



Climate
Change

User interaction in the development of climate services: the lessons learnt from Copernicus Climate Change Service (C3S)



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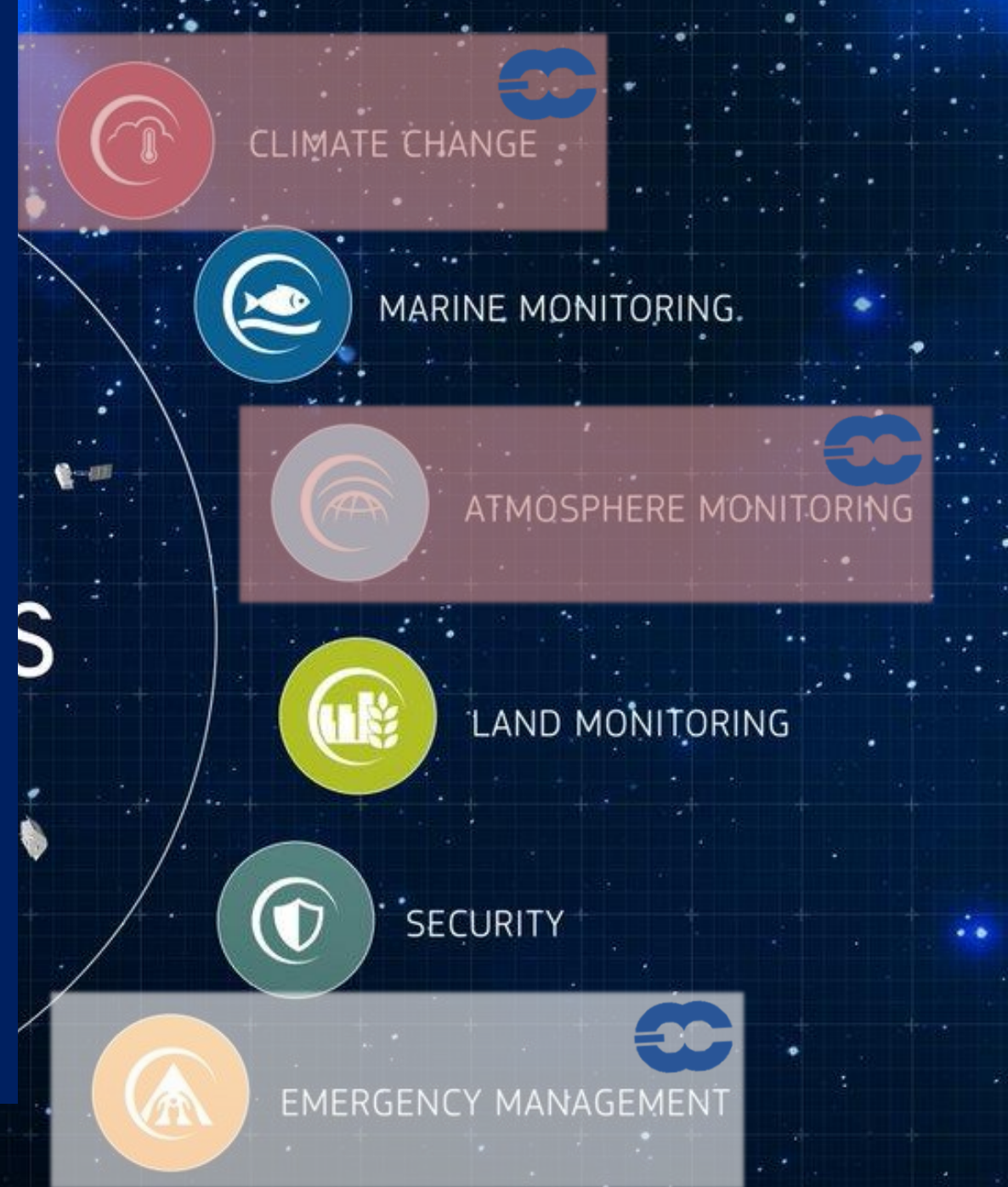
implemented by  ECMWF

An **operational** climate service embedded in the **Copernicus Earth** observation program

Implemented by ECMWF together with **over 300 public and private entities** from more than 40 countries in Europe and elsewhere; ~240 Meuros.

