acknowledgement

DOI: 10.24381/cds.bd0915c6

Related data

Complete ERA5 global atmospheric reanalysis

ERA5 hourly data on pressure levels from 1950 to 1978 (preliminary version)(deprecated 2023-08-15)

ERA5 hourly data on single levels from 1940 to present

ERA5 hourly data on single levels from 1950 to 1978 (preliminary version)(deprecated 2023-08-15)

ERA5 monthly averaged data on pressure levels from 1940 to present

ERA5 monthly averaged data on pressure levels from 1950 to 1978 (preliminary version)(deprecated 2023-08-15)

ERA5 monthly averaged data on single levels from 1940 to present

ERA5 monthly averaged data on single levels from 1950 to 1978 (preliminary version)(deprecated 2023-08-15)

Extreme precipitation risk indicators for Europe and European cities from 1950 to 2019

Flood risk indicators for European cities from 1989 to 2018

Mass-consistent atmospheric energy and moisture budget monthly data from 1979 to present derived from ERA5 reanalysis

Related applications

Daily statistics calculated from ERA5 data

ERA5 explorer

Heat wave days for Europe derived from ERA5 reanalysis

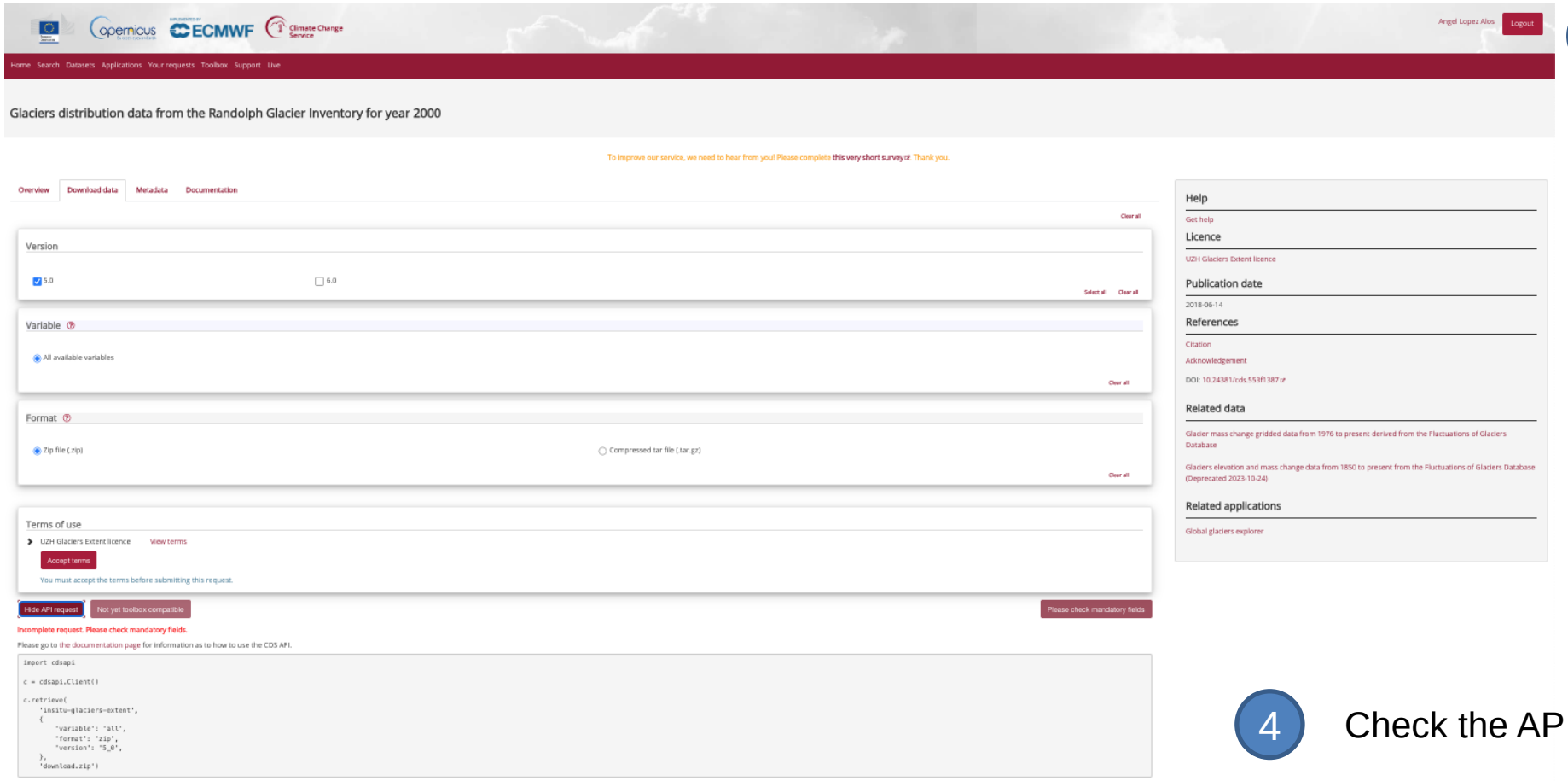
Heating and cooling degree days from 1979 to 2100

