

State of the Climate

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Copernicus
Europe's eyes on Earth



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Climate Change

Climate change is already impacting everyone

2023 was the
warmest year
on record

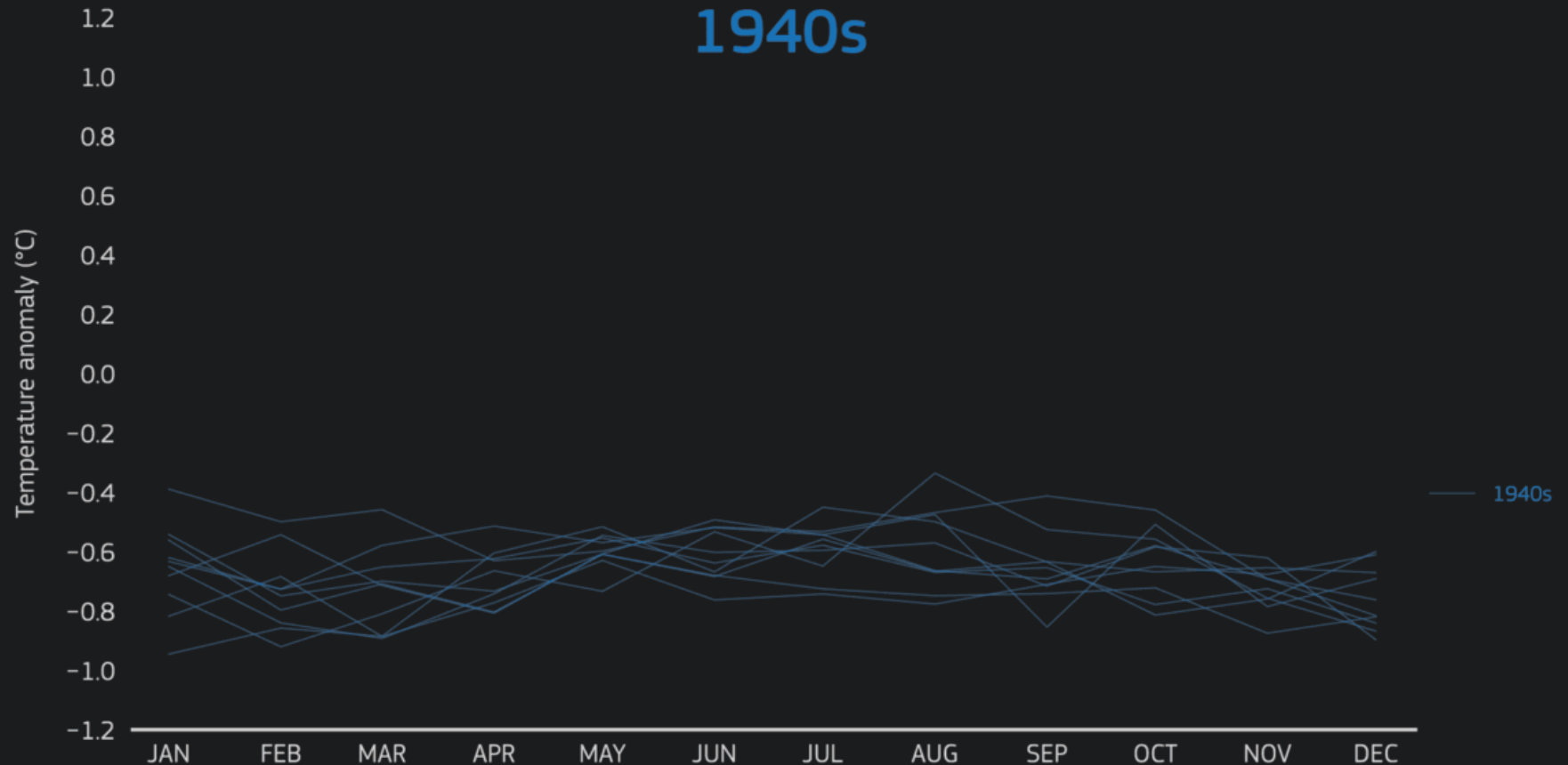
**7 record breaking
months**

**0.60°C higher than
1991-2020**

0.17°C higher than 2016

GLOBAL SURFACE AIR TEMPERATURE ANOMALIES

Data: ERA5 1940–2023 • Reference period: 1991–2020 • Credit: C3S/ECMWF



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ECMWF





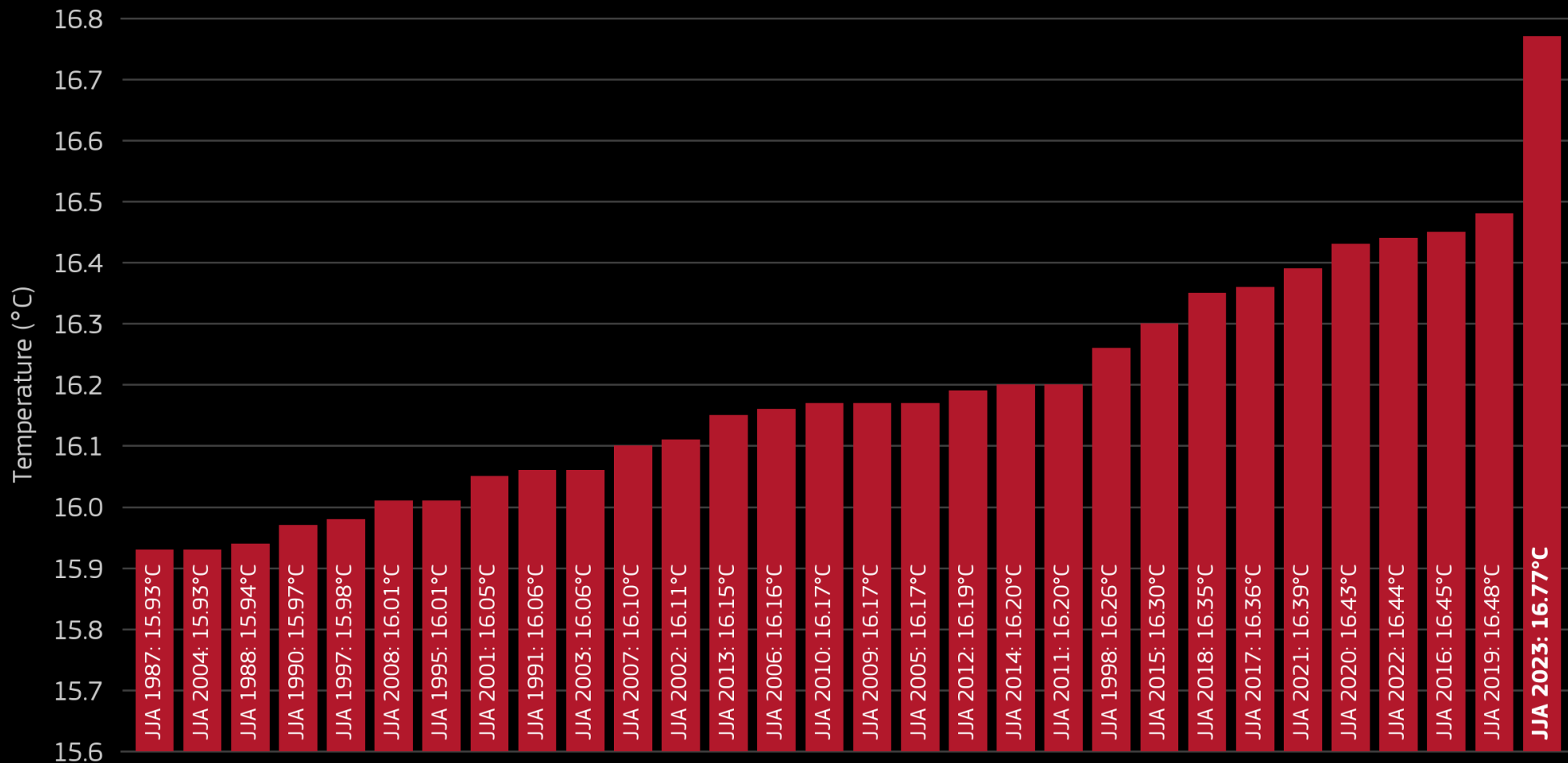
THE 30 WARMEST BOREAL SUMMERS (JJA) GLOBALLY