It provides **reliable, open, and free access** to state of the art data available on the past, present, and potential evolution of climate


- Authoritative source of data
- Based on latest science
- Fully transparent and traceable
- Quality information available






Operationalising climate services

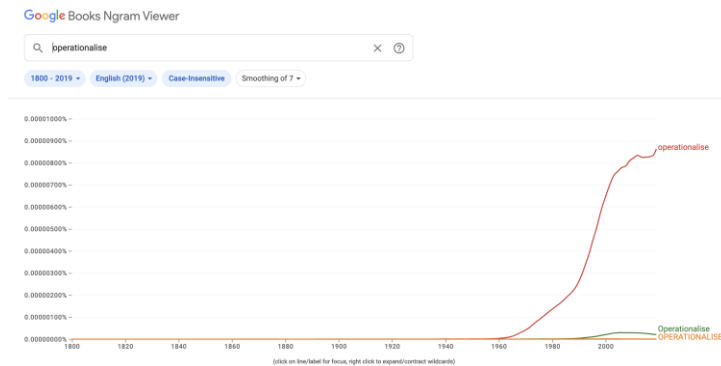
Dictionary
Definitions from [Oxford Languages](#) · [Learn more](#)

 **operationalize**
/ˌɒpəˈreɪʃənəlaɪz/

 [Learn to pronounce](#)

verb
verb: **operationalise**

- put into operation or use.
"such measures would be difficult to operationalize"
- PHILOSOPHY**
express or define (something) in terms of the operations used to determine or prove it.
"previous studies have operationalized panic in terms of average time of group escape"



Retrieved from <https://www.google.com/> on Thu Oct 19

What are climate services?

A climate service is a decision aide derived from climate information that assists individuals and organizations in society [..]

<https://public.wmo.int/en/bulletin/what-do-we-mean-climate-services>



Put into **operational use** a decision aide derived from **climate information** in an way that **support individuals and communities in their decisions.**





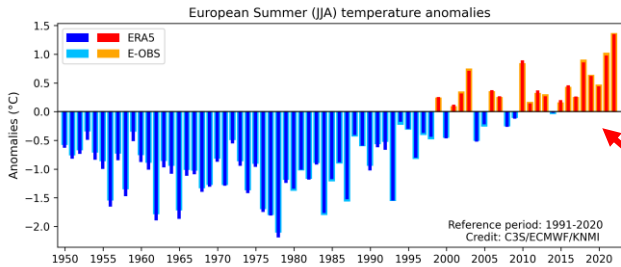
- Produced regularly following a predictable schedule (e.g., SLA).
- Resourced/funded to continue in the long run.
- Based on methodologies (perceived to be) of high quality.
- **Large user base.**
- Designed to support customers/users (help desk, up-to-date documentation, known issues).
- Responsive/adaptable to users inputs.
- Enriched by training material.
- **Open and free.**