1 Discover the dataset

2 References, licences, other

3 Related data & applications

Download form



1 Check if you are registered

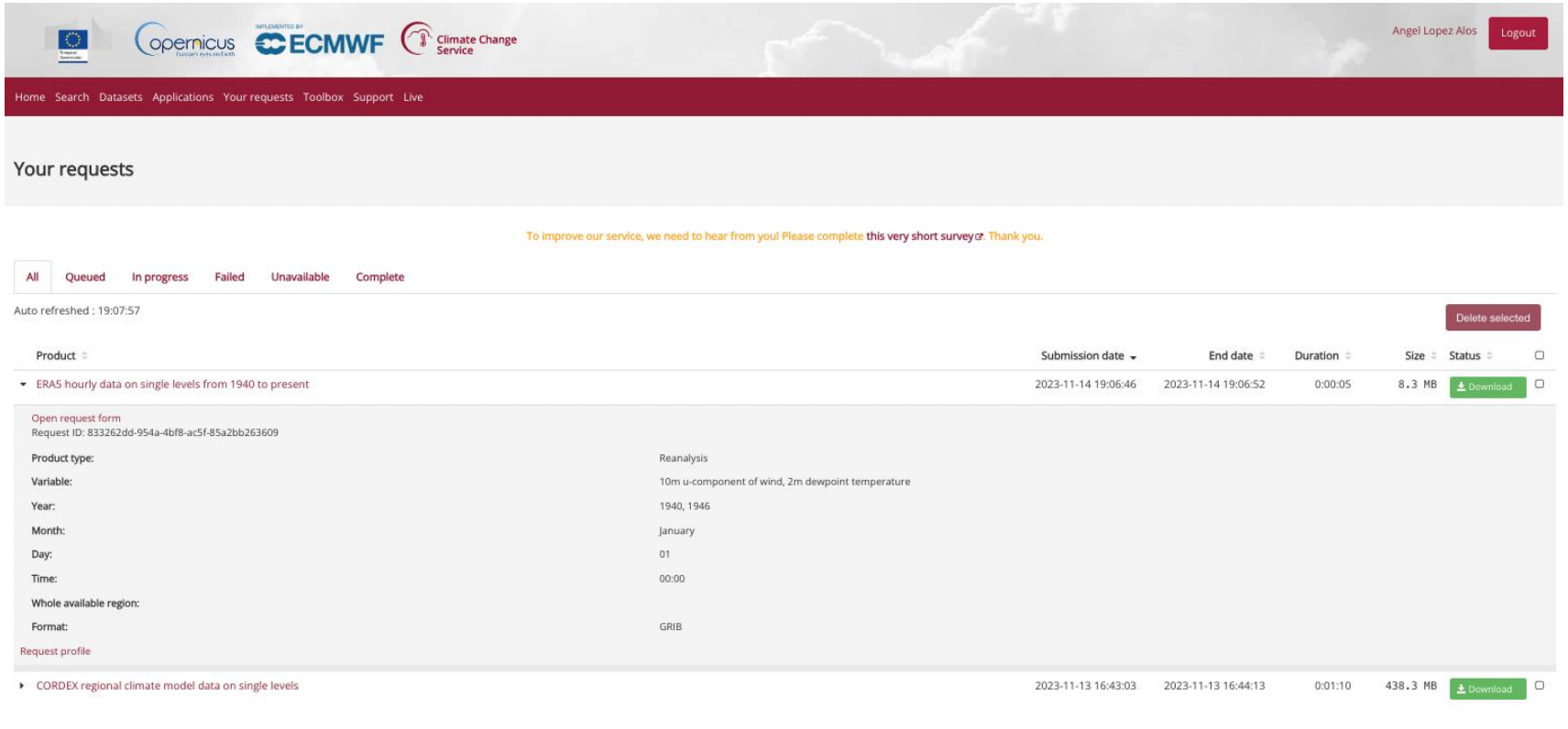
2 Make your selection

3 Accept the license

4 Check the API Request

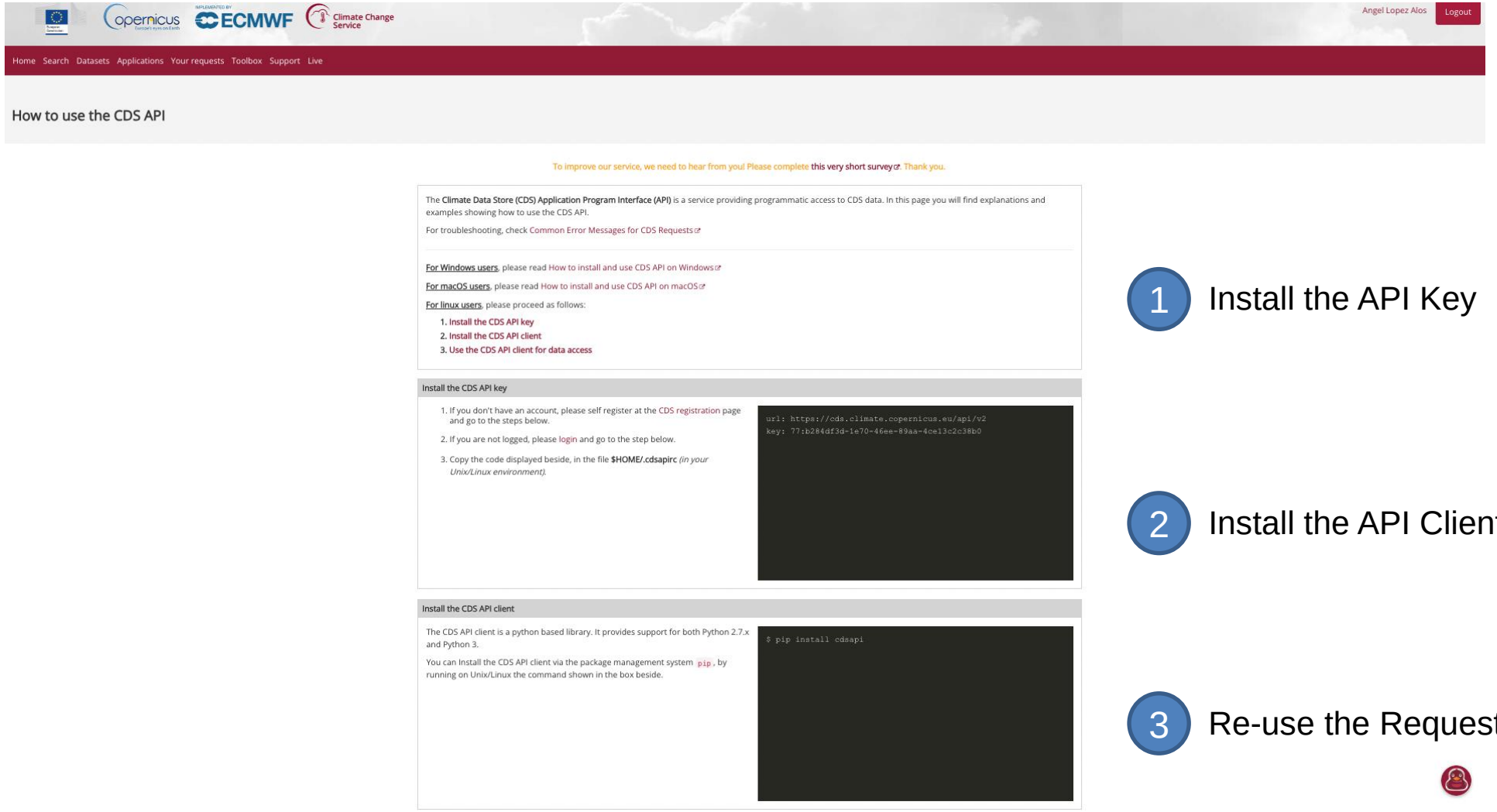
