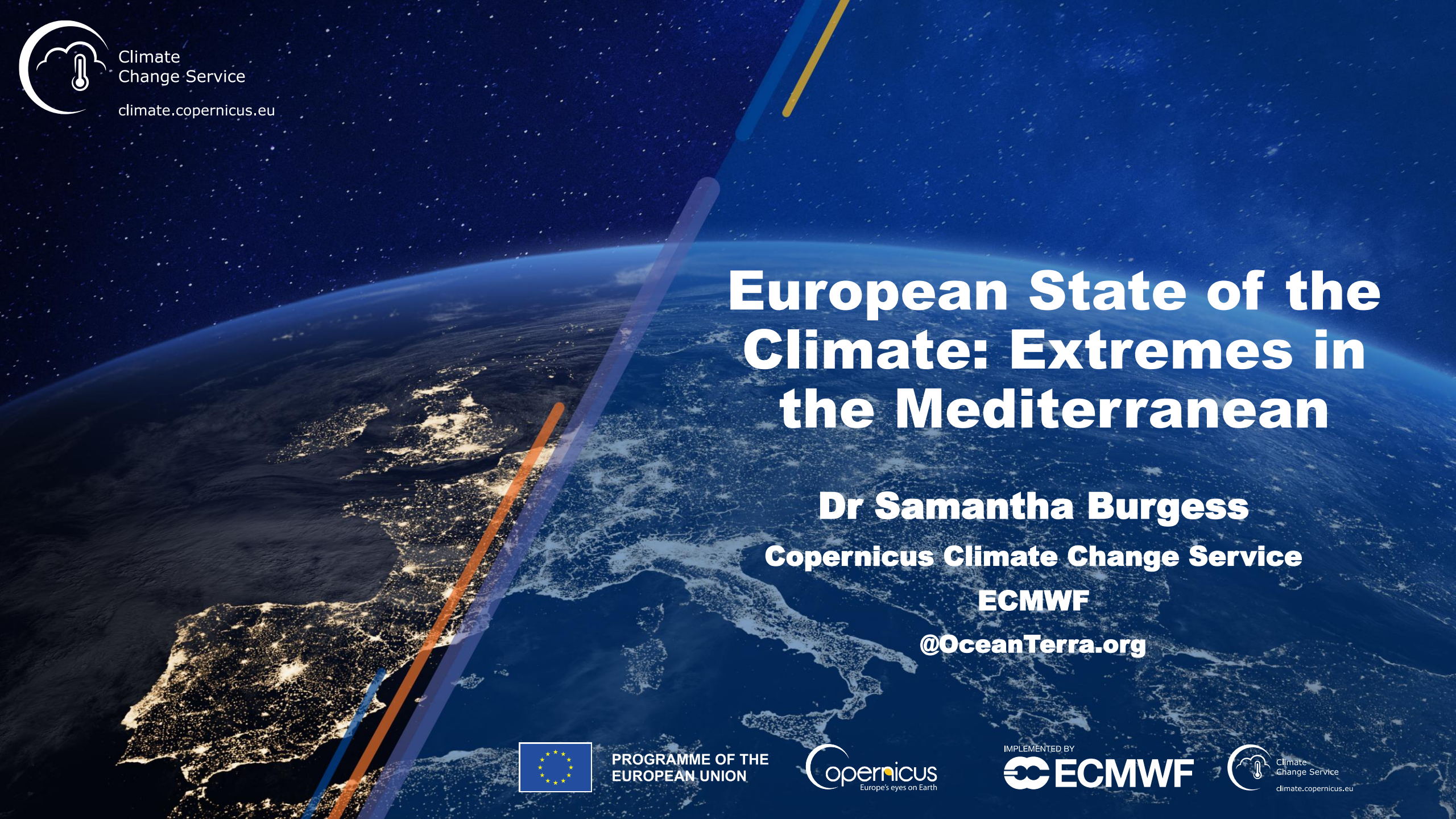


European State of the Climate: Extremes in the Mediterranean

Dr Samantha Burgess

Copernicus Climate Change Service

ECMWF

@OceanTerra.org

PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

IMPLEMENTED BY ECMWF

Climate Change Service
climate.copernicus.eu

[Credit: Hong Nguyen | Unsplash]

"Climate change is already affecting every region on Earth, in multiple ways.

The changes we experience will increase with further warming.

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

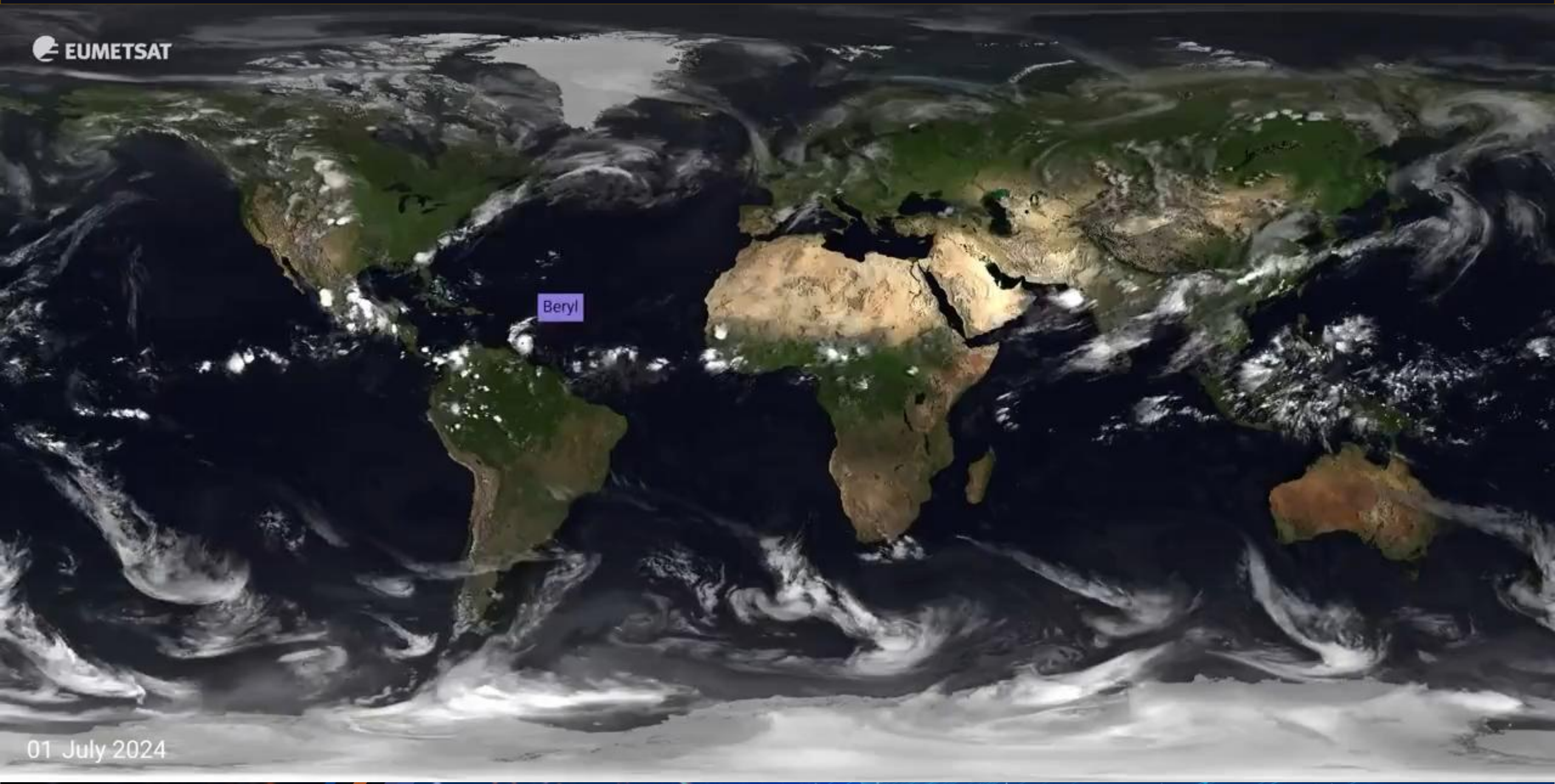
[Credit: Peter John Maridable | Unsplash]

"Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach.

ipcc
INTERGOVERNMENTAL PANEL ON climate change

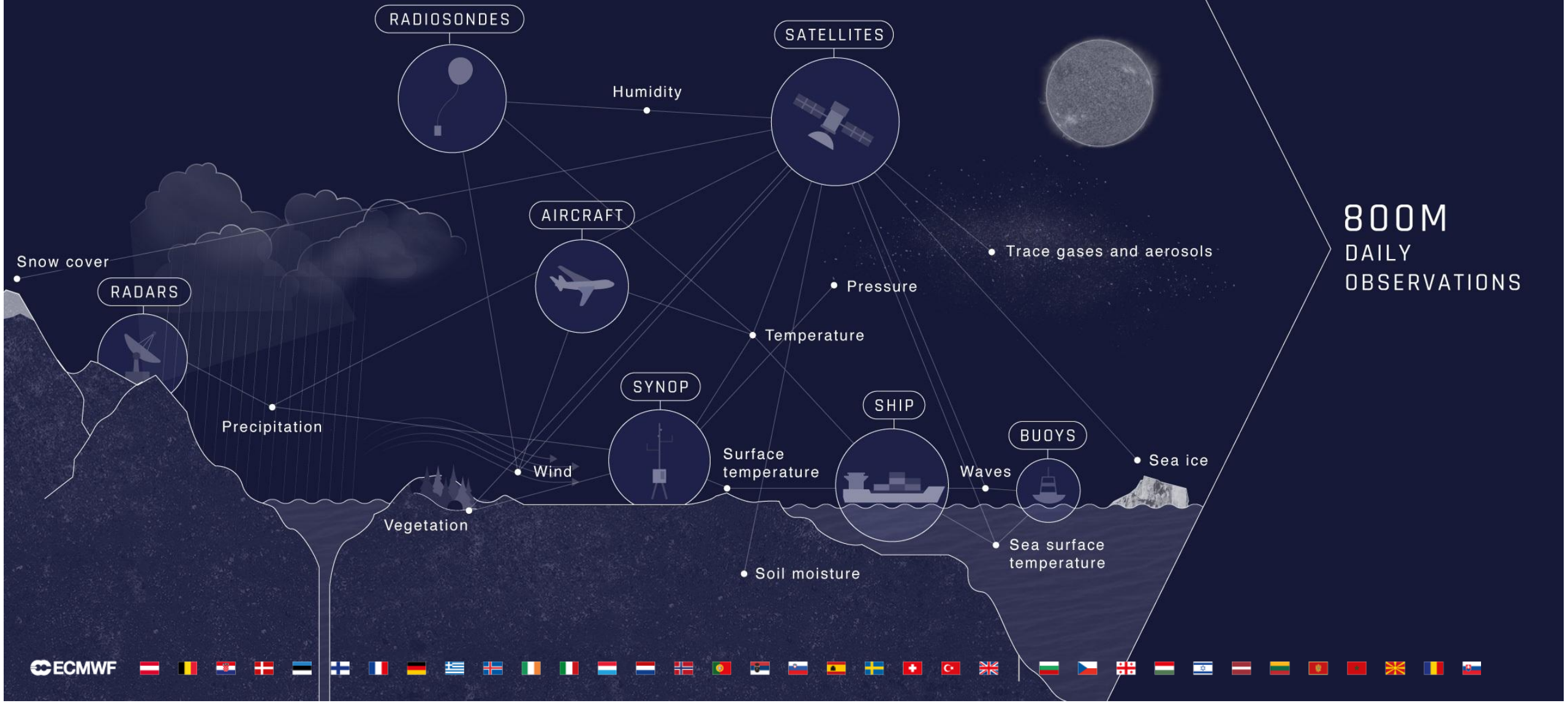
WMO UNEP

The weather of 2024 as seen from space



CAPTURING THE WEATHER

To predict the future, we observe the present. Every day, we absorb 800 million observations to create a detailed snapshot of Earth's weather.



The Blue Marble, Apollo 17
NASA, 1972

Image @NASA | Apollo

Recreation from ECMWF IFS, initialized with ERA5

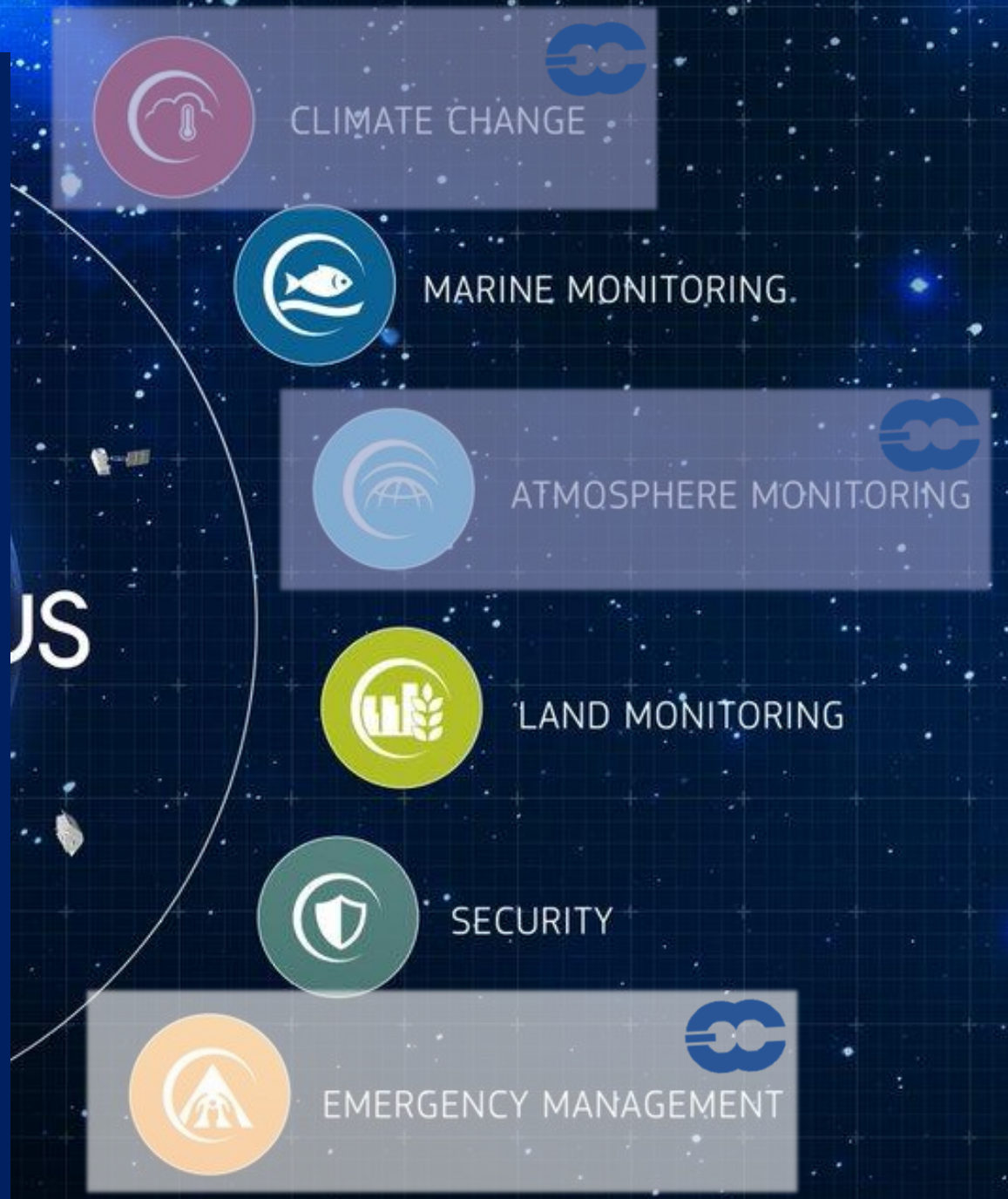
Image ECMWF @Philippe Lopez

- Earth observation component of the **EU's Space programme** to benefit all citizens

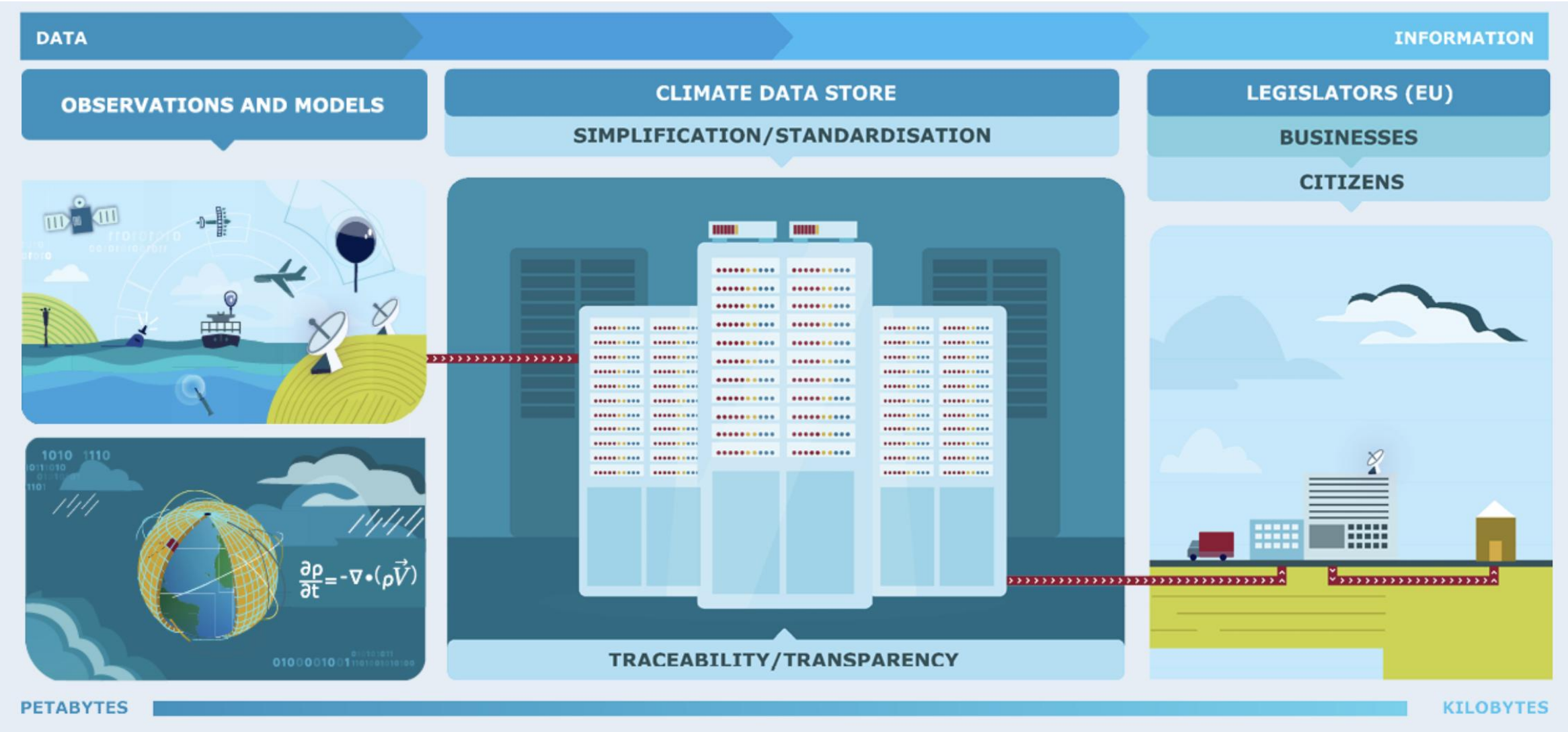
- Implemented in partnership with Member States, ESA, EUMETSAT, and entrusted entities such as ECMWF

- The **Copernicus Climate Change Service (C3S)** is an **operational climate service** implemented by ECMWF together with **over 300 public and private entities** from more than 40 countries in Europe and elsewhere

- C3S provides **reliable, open, and free access** to state of the art data on the past, present, and potential evolution of climate