Climate

Copernicus Climate Change Service

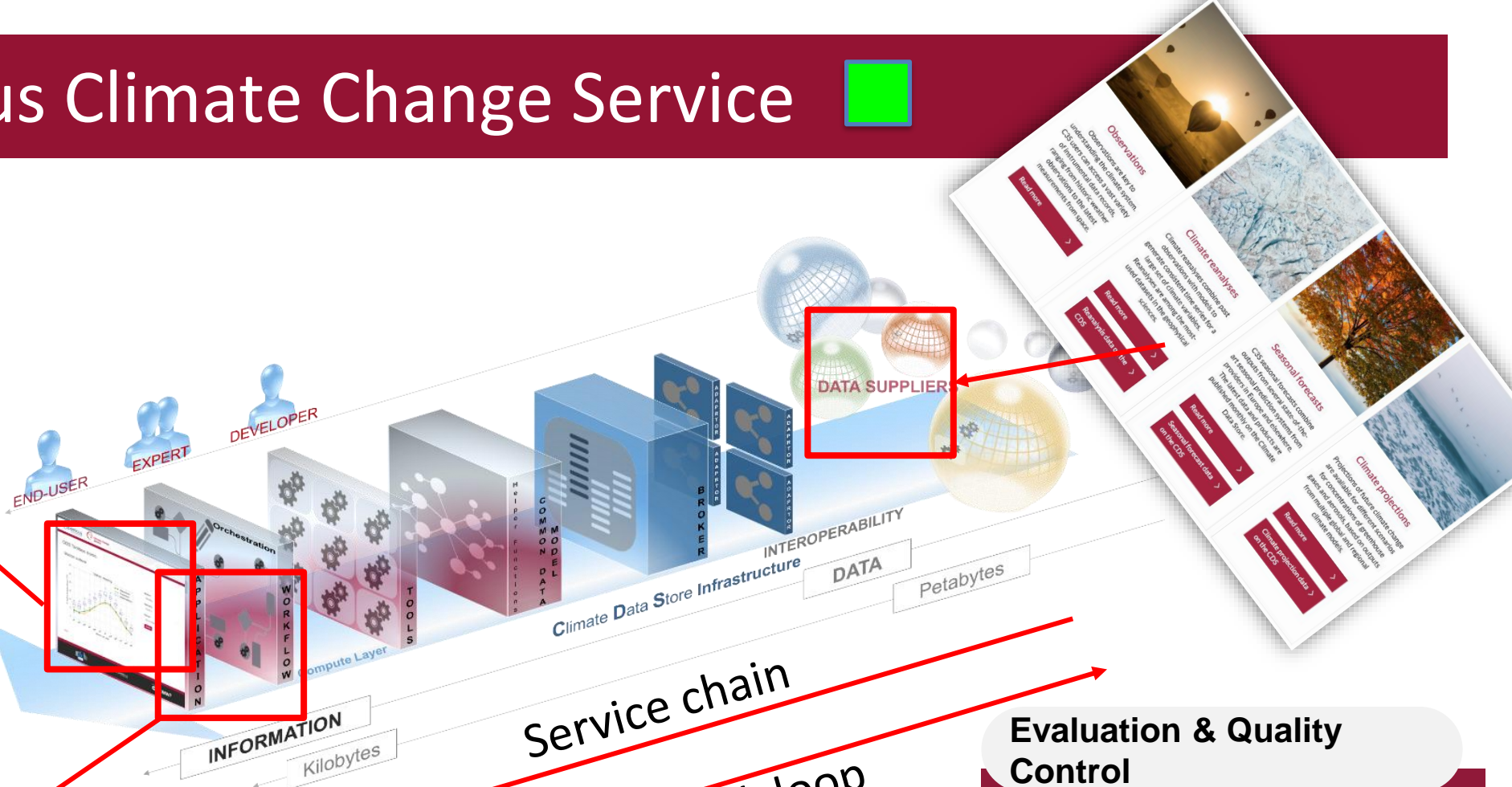
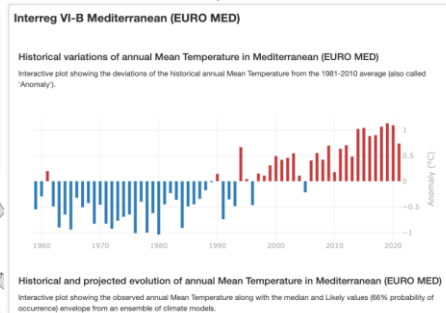
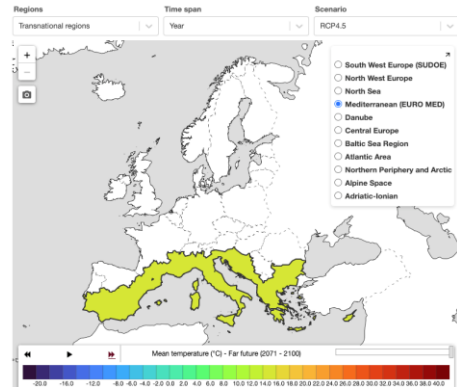


Copernicus Climate Change Service
European State of the Climate | 2022

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Copernicus

ECMWF



Observations
Observations are key to understanding the climate system. Copernicus can access more data than ever before, from a wide range of sensors and instruments, to provide a comprehensive picture of the world's climate.