Data: Global-mean surface air temperatures from ERA5 • Credit: C3S/ECMWF



Climate
Change Service

climate.copernicus.eu



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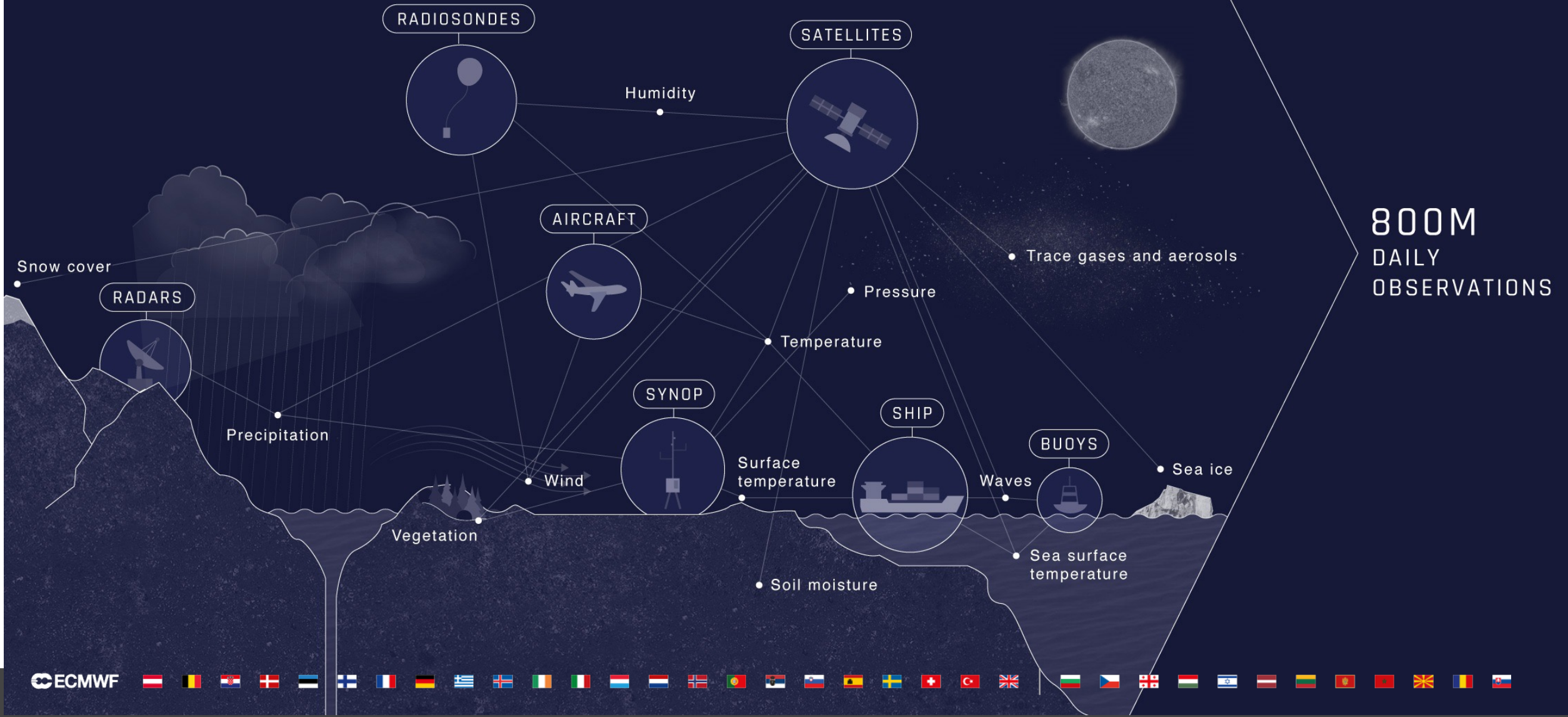
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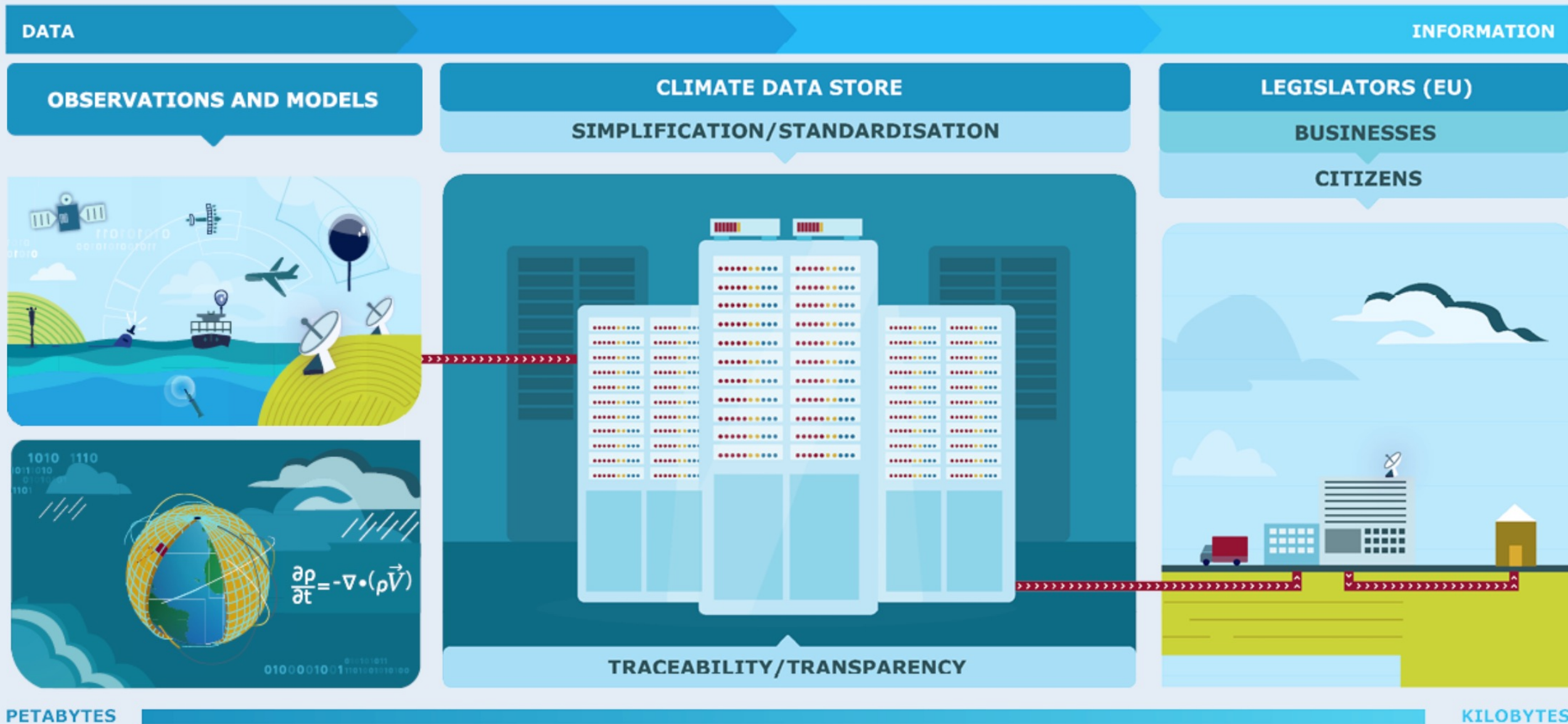
To predict the future, we observe the present. Every day, we absorb 800 million observations to create a detailed snapshot of Earth's weather.



