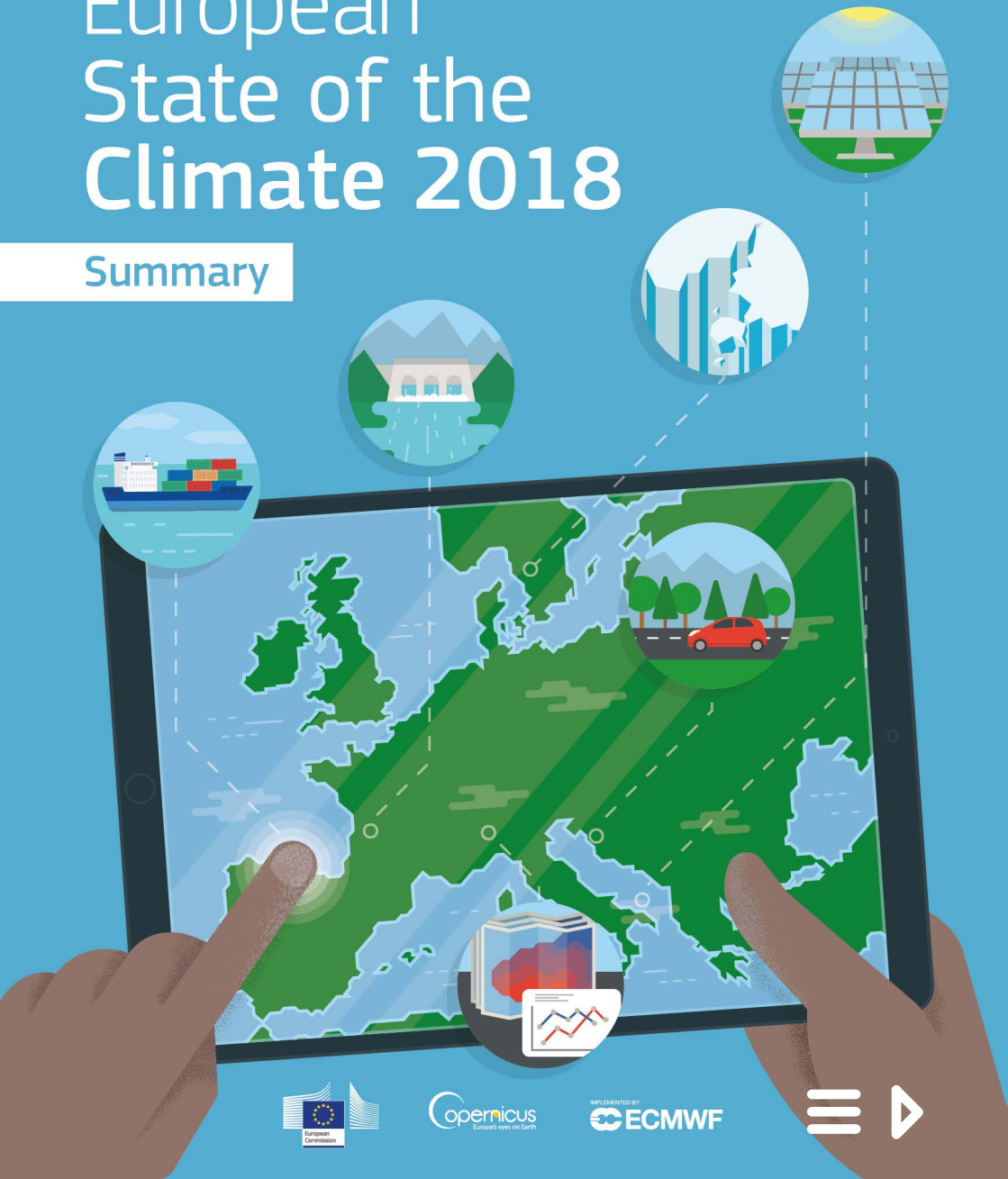
Copernicus
Europe's eyes on Earth

European State of the Climate 2018

Summary



European Commission

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Europe's eyes on Earth

IMPLEMENTED BY ECMWF

Contents

Welcome to the European State of the Climate 2018

The Alps, as seen from the ISS
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The content for the report builds on the latest measurements from satellites and in situ stations, on data from global 'reanalyses' - a combination of computer modelling and multiple historic data sources - as well as model-based estimates. By comparing 2018 against a reference period, we can see how the year fits within a longer-term context. Generally, the reference period used is 1981-2010, but where less extensive data records are available, in particular those based on satellite measurements, more recent and shorter periods are used.

Welcome to the summary of the European State of the Climate 2018, compiled by the Copernicus Climate Change Service (C3S), implemented by the European Centre for Medium-Range Weather Forecasts (ECMWF) on behalf of the European Union. The report's findings are based on data and expertise from C3S, as well as other Copernicus services and external partners.

2018 was one of the three warmest years on record for Europe. It began with a relatively cold period across most of the region. Throughout the rest of the year, northern, central and western Europe experienced sustained warm and dry conditions, while the south, in particular areas along the Mediterranean coast, saw a long period of repeated heavy rainfall events, making spring and summer in those regions amongst the wettest on record.

The full European State of the Climate 2018 report gives a general description of the year as a whole, including a view of the European sector of the Arctic. It illustrates in further detail the events mentioned above, and explores associated variations in sunshine duration, vegetation and soil moisture, river discharge, wildfires, glaciers and sea ice. Finally, a number of key indicators for climate change are highlighted, placing the events and their impacts into a longer-term global context.