C3S – provision of climate data and services to society



https://cds.climate.copernicus.eu

140 Datasets | **38** public applications

Free data for smart decisions

Past — Present — Possible futures

C3S PRODUCTS

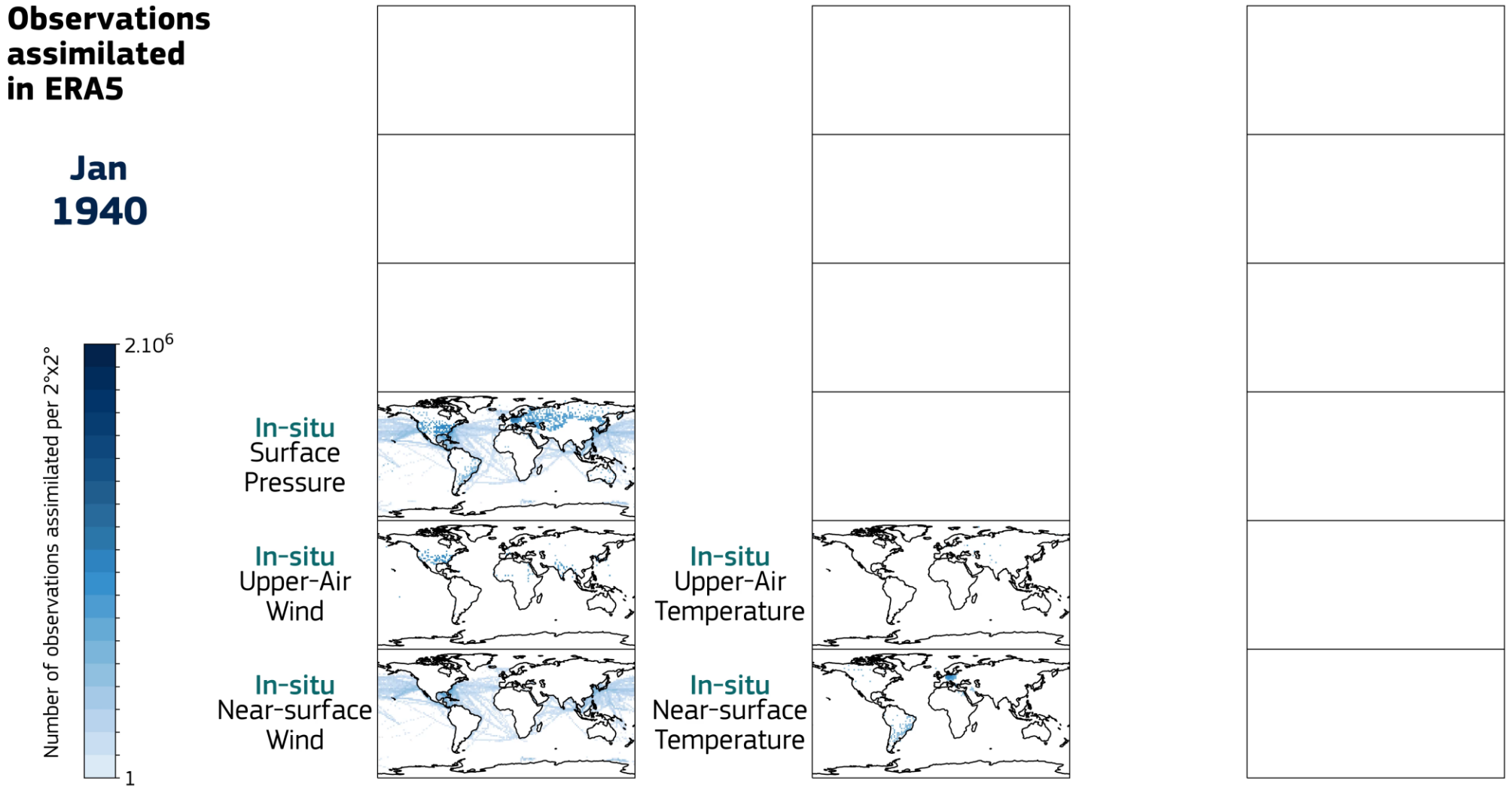
Observations

Reanalysis

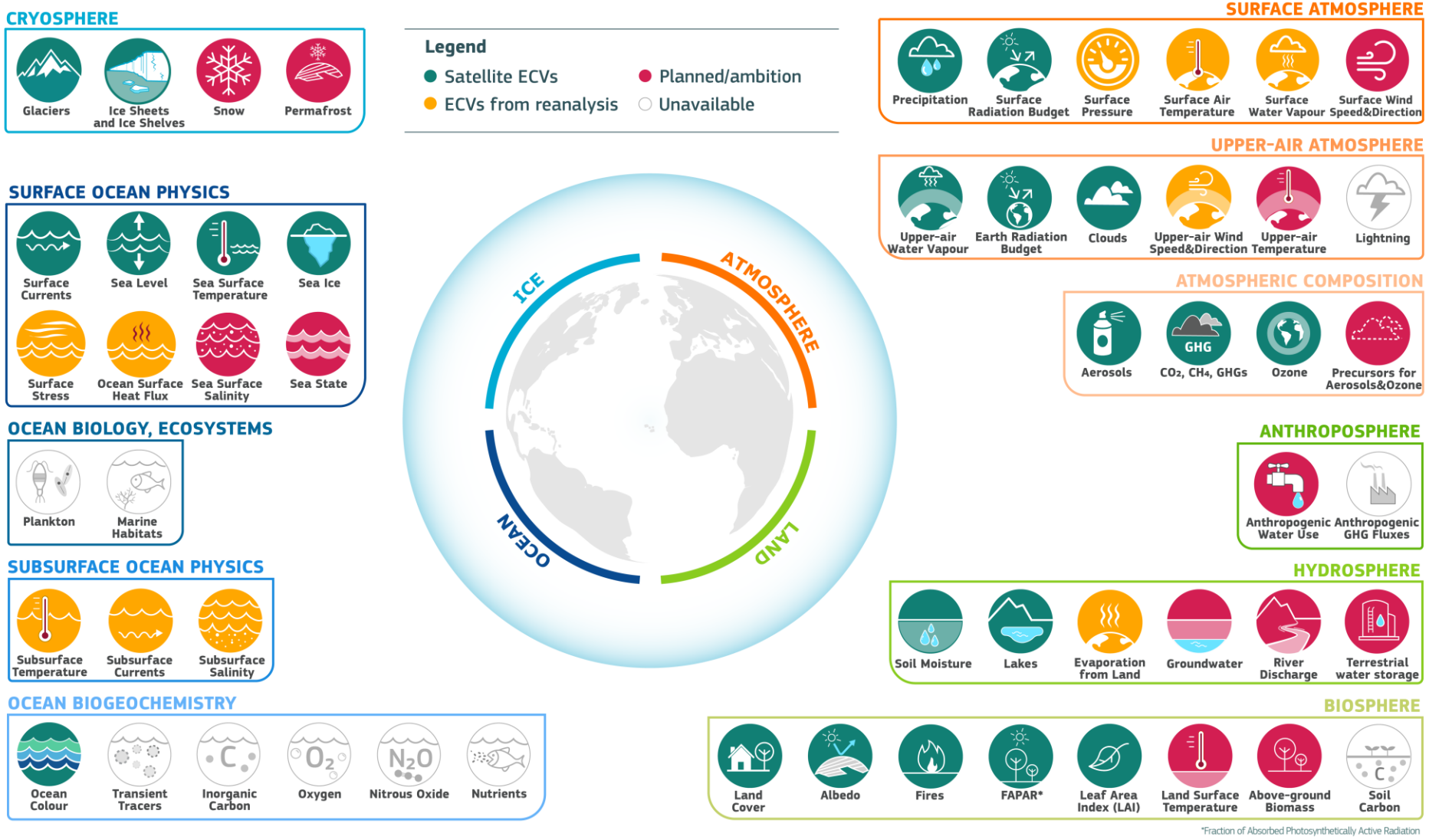
Seasonal to decadal predictions

Climate projections

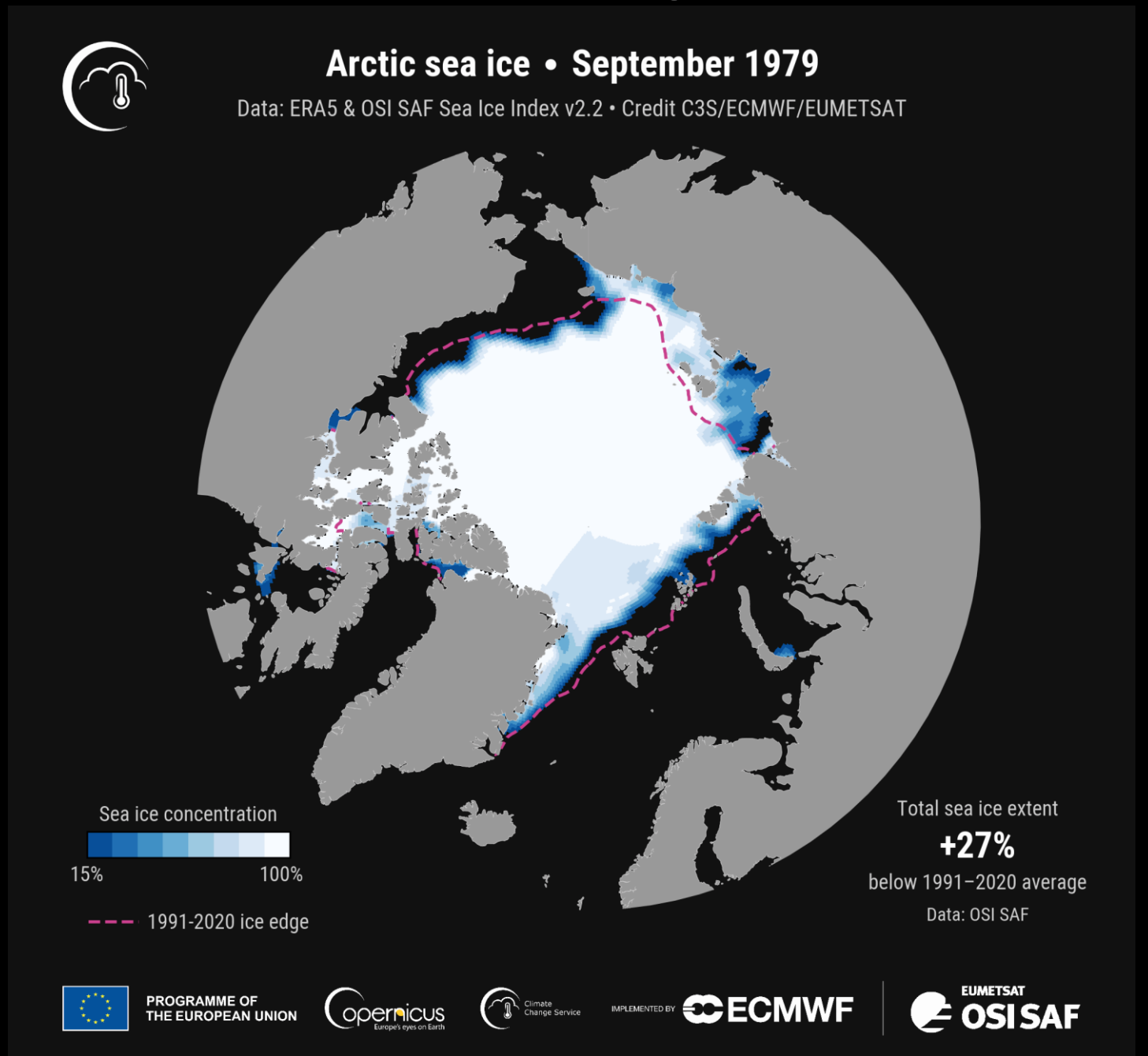
In situ observations: foundations of the climate record



Essential Climate Variables



The Arctic is the fastest warming place on our planet



From ERA5 to ERA6 – benefiting from 8 years of R&D

Enhanced products, in response to user demands

- Double the resolution from ERA5, from 31 km to 14 km
- Additional parameters
- Extended monthly and daily pre-calculated quantities

Advances in data assimilation and modelling

Improved atmospheric (4D-Var) data assimilation

- Better ensemble that evolves the background error covariance matrix
- Weak constraint to handle systematic model error (biases)
- Assimilation of near-surface air temperature observations in 4D-Var

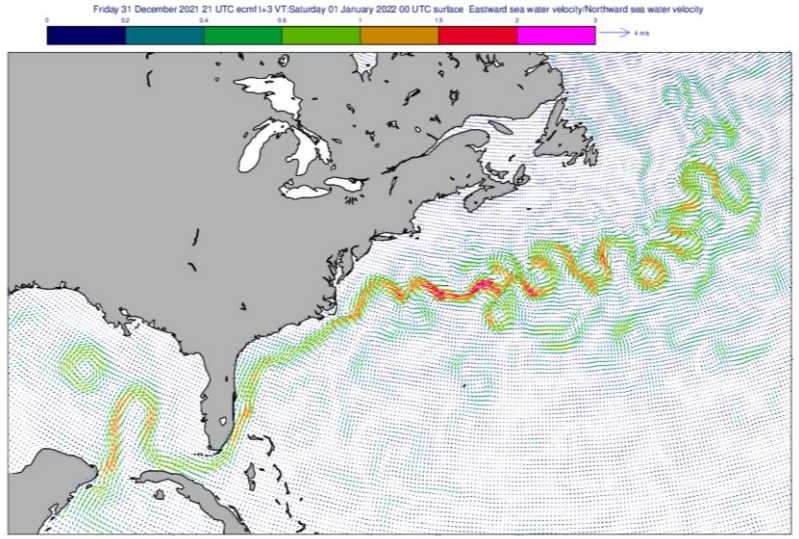
Improved land data assimilation

- Reduced biases in snow and improve assimilation of snow observations
- Inclusion of soil temperature data assimilation

Improved ocean wave physics

- At same resolution as the atmosphere
- Improved drag for extreme situations

Improved observations



Improved atmospheric model

- New ozone model and prognostic with radiation
- Revision of moist physics (clouds, precipitation, radiation)
- Account for snow on ice
- Upgrade from CMIP5 forcings (ERA5) to CMIP6
- More species of aerosols and greenhouse gases

Improved interfaces with the land component

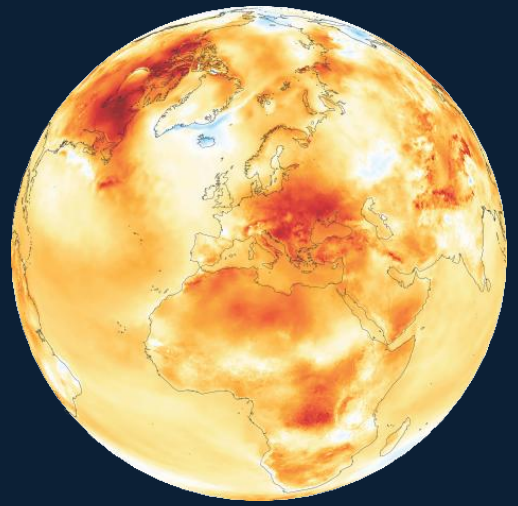
- Vegetation cover and type, leaf area index, lake cover and properties, urban tile, potentially time-evolving in ERA6-Land

Improved interfaces with the ocean component

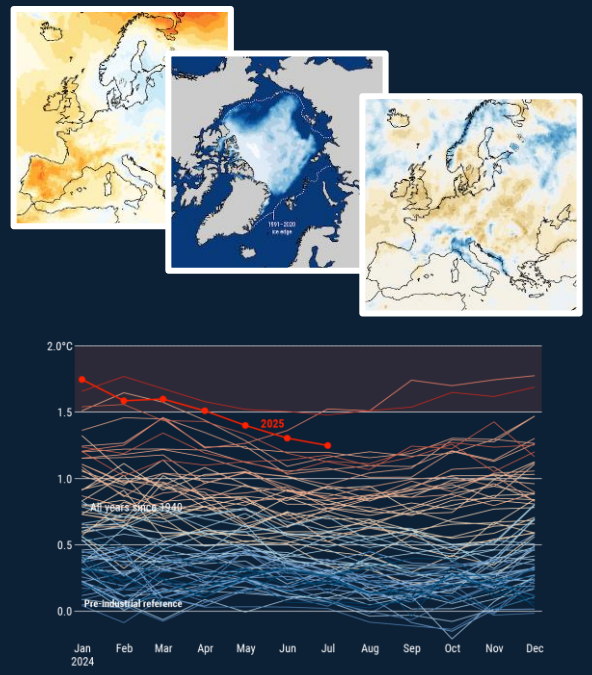
- Partial coupling with an ocean and ice model

Climate
Change Service
climate.copernicus.eu

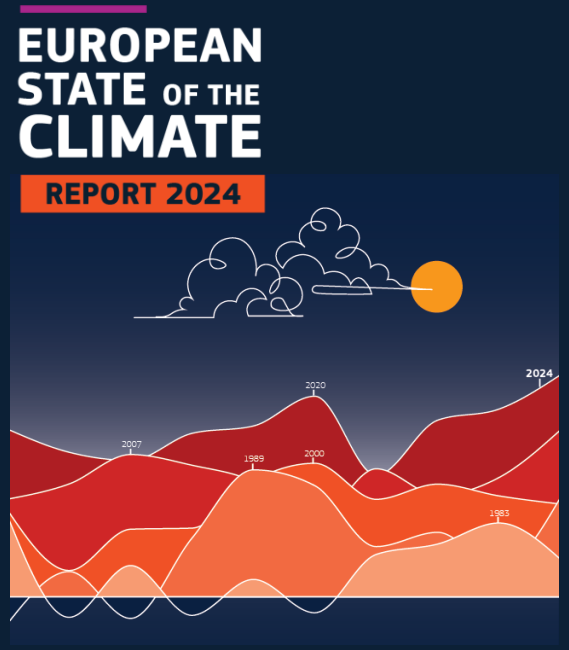
Climate Intelligence



Global Climate Highlights



Monthly Bulletins



ESOTC

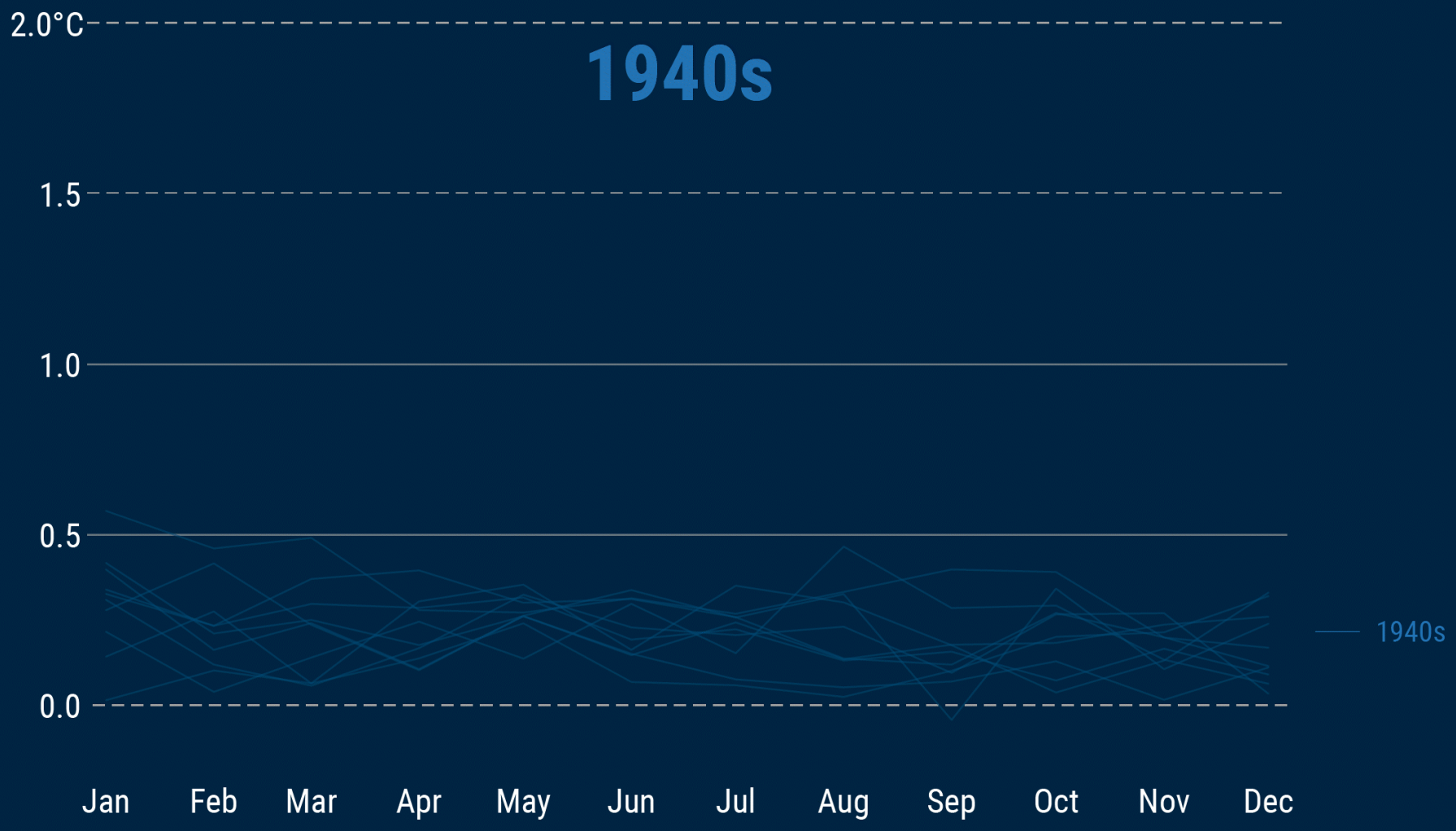
Climate Pulse

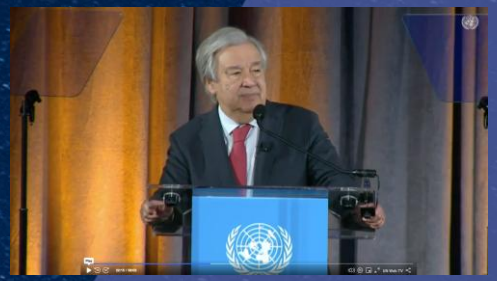
Thermal Trace

Web applications

Global surface air temperature increase above pre-industrial

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





PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

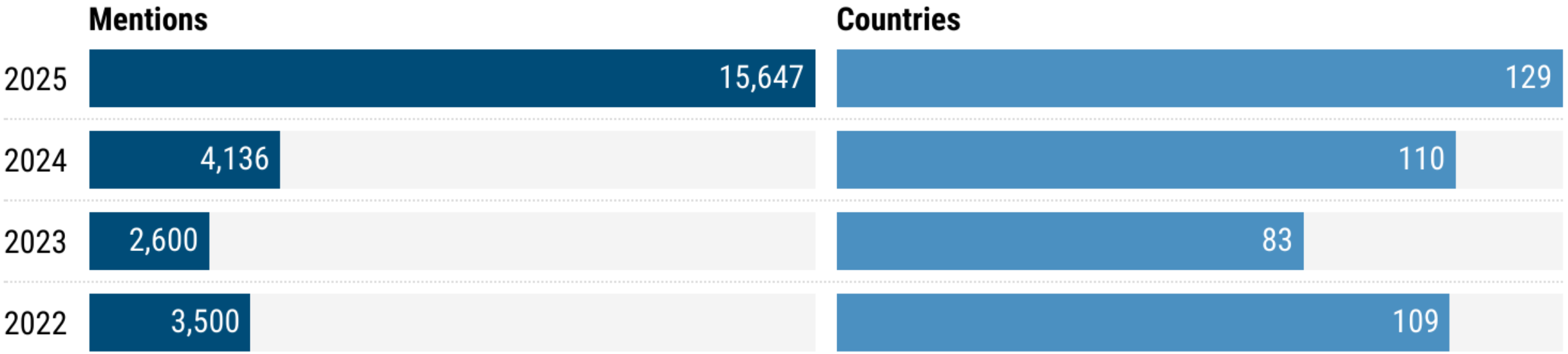
Climate Change Service climate.copernicus.eu