Climate reanalyses
Climate reanalyses combine past observations with modern data assimilation techniques to provide a consistent and comprehensive picture of the climate system. Copernicus reanalyses are used for a wide range of climate research and policy-making.

Seasonal forecasts
Copernicus seasonal forecasts provide a comprehensive picture of the climate system, from the tropics to the poles. The latest data are used to produce seasonal forecasts on the Copernicus Data Store.

Climate projections
Projections of future climate change are essential for understanding the potential impacts of climate change on our planet and society. Copernicus provides a comprehensive picture of the future climate system, from multiple global and regional climate models.

Evaluation & Quality Control

- Fitness of the CDS data
- Fitness of the CDS Toolbox
- Fitness of the overall Service

User Engagement



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Use-cases

The economic impacts of climate change on the utilities sector

Floods and storms can have large effects on the infrastructure of utility companies. Having access to climate impact information tailored to the utilities sector will enable policymakers to develop effective policies to meet international commitments.

Sector: Global Users , Infrastructure Region: Europe Country: Spain



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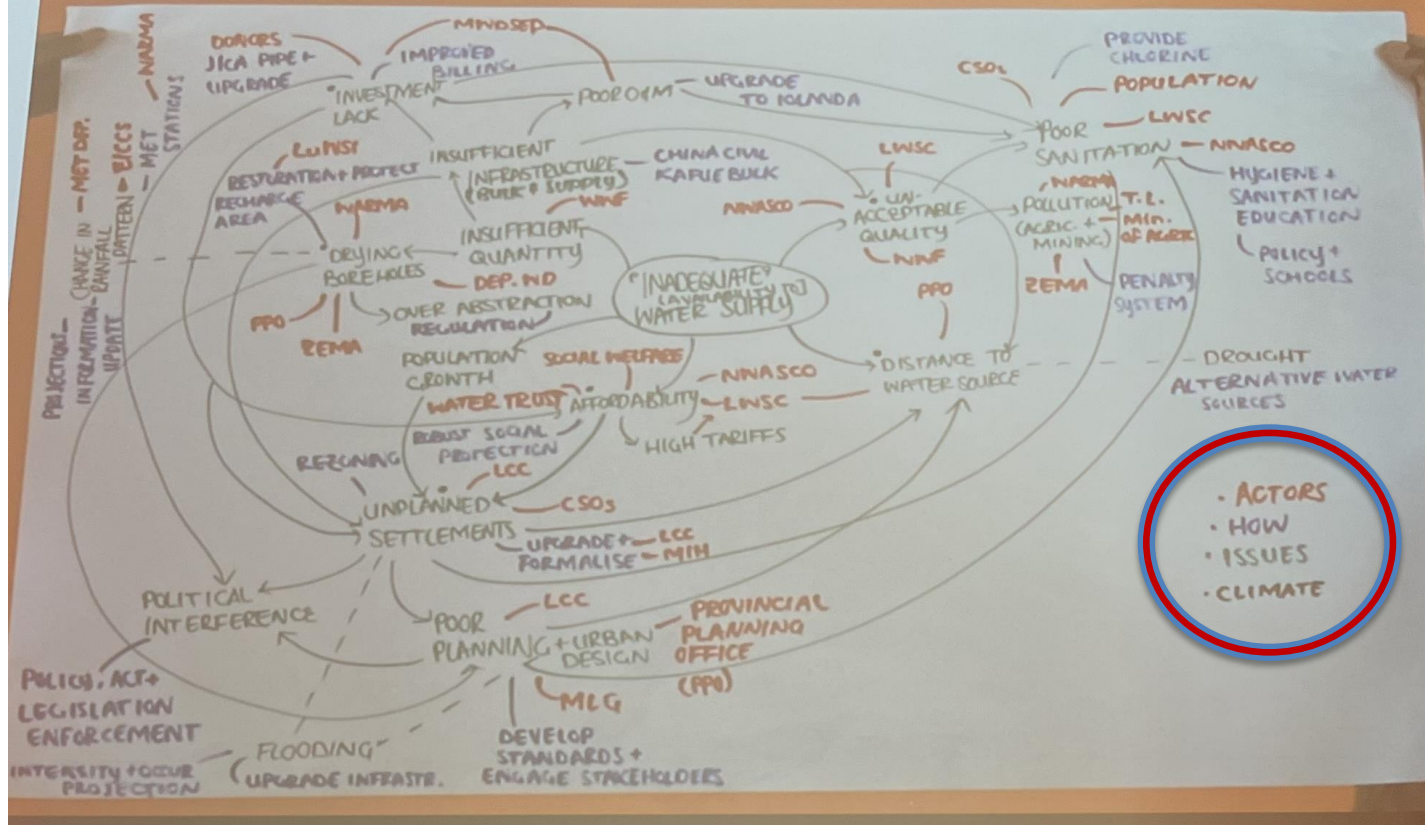
implemented by ECMWF