The complete report is available online:
climate.copernicus.eu/ESOTC

Additional information about the global climate during 2018 can be found in the WMO Statement on the State of the Global Climate in 2018, to which the Copernicus services contributed.

Climate in 2018

General

An overview of annual and seasonal conditions in Europe and the European Arctic, compared with the long-term average

Snow in Scandinavia
Copyright: EUMETSAT

Dramatic weather over Portugal
Copyright: NASA/ESA - A. Gerst

Climate in 2018

General

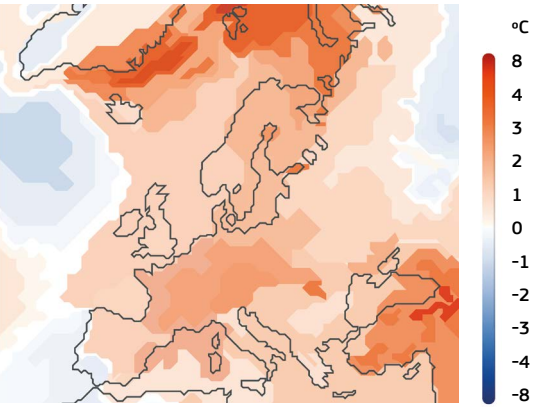
European temperature

European average temperature one of the three highest on record

Over the last four decades, temperatures in Europe have shown a clear warming trend. In 2018, the annual temperature for Europe was one of the three highest on record. All seasons were warmer than usual, with late spring, summer and autumn all seeing anomalies more than 1°C above average. Summer 2018 was the warmest on record - more than 1.3°C higher than usual - and autumn was one of the two warmest. These above-average temperatures were felt across most of Europe, with the largest annual anomalies in central Europe and Turkey. Below-average annual temperatures were recorded only in the southwest of the Iberian Peninsula.

1.2°C ⌃⌃ **2018** average temperature

summer **1.3°C** ⌃⌃



Surface air temperature anomaly for 2018 relative to the annual average for the period 1981-2010. **Data source:** ERA5 **Credit:** C3S/ECMWF

European wet and dry conditions

Lowest annual soil moisture of the last 40 years

2018 average soil moisture

2018 average precipitation

There is no clear trend in precipitation for Europe as a whole, and the 2018 total was close to average. However, there was a north-south divide from spring onwards, with generally drier-than-average conditions in the north and wetter conditions in the south. Extreme precipitation indices suggest below-average values over most of Europe, with only a few regions - mainly those bordering the northern Mediterranean coast - recording above-average values.

