



Climate
Change Service

climate.copernicus.eu

Copernicus Climate Change Service (C3S) Extreme events attribution at an operational climate service

**Seminar for COMPASS workshop
February 2025**

Freja Vamborg (ECMWF)

With input from across C3S



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C3S: a truly European effort



164

entities involved as
contractor or subcontractor

From 23 countries

EU/ ECMWF MS/CS
Two international organisations
two third countries

63

Signed
contracts

~75.8 M €

total value of
signed Framework
Agreements



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dd. end Q3 2024
C3S and joint services



A brief story of C3S@ECMWF



2014
C3S launch



2018
CDS becomes operational



2024
Climate Atlas

2015
Paris Agreement



2020
European Green Deal



2023
Global Stocktake



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A brief story of ATTRIBUTION at C3S@ECMWF



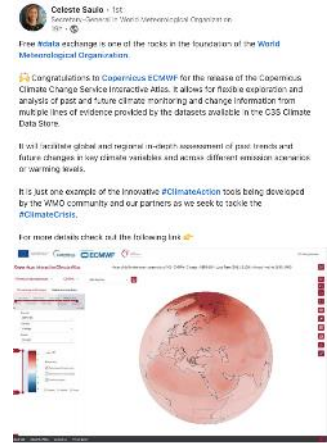
2014
C3S launch



2018
CDS becomes operational

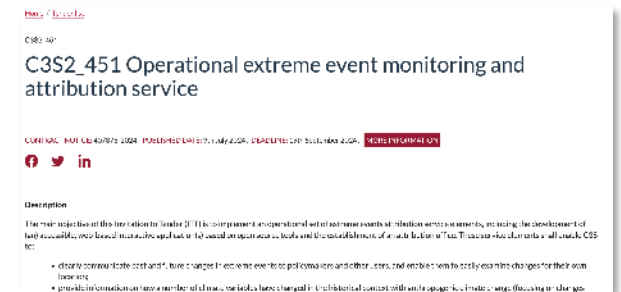
2017
Workshop on extreme events attribution in Prague

2019
+1.5 years
Prototype extreme events and attribution service



2024
Climate Atlas

2024
ITT on Operational attribution



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Operational extreme event monitoring and attribution @C3S

ITT published in July 2024, expected start date March 2025

What did we ask for in the ITT?

- Interactive web-application(s) based on ERA5, heat-indices (precip) trends ...
- Operational attribution office
 - Automatic trigger based on e.g. Extreme forecasting index (EFI)
 - 5-day delay time to deliver factsheet or similar
 - Multiple lines of evidence approach
 - Global coverage
 - Embedded in Climate Intelligence Team's operational activities
- Counter-factual dataset(s) development and research for operational evolution

- Note, hazards only. No impacts.





Operational activities – some key ingredients

- Generating regular workflows (human and automated) predictable schedule, maintained in the long-term
- It happens via applying (or defining new) standards (*)
- It includes elements:
 - full documentation, quality control, including suitability & traceability
 - user support, hot fixing, reliable & responsive
- Pathway towards operationalization:
 - agile approaches & pragmatic decisions
 - Estimate running costs

(*) **Standards:** minimum best practices as identified through a consensus process



Examples

- **Climate Intelligence team's operational activities**
 - Interactive web-application → **Climate Pulse**
 - Reporting with short time-delay → **monthly Climate Bulletin**
 - Extreme events monitoring → **annual European State of the Climate**
- >> In decreasing order of automatisisation & timeliness
- >> In increasing order of number of datasets & variables considered, people involved, complexity of workflow, communications activities associated,...
- **C3S service chain** generally stops before impacts,
 - unless in partnership with others → **European Investment Bank**





Video:

<https://x.com/CopernicusECMWF/status/1763143212951085111>



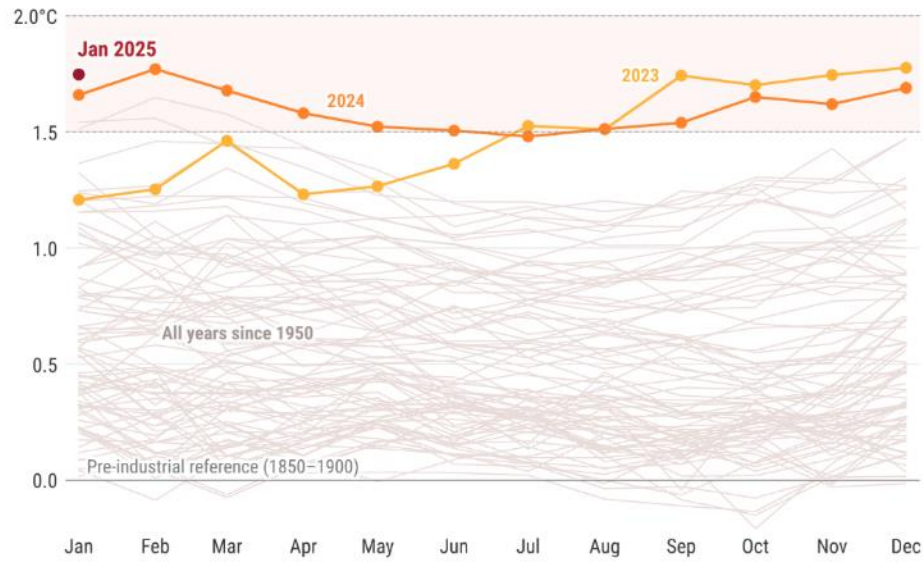


Monthly Climate Bulletin



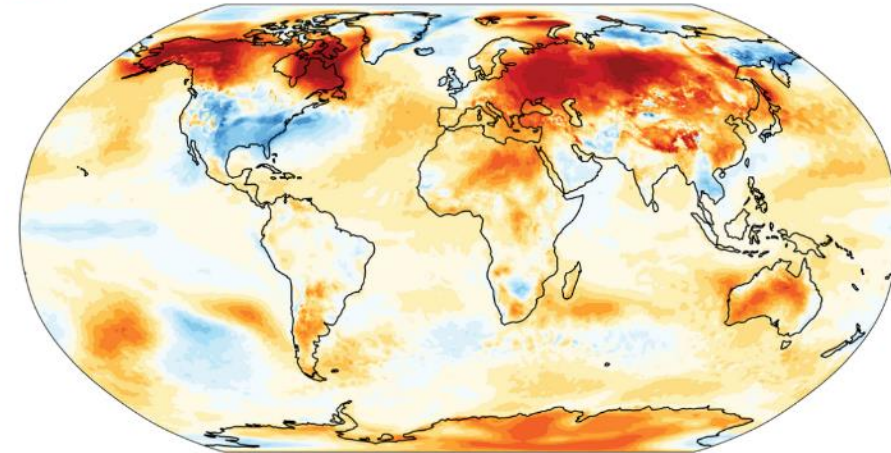
Monthly global surface air temperature anomalies

Data source: ERA5 • Reference period: pre-industrial (1850–1900) • Credit: C3S/ECMWF



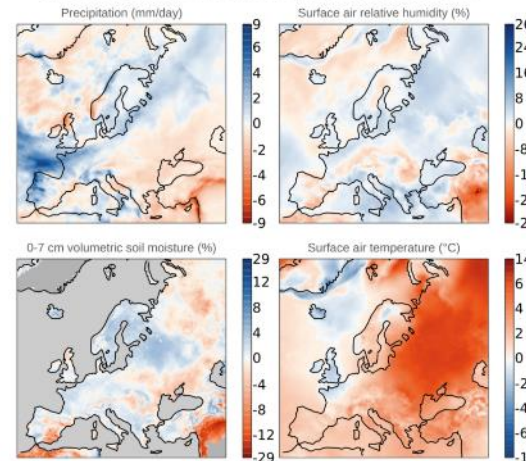
Surface air temperature anomaly in January 2025