IMPLEMENTED BY ECMWF

WMO

UN environment programme

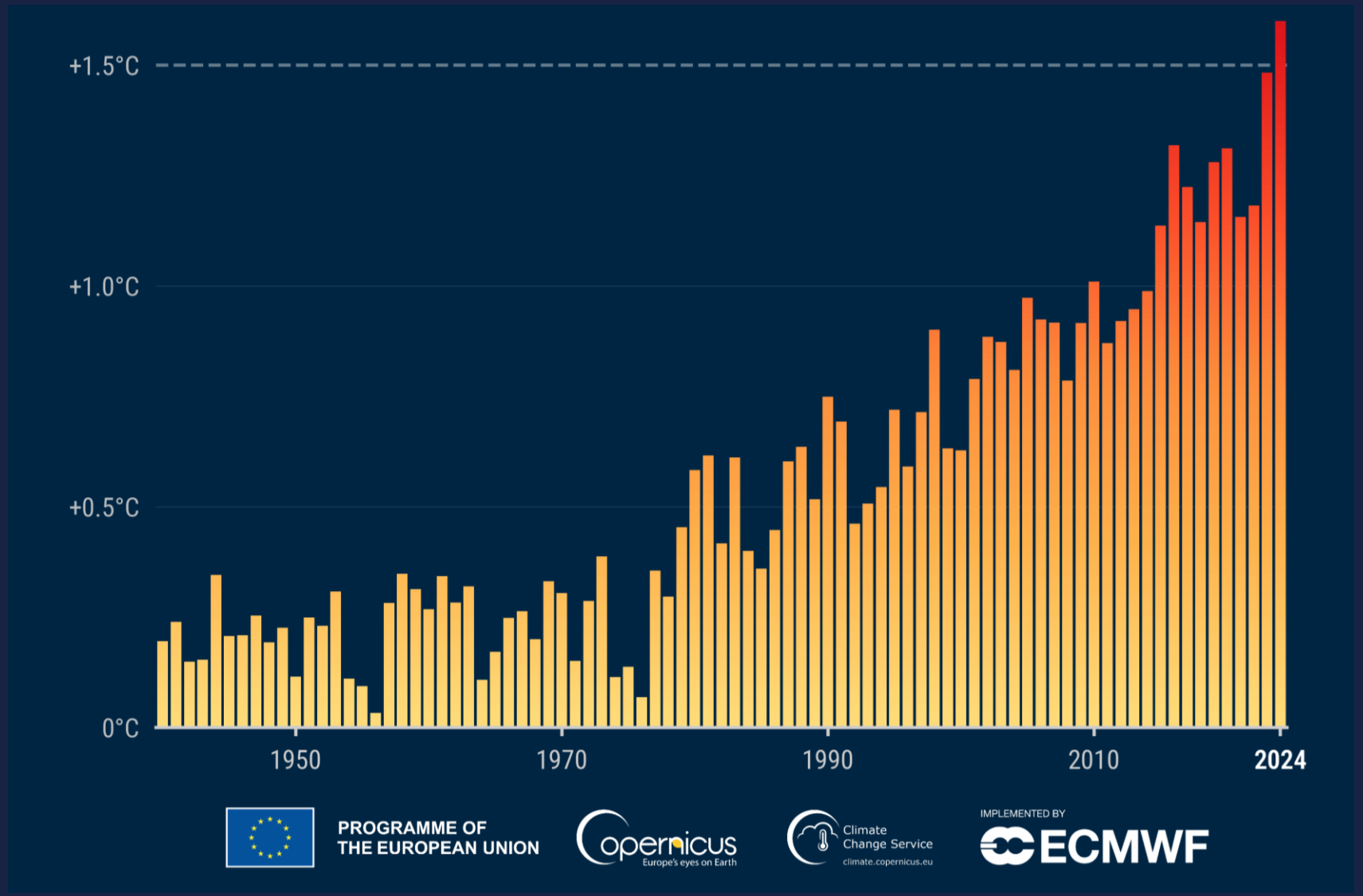
Global Climate Highlights media coverage



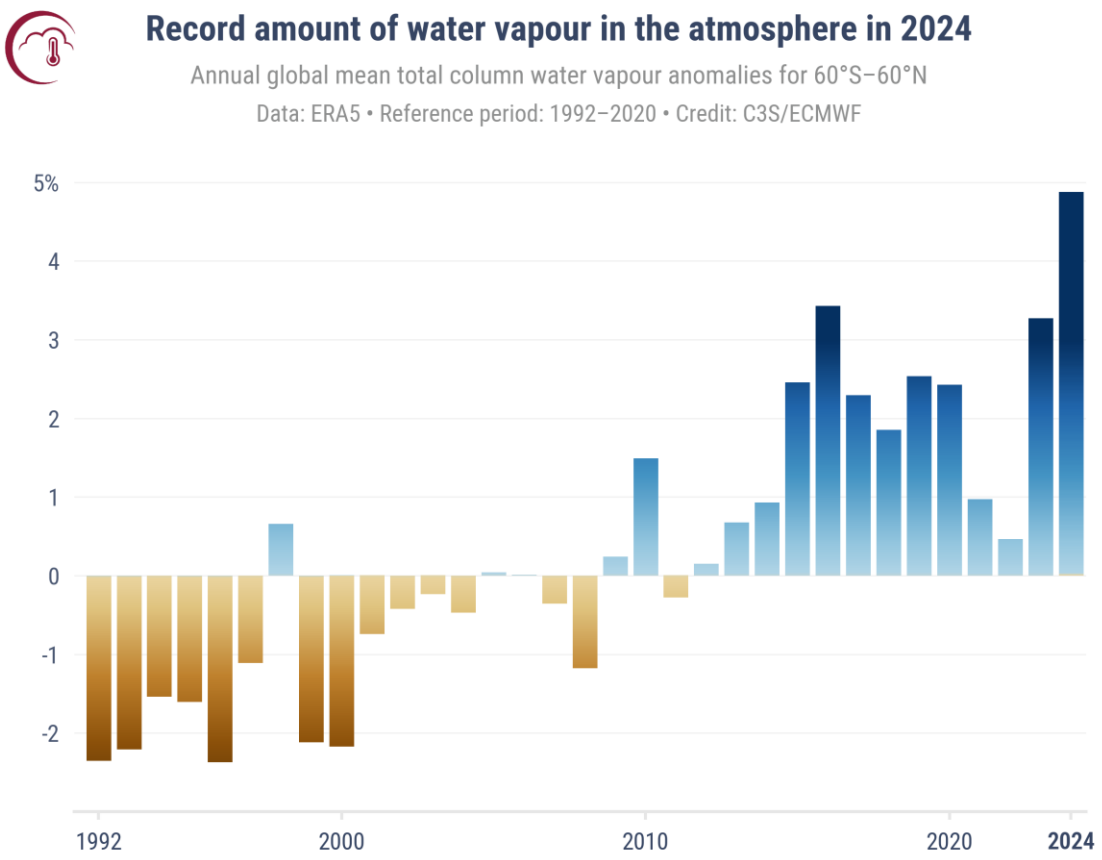
climate.copernicus.eu/global-climate-highlights

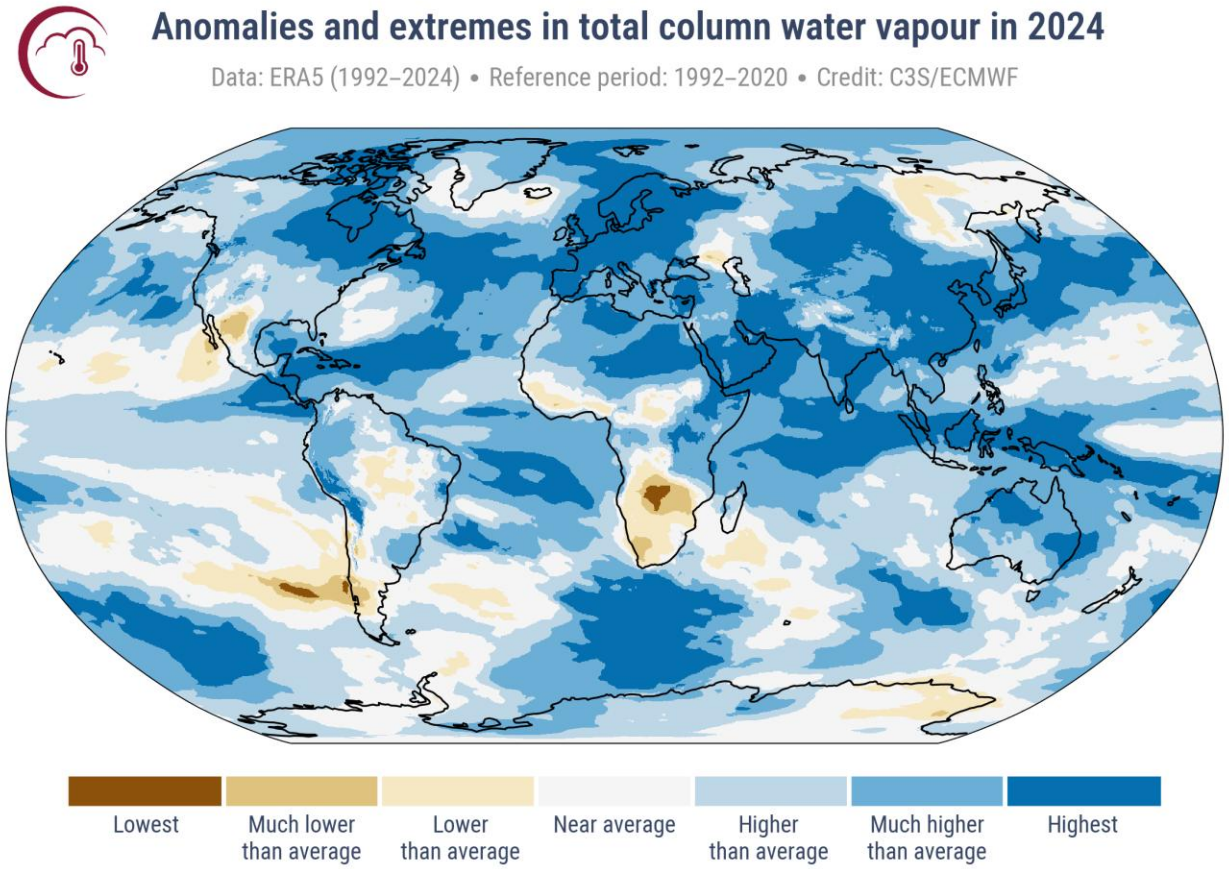
PROGRAMME OF THE EUROPEAN UNION
Copernicus Europe's eyes on Earth
Climate Change Service
IMPLEMENTED BY ECMWF

2024 was the hottest year on record and first year above 1.5°C



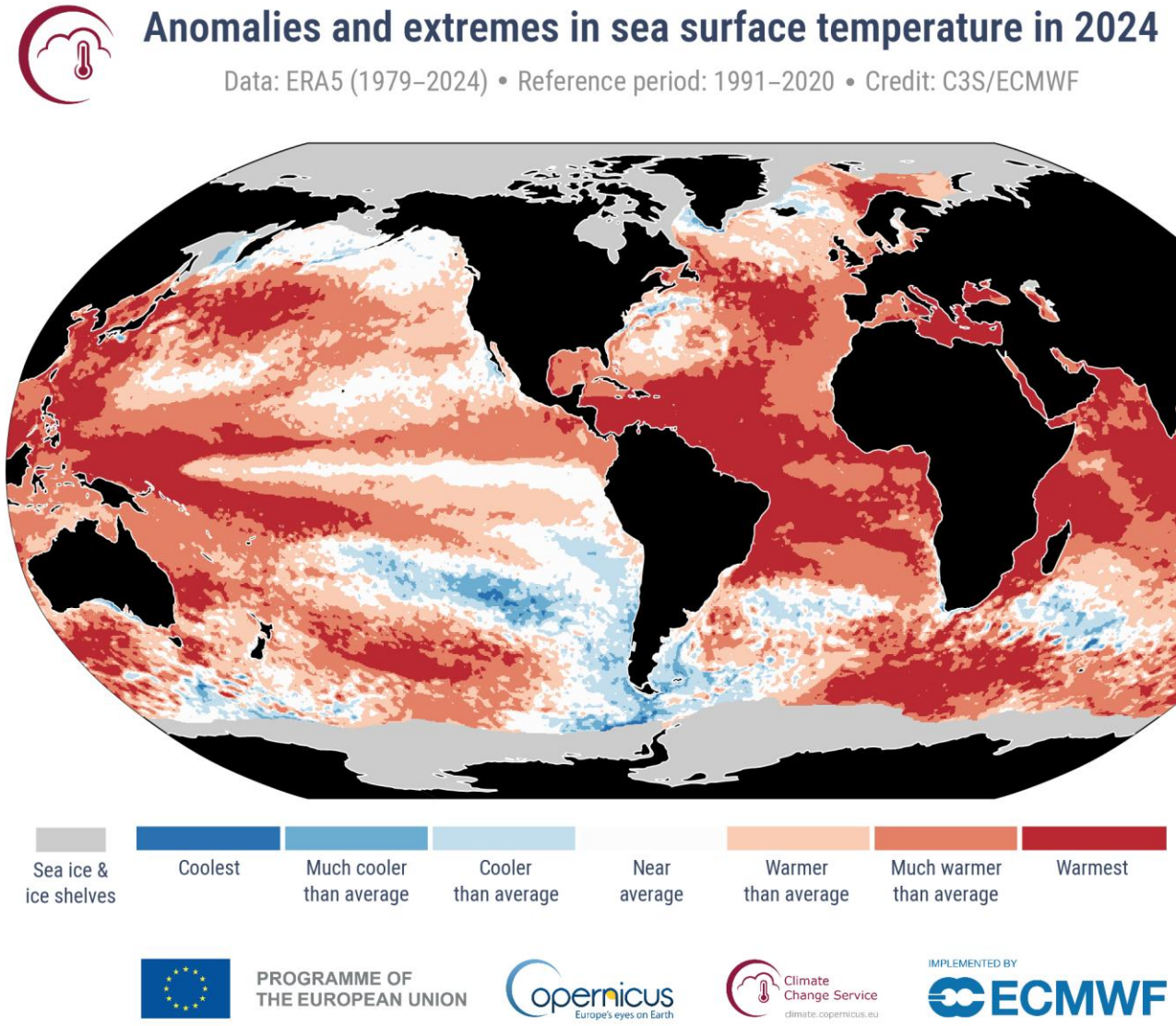
Record atmospheric water vapour in 2024

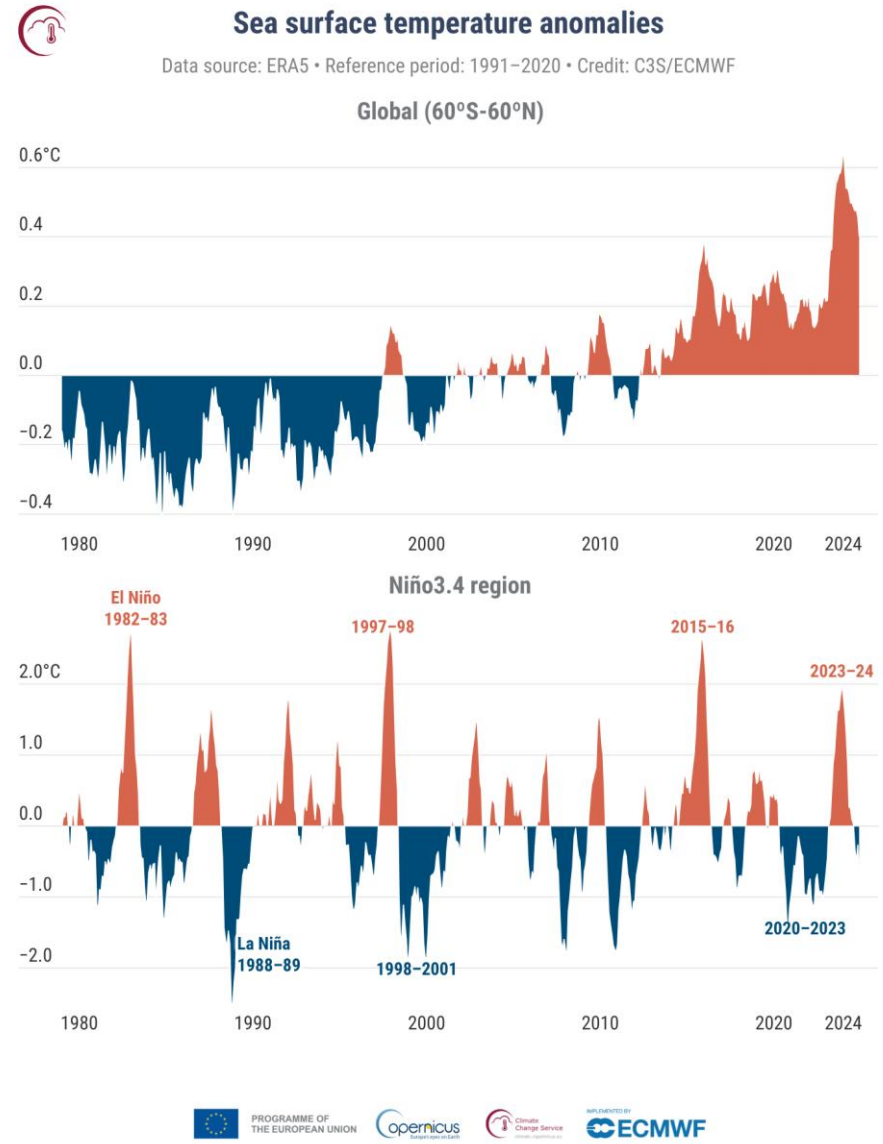




The total amount of water vapour in the atmosphere reached a record value in 2024, at about 5% above the 1991–2020 average