5 Submit your request

Your request



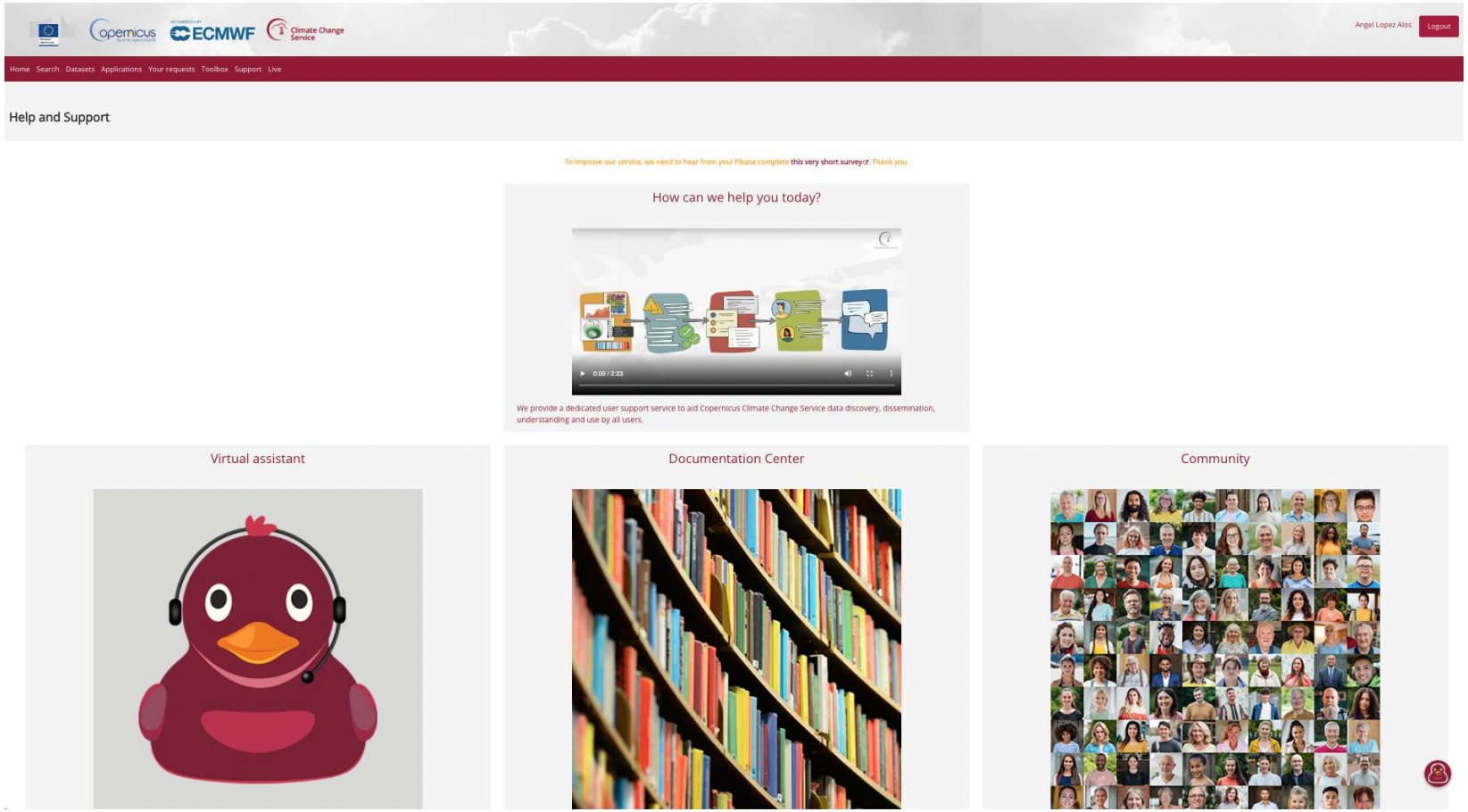
1. Check status of your request
2. Download data
3. Request ID for tracking
4. Check in case of error
5. Resubmit or use a s template
6. Explore the execution profile