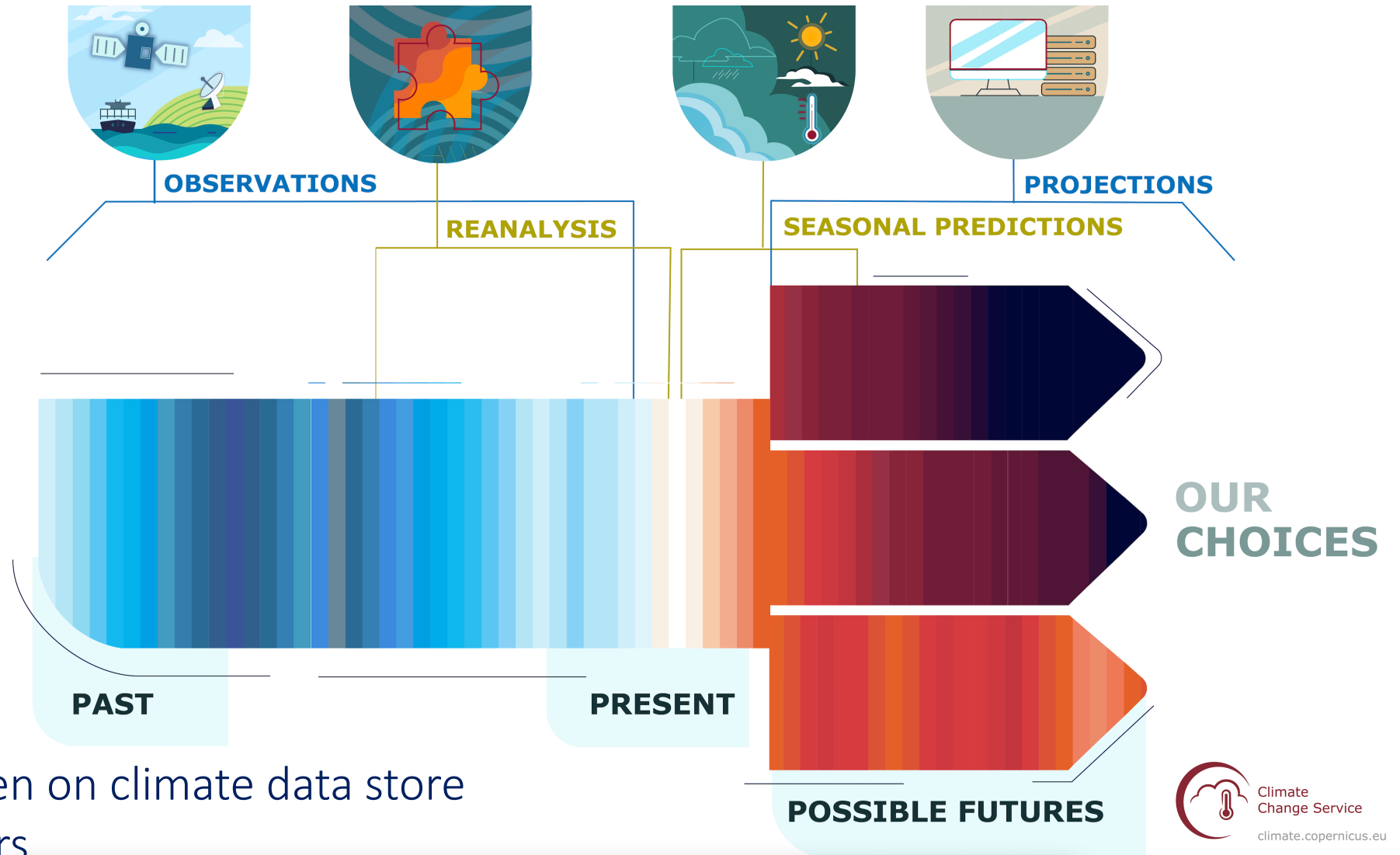


Climate Change

C3S – provision of climate data and services to society



C3S – covering all climate data time periods



C3S – monitoring the Earth system

CRYOSPHERE



Snow



Ice Sheets and Ice Shelves



Glaciers



Permafrost

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



Nutrients

Available now

■ Satellite ECVs

■ ECVs from reanalysis

□ Ambition

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



CO₂, CH₄, and other GHGs



Ozone

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



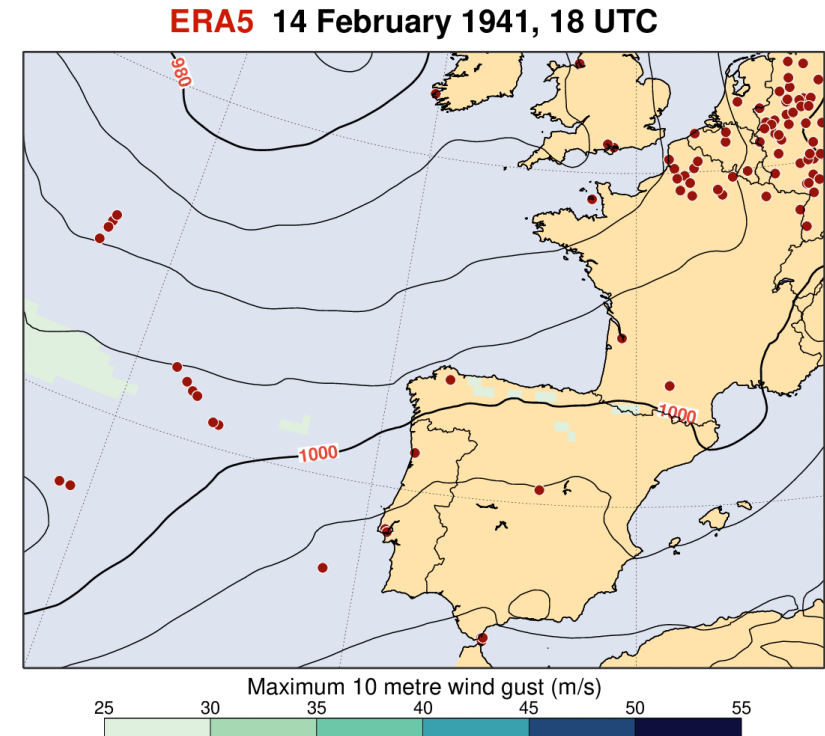
Land Cover

*Fraction of Absorbed Photosynthetically Active Radiation

Reanalysis products

Global ERA5 reanalysis

- A global reanalysis for the atmosphere, land and ocean waves