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The complexity of decision points

Mapping actors, issues, solution options



The interface between climate information and decisions/policies is complex, multidimensional, and often driven by priorities different from climate.

The operationalisation of climate services requires a very significant of effort on the societal context, the users communities, to enhance their ability to account for the insights.

There is, still, a large **ignorance** among the climate data providers of the contexts, practices and issues the users face.

Courtesy of Richard Jones (Met Office), Image taken during his presentation at C3S GA 2023 in Brno



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The climate service trilemma (multilemma...)

Openernicus | ECMWF | Climate Change Service

Home Search Datasets Applications Your requests Toolbox Support Live

Toolbox Editor

```

1 import calendar
2 import cdstoolbox as ct
3
4 YEARS = [str(year) for year in range(1959, 2022)]
5 REFERENCE = {"start_time": "1961-01", "stop_time": "2010-12"}
6
7 layout = ct.Layout(rows=4)
8 layout.add_widget(row=0, content="month")
9 layout.add_widget(row=1, content="city")
10 layout.add_widget(row=2, content="output-0")
11 layout.add_widget(row=3, content="output-1")
12
13 @ct.application(layout=layout)
14 @ct.input.city('city', default='Bonn', label='City')
15 @ct.input.dropdown('month', label='Month', values=calendar.month_name[1:])
16 @ct.output.markdown()
17 @ct.output.LiveFigure()
18 def application(month, city):
19     data = ct.catalogue.retrieve(
20         'reanalysis-era5-single-levels-monthly-means',
21         {
22             'product_type': 'monthly_averaged_reanalysis',
23             'variable': '2m_temperature',
24             'year': YEARS,
25             'month': f'{List(calendar.month_name).index(month):02d}',
26             'time': '00:00',
27         }
28     )
29     data = ct.geo.extract_point(data, lat=city['lat'], lon=city['lon'])
30
31     reference = ct.cube.select(data, **REFERENCE)
32     reference = ct.climate.climatology_mean(reference)
33     anomaly = ct.climate.anomaly(data, reference)
34
35     figure = ct.chart.warming_strips(anomaly, height=150)
36
37     return {
38         f'Climate stripes for {city['label']}**',
39         figure
40     }
41

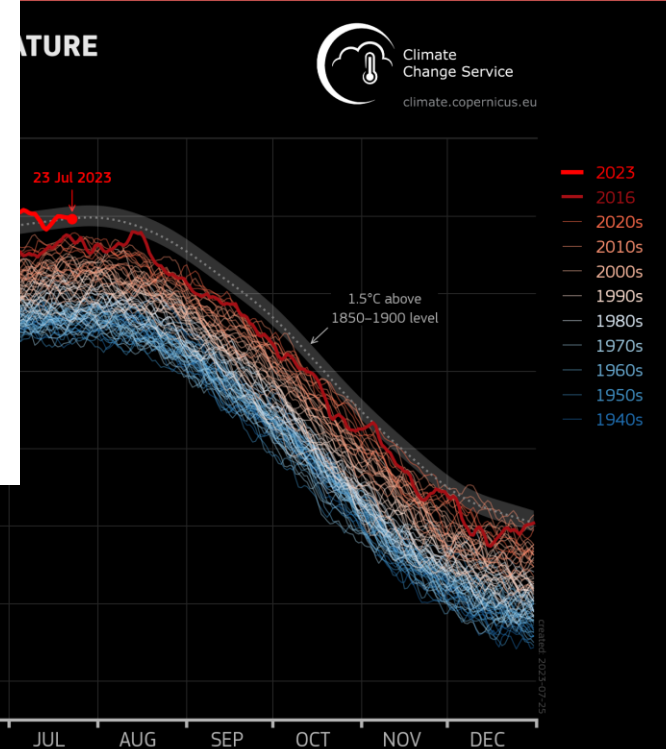
```