API



1. Install the API Key
2. Install the API Client
3. Re-use the Request API

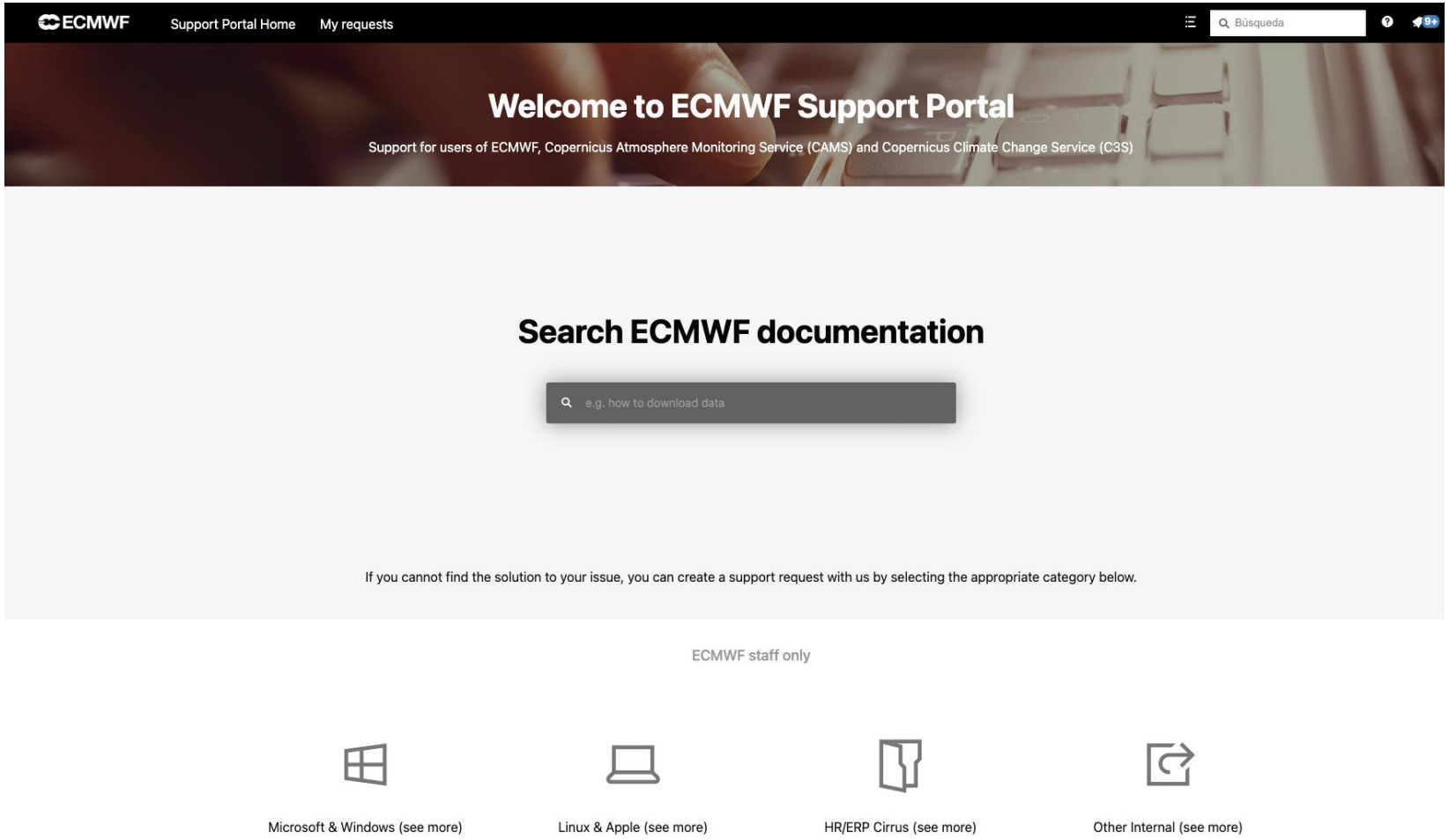
Help & Support



1. Access to Help & Support
2. Virtual Assistant
3. Documentation center
4. Forum
5. Training
6. Contact-us

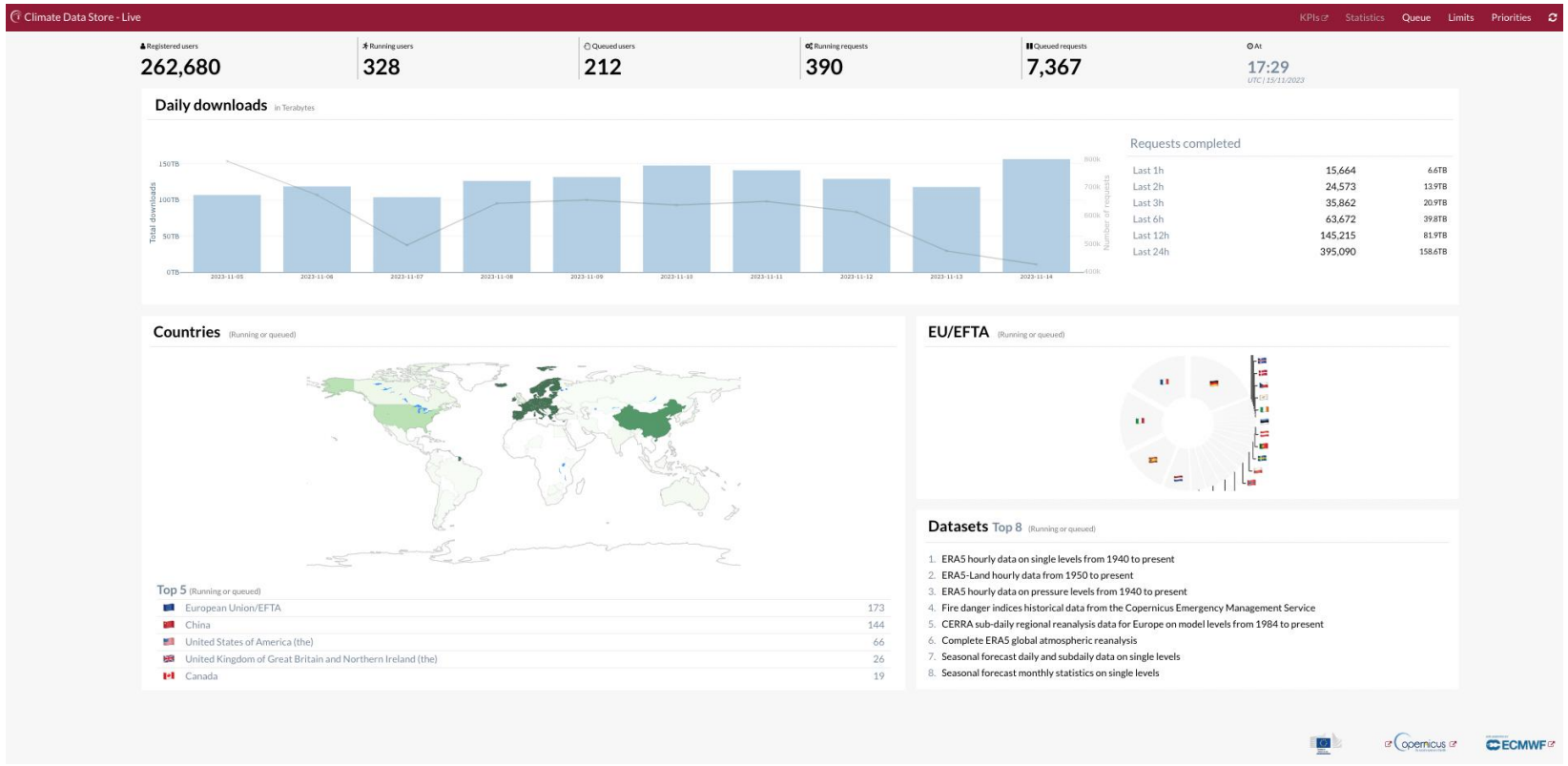
Support portal

https://confluence.ecmwf.int/site/support



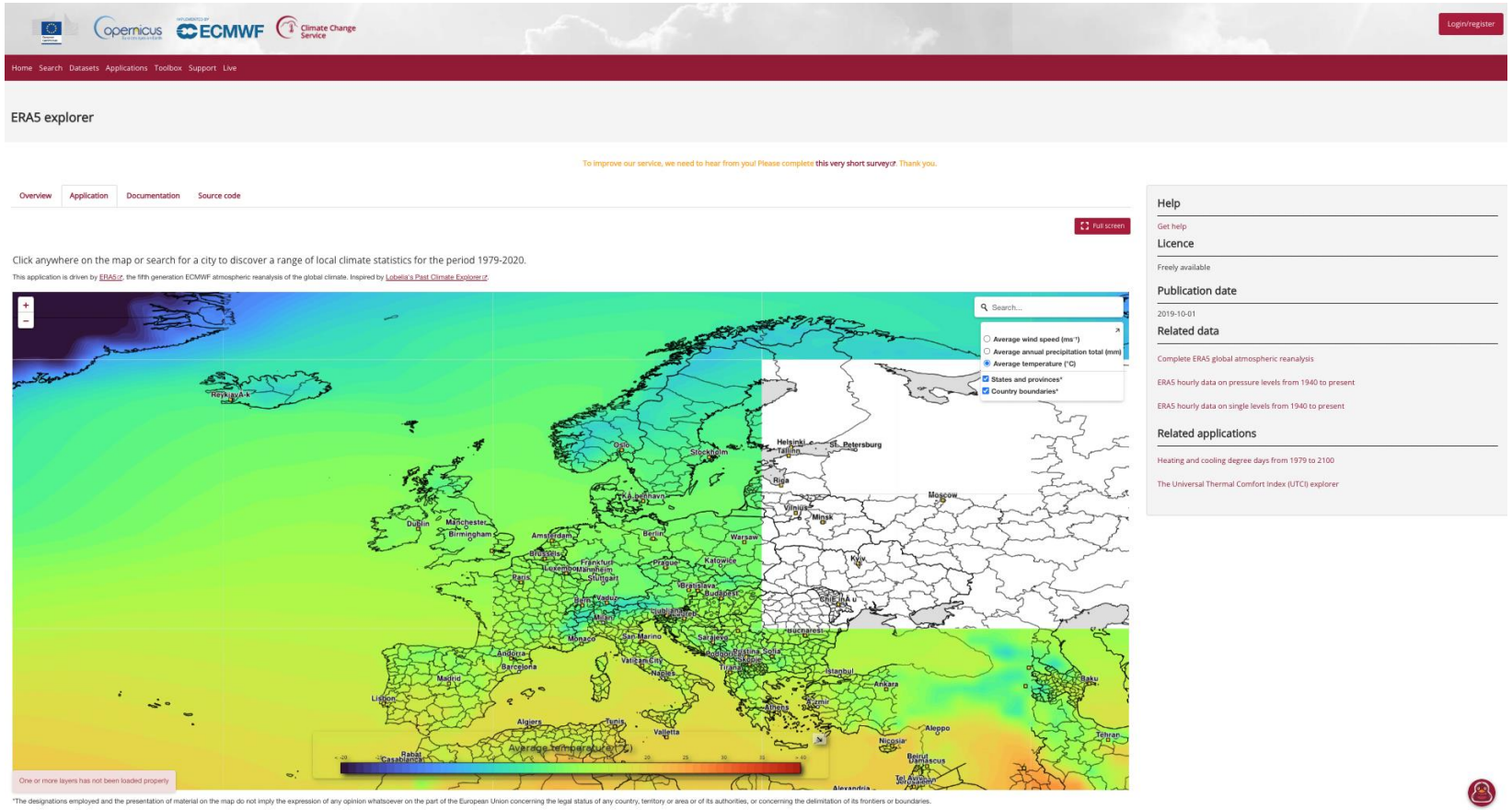