- Available from 1940 onwards
- Used to train AI weather prediction models

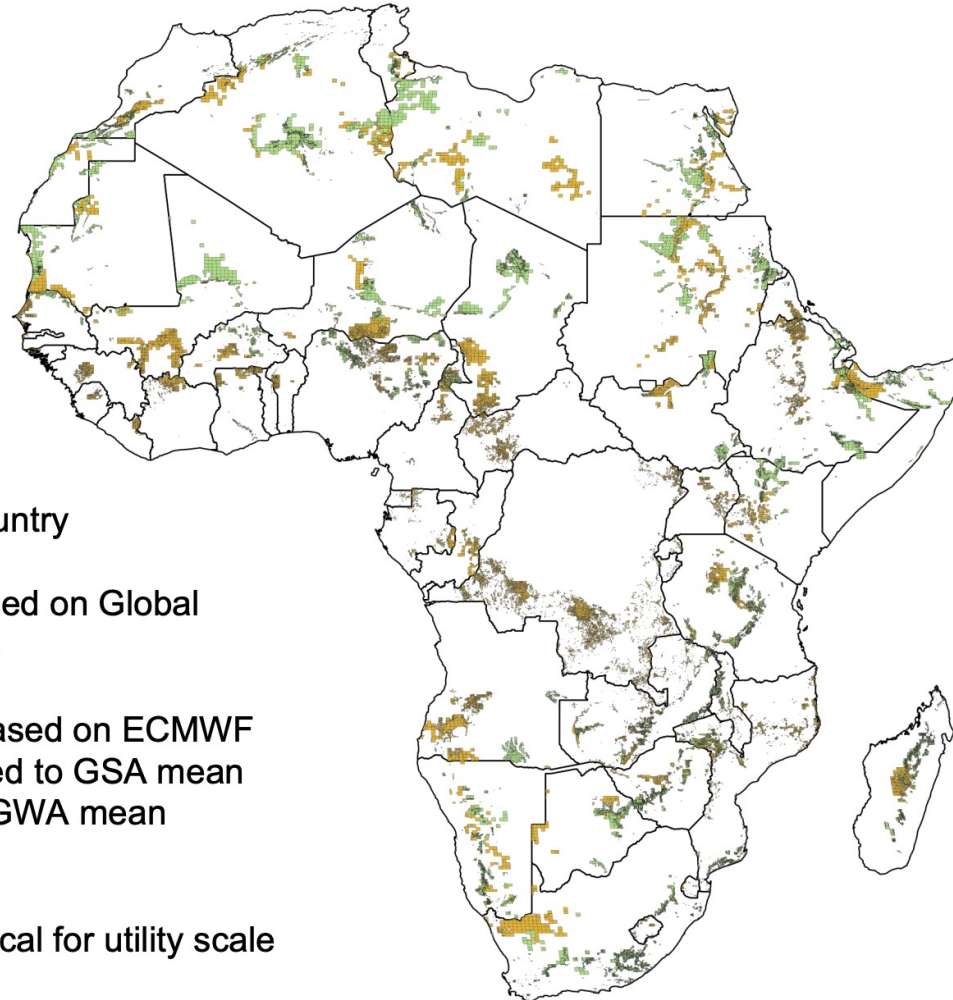


C3S - Supporting energy security

Analysing Africa's solar and wind Model Supply Regions (MSRs) – up to 5% of country area

Solar PV

Wind (onshore)



- Cheapest locations in each country
- Spatial resolution: 1x1 km, based on Global Solar Atlas / Global Wind Atlas
- Temporal resolution: hourly, based on ECMWF ERA5 reanalysis, bias-corrected to GSA mean (additive bias-correction) and GWA mean (empirical quantile mapping)
- Limit of MSR area: ~3GW, typical for utility scale evacuation



Climate Change

Climate predictions & projections

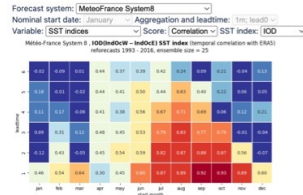
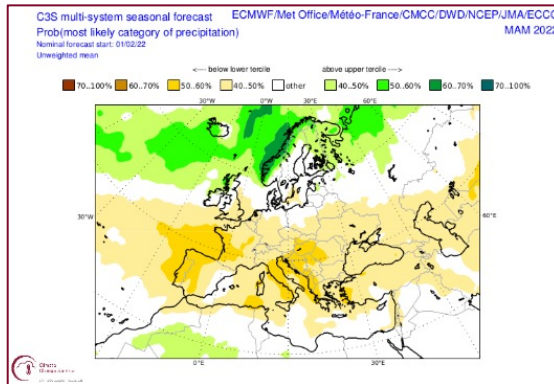


