EUROPEAN STATE OF THE CLIMATE

SUMMARY 2022

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Europe's eyes on Earth

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ECMWF

Climate
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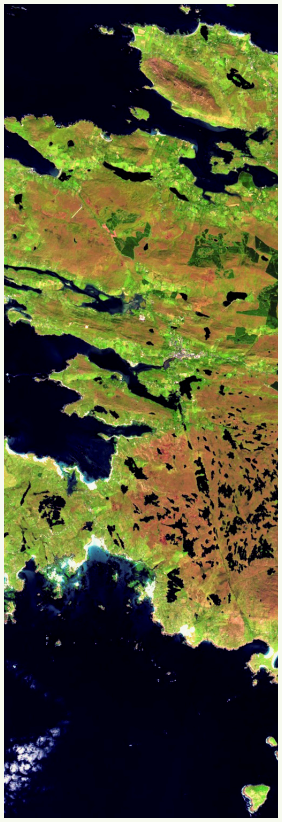
Report sections 2022



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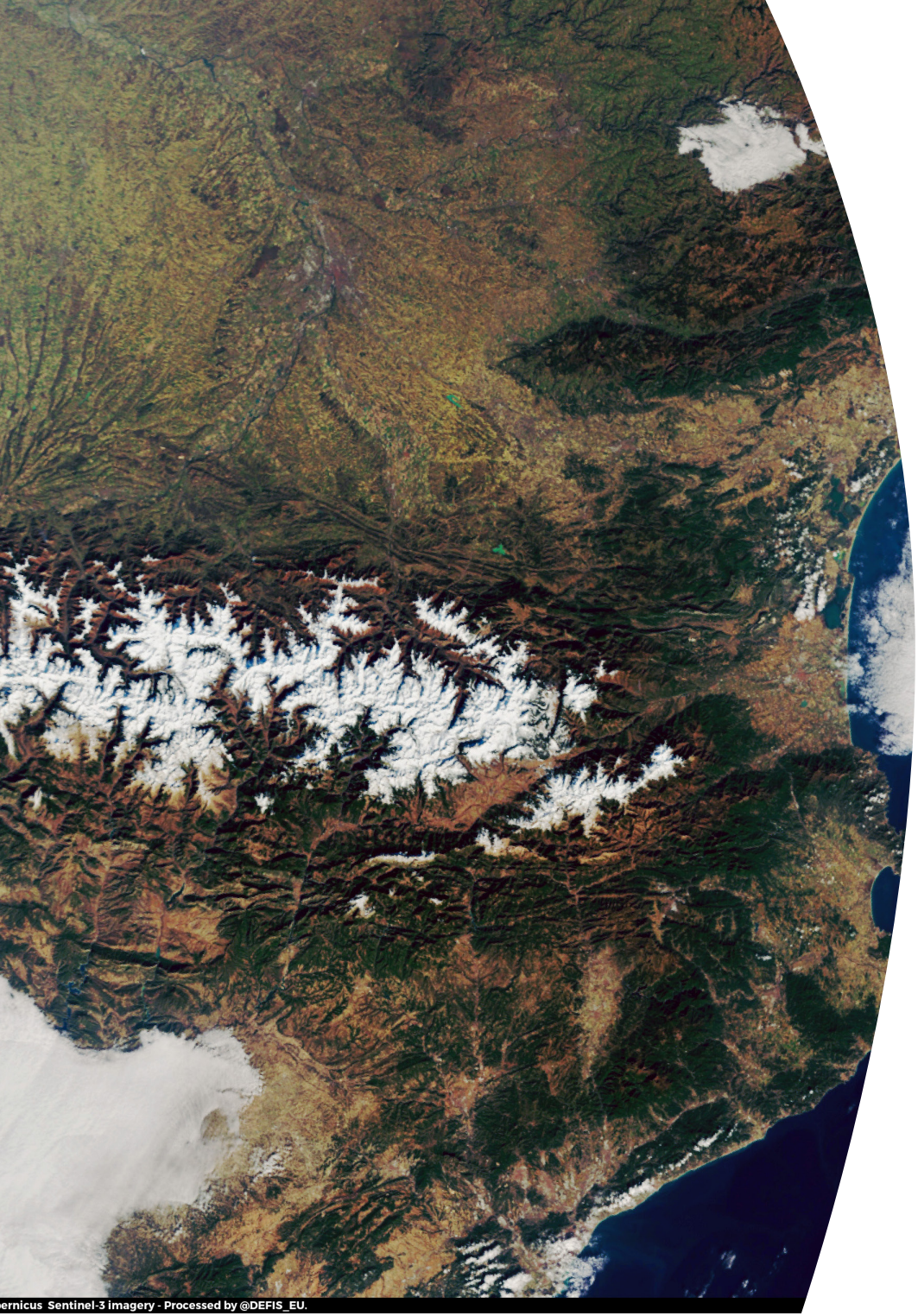