Soil moisture levels have been decreasing over the last four decades. In 2018, the warm temperatures meant that soil moisture gradually moved further away from the average throughout the year. Autumn and the year as a whole recorded their lowest levels in four decades. Only the southernmost areas of Europe experienced above-average soil moisture.

Mediterranean Wonders
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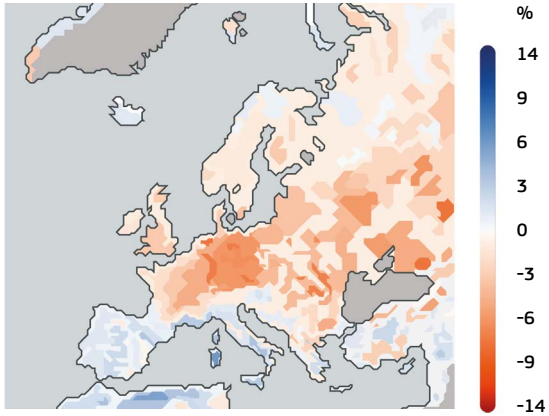
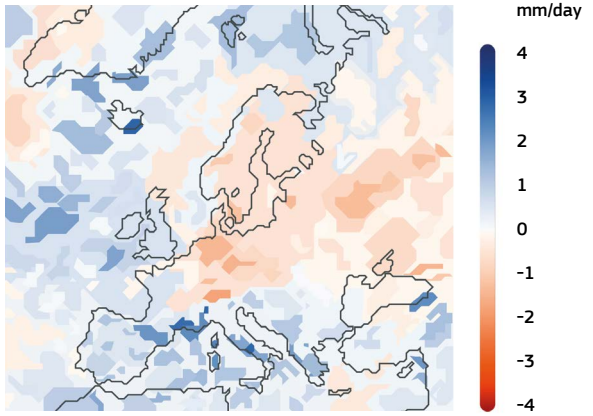