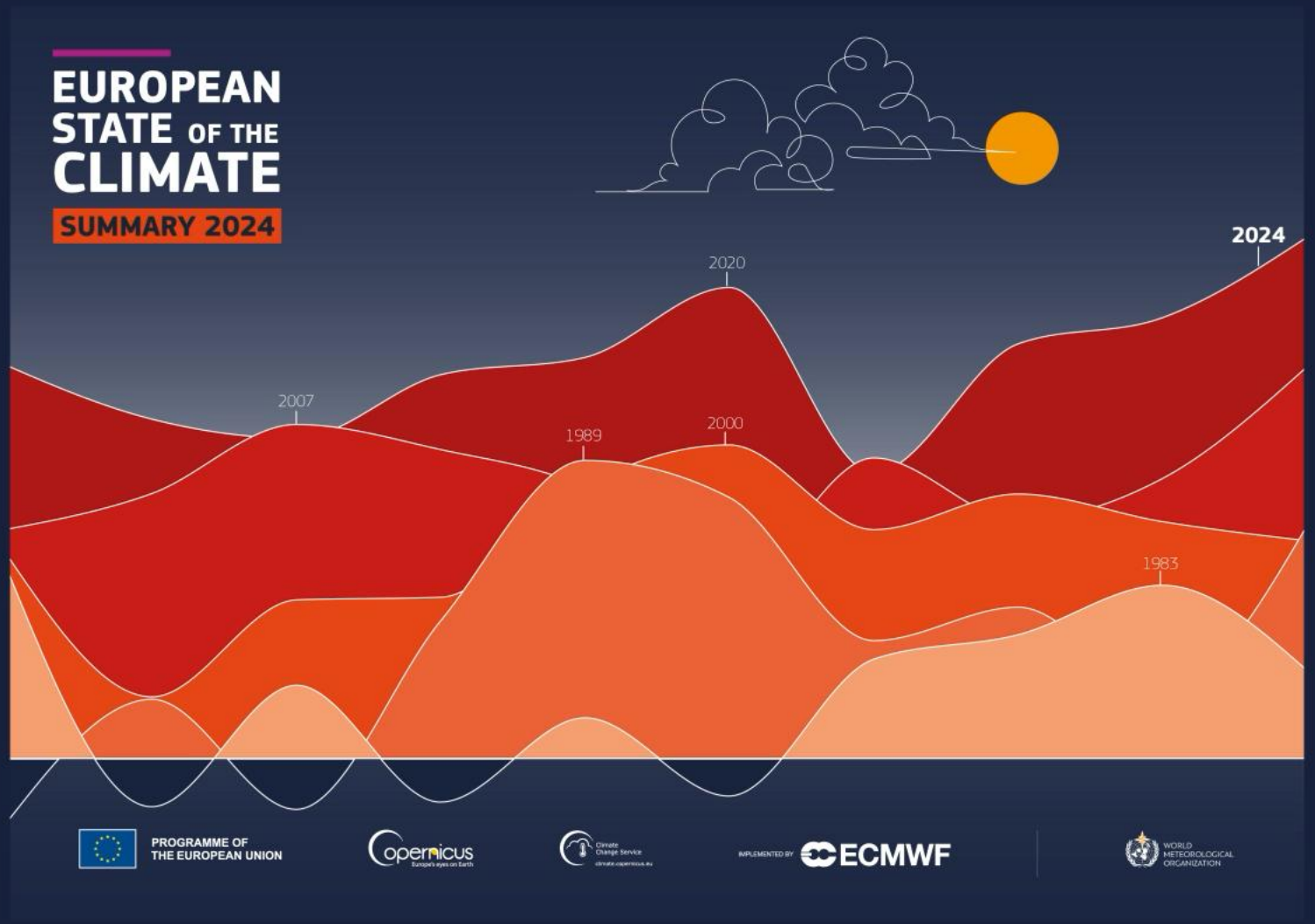
What role did El Niño play?





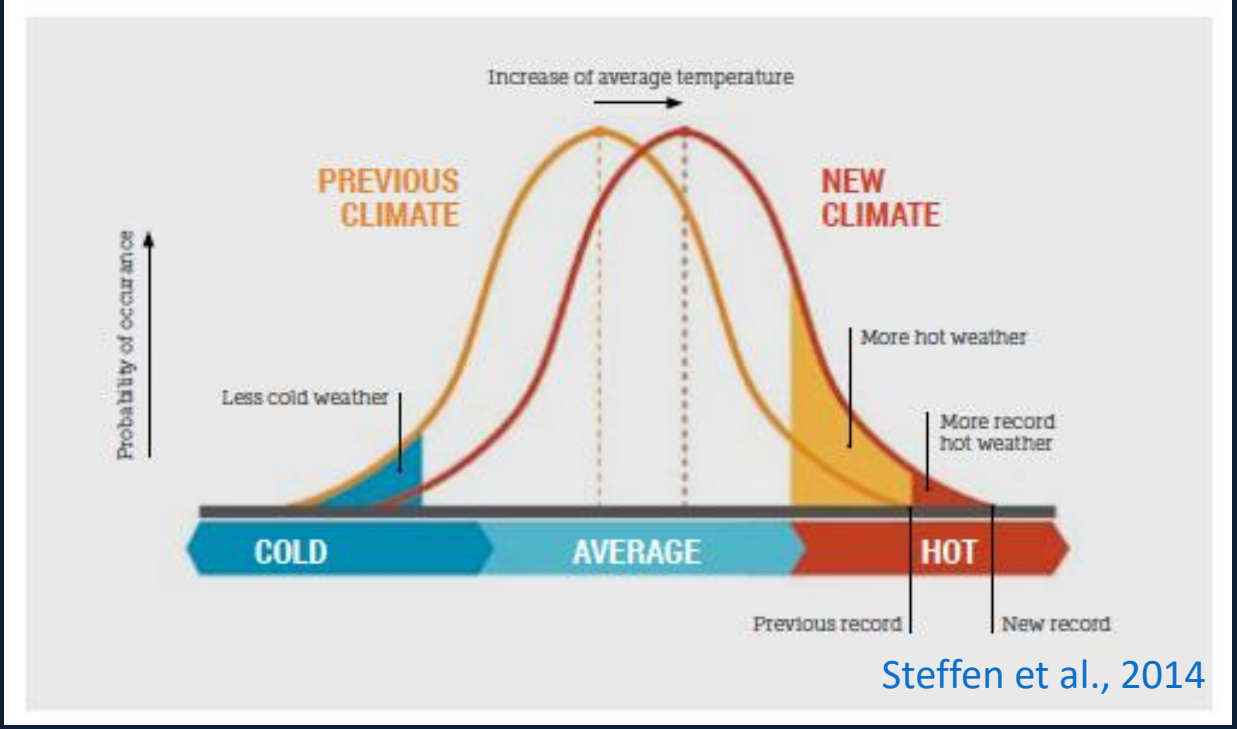
"The European State of the Climate Report of C3S is an invaluable resource for policy makers in Europe".

Belgian Minister for Climate, Zakia Khattabi



How are heatwaves changing?

- Human induced climate change warming the background (average) temperature above pre-industrial conditions
- only need a small increase in mean temperature to see large changes in extremes.

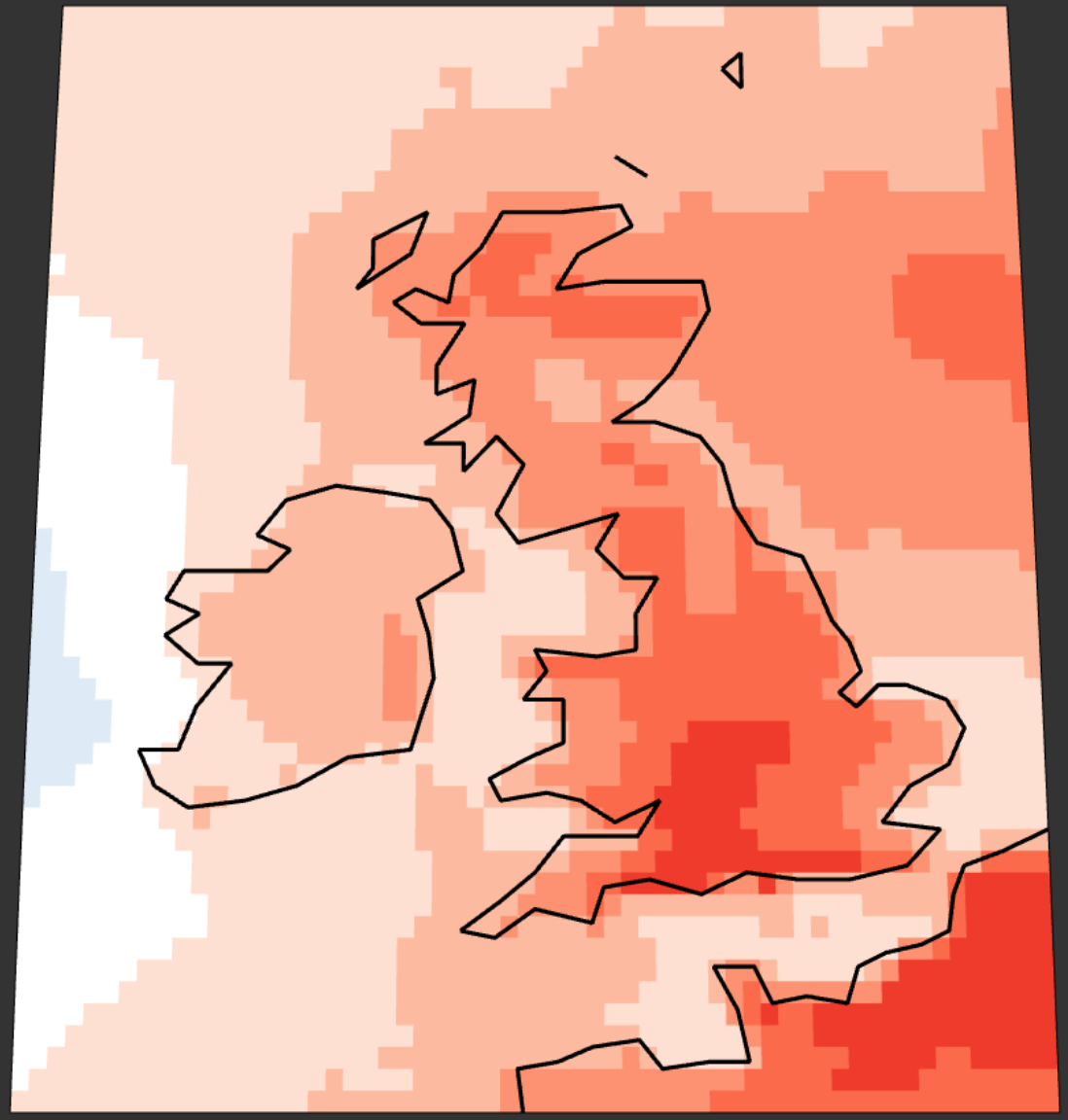


Steffen et al., 2014

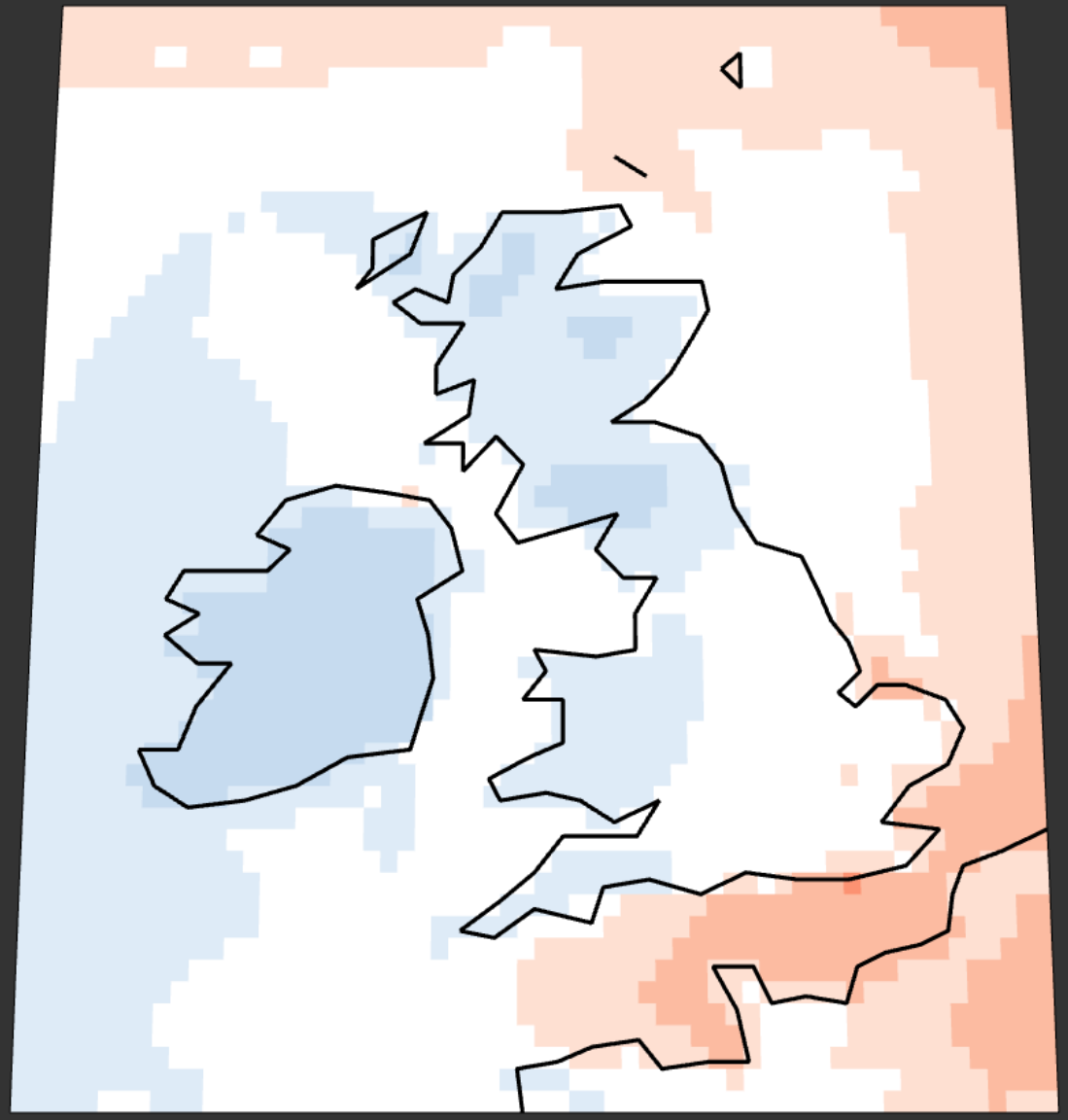
Heatwaves: longer, hotter, more often.

Warmer or cooler than normal?

JULY 1976

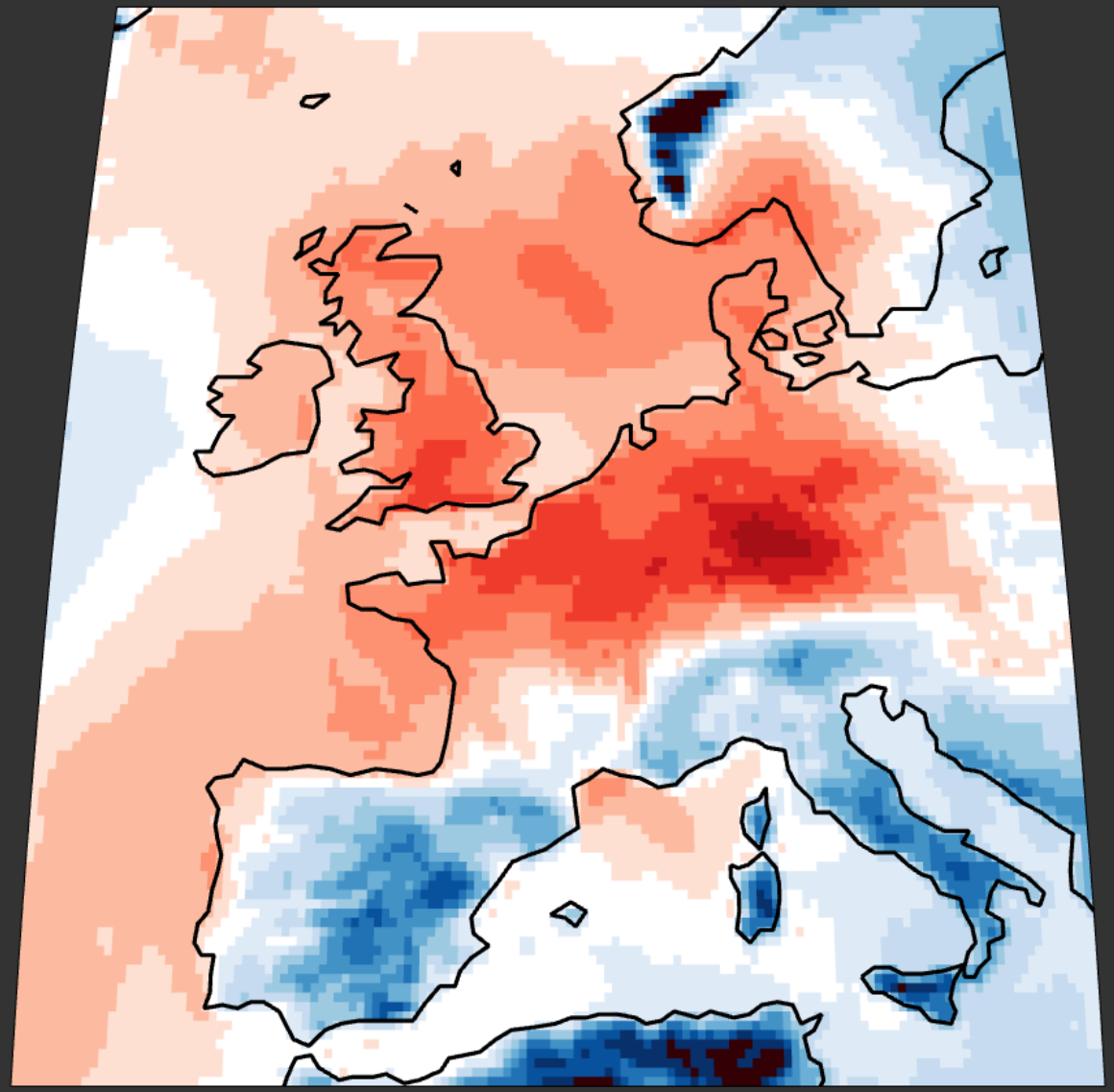


JULY 2024

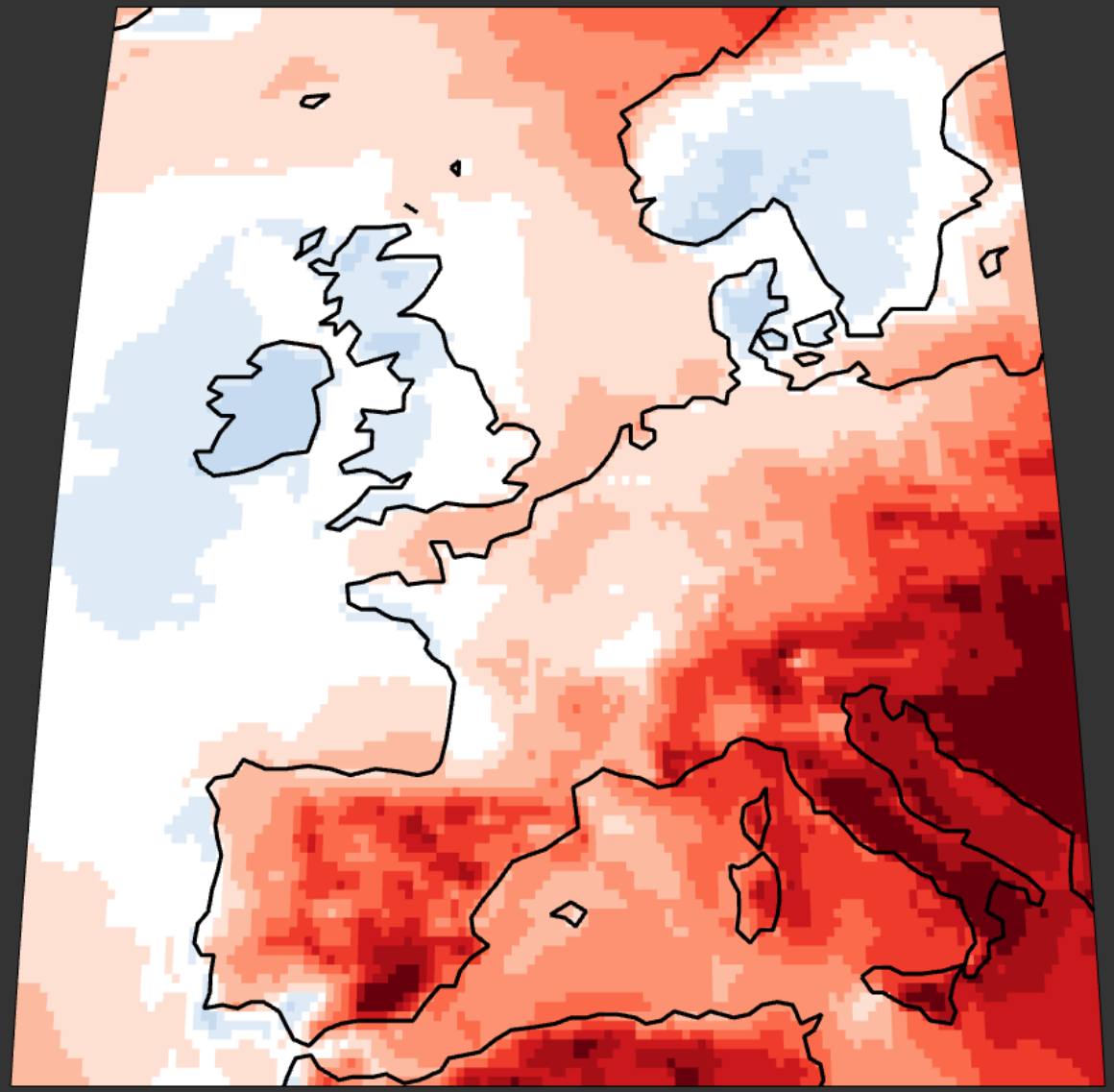


Warmer or cooler than normal?