C3S provides climate monitoring for the globe, Europe and the Arctic, and annually releases the European State of the Climate (ESOTC). This report includes a short overview of the global context, a more comprehensive overview of Europe, and a focus on the Arctic. The report provides a detailed analysis of the past calendar year, with descriptions of climate conditions and events, and explores the associated variations in key climate variables from all parts of the Earth system. The ESOTC also gives updates on the long-term evolution of key Climate Indicators.

Throughout the report you will find symbols that indicate the types of data and the reference period used for each section. More information on these are in About the report.

The global context is provided by the evolution of key Climate Indicators. These typically build on multi-source or community estimates, in some cases leading to a delay in producing final data records, and so not all indicators are covered here.

Additional information about the global climate during 2022 can be found in the World Meteorological Organization (WMO) statement on the State of the Global Climate in 2022.

Surface temperature

Globally, the last eight years were the warmest on record, although 2022 was one of the cooler of these. Despite this, 2022 was the warmest year on record for several regions of the globe, including much of western Europe, parts of northwestern Africa, the Horn of Africa, central Asia and

This section provides the 2022 view for Europe, compared to long-term trends of variables across the climate system. Key events that occurred during the year are also described within a climatic context.

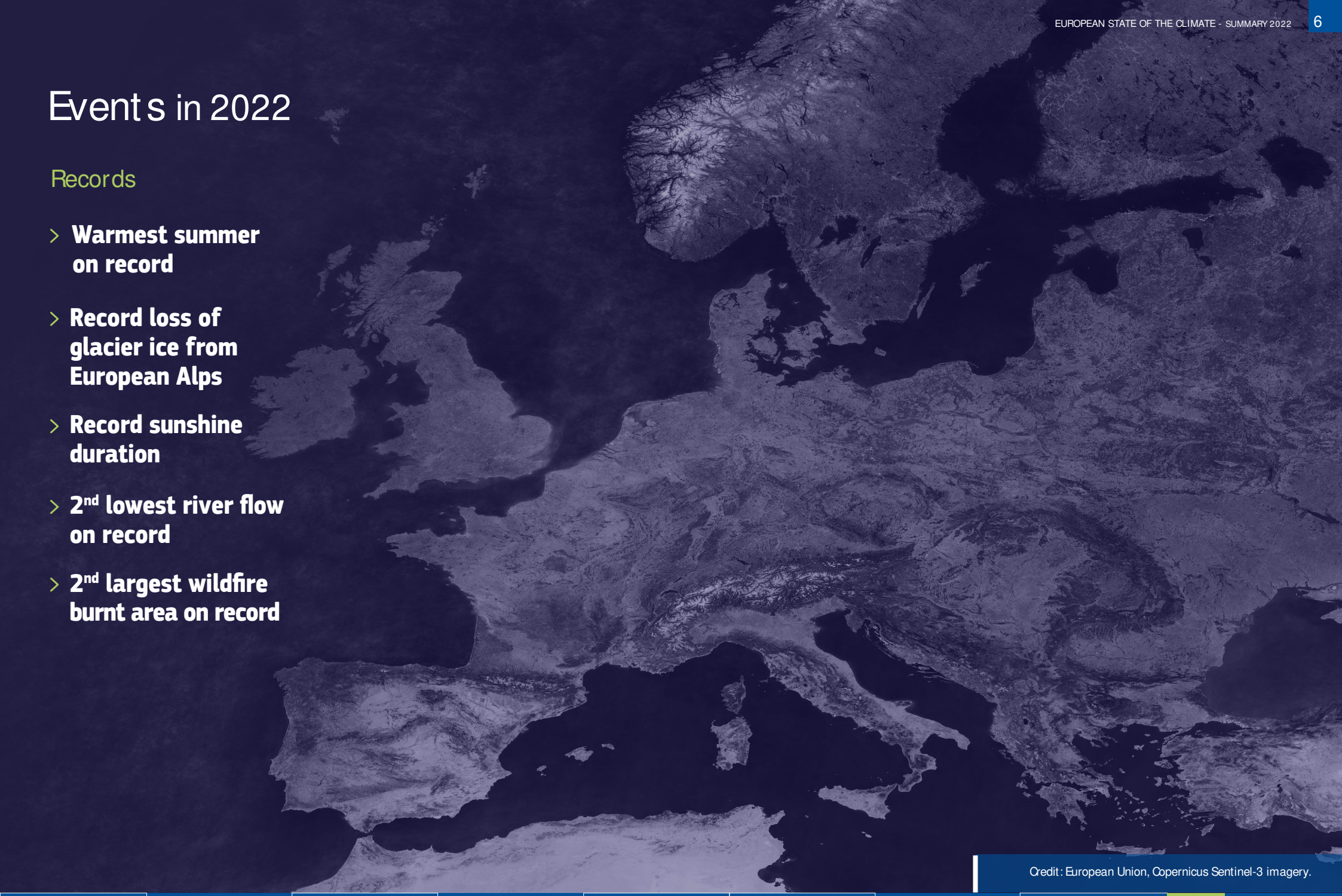
During summer, much of the continent was affected by exceptional heatwaves, and the highest temperatures in western Europe reached around 10°C warmer than typical summer maximum temperatures. Southern Europe saw a record number of days with