Live status

https://cds.climate.copernicus.eu/live/



1. Overall Statistics
2. Queue Status
3. Limits

Applications



1. Explore the catalogue of applications

2. Check and reuse the source code behind

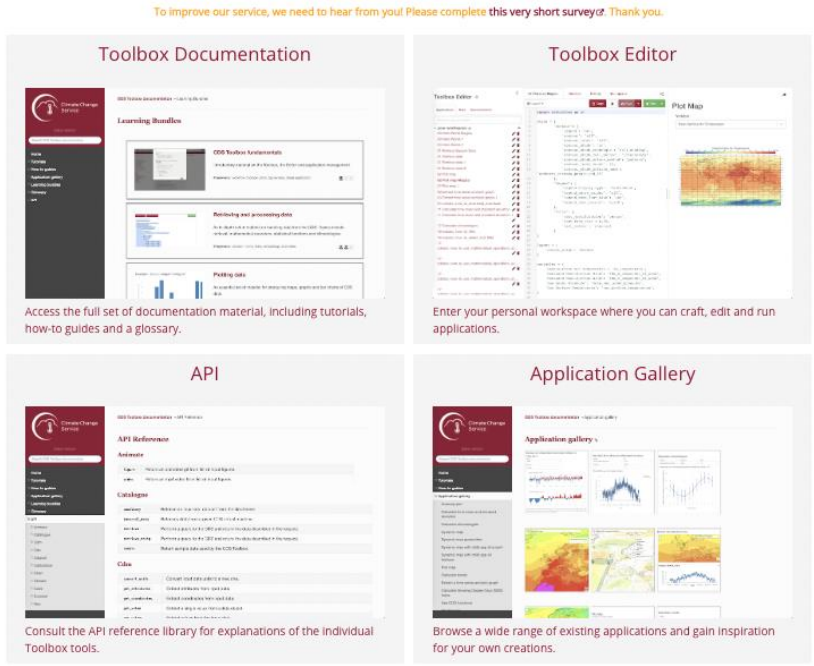
3. Access related data and applications

Toolbox

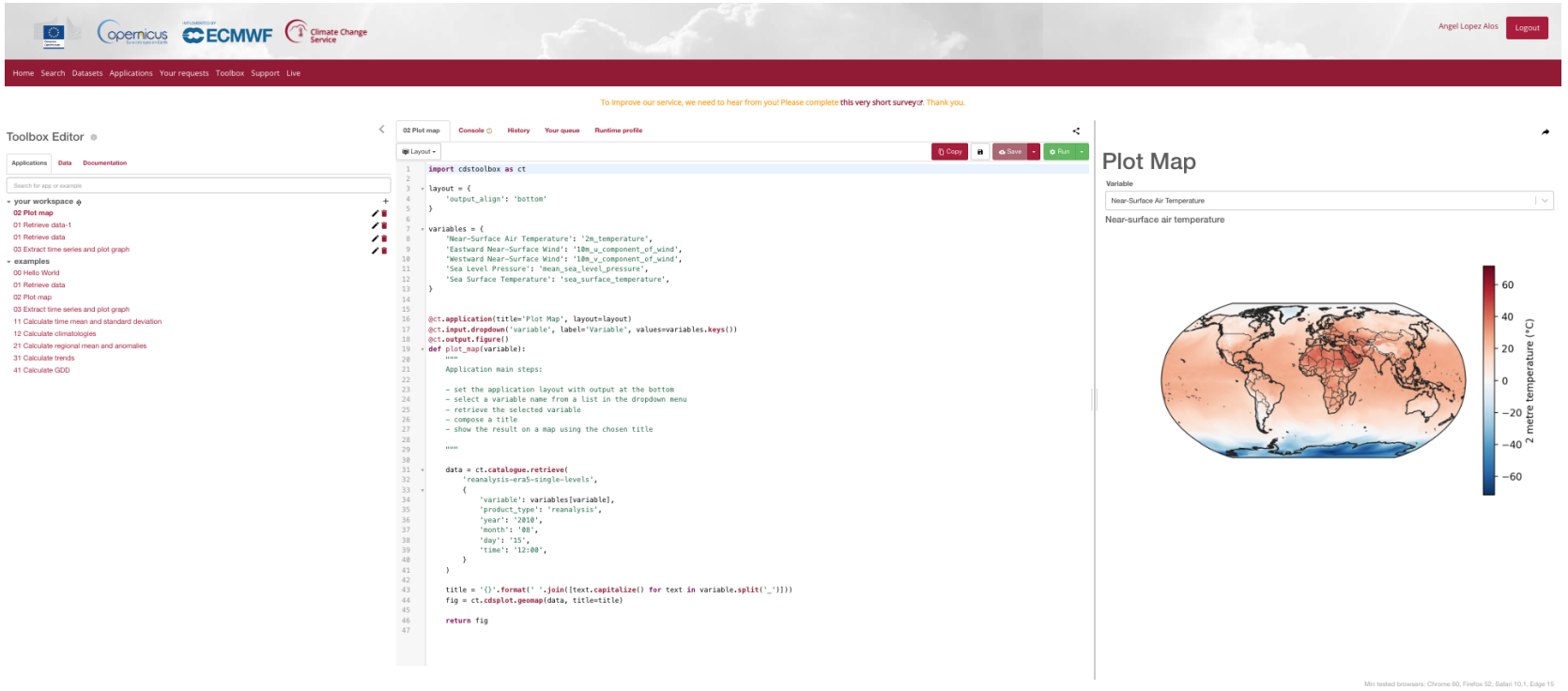
https://cds.climate.copernicus.eu/cdsapp#!/toolbox