Reference period: 1991–2020 • Data: ERA5 • Credit: C3S/ECMWF



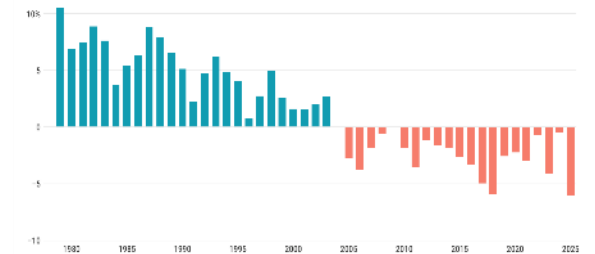
Anomalies for January 2025

Data: ERA5 / soil moisture ERA5-Land. Reference period: 1991–2020. Credit: C3S/ECMWF



January Arctic sea ice extent anomalies

Data: OSI SAF Sea Ice Index v2.2 • Reference period: 1991–2020 • Credit: C3S/ECMWF/OSISAF



1991–2020 January average sea ice extent: 12.98 million sq. km



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European State of the Climate

EUROPEAN STATE OF THE CLIMATE
2023



Copernicus Climate Change Service
European State of the Climate | 2023

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Copernicus
ECMWF
WORLD METEOROLOGICAL ORGANIZATION

Since 2023 in collaboration with WMO

Key events in 2023

- Heatwave
- Wildfire
- Drought
- Storm
- Coldwave
- Flood
- Marine heatwave
- Windstorm

Interactive map

Records

- Highest number of days with **'extreme heat stress'**
- Largest area of Europe affected by at least **'strong heat stress'**
- Largest **wildfire**
- Highest December **river flows**
- Largest proportion of **renewable energy generation**
- Warmest **marine heatwave** in northeastern Atlantic

**According to preliminary estimates for 2023 from the International Disaster Database. Estimates of the impacts of heatwaves in 2023 are not yet available.*

Flooding

Around 1.6 million people were affected by flooding in Europe in 2023

In May, 23 rivers in Italy burst their banks, with floods covering an area of around 540 km². Around 36,000 people were displaced, with 15 fatalities.

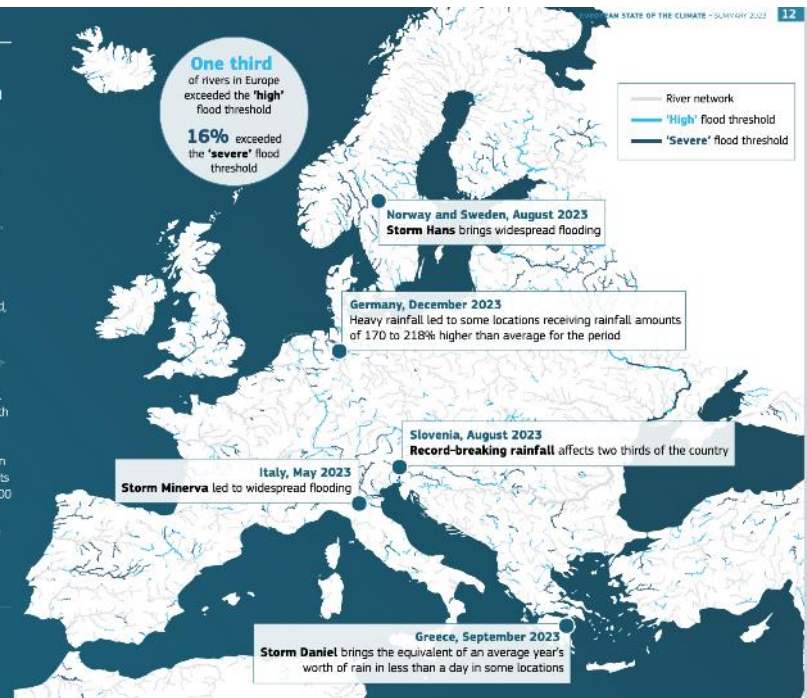
In August, flooding affected two thirds of Slovenia, with record-high flows at 31 stations. Around 1.5 million people were affected, with 8000 people evacuated and six fatalities. Norway and Sweden were also affected by flooding in August. In Norway, a hydroelectric power plant on the Glomma partially collapsed, leading to further flooding. More than 5000 people were displaced.