Europe has been warming faster than any other continent in recent decades, with temperatures increasing at twice the global average rate.

Events in 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**



Credit: European Union, Copernicus Sentinel-3 imagery.

Temperature

The summer temperature for Europe was the highest on record.

2022 was the second warmest year on record for Europe, at 0.9°C warmer than average. For many countries in southwestern Europe, the year was the warmest on record. The most-above-average temperatures occurred in northeastern Scandinavia and those countries bordering the northwestern Mediterranean Sea.

Winter, summer and autumn were all warmer than average, and spring was slightly cooler than average, by 0.1–0.2°C. Summer was the warmest on record, at 1.4°C above average, and 0.3–0.4°C above the previous warmest summer, in 2021. The year was characterised by many more warm than cool events. A long-term trend towards higher surface air temperatures over Europe's land regions continues.

Extreme heat

Many more warm spells than cool periods were seen during 2022. In southwestern and western areas, up to 30% more warm days occurred than average, highlighting the frequency of high temperature extremes.

In March and May, daily maximum temperatures reached as much as 8°C above average.

During summer, much of Europe was affected by exceptional heatwaves, and, in western Europe, the highest temperatures were around 10°C warmer than typical summer maximum temperatures. In July, temperatures in the UK reached 40°C for the first time on record. Globally, increasingly high latitudes are seeing more extreme temperatures, including those exceeding 40°C. The heatwaves impacted human health, with a record

Soil moisture

Soil moisture conditions were the second lowest in the last 50 years.

Most months saw lower-than-average soil moisture conditions, with the lowest in July at -8%, and the highest in September at +2%. Central European countries experienced a prolonged drought that not only affected surface soil moisture, but deeper soil layers too.