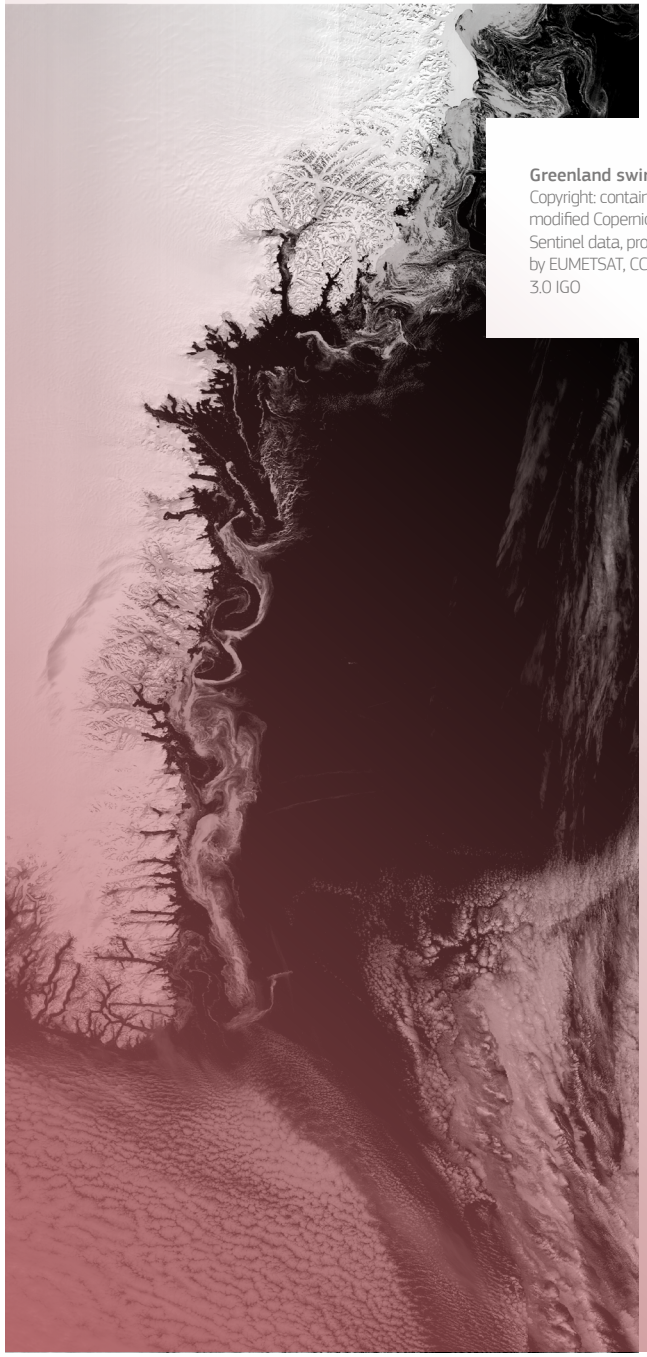
ERA5 soil moisture anomaly for 2018



ERA5 precipitation anomaly for 2018

Annual precipitation and soil moisture anomalies for 2018 relative to the annual average for the period 1981-2010.

Data source: ERA5
Credit: C3S/ECMWF



Greenland swirls
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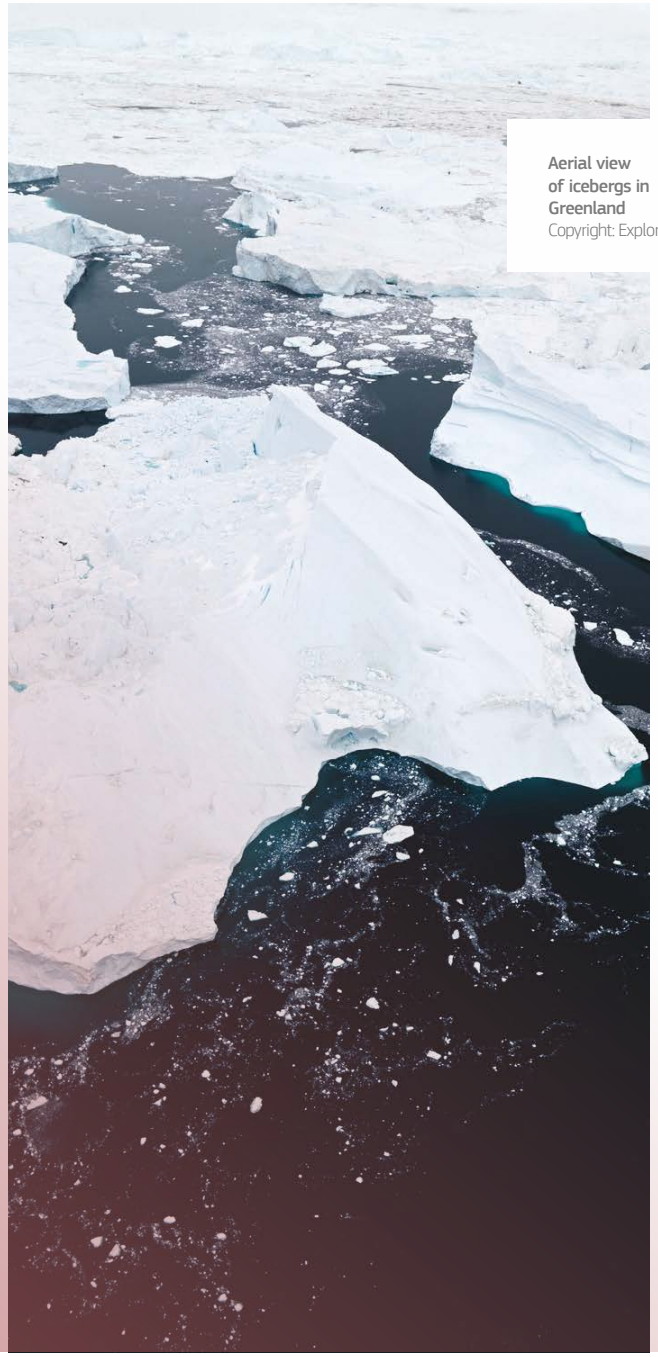