Month: January
City: Bonn (DE)
Latitude: 50.73438 Longitude: 7.09549

Climate stripes for Bonn (DE)

Service fit

Conversion models from climate



PV Solar power generation

Wind power generation (onshore and offshore)

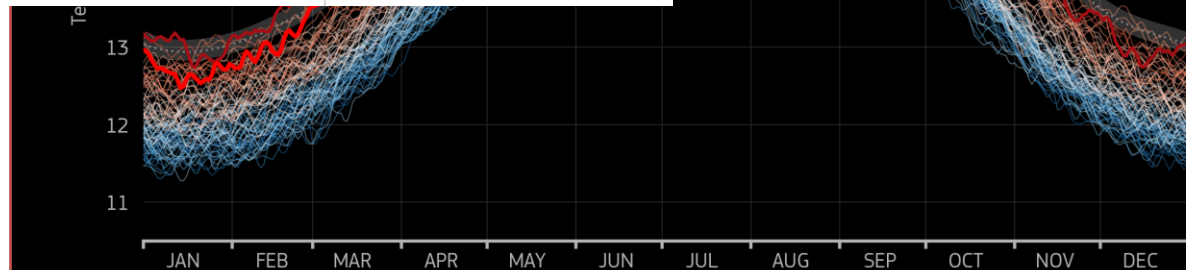


City Demand

Hydro power generation (reservoir and run-of-river)

Projections

2100



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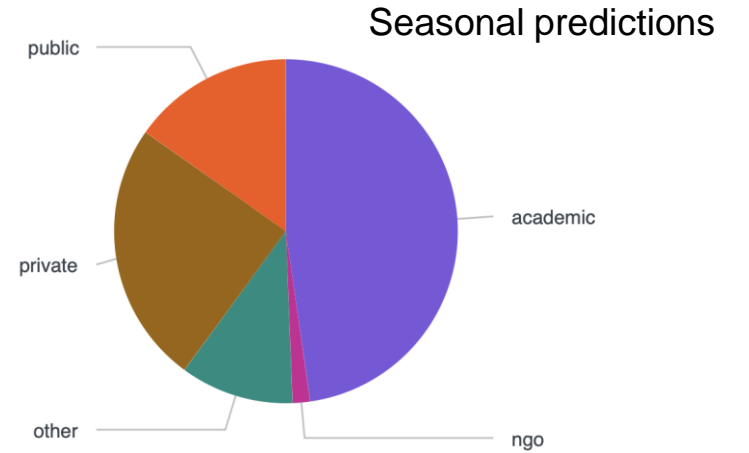
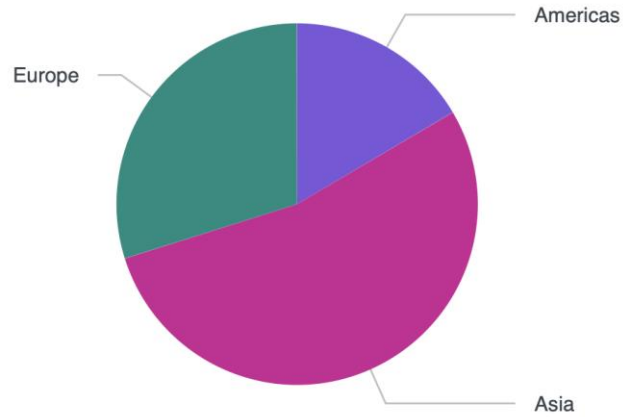