DATA PRODUCTS

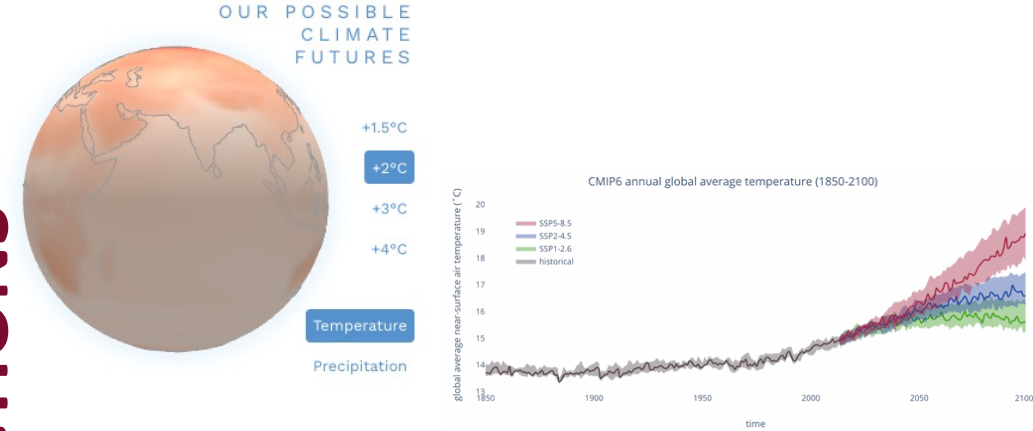
Datasets available in the Climate Data Store

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

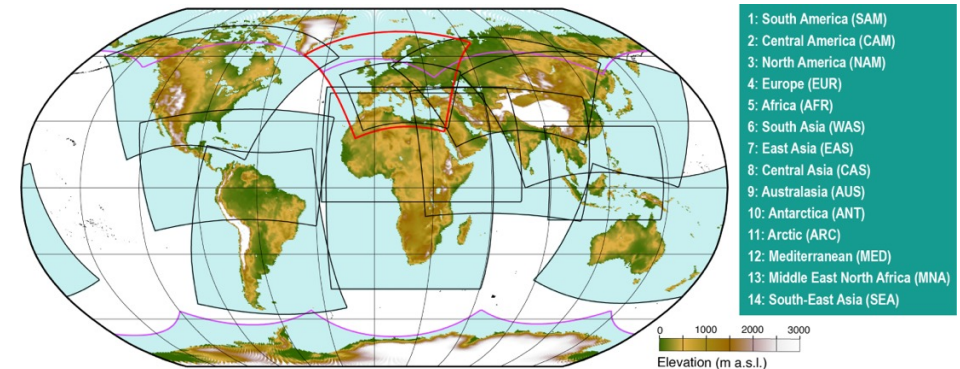
GRAPHICAL PRODUCTS



CLIMATE PROJECTIONS



- Global (CMIP5 & CMIP6)
- Regional: CORDEX
- IPCC Climate Atlas



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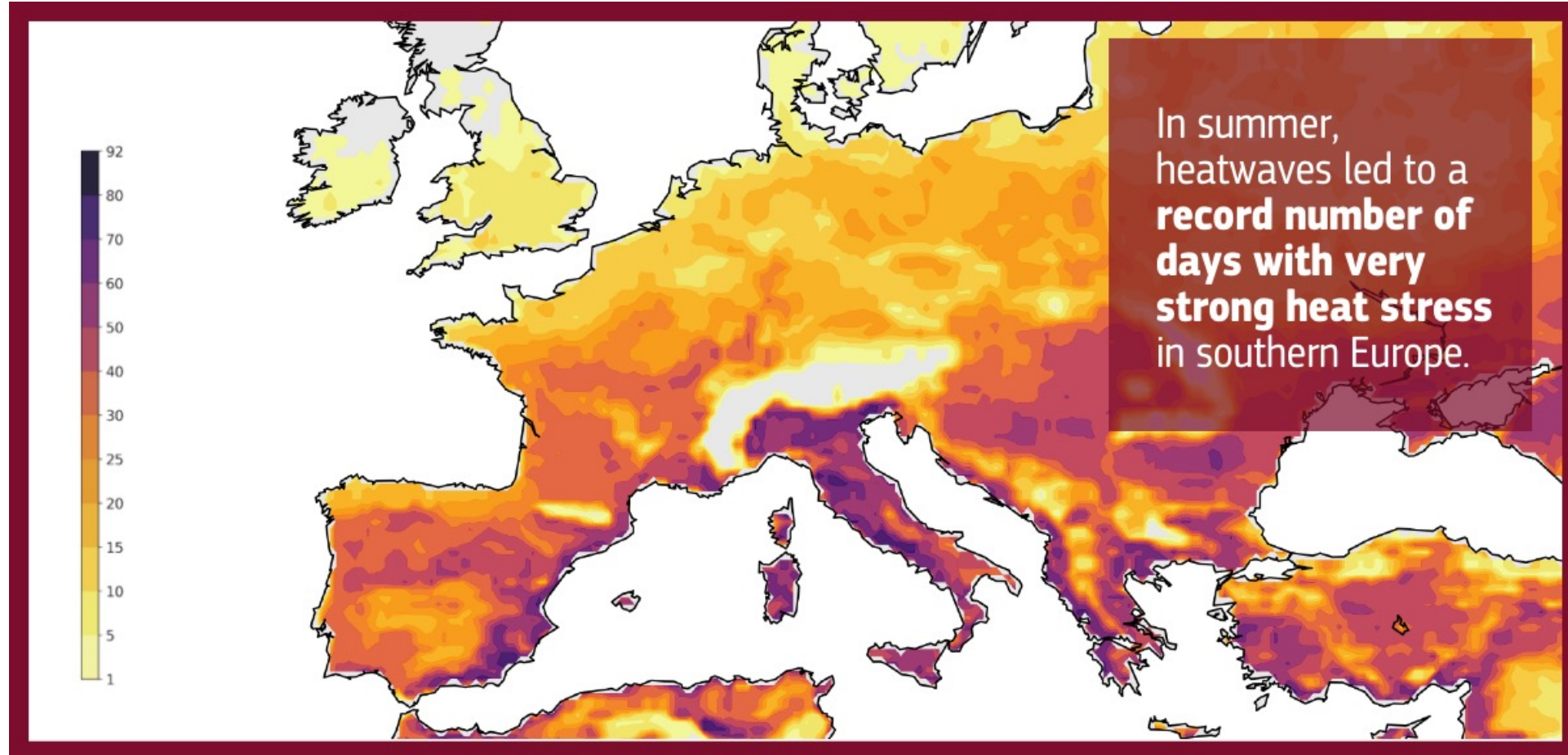


Climate intelligence – range of accessible products



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

Belgian Minister for Climate, Zakia Khattabi



In 2022 Europeans suffered more heat stress than ever before

Well... until 2023

Climate Indicators



Climate Indicators show the long-term evolution of several key variables which are used to assess the global and regional trends of a changing climate. They are updated at least once a year, for the publication of the [European State of the Climate](#).