Greece, Bulgaria and Türkiye saw record-breaking rainfall and flooding in September. Greece had a flooded area of approximately 700 km². In some places, the equivalent of a year's worth of rain fell in one day. At least 17 people lost their lives in Greece, eight lives were lost in Türkiye and four in Bulgaria. The storm went on to impact Libya, where flooding and dam bursts resulted in at least 4700 fatalities. Around 8000 people were missing as of mid-December 2023.

In December, widespread flooding impacted northwestern Europe. River flow averaged across the European river network for the month was the highest on record.

Reference period 1991-2020

Data source: ERA5 - Copernicus Climate Change Service



Europe's contrasting summer

Summer 2023 was not the warmest on record, but saw conditions that were, at times, extreme. There were contrasts in temperature and precipitation across the continent and from one month to the next. The 'extended summer' (June to September) saw heatwaves, wildfires, droughts and flooding.

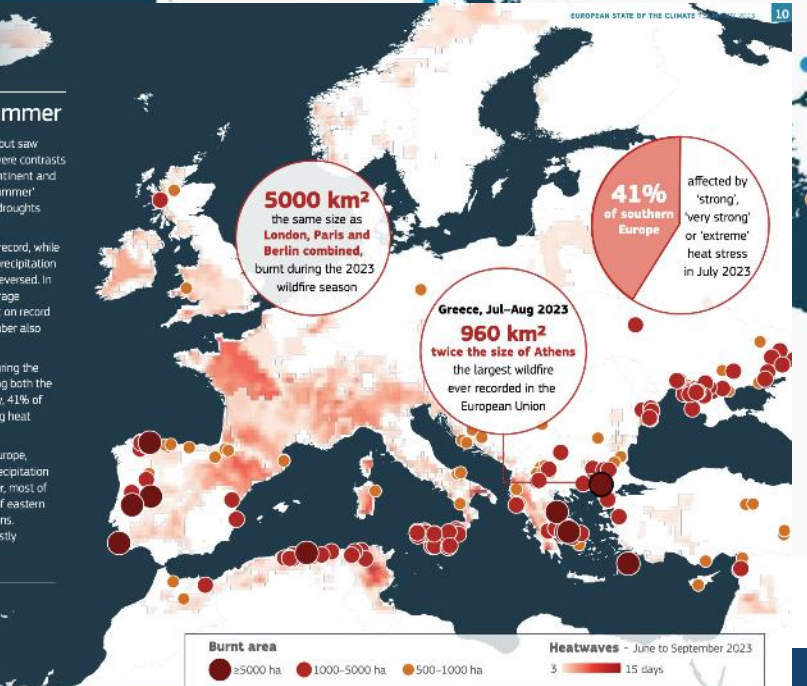
Northwestern Europe saw its warmest June on record, while Mediterranean areas saw well-above-average precipitation for the month. In July, this pattern was almost reversed. In August, southern Europe saw warmer-than-average temperatures, and September was the warmest on record for Europe as a whole. Both August and September also saw severe flood events (see P12).

Much of Europe was impacted by heatwaves during the extended summer, with high temperatures during both the day and night. At the peak of a heatwave in July, 41% of southern Europe was affected by at least 'strong heat stress', with potential for health impacts.

By the end of August, large parts of southern Europe, especially the Iberian Peninsula, experienced precipitation deficits that induced drought. By late September, most of the Iberian Peninsula had recovered, but parts of eastern Europe transitioned to extreme drought conditions. Wildfires were also observed across Europe, mostly coinciding with droughts.