JULY 1976

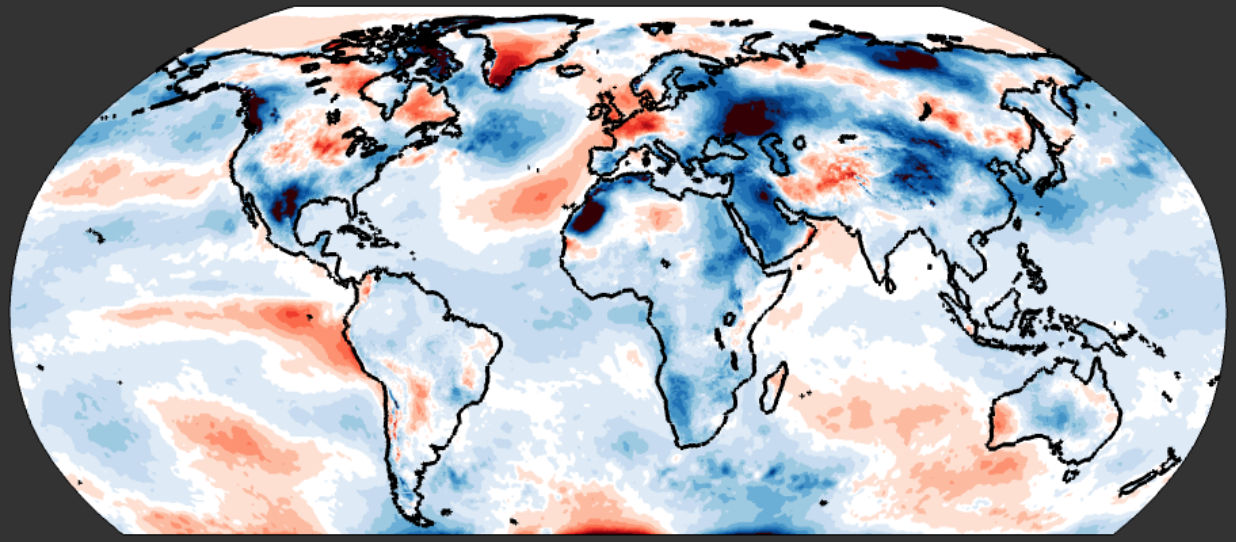


JULY 2024

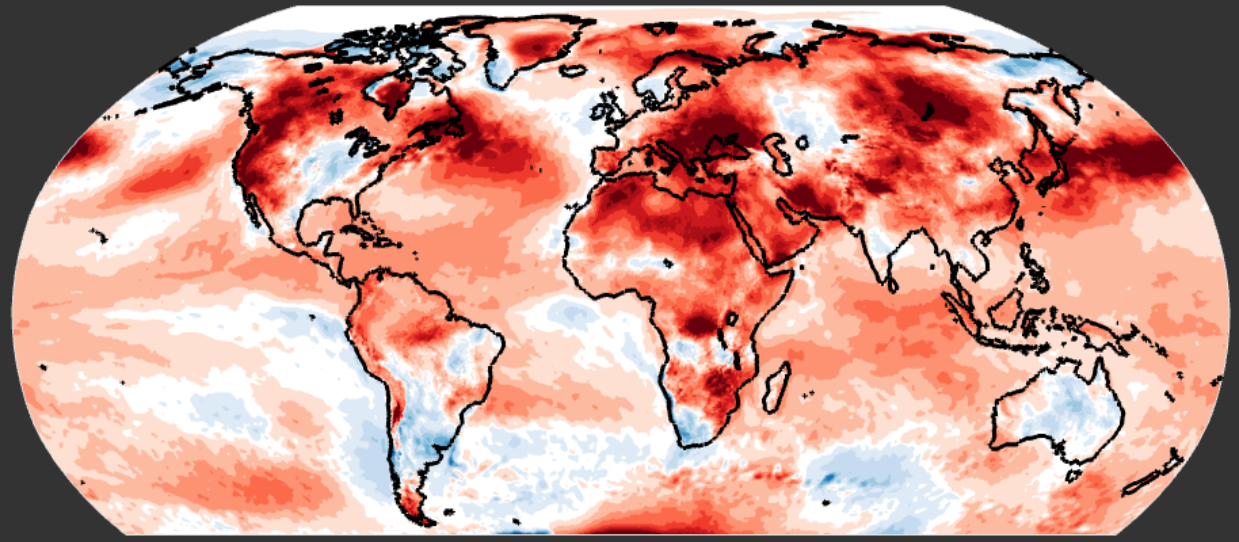


Warmer or cooler than normal?

JULY 1976

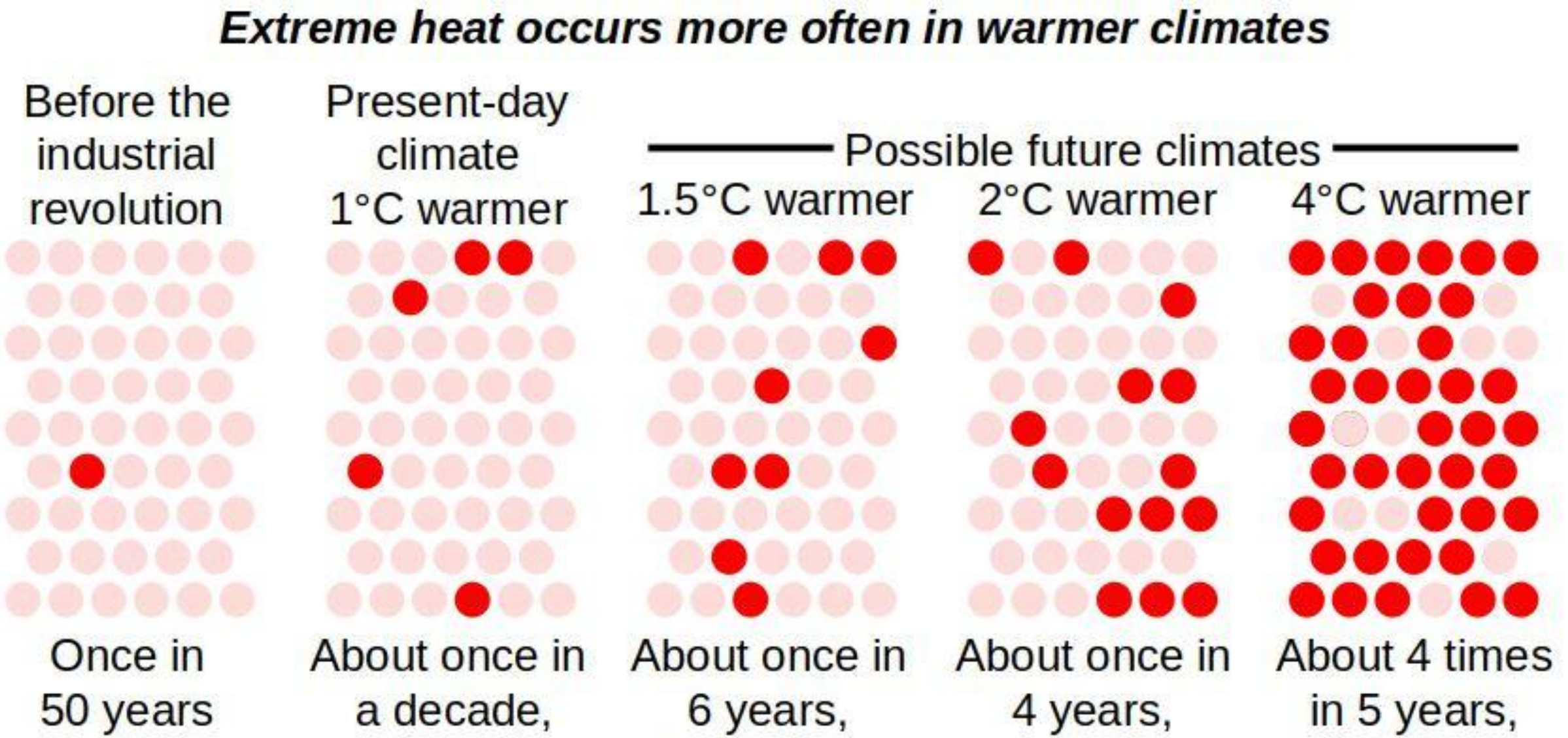


JULY 2024



19th July 2022 – 40°C heatwave & London wildfire

- Temperatures would have peaked ~ 36°C without human influence
- 6x more likely to see very high risk fire weather now
- 2800 excess deaths that summer

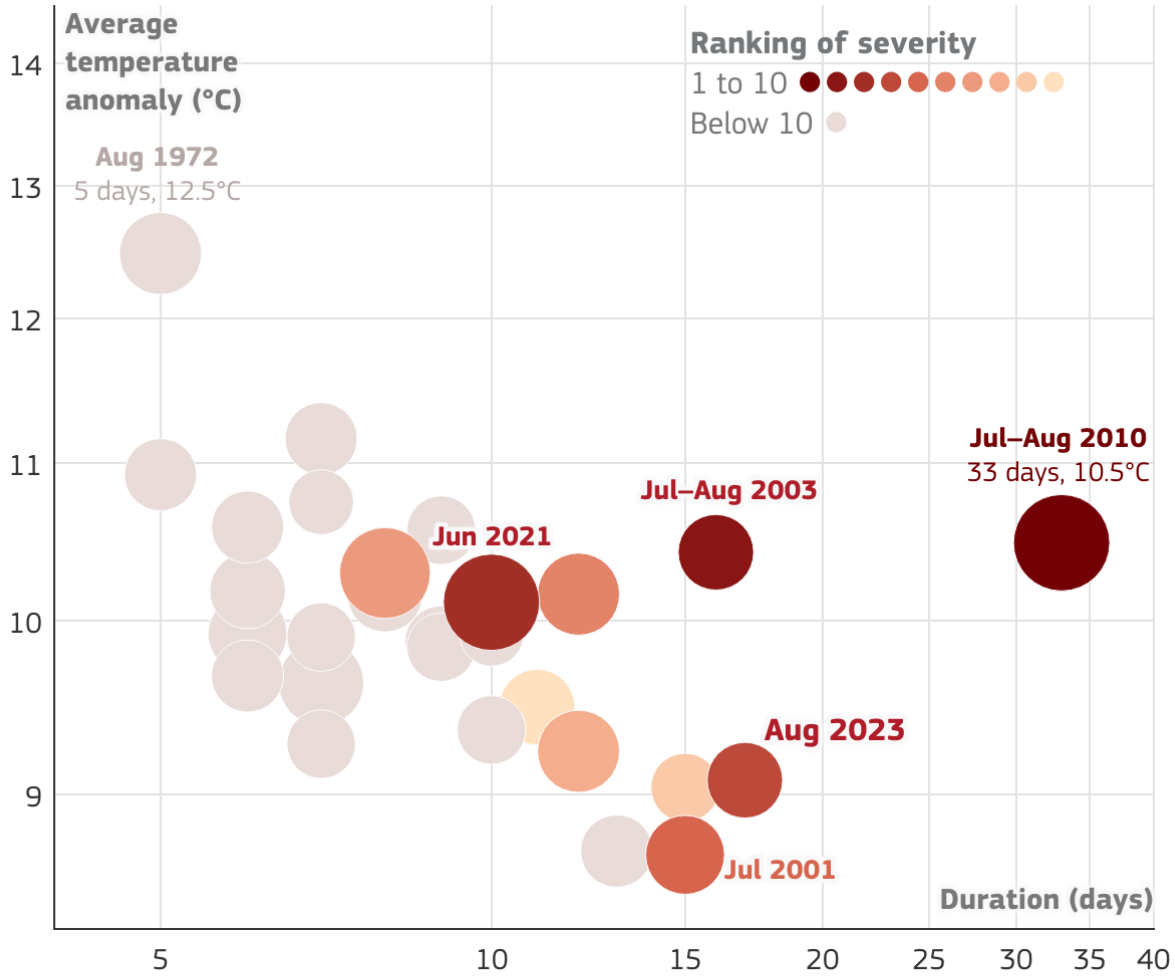


Credit: J Gregory

23 of the 30 most **severe heatwaves** have occurred **since 2000**, and **five in the last three years**

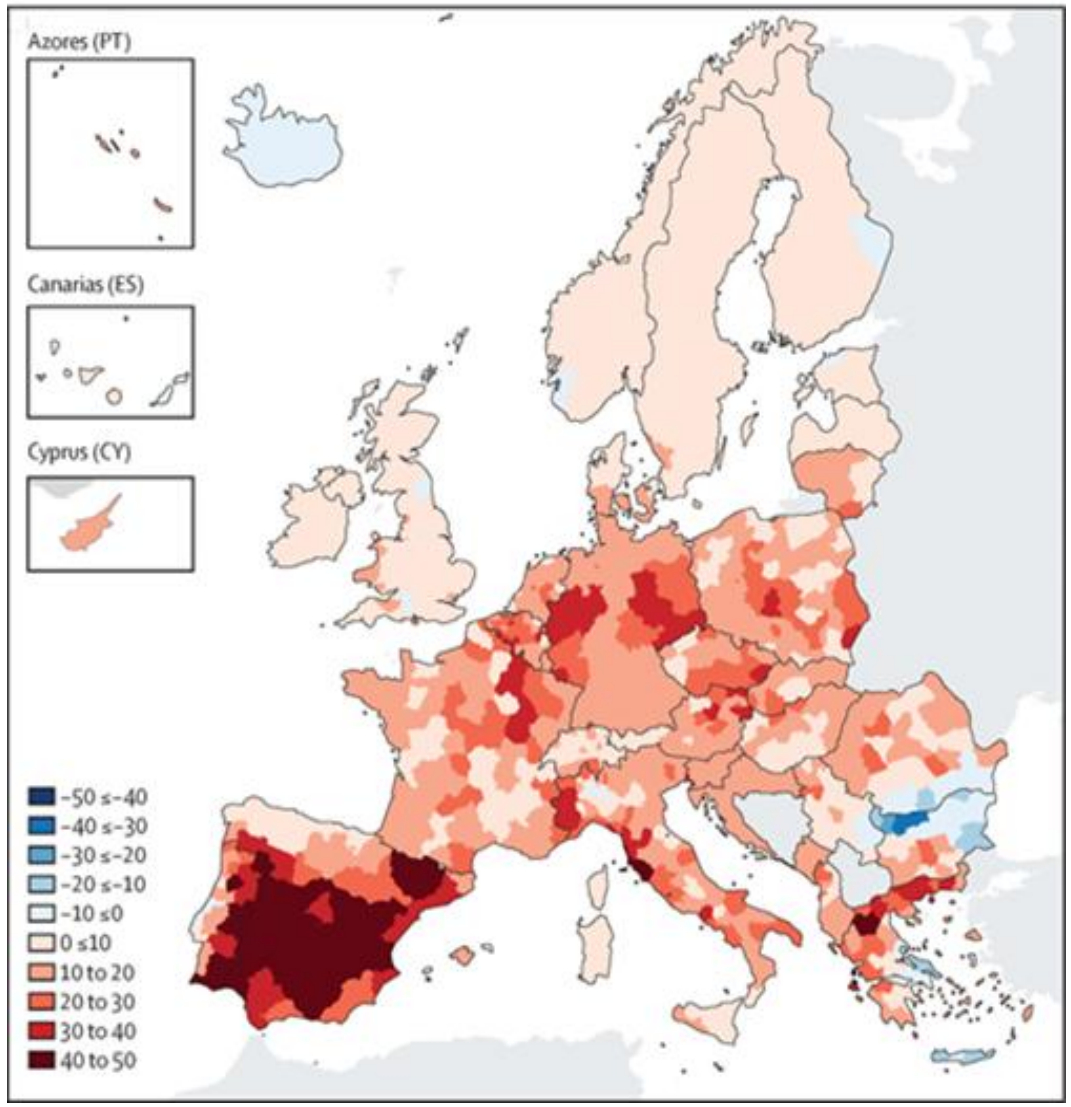
Top 30 severe heatwaves in Europe (1950–2023)

The size of a circle is proportional to the area affected by the corresponding heatwave. Select one to find out more information. A logarithmic scale is used on both axes.



Heatwaves are defined as periods when the maximum temperature exceeded the 98th percentile of the 1961–1990 reference period, and exceeded 28°C, for a period of three or more days.