led by ECMWF

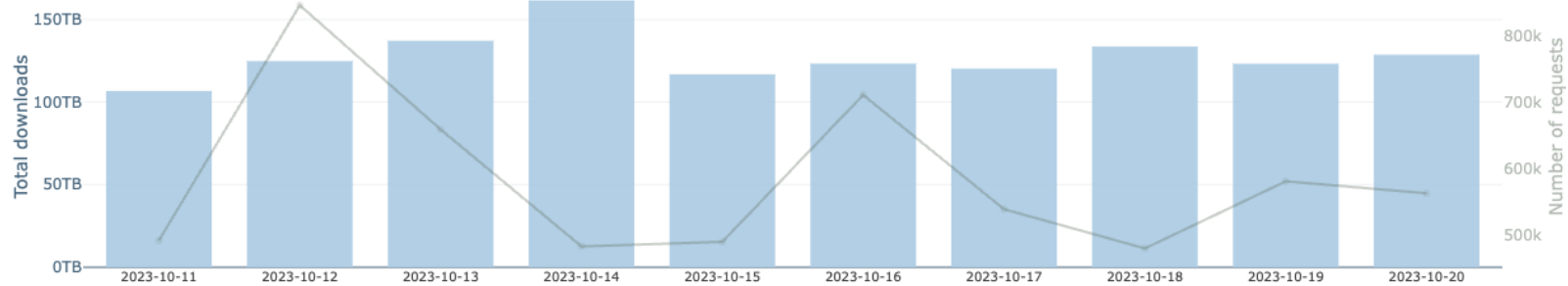


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We never know enough about the users



Registered users	Running users	Queued users	Running requests	Queued requests	At
256,481	257	6	281	2,036	08:09 <small>UTC 21/10/2023</small>



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It is not just about the data, it is about the ancillary information.



News > UK News

BEAST IS BACK UK weather forecast – Coldest winter in 30 YEARS as Beast from the East to bring -14C lows

Brittany Vonow
Published: 13:59, 8 Sep 2019 | Updated: 16:39, 19 Jan 2020

- Make a statement about what climate will see in the future is not difficult. Many tabloid do this on a regular basis... But why should we trust this information?
- How can users establish to what extent they can trust a specific data source to inform a pre-defined decision ? Is the information **bankable**?
- C3S has been investing in quality assessment to ensure all data available is not only fit for purpose but also enriched by sufficient quality attributes to make easier for users to assess their usefulness/applicability to the specific context of interest.



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implemented by 



Summary assessment for ERA5 (1978-2022): Temperature ECV

The temperature ECV of “ERA5 hourly data on pressure levels from 1979 to present” dataset is **global**, complete with a **high spatial and temporal resolution** with respect to previous generation of global reanalyses.

Data are available at 37 pressure levels ranging from 1000 hPa (surface) up to 1 hPa (top of stratosphere)

The high spatial (0.25°) and temporal (hourly) resolution of the ERA5 dataset along with **improved capability to reproduce the tropospheric processes** enable its use both for **climate monitoring and for impact assessment studies**.

Mean/climatology 😊

- ERA5 is a valid candidate for long-term climate studies, but also for retrospective weather and extreme event analysis
- Daily updates of ERA5 data are available five days behind real time (ERA5T).