Reference period 1991-2020

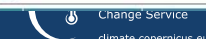
Data source: European Forest Fire Information System; ERA5
Grid: ERFIS/ERA5/ERA5/ERA5



Burnt area: ≥5000 ha, 1000-5000 ha, 500-1000 ha. Heatwaves - June to September 2023: 3, 15 days.



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Managing Physical Climate Risks at the EIB

EIB Climate Data Needs

Objective: To support the EIB for assessing climate hazards in line with the EU Taxonomy Regulation adaptation objective

European Investment
Bank - EIB

One of the world's largest
multilateral lenders

Leading provider of climate
finance

Governed by the EU Member
States



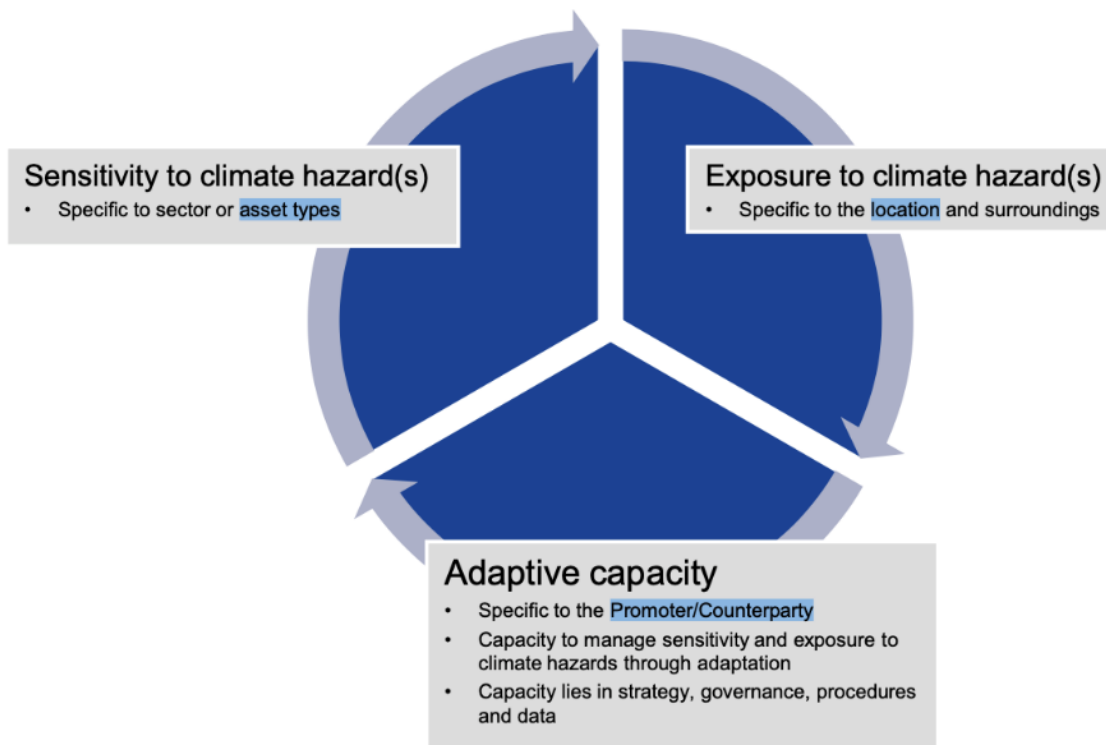
EU Taxonomy for Climate Risk Assessment



Classification of climate related hazards as defined by the EU Taxonomy regulation for sustainable finance

Category	Chronic Hazards	Acute Hazards
Temperature - related	Changing temperatures (air, freshwater, marine)	Heat wave
	Heat stress	Cold wave frost
	Temperature variability	Wildfires
	Permafrost thawing	
Wind-related	Changing wind patterns	Cyclone, hurricane, typhoon
		Storms (including blizzards, dust and sandstorms)
		Tornadoes
Water - related	Changing precipitation patterns and types (rain, hail, snow/ice)	Drought
	Precipitation or hydrological variability	Heavy precipitation (rain, hail, snow, ice)
	Ocean acidification	Flood (coastal, fluvial, pluvial, ground water)
	Saline intrusion	Glacier Lake outburst
	Sea level rise	
	Water stress	
Solid-mass related	Coastal erosion	Avalanche
	Soil degradation	Landslide
	Soil erosion	Subsidence
	Solifluction	

Is my project at risk?