1. Access the toolbox area

2. Discover available options, documentation, applications, API and Toolbox Editor

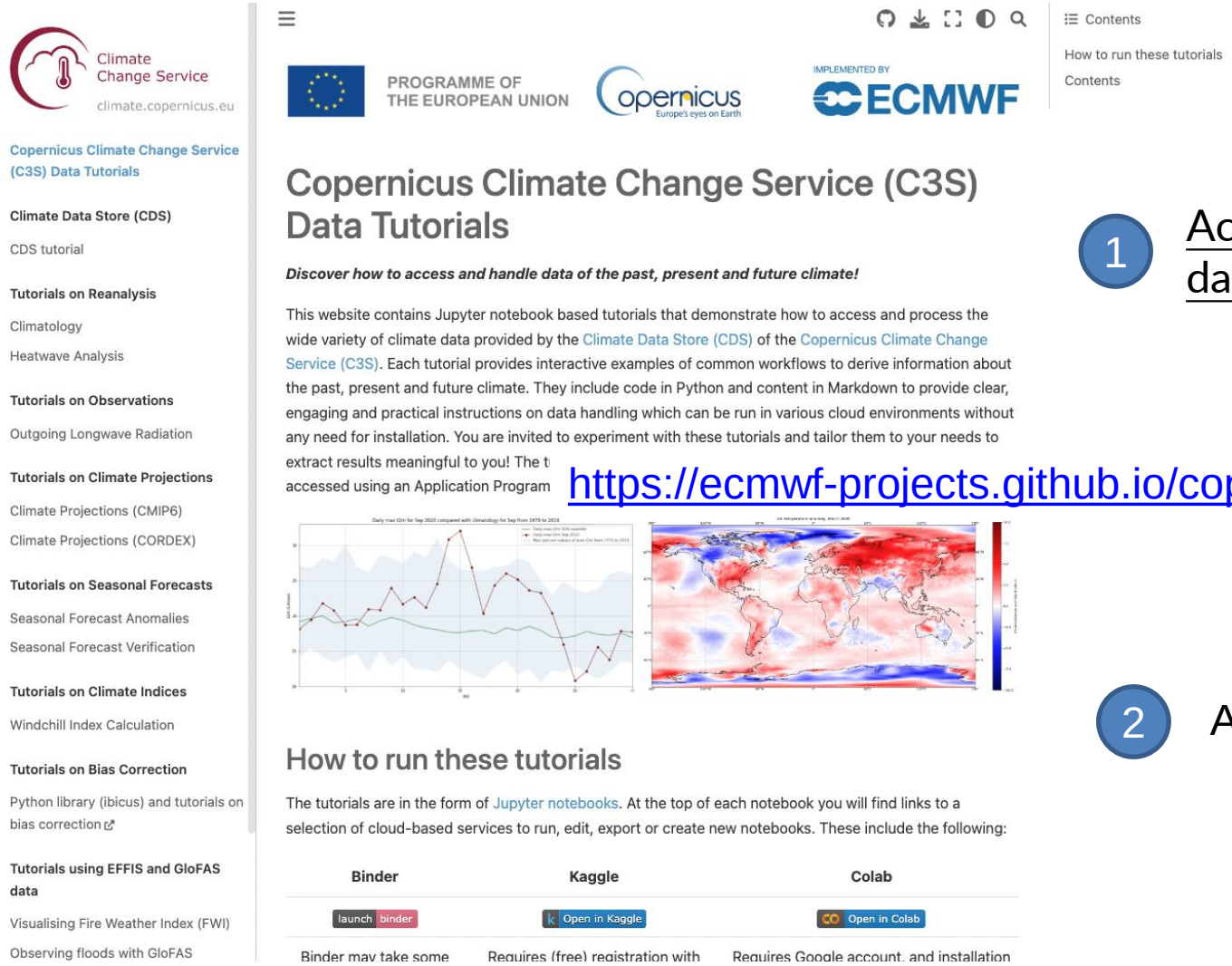


Toolbox editor



1. Check examples
2. Edit the code
3. Display the results

Training Material



1 Access Jupyter notebooks on use of C3S data on the Climate Data Store