Trends in heat related mortality in Europe, for the general population
annual death per million per decade 2000–2020)

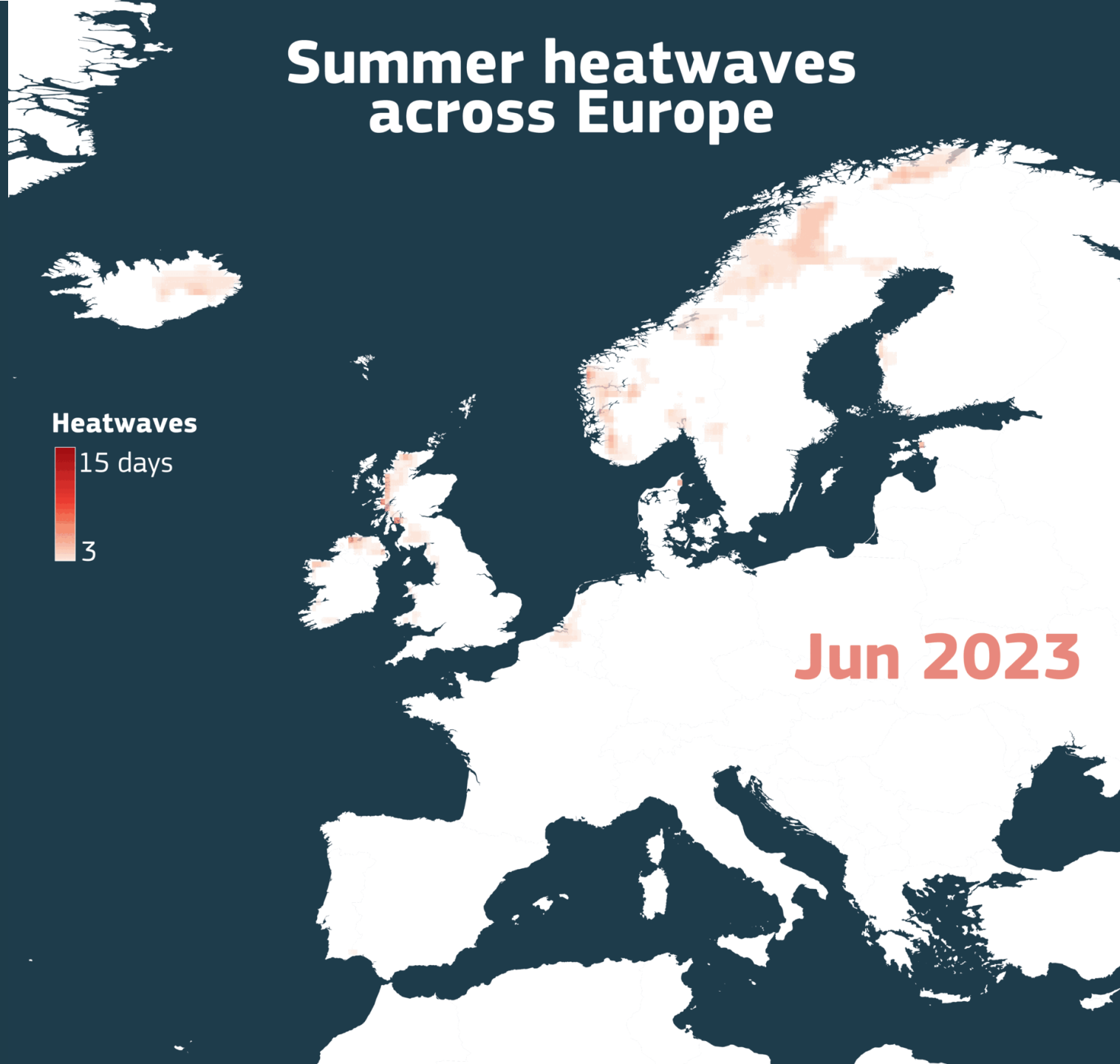


Credit: The 2022 Europe report of the Lancet Countdown on health and climate change

Heat-related mortality has **increased by around 30%**
in the past 20 years

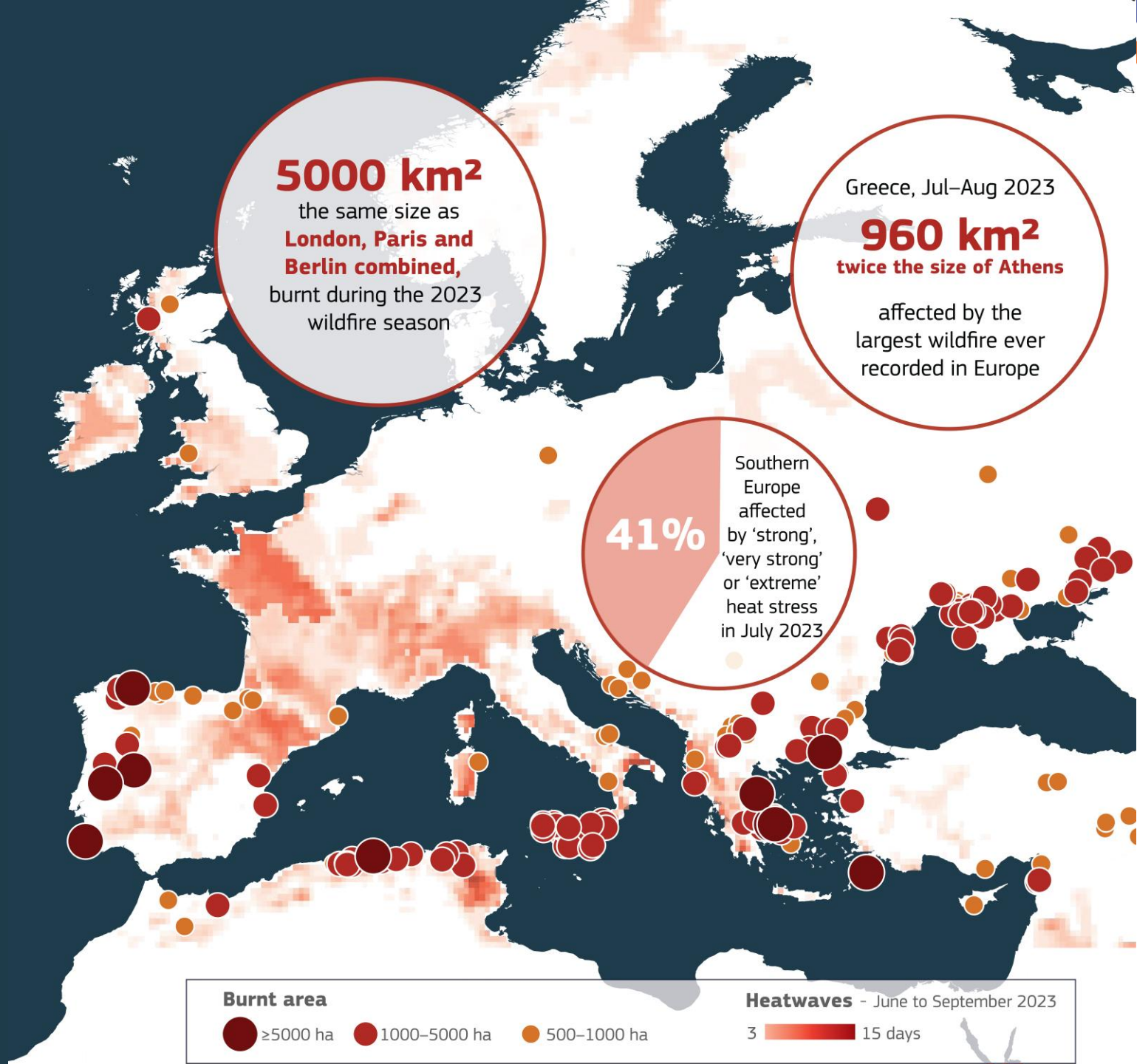
Heat-related deaths are estimated to have **increased in 94%** of European regions monitored

Europe’s contrasting summer

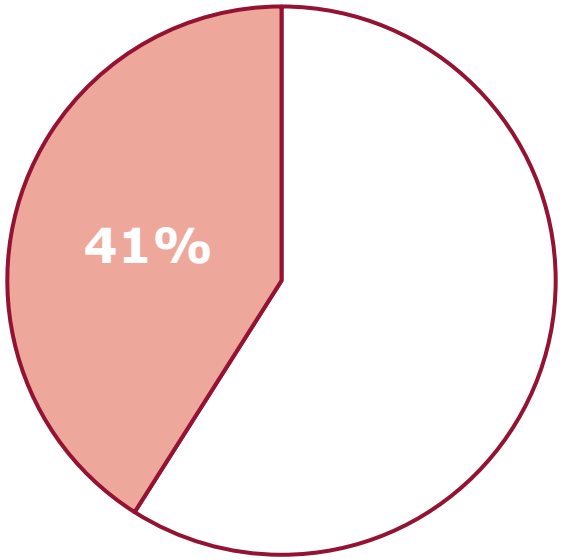


Emergency Management

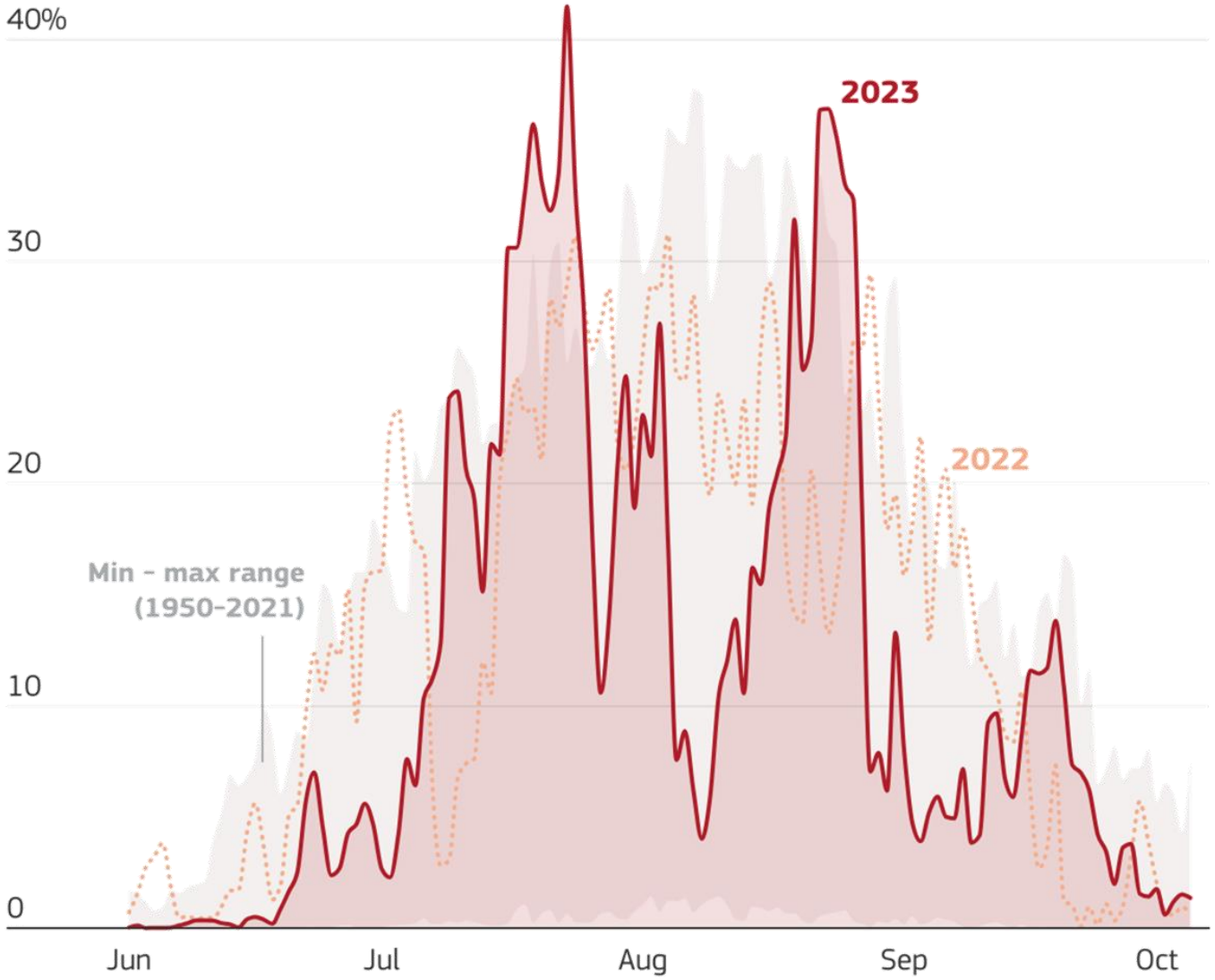
Europe’s contrasting summer



Emergency Management

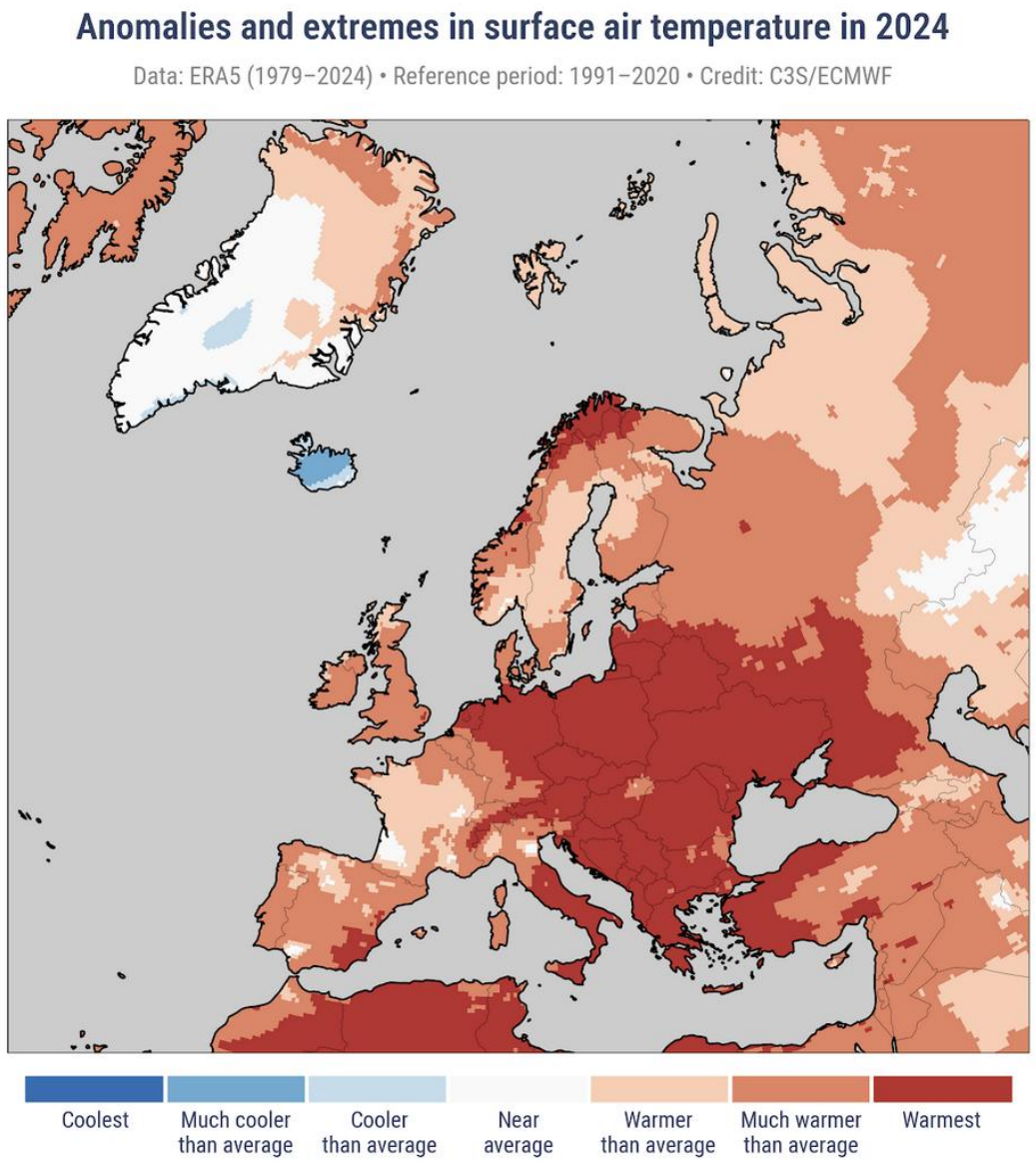


41% of **southern Europe**
affected by
'strong', 'very strong' or 'extreme'
heat stress
on 23 July 2023

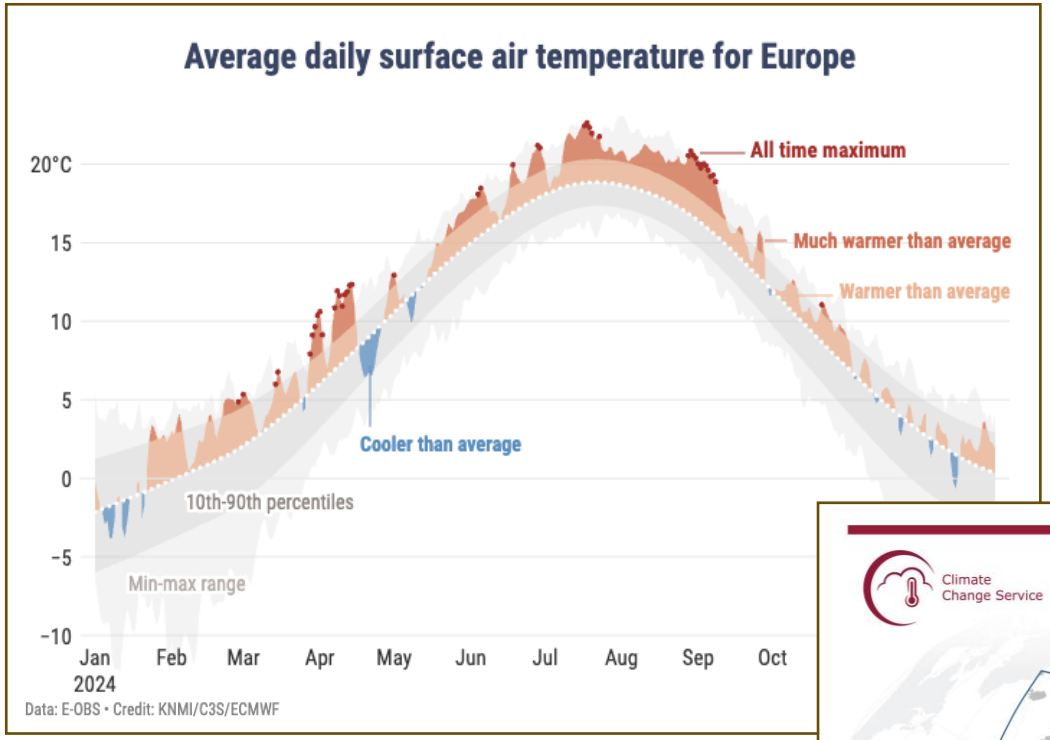


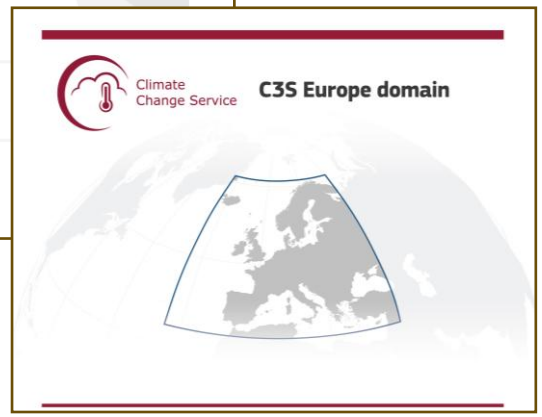
Area of southern Europe impacted by at least 'strong heat stress'

Record annual temperatures in central and eastern Europe



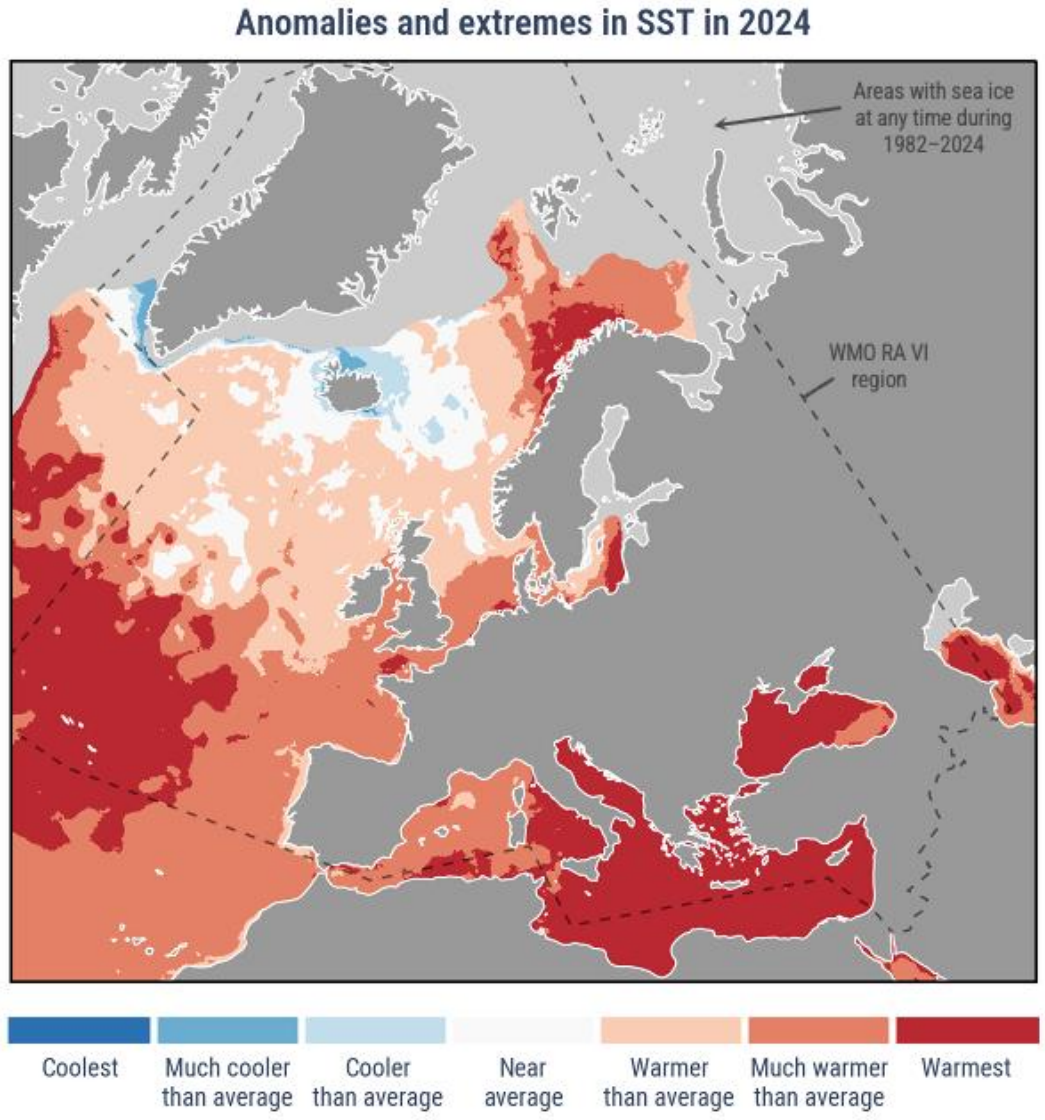
Averaged over Europe:
45% of days were **much warmer than average**
12% of days were the **warmest on record**