Supporting the sustainable finance sector



Which Data Needs?

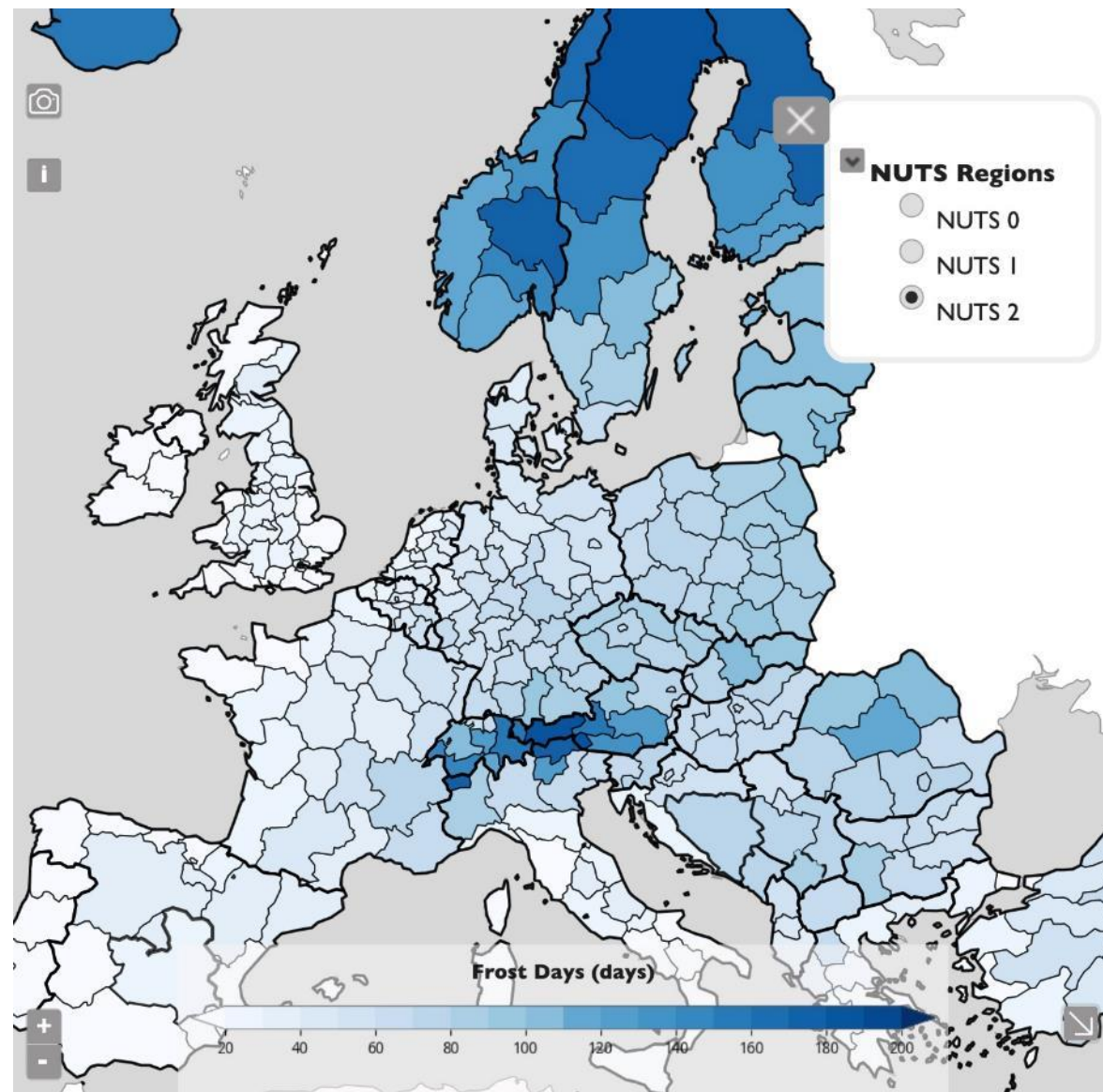
- Climate information to characterize the hazard
- Timescale: next 30 yrs – need of consistent historical and projections
- Data must be maintained, quality controlled, updated, cleaned, based on state-of-the-art observations and models
- EIB sensitivity sector information