The near-average conditions in winter gave way to predominantly below-average conditions in spring, with the largest dry anomalies occurring in northern Germany and Poland, and in countries to the west of the Black Sea. The most widespread dry conditions occurred during summer, affecting much of Europe, before returning to near or above average soil moisture conditions in autumn. In deeper soil layers, the dry conditions also persisted through autumn in

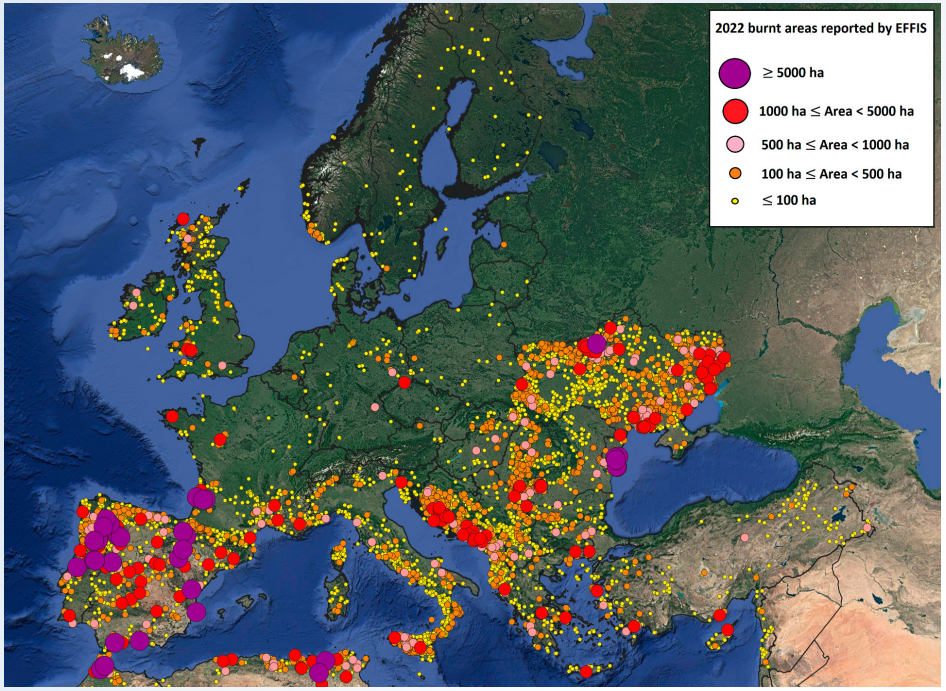
From January to August, much of the continent saw less precipitation than average.

The Italian Alps were among the worst-affected areas, with spring snowfall as much as 60% below average.

Wildfires

Second largest burnt area on record across the EU countries.

Above-average fire danger conditions were seen for most of the year, driven by persistent drought and heat conditions, in particular in southwestern areas. Here, fire danger was



Distribution and extent of burnt areas across Europe and the Mediterranean in 2022. Data source: European Forest Fire Information System (EFFIS). Credit: EFFIS/Copernicus EMS.

Annual glacier ice mass changes in the European Alps from 1962 to 2022. Data source: WGMS (2022, updated) based on observations from NVE and GLAMOS. Credit: C3S/ECMWF/WGMS.

Glaciers

Both globally and across Europe, glaciers, distinct from the two ice sheets in Greenland and Antarctica, have seen a substantial and prolonged loss of ice since the mid-19th Century. This loss has intensified since around the 1990s. Melting of ice from glaciers has contributed to more than 3 cm of global sea level rise.

Wind and solar energy resources

Surface solar radiation was the highest on record.

Wind and solar renewable energy resources complement each other throughout the year: winds are usually stronger in winter while solar radiation reaches a maximum in summer. In 2022, the annual average wind speed for Europe as a whole was virtually equal to the 30-year average, while the region experienced its highest

Annual anomalies in (left) onshore wind capacity factor (CF), (centre) solar photovoltaic (PV) CF, and (right) electricity demand for 2022. Data: C3S Climate and Energy Indicators for Europe. Credit: C3S/ECMWF.

Annual European sunshine duration anomalies (hours) for 1983–2022. Data source: SARAH-2.1 CDR/ICDR. Credit: EUMETSAT CM SAF.

The Arctic section provides an overview of key climate events in high northern latitudes during 2022.

The Svalbard region experienced its warmest summer on record, with some areas seeing temperatures 2.5°C above average.

Greenland experienced record-breaking temperatures and ice sheet melt during a period of heatwaves in September.

Image: Svalbard, August 2022.
Credit: European Union, Copernicus Sentinel-2 imagery.

Arctic wildfires

Arctic wildfire activity and carbon emissions were near average.