Global Temperature

↑ **1.2** °C above pre-industrial level
[More](#)

European Temperature

↑ **2.2** °C above pre-industrial level
[More](#)

Arctic Temperature

↑ **3** °C above pre-industrial level
[More](#)

Carbon Dioxide (CO₂)

↑ **417** ppm, annual average level
[More](#)

Carbon Dioxide (CO₂) Increase

↑ **2.4** ppm per year, since 2010
[More](#)

Methane (CH₄)

↑ **1894** ppb, annual average level
[More](#)



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EUROPEAN STATE OF THE CLIMATE

KEY EVENTS 2022

RECORDS

- > **Warmest summer on record**
- > **Record loss of glacier ice from European Alps**
- > **Record sunshine duration**
- > **2nd lowest river flow on record**
- > **2nd largest wildfire burnt area on record**

KEY EVENTS



Drought

Spring through summer across much of Europe



Heatwaves

MAY: Southwestern Europe

SUMMER: Affecting much of Europe

SEPTEMBER: Greenland



Marine Heatwave

MAY ONWARDS: The western Mediterranean Sea



Wildfires

JULY, AUGUST: Czechia, France, Portugal, Slovenia, Spain, UK



Storms

FEBRUARY: 3 storms in 1 week



Heavy Rainfall and Flooding

SEPTEMBER: Bulgaria, Croatia, Italy, Portugal, Slovenia, Spain



Coldwave

DECEMBER: Northern Europe

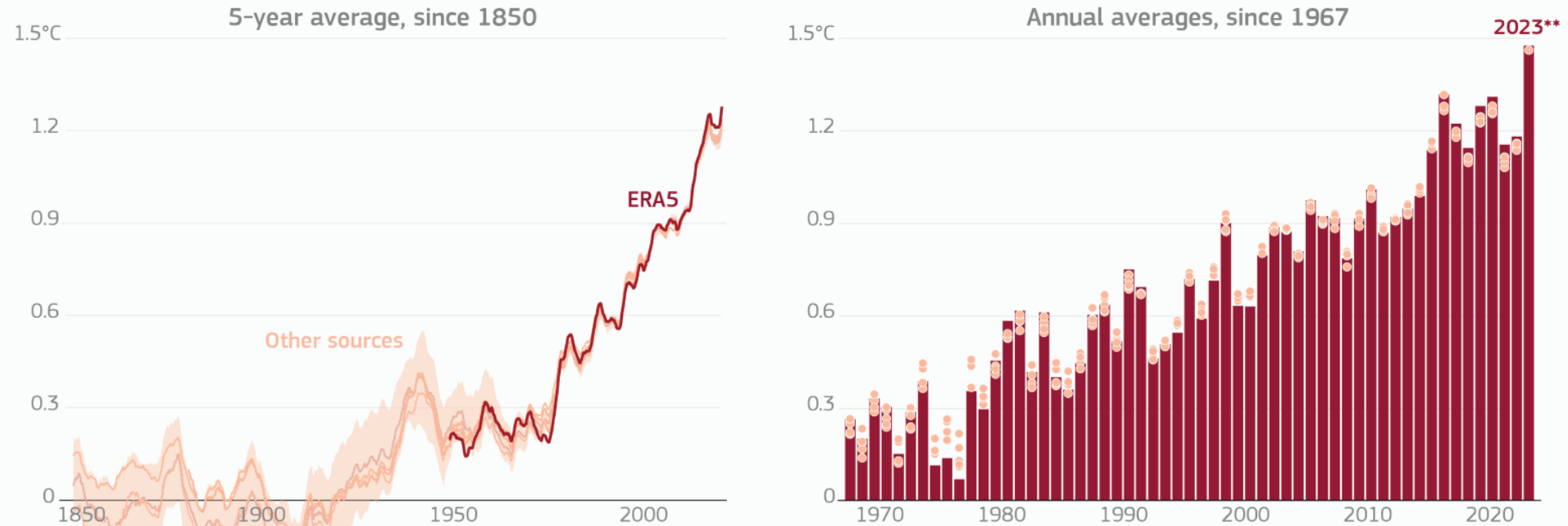
Global average temperature: close to the 1.5°C limit above pre-industrial level

Global average temperature compared with 1850-1900: +1.48°C in 2023

possibly +1.5°C or more for 12-month period ending in Jan or Feb 2024

GLOBAL SURFACE TEMPERATURE: INCREASE ABOVE PRE-INDUSTRIAL LEVEL (1850-1900)

■ ERA5 data ● Other sources* (including JRA-3Q, GISTEMPv4, NOAA GlobalTempv5, Berkeley Earth, HadCRUT5)



*ERA5 and JRA-3Q data are only shown from 1948. Shaded area represents the uncertainty for HadCRUT5 data