Which process?

- No standard existing
- Based on state of the art practices and recommendations
- Fully transparent workflow

Which outputs & benefits ?

- Tailored tool for the EIB for downstream use
- Change of the organization
- to co-create bespoke climate data services for the EIB's internal use and the public – potential of horizontal upscaling



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Sharing climate reporting with media – a dialogue?



Copernicus: January 2025 was the warmest on record globally, despite an emerging La Niña

Summary

Surface air temperature anomaly in January 2025
Reference period: 1991–2020 • Data: ERA5 • Credit: Copernicus

NEWSFLASH
Burst: 06/02/2025

Download translation

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RELATED CONTENT

4TH FEBRUARY 2025
Copernicus: January 2025 was the warmest on record globally, despite an emerging La Niña
The Copernicus Climate Change Service (CCS)

4TH FEBRUARY 2024
Copernicus: In 2024, the world's warmest year on record, the Copernicus Climate Change Service (CCS) routinely publishes monthly climate bulletins, including monthly global average temperatures, sea ice cover and hydrological data.

4TH FEBRUARY 2023
Copernicus: Exceptionally warm January on record; Antarctic sea ice minimum on record
January 2023 was the 3rd warmest in Europe. Balkans and eastern Europe, where New Year warm anomalies were the most pronounced.

News Opinion Sports

World UK Climate crisis Ukraine En

Climate crisis
Hottest January

The Guardian

DAGENS NYHETER. Nyheter Sverige Världen Ekonomi Kultur Sport Klimatet Ledare DN Debatt

VÄRLDEN
Rekordvärme i januari trots avkylande fenomen

Uppdaterad 2025-02-06 Publicerad 2025-02-06

European State of the Climate 2023 – Media Briefing

EUROPEAN STATE OF THE CLIMATE REPORT 2023 MEDIA BRIEFING

1:18:54 / 1:32:15 • Q&A session

Scroll for details

4TH FEBRUARY 2025
Copernicus: Europe gets its warmest January on record as average temperatures rise
Daily, January 2025 was 0.2°C warmer than the same month in 2024, and 0.2°C warmer than the 2010 average.

4TH FEBRUARY 2021
Copernicus: January 2021 was the sixth warmest in Europe since 1991, but the warmest since 2010.

4TH FEBRUARY 2020
Copernicus: January 2020 was the warmest January recorded in Europe since 1991, making it the warmest January since 1991, making it the warmest January since 1991, making it the warmest January since 1991.

Le Monde

Planète Comprendre le réchauffement climatique 9 indicateurs de l'urgence climatique

PLANÈTE • CLIMAT

Climat : le mois écoulé a été le plus chaud mois de janvier mesuré dans le monde, selon Copernicus

Avec une température moyenne de 13,23 °C, « janvier 2025 a dépassé de 1,75 °C le niveau préindustriel », douchant l'espoir que le phénomène La Niña mette fin à près de deux ans de records de températures.

Le Monde avec AFP
Publié le 06 février 2025 à 06h30, modifié le 06 février 2025 à 08h09 • Lecture 2 min.

Offrir l'article





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Change

Thank you !

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