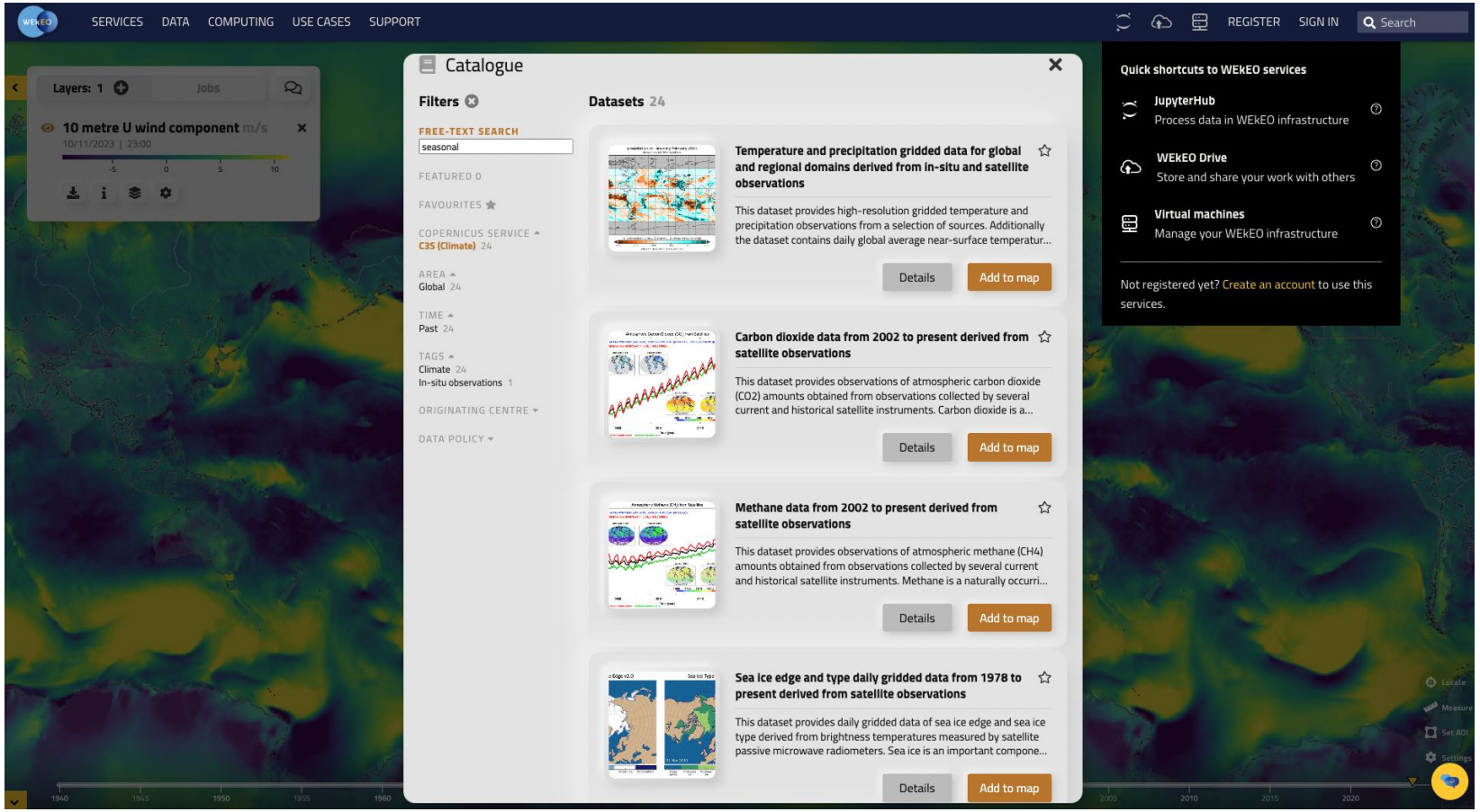
https://ecmwf-projects.github.io/copernicus-training-c3s/intro.html

2 Access e-learning resources at ECMWF

https://learning.ecmwf.int/

WEkEO

https://www.wekeo.eu/



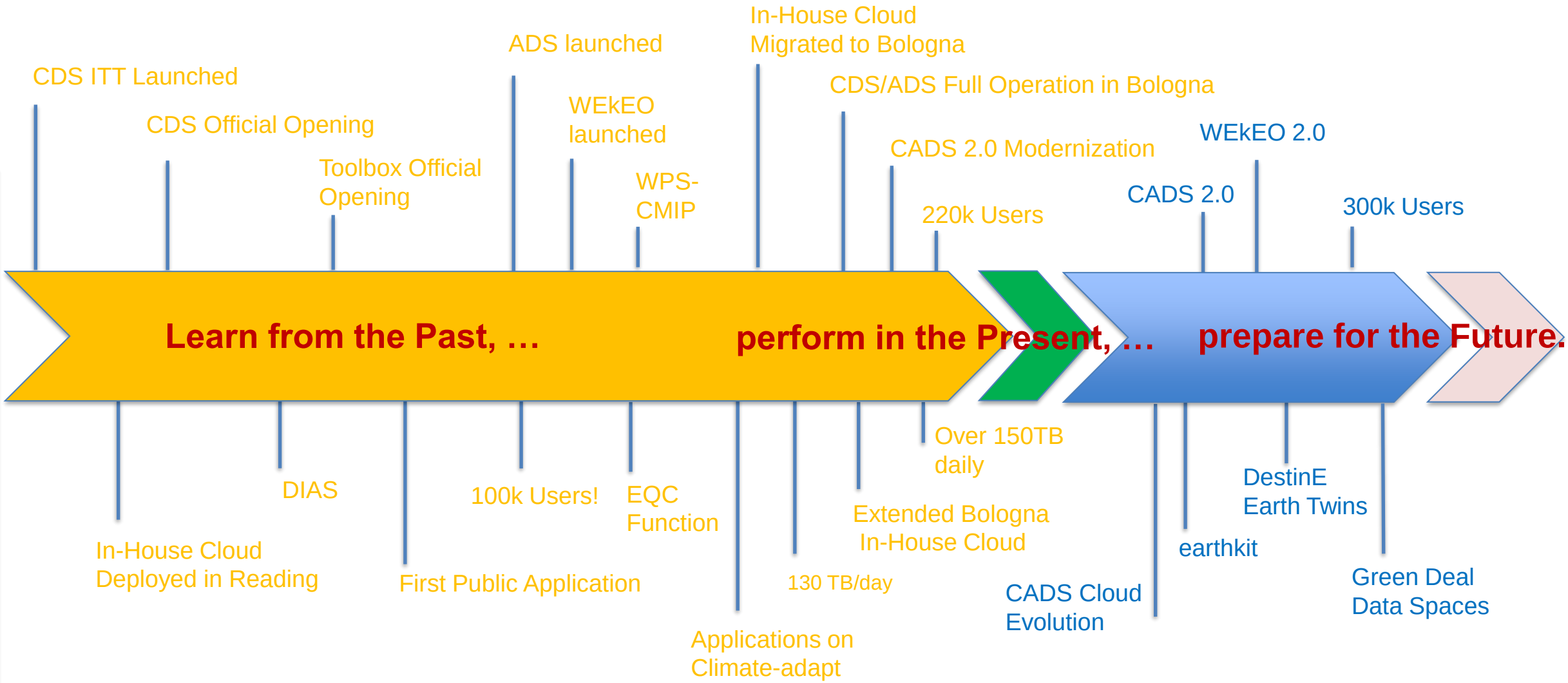
1. Discover and access other Copernicus resources
2. JupyterHub
3. Virtual Machines (IaaS)