In contrast to the previous three years, high latitude wildfire activity and emissions were mostly from North America. These were concentrated in Alaska and Canada's Northwest and Yukon territories rather than Siberia, as has been seen in recent years, reflecting a change in soil moisture anomalies. The location of wildfires, particularly the most intense ones, coincided with drier-than-average soils, which make vegetation more vulnerable to burning.

Wildfire emissions from the Arctic reached an estimated total of nine million tonnes of carbon in 2022. This is considerably less than the record 58 million tonnes emitted in 2020 and the 15 million in 2021, and closer to the average annual emis-

September
2022

Trends in Climate Indicators

Climate Indicators show the long-term evolution of several key variables that are used to assess the global and regional trends of a changing climate. These also provide the wider context in which to read the report.

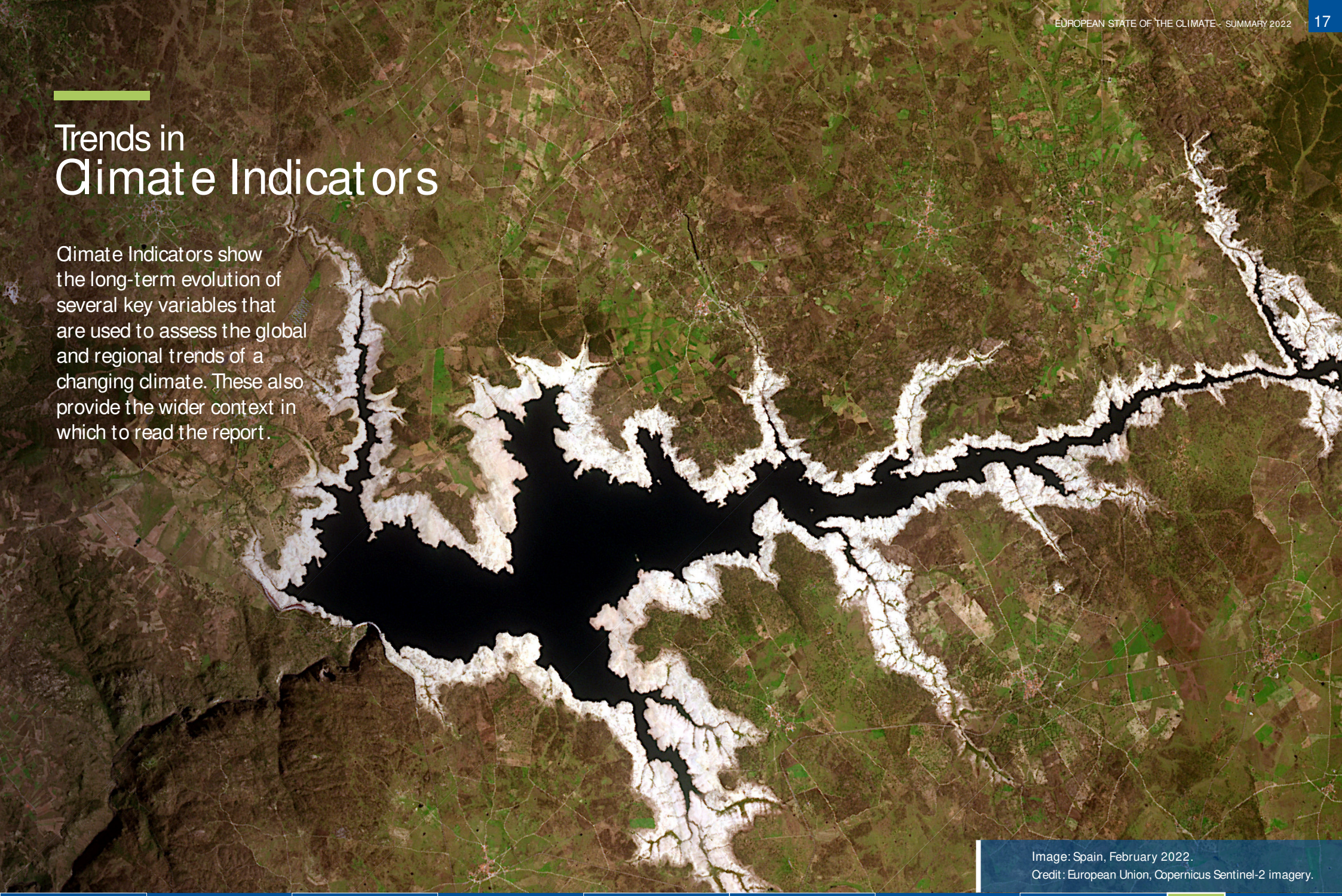


Image: Spain, February 2022.
Credit: European Union, Copernicus Sentinel-2 imagery.

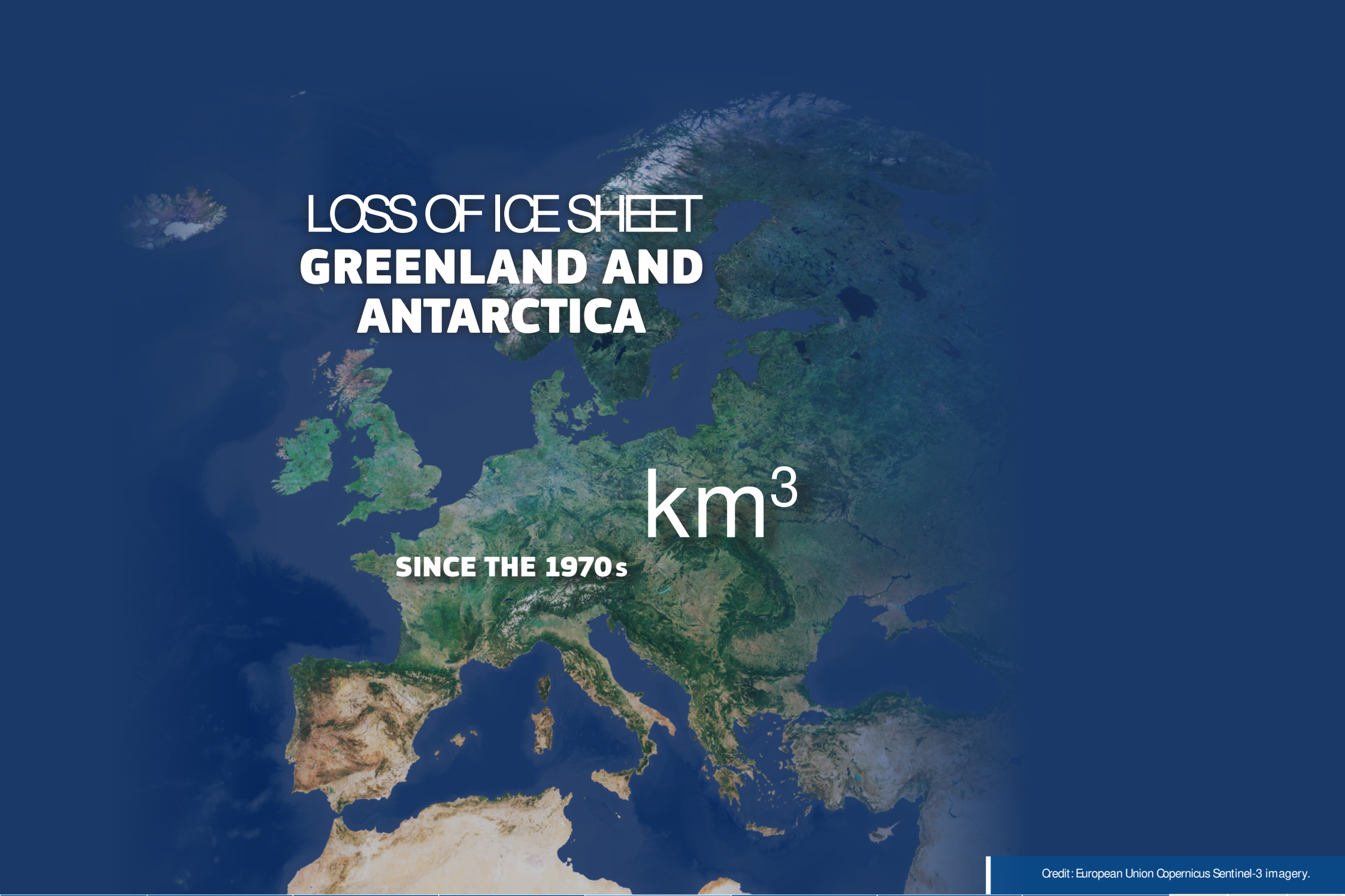
The Paris Agreement aims to hold the increase in global average temperature to well below 2°C above pre-industrial levels, with countries pursuing efforts to limit the increase to 1.5°C. The Global Stocktake, currently underway and to be repeated every five years, facilitates the assessment of collective progress in the implementation of the Paris Agreement. Monitoring surface air and sea surface temperatures globally and regionally contributes to this stocktake. Global average values for these variables have increased significantly since the pre-industrial era, by 1.2°C and 0.9°C, respectively, but the rate of increase has varied in both space and time.