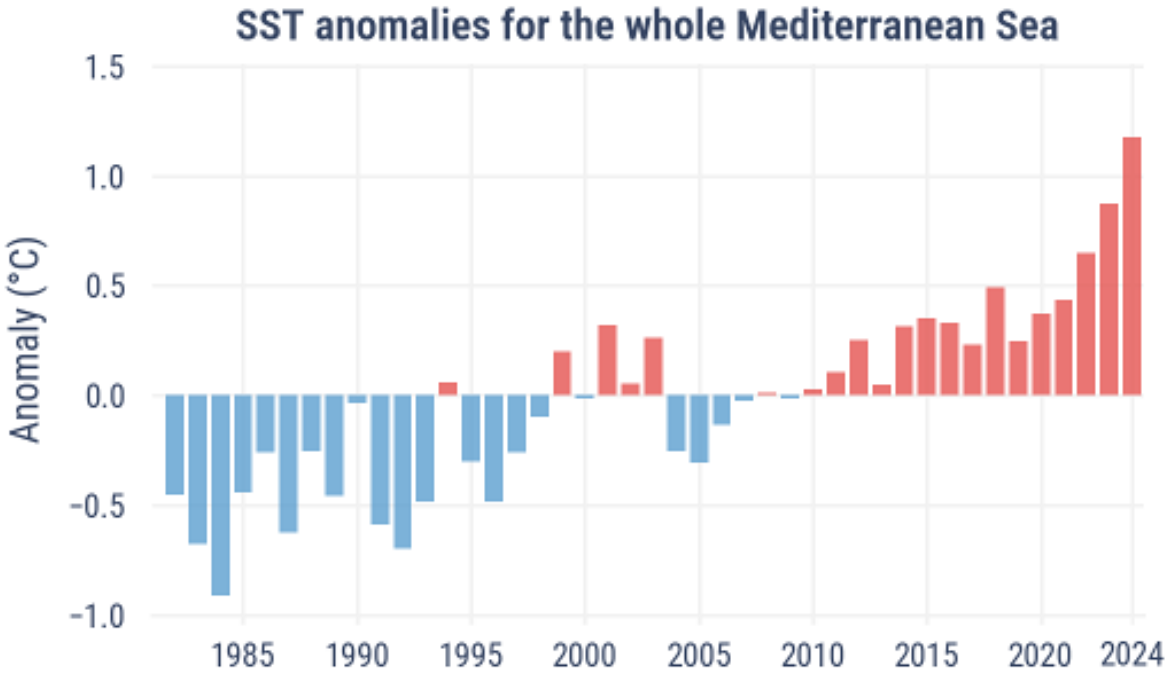




Data: DWD, ERA5-HEAT UTCI, E-OBS temperature • Reference period: 1991–2020 • Credit: C3S/ECMWF DWD/KNMI

Record-warm sea surface temperatures

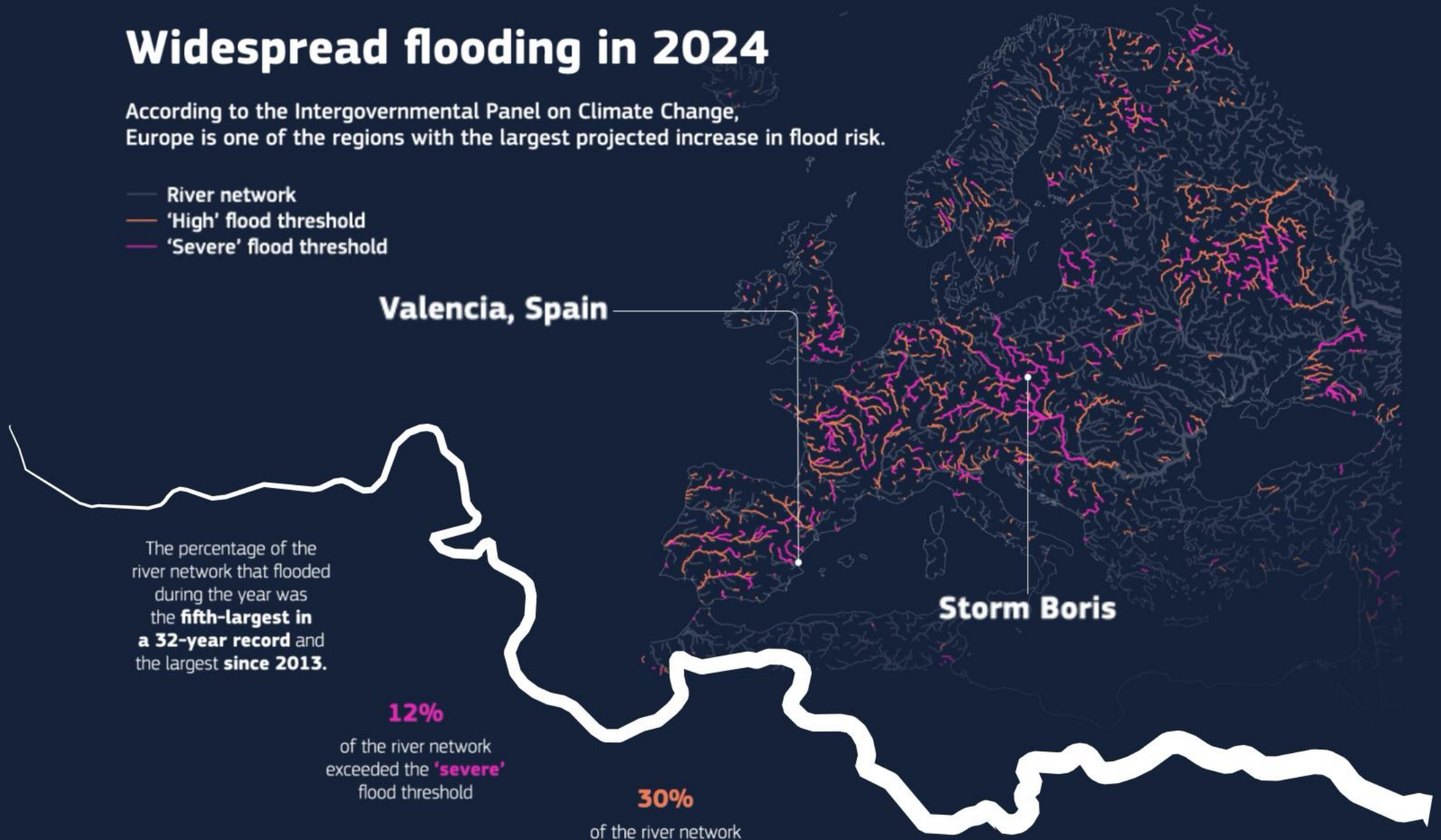




Widespread flooding in 2024

According to the Intergovernmental Panel on Climate Change, Europe is one of the regions with the largest projected increase in flood risk.

River network
'High' flood threshold
'Severe' flood threshold



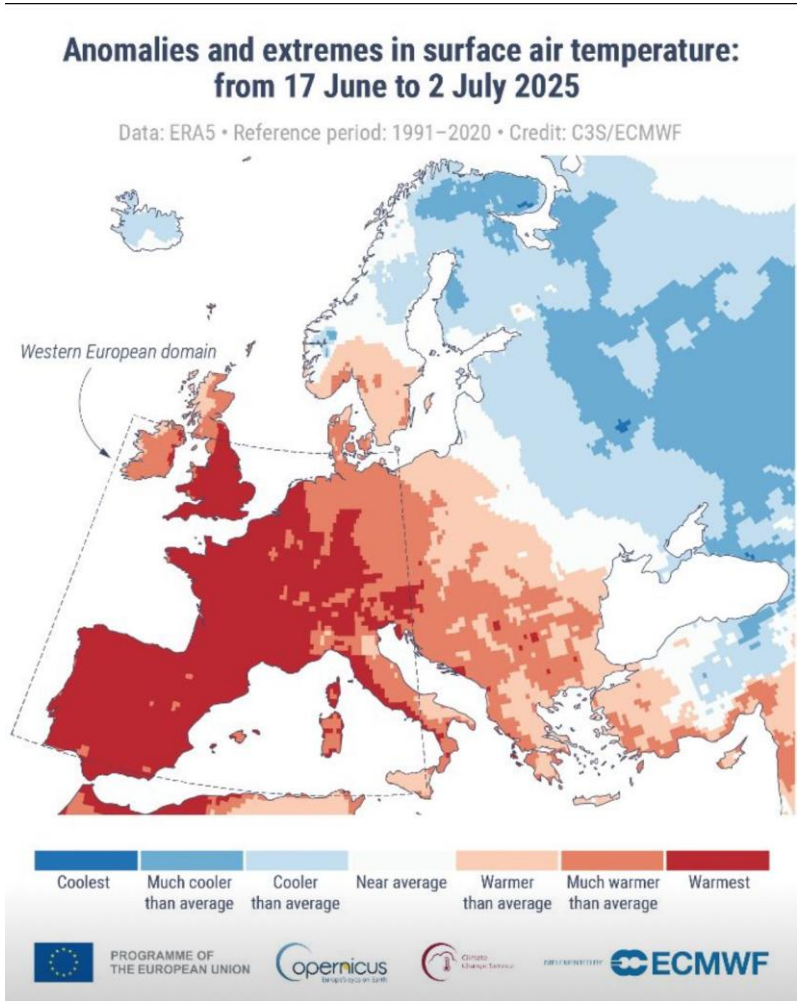
The percentage of the river network that flooded during the year was the **fifth-largest in a 32-year record** and the largest **since 2013.**

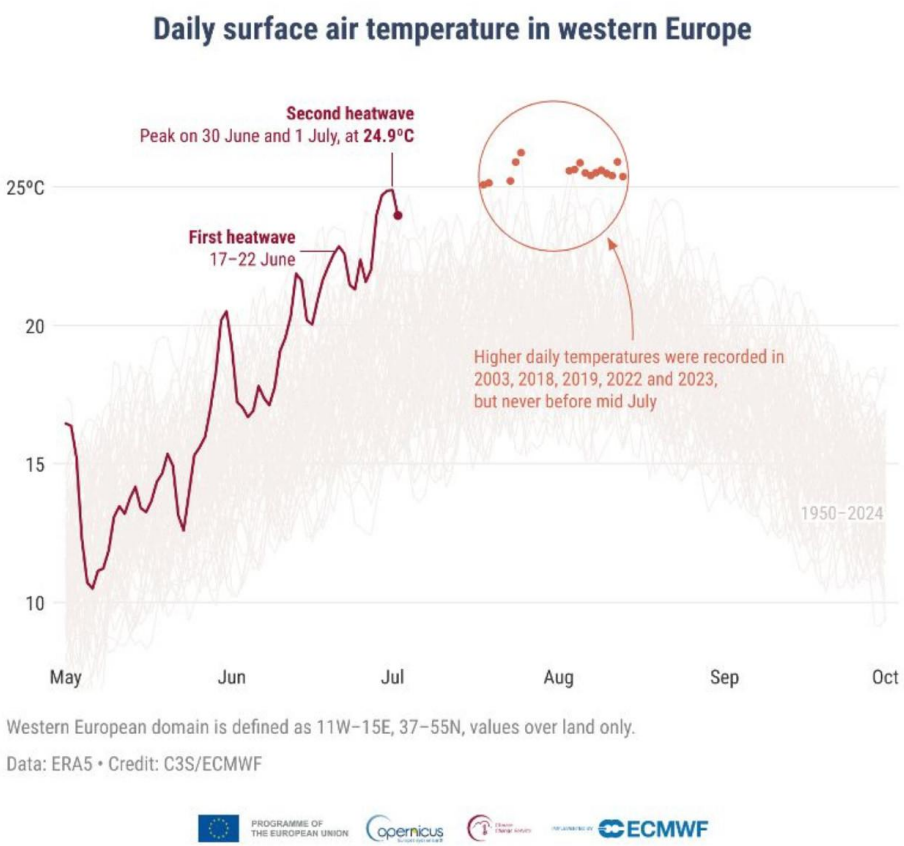
12%
of the river network exceeded the **'severe'** flood threshold

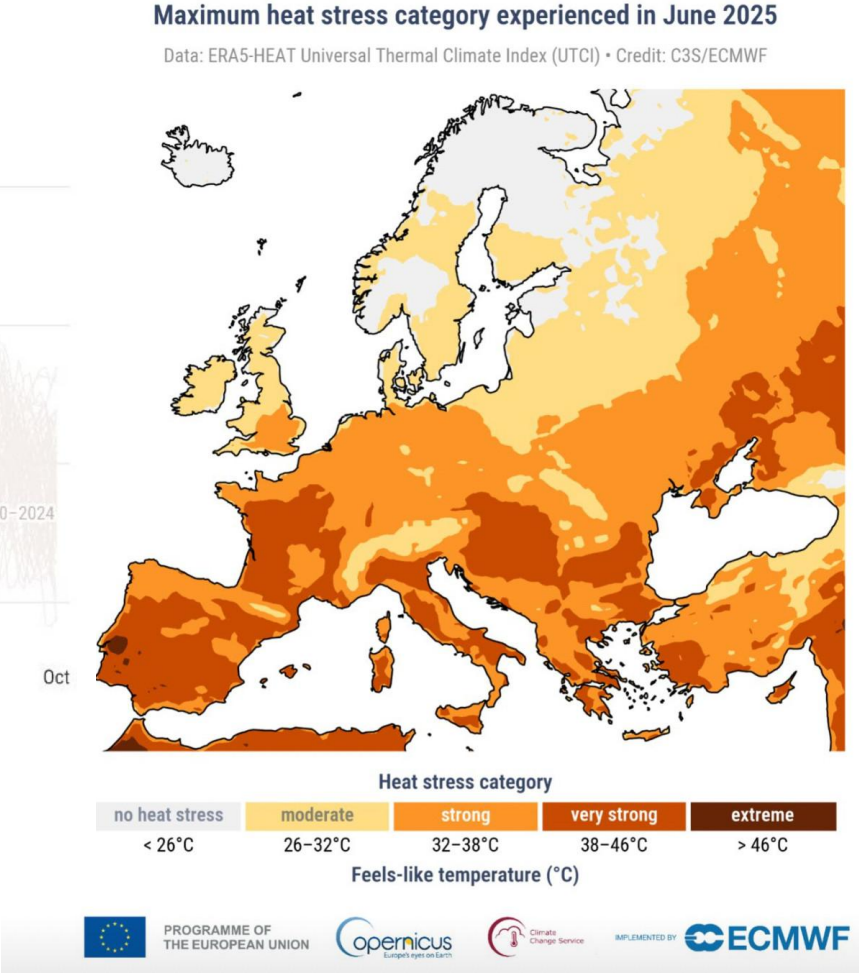
30%
of the river network exceeded at least the **'high'** flood threshold

Notable flood events occurred throughout the year. See the ESOTC 'Flooding' section and the interactive key events map for more details. Data: EFAS • Credit: CEMS/C3S/ECMWF

2025 June heatwaves in Europe







Resilience of the built environment to climate extremes

ESOTC 2024 | Climate Policy and Action

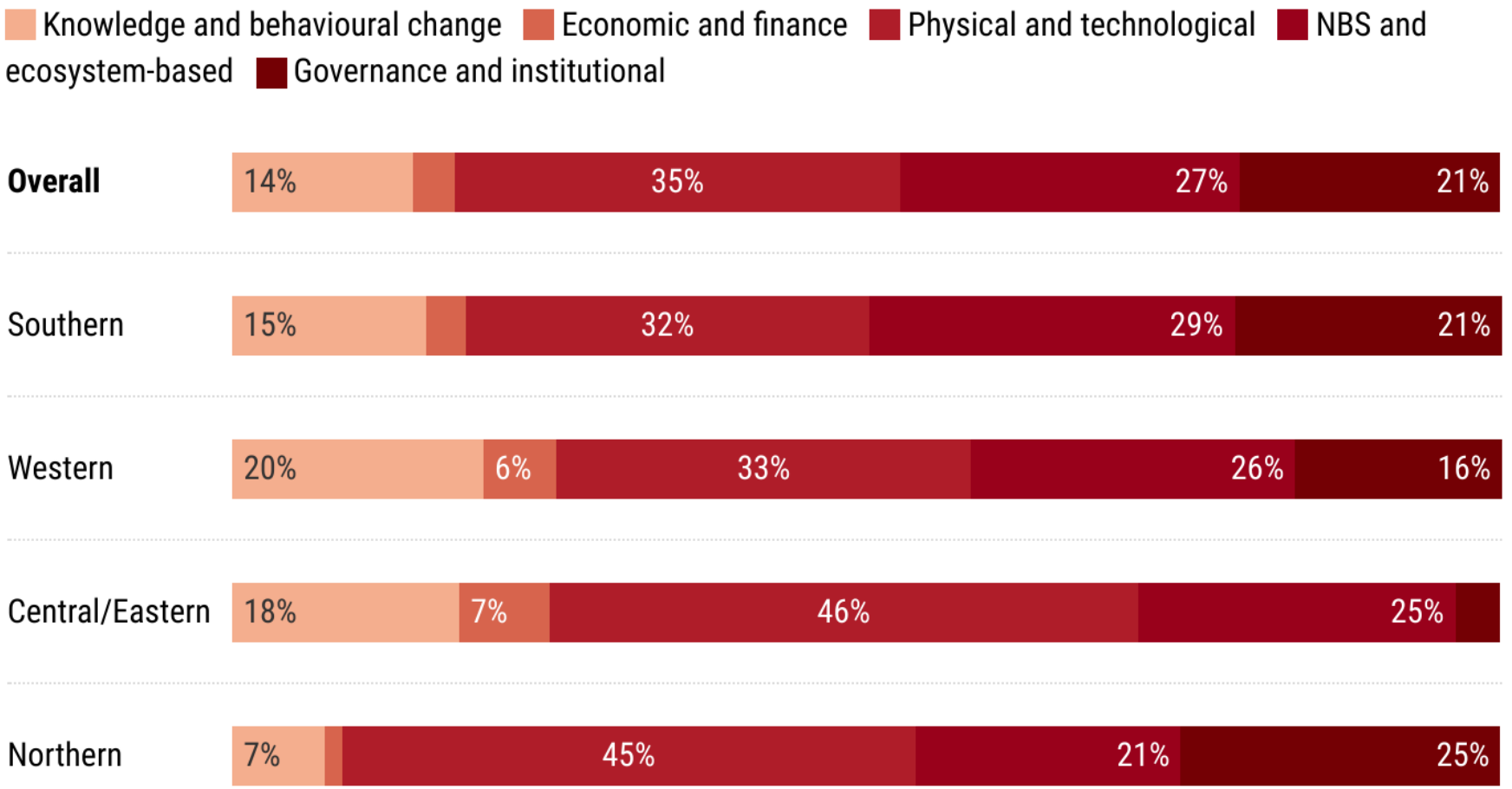
Extreme weather events present **increasing risks** to Europe's **built environment and infrastructure**

Climate risks for 'Infrastructure' cluster	Urgency to act	Risk severity		
		Current	*Mid-century*	*Late century (low/high warming scenario)*
Pluvial and fluvial flooding	Urgent action needed	Substantial •••	Critical •••	Critical/Catastrophic ••
Coastal flooding	More action needed	Substantial •••	Critical •••	Catastrophic •••
Damage to infrastructure and buildings*	More action needed	Substantial ••	Substantial ••	Substantial/Critical ••
Energy disruption due to heat and drought (hotspot region: southern Europe)	More action needed	Substantial ••	Critical ••	Critical ••

Data: EUCRA

What are cities already doing?