**Estimate for 2023 based on ERA5 and JRA-3Q data only
Credit: C3S/ECMWF

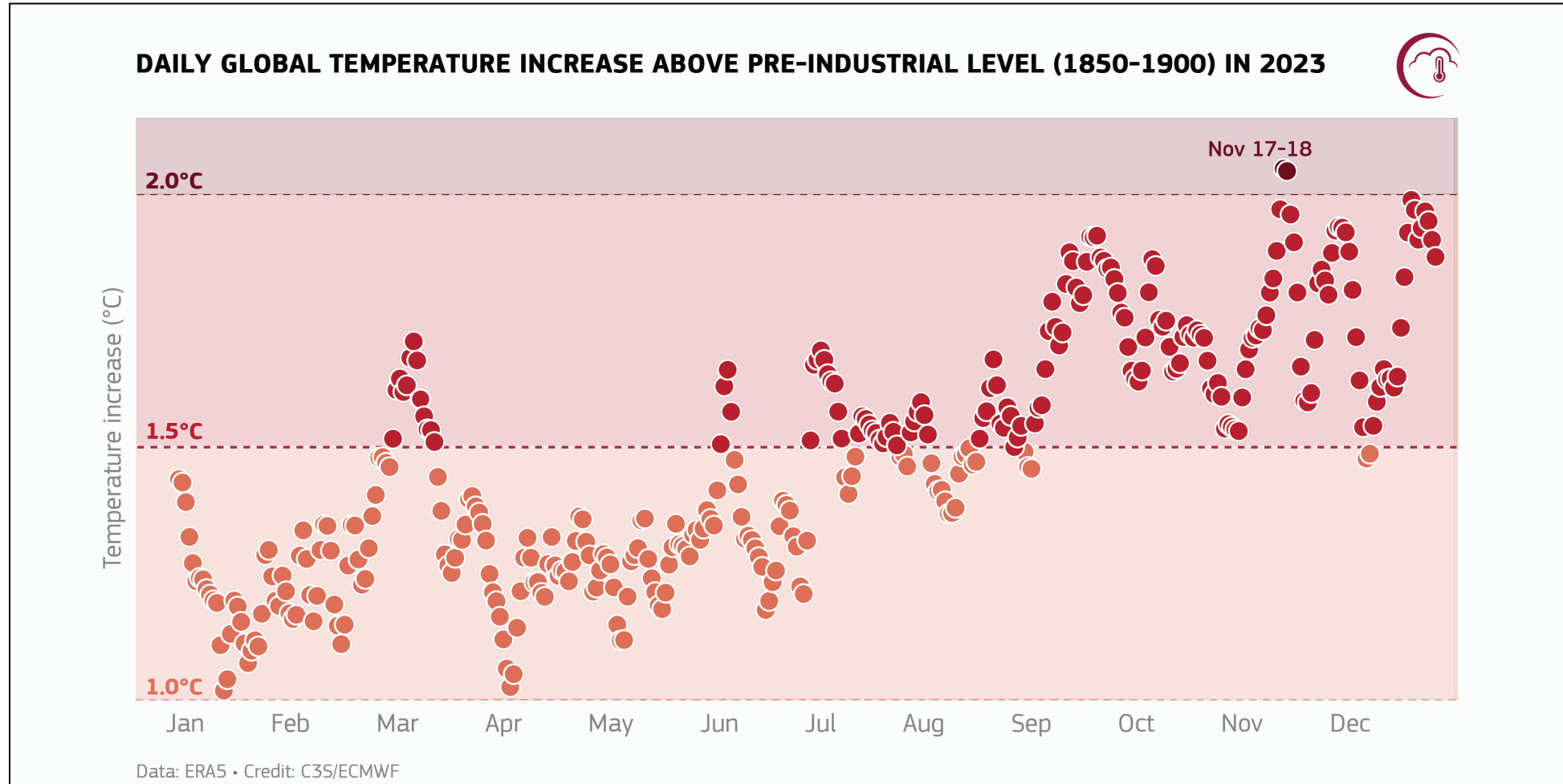


Climate Change

All days in 2023 were higher than 1°C above pre-industrial level

**Nearly 50% days
were above
+1.5°C**

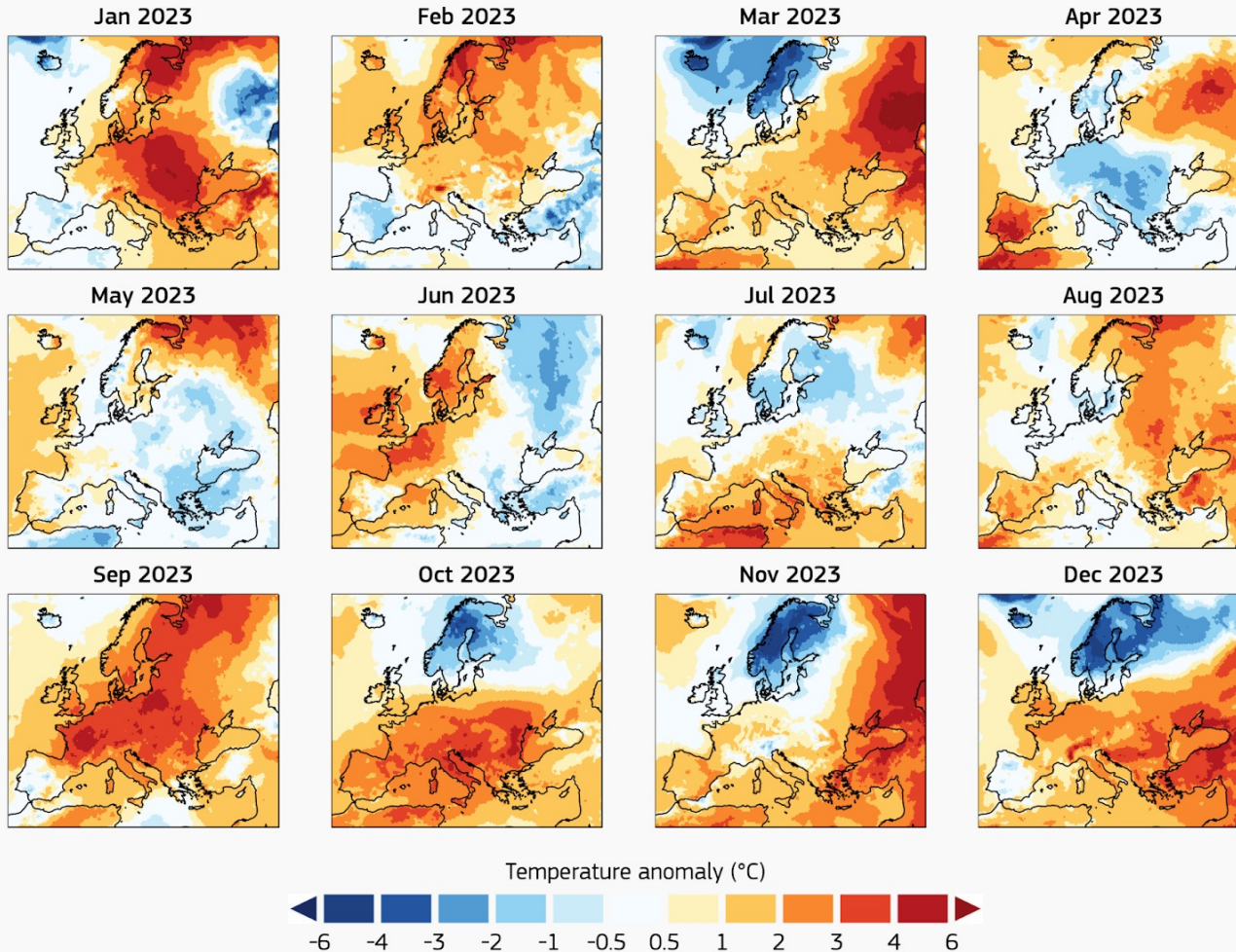
**Two days in
November above
+2°C (1st time)**