Greenhouse gases driving climate change

Greenhouse gases (GHGs) in the atmosphere trap heat close to Earth's surface. If concentrations increase, then Earth's near-surface temperature also rises, with significant global impacts. Human activities lead to the emission of GHGs in various ways, including the combustion of fossil fuels for energy, deforestation, the use of fertilisers in agriculture, livestock farming, and the decomposition of organic material in landfills. Of all the long-lived GHGs that are emitted by human activities, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have the

The cryosphere in a changing climate

The cryosphere encompasses all parts of the Earth system where water is in solid form, including ice sheets, glaciers, snow cover, permafrost and sea ice. The cryosphere exerts an important influence on Earth's climate, and vice versa. Due to its high reflectivity, changes in the cryosphere impact the amount of solar energy taken up by the planet's surface, and consequently temperatures. As temperatures rise, vast amounts of water stored on land, in glaciers and ice sheets, melt, which contributes to global sea level rise. The changing cryosphere therefore has many further environmental and societal implications.



Credit: European Union Copernicus Sentinel-3 imagery.

Credit: European Union, Copernicus Sentinel-2 im

Sea level trends (mm/year) from January 1993 to June 2022. Data source: CMEMS Ocean Monitoring Indicator based on the C3S sea level product. Credit: C3S/ECMWF/CMEMS.

Extreme heat impacts on agriculture

The climate and related extreme events, such as those discussed in the ESOTC, can impact agriculture, affecting crop management, development and distribution of diseases and pests, and ultimately the harvest. Heat stress, for example, at stages such as flowering, can lead to yield losses and decreased quality.

C3S' 'Agroclimatic indicators explorer', with European location-specific data and climate scenarios, is designed to help facilitate decision-making 'at farm level', and adaptation planning at a larger scale. It provides a visual means of exploring agroclimatic indicators in the current climate, and assessing their evolution based on x(n)-6

Contributors

The ESOTC's findings are based on expertise from across the C3S community, as well as other Copernicus services and external partners. The sections are authored by C3S and data providers from institutions across Europe and edited by the C3S team. This report is reviewed by colleagues across the Copernicus network.

The EU Copernicus Services:
C3S, CAMS, Copernicus EMS, CMEMS, CLMS.

International organisations and initiatives: ECMWF, EC JRC, EEA, ESA, EUMETSAT SAF Network, GCOS and WMO RA VI RCC Network.

European national and regional meteorological and hydrological services: DMI (Denmark), DWD (Germany), KNMI (the Netherlands), MET Norway, Météo-France, Met Office (United

About us

Vital environmental information for a changing world

The European Centre for Medium-Range Weather Forecasts (ECMWF) has been entrusted by the European Commission to implement two of the six services of the Copernicus programme: the Copernicus Climate Change Service (C3S) and the Copernicus Atmosphere Monitoring Service (CAMS). In addition, ECMWF provides support to the Copernicus Emergency Management Service (Copernicus EMS).

To meet the challenge of global climate change, accurate, reliable and timely data are key. The Copernicus Services at ECMWF routinely monitor data on a global scale, including surface air temperature, precipitation, sea ice area and atmospheric greenhouse gases.