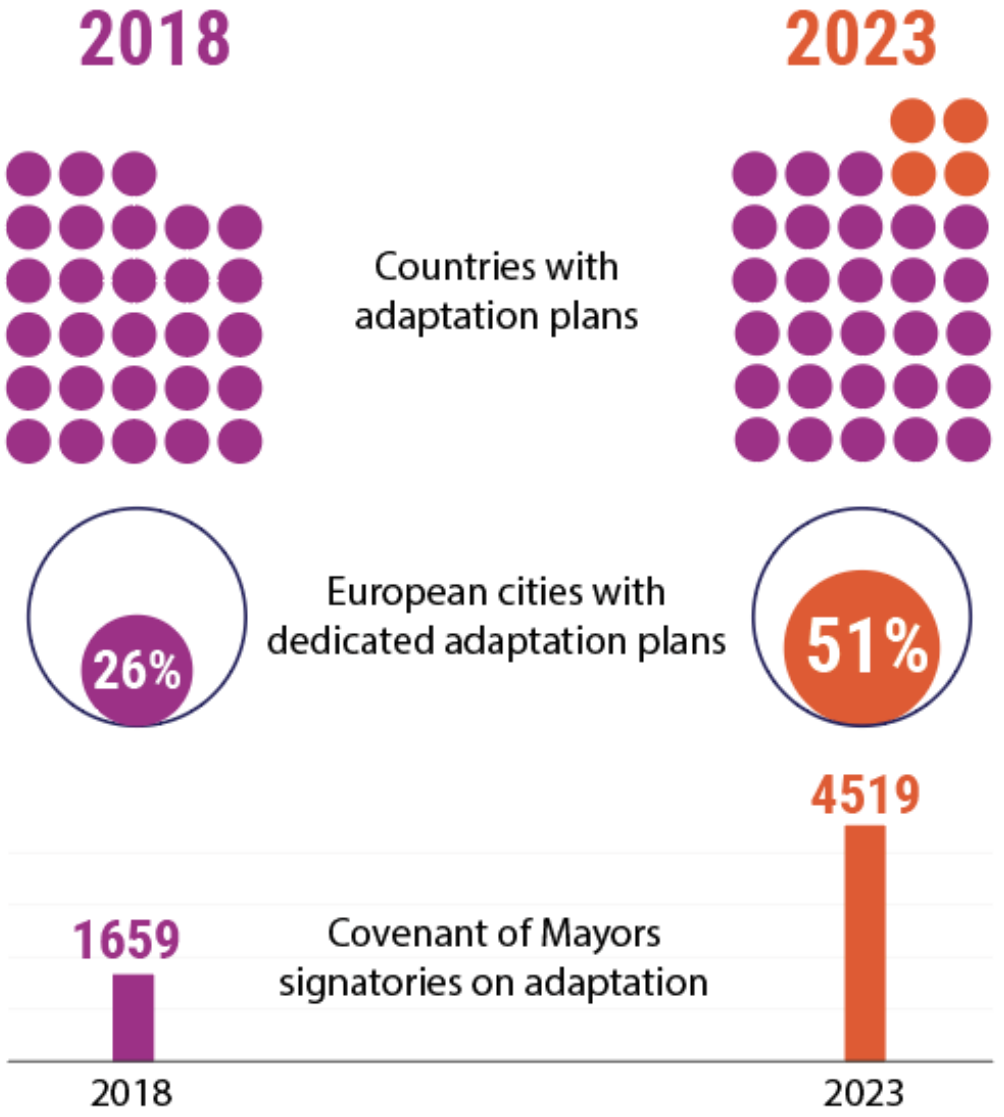
Cities play an essential role in implementing adaptation measures



Data: EEA Urban adaptation report • Credit: EEA/C3S/ECWMF

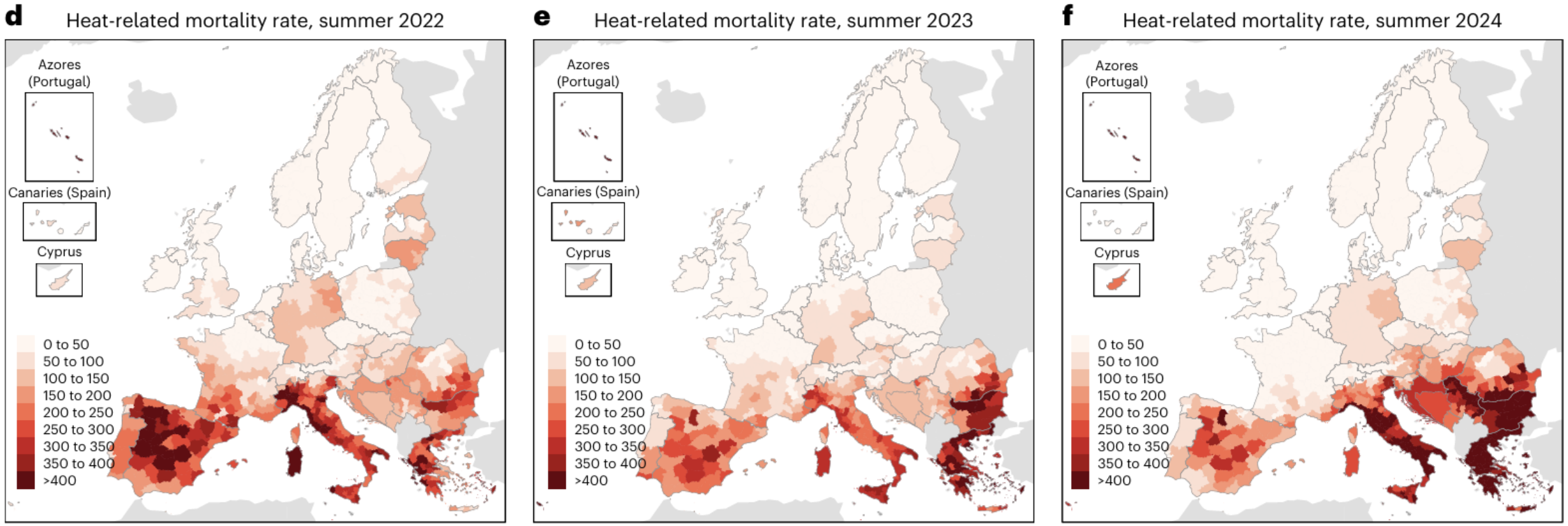
European cities have become **more resilient**

But **continued efforts** will further Enhance their capacity to **address climate challenges** more effectively



Heat related mortality

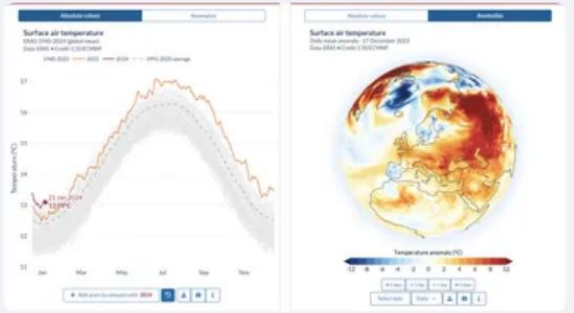
Estimated 62,775 heat-related deaths in 2024, exceeding 2023 (50,798), but less than 2022 (67,873)



Janos et al 2025

Climate applications

- **Accessible climate intelligence to inform policy**
- **Explore near real time updates of the global ocean**
- **Compare past trends and future changes with different scenarios**

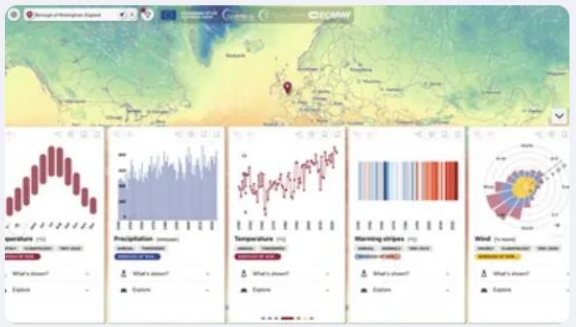


Climate Pulse

Climate Pulse visualises near-real-time updates of global average air- and sea-surface temperatures from ECMWF's flagship ERA5 reanalysis

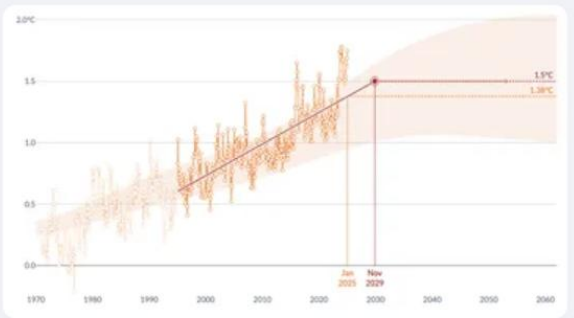
Copernicus Interactive Climate Atlas

The Copernicus Interactive Climate Atlas provides graphical information about recent past trends and future changes (for different scenarios and global warming levels)



ERA Explorer

Use the ERA Explorer to discover historical climate data from anywhere on earth, powered by the ERA5 reanalysis dataset.



Global temperature trend monitor

The global temperature trend monitor keeps track of the rate at which we approach 1.5°C of global warming - a limit agreed under the Paris Climate Agreement.

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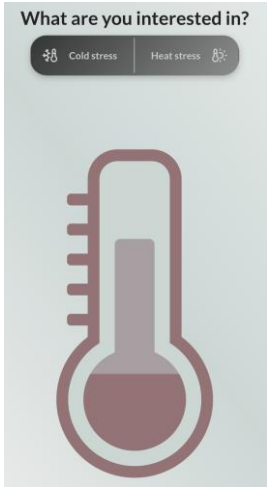
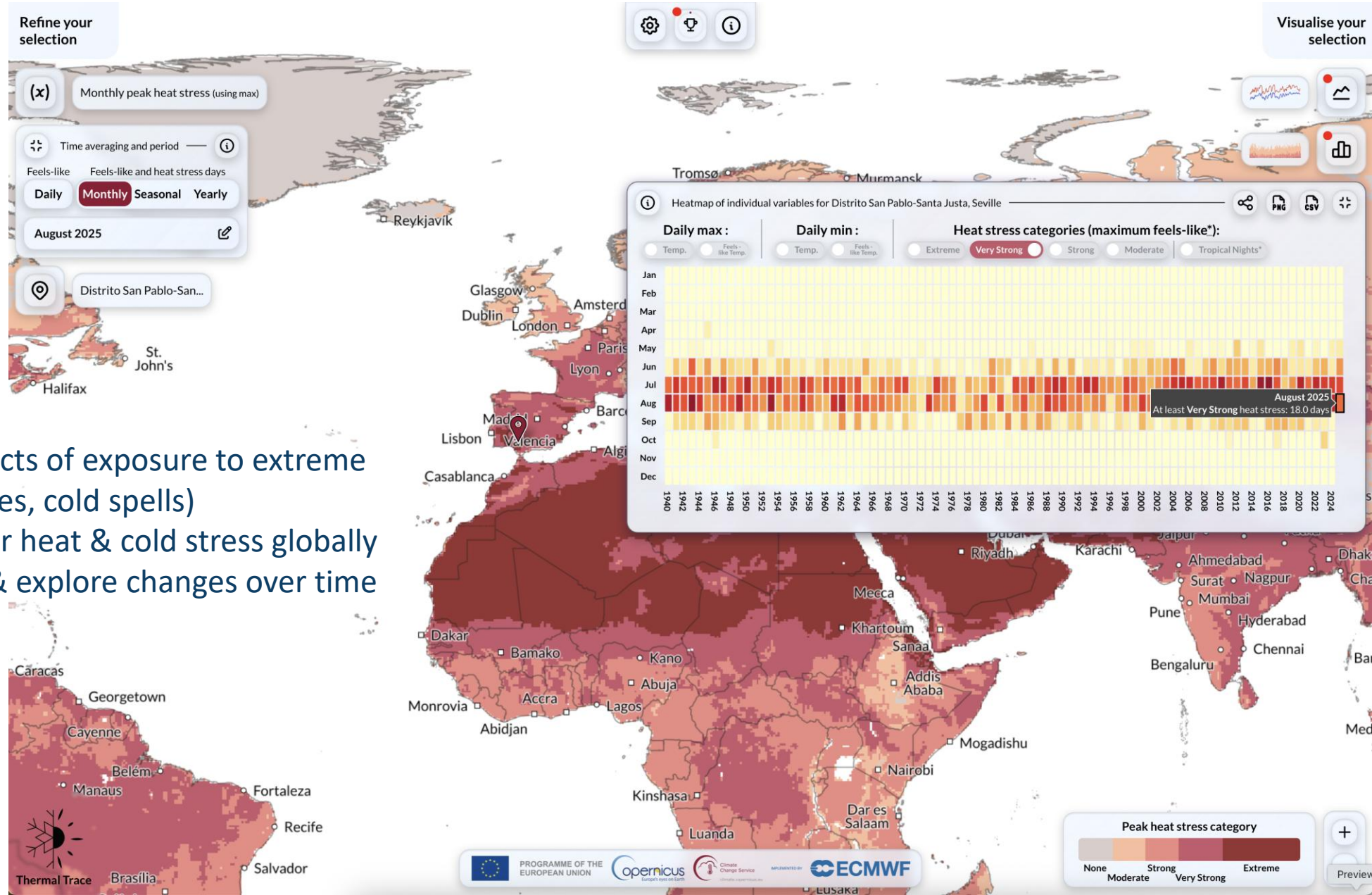
Thermal Trace





Thermal stress = health impacts of exposure to extreme thermal conditions (heatwaves, cold spells)

Use Thermal Trace to monitor heat & cold stress globally (five days behind real time) & explore changes over time

Economic costs of the climate crisis in the EU

38% of Europeans report feeling **exposed to climate risks** (2025)

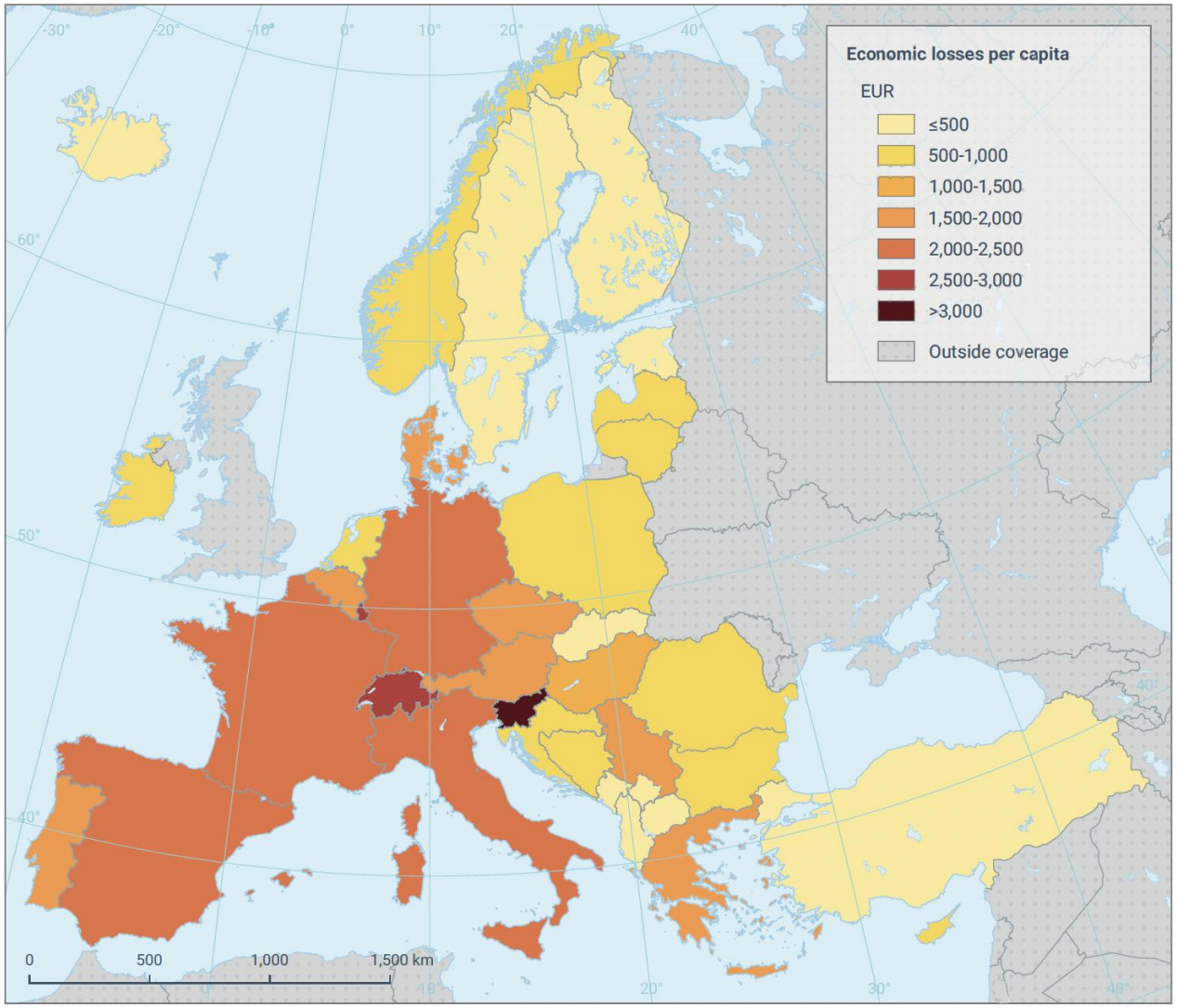
Extreme events from 1980-2023 in EU-27 have resulted in:

>240,000 fatalities

€ 738 billion in economic losses

Slovenia has the highest losses per capita, amounting to € 8,733 followed by **Luxembourg** (€ 2,694), **Switzerland** (€ 2,685), **Italy** (€ 2,330) and **Spain** (€ 2,279)

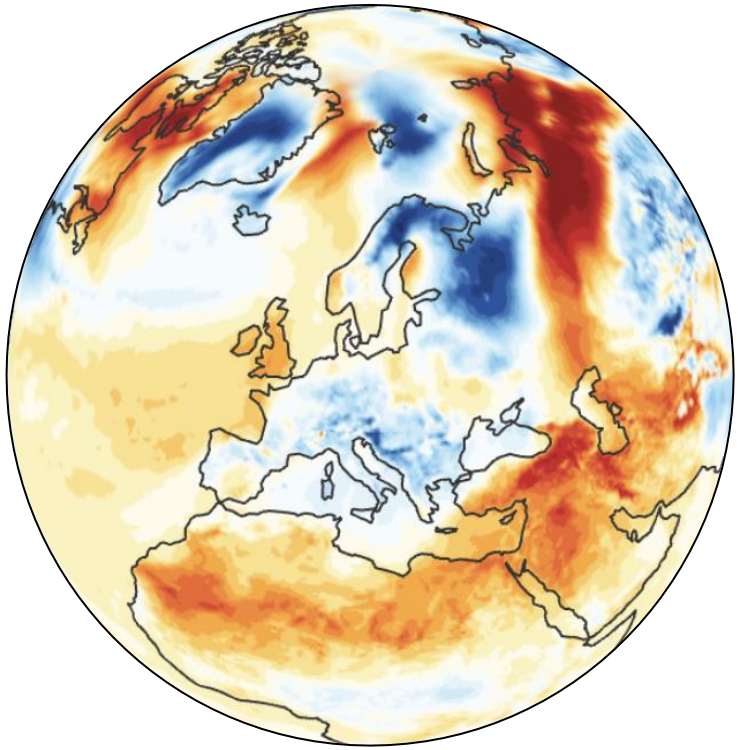
EEA, 2025



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

The Future …

- Climate Services such as C3S play a critical role; informing society, the EU, the IPCC and UN institutions.
- Developing an operational climate attribution service with applications, case studies and new counterfactuals
- Evolving our climate monitoring, with new applications
- Exciting developments with AI/ML and next generation global reanalysis
- **However, we are currently failing to adapt to extreme weather as fast as risk levels have increased**



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Thank you

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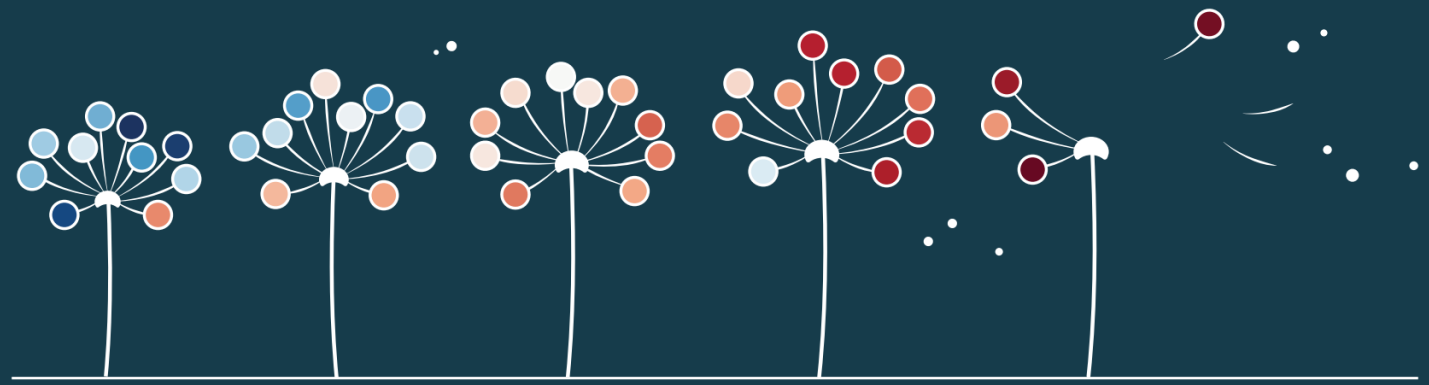

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