Europe in 2023: high variability and many extreme events

MONTHLY SURFACE AIR TEMPERATURE ANOMALIES IN 2023

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



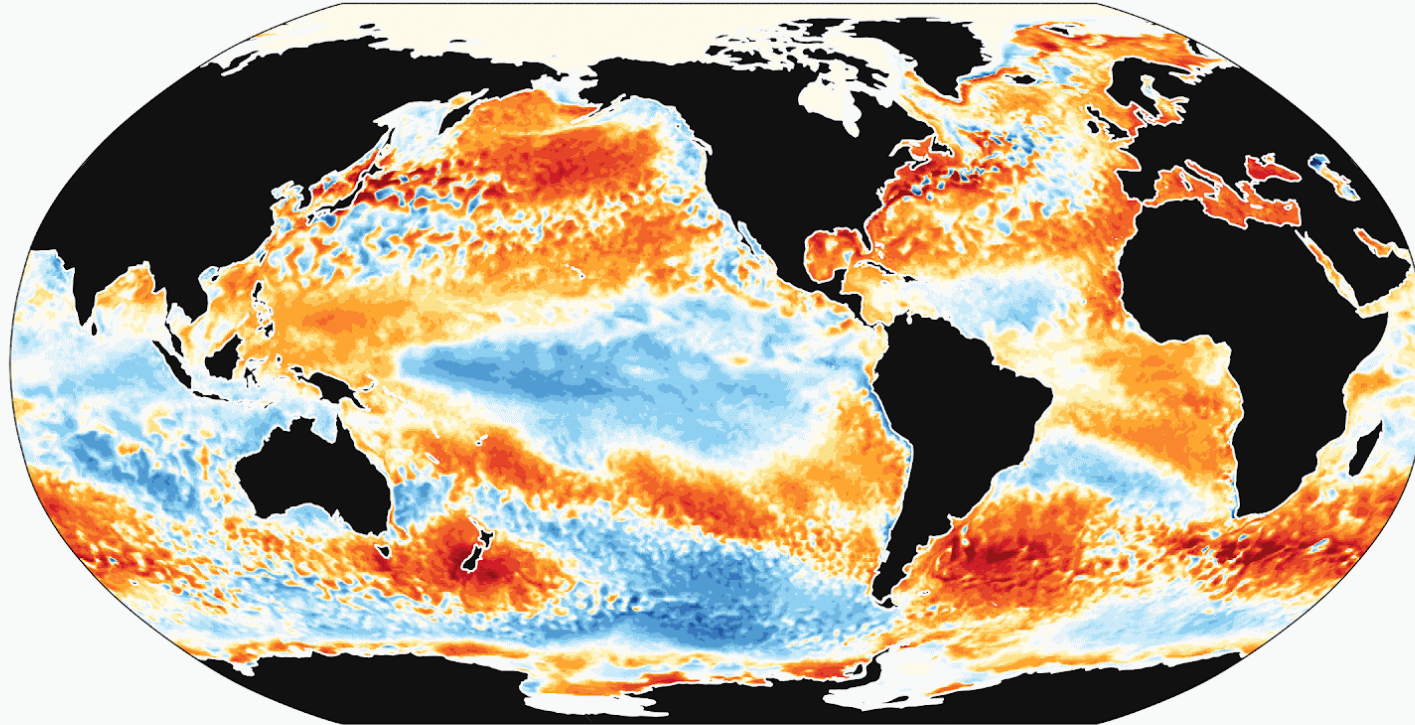
2023 was second-warmest year for Europe:

- **1.02°C above average**
- **0.17°C less than in 2020**

Exceptional global sea surface temperatures

SEA SURFACE TEMPERATURE ANOMALY • JAN 2023

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



Temperature anomaly (°C)



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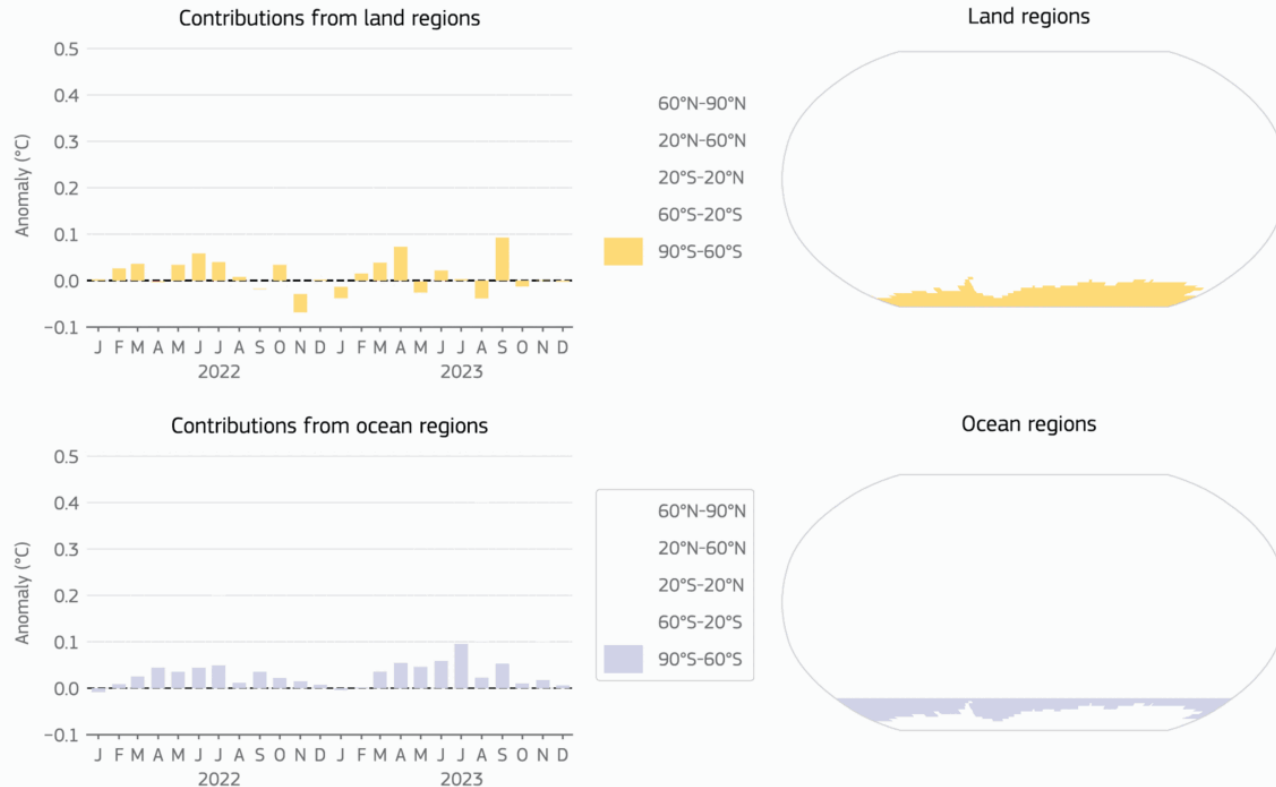
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Why was 2023 so warm and what is next?

CONTRIBUTIONS TO GLOBAL SURFACE AIR TEMPERATURE ANOMALIES

Area-weighted regional contributions to global temperature anomalies in 2022-2023 relative to 1991-2020



How to read this chart:

- Land and ocean regions within five latitude bands are assigned different colours.
- For a given region, the monthly anomalies are weighted by the region's fraction of Earth's surface.

What does this mean for 2024 and beyond?

- Global temperatures will continue to rise until we reach global net zero emissions
- Continuation of El Nino in 2024 will lead to warmer global temperatures for spring
- More extreme weather events made worse by climate change
- Our global choices determine what happens next

Thank you

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