Variability 😊

- Provides a complete set of atmospheric, ocean surface and land parameters, including > 250 different variables
- Data from a large set of instruments on current and recent satellite missions
- Mature dataset in terms of metadata, public access, user feedback, update and usage

Limitations 😊

- Changes in the amounts and types of observational data that is assimilated may produce artificial trends.
- Variability at local scales can differ from the values provided by the reanalysis, which represent a statistical summary of the area surrounding a grid point.
- Even if higher than other global reanalysis datasets, the spatial resolution of ERA5 can be insufficient for some regional or local applications.





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Large institutional users

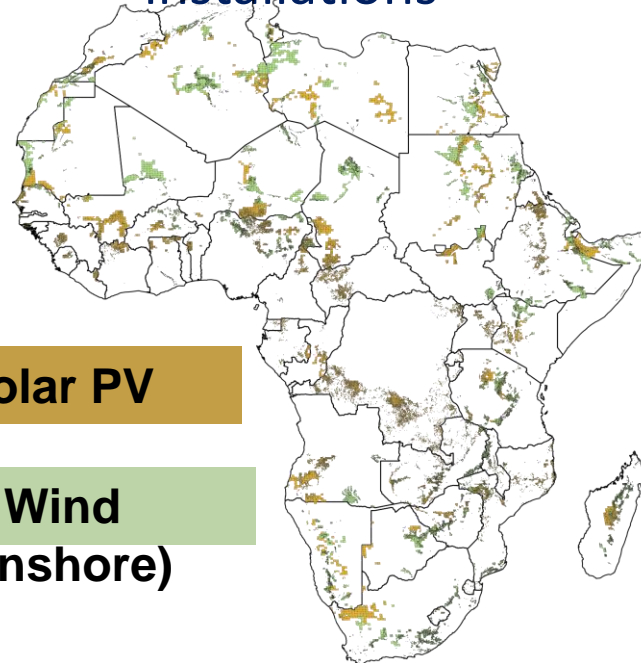
ENTSO-E to deliver pan-European outlooks of the power system in the short to long-term



in partnership with **entsoe**



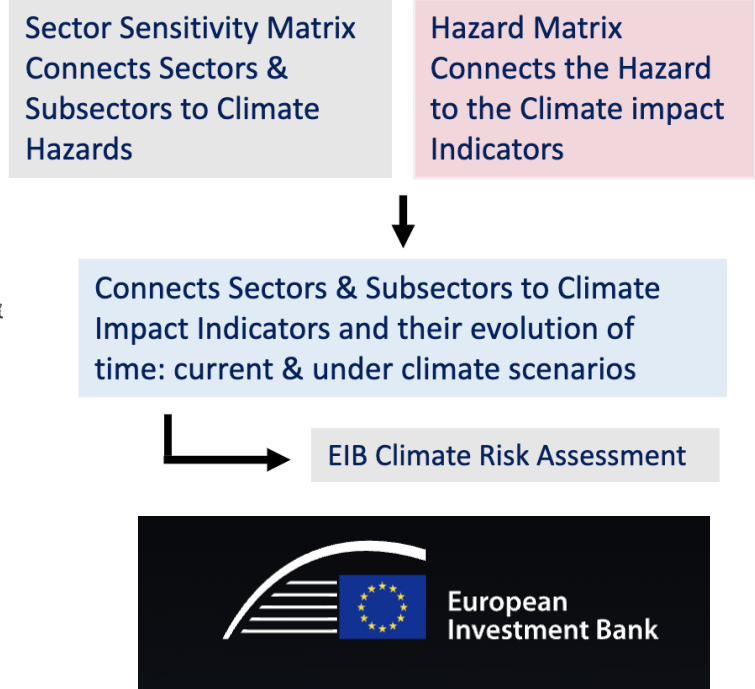
Locations of the most attractive sites for investment in new solar and wind installations



Solar PV

Wind (onshore)

The European Investment Bank Climate Risk Assessment



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Thank you !

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