PROGRAMME OF THE EUROPEAN UNION

Europe's eyes on Earth

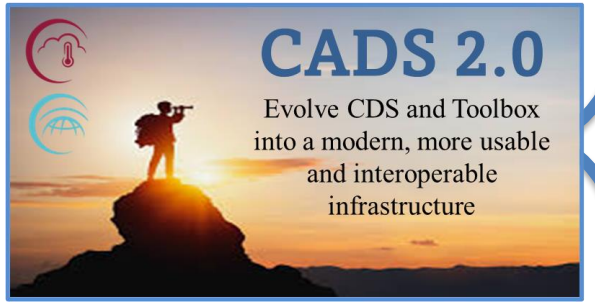
IMPLEMENTED BY ECMWF

CADS an infrastructure in continuous evolution

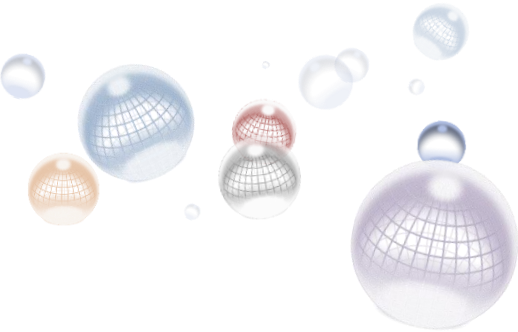


CADS 2.0

Currently under development
Expected release Q1-2 2024



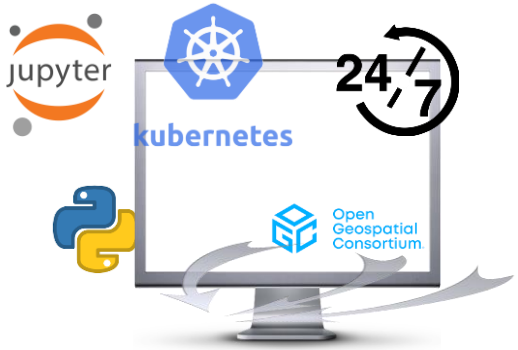
- Engage with a **broader user community**.
- Capitalize **experience, feedbacks, lessons learned, know-how** and advanced technologies.
- Make the current services more **accessible (FAIRest)**



WEkEO by COPERNICUS

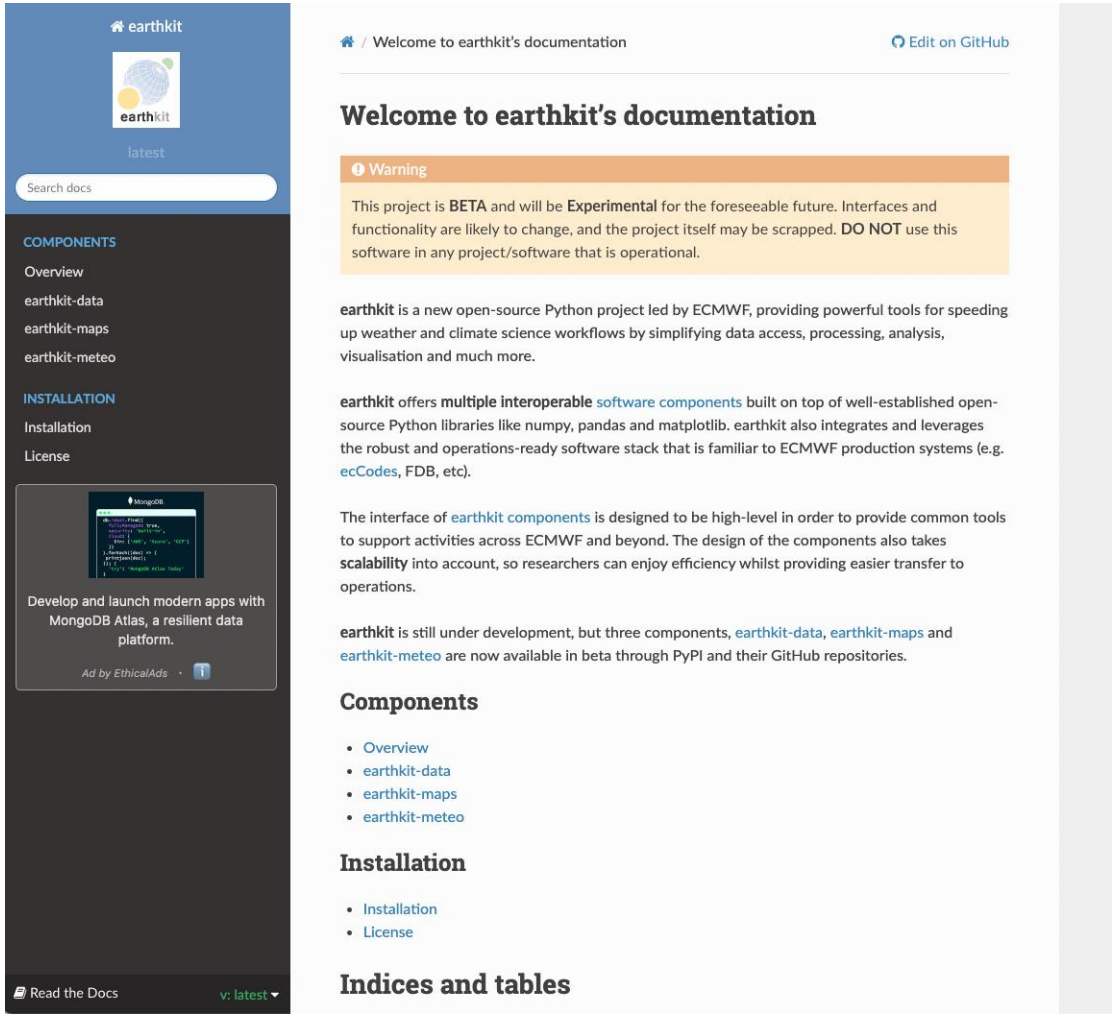
Findable Accessible Interoperable Reusable

cads toolbox



- Advanced use of **Cloud Computing**
- Ensure compatibility with **state-of-the-art solutions** - machine learning, data cubes and interactive notebooks.
- **Strengthen synergies** with **WEkEO** other platforms
- Improve **work methodologies** (ingestion, cloud resources)

earthkit



https://earthkit.readthedocs.io/en/latest/

1. Discover the new earthkit project
2. Install and use
3. Contribute

Thanks!

PROGRAMME OF
THE EUROPEAN UNION

Europe's eyes on Earth

IMPLEMENTED BY
ECMWF