Aerial view of icebergs in Greenland
Copyright: Explora

European Arctic

August sea ice area close to the lowest for any month on record

2018 average temperature ⏫

2018 average sea ice cover ⏬

The European sector of the Arctic has shown an upward trend in temperature and a downward trend in sea ice cover over the last 40 years. 2018 was no exception, with most months registering above-average temperatures and below-average sea ice. The largest anomalies in monthly temperatures were recorded during the first two months of the year, at more than 4°C above the long-term average. Sea ice cover was particularly below average at the beginning of the year and then again during the summer months, when the area covered reached record lows, more than 30% below the long-term average.

Climate in 2018

Events

Three longer events in 2018 showed persistent weather conditions over several months, leaving a clear imprint on seasonal and annual averages

Cloud streets over Scandinavia

Climate in 2018

Events

Snowbound Italy
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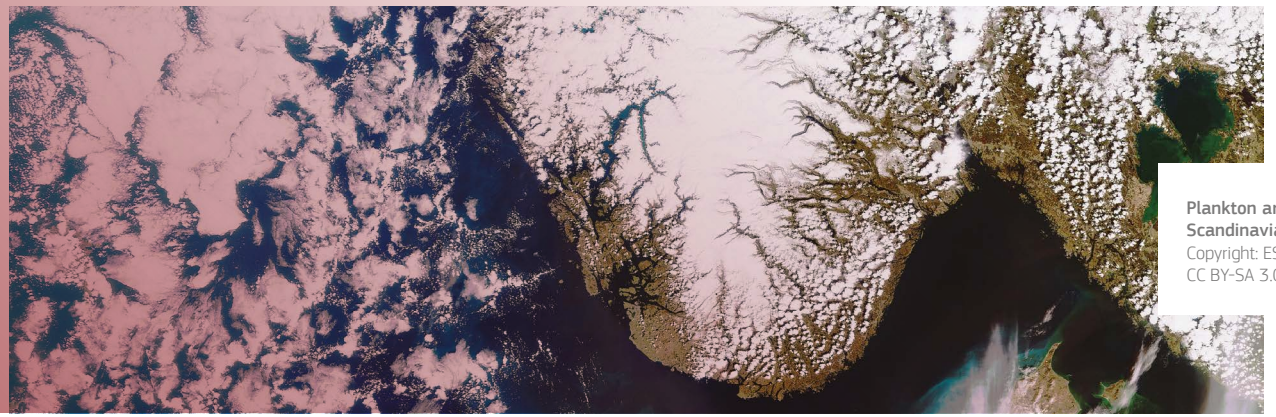

Plankton arrive in Scandinavia
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Cold start to the year

February and March only months with below-average temperatures

The year started with a month of unsettled weather, with large amounts of rain and snow falling across much of Europe. Several episodes of extremely cold air during February and March made these two months the only ones in 2018 with below-average temperatures. There were a higher-than-average number of 'frost days' - days with minimum temperature below 0°C - over much of western Europe in February and March, while the number of 'ice days' - days with maximum temperature below 0°C - was higher than usual in Scandinavia and north-eastern Europe. These cold spells also brought exceptional snowfall to large parts of Europe.

Dry and warm spring and summer

Spring to summer more than 2.5°C above average in central Europe

Following the unusually cold February and March, Europe experienced an extensive warm period that lasted until the end of the year. Average temperatures were higher than normal for every month from April to December, with April and May showing the largest anomalies. From spring until the end of summer, almost the whole of Europe saw temperatures above the seasonal average. It was exceptionally warm in central Europe, where temperatures were the highest recorded since at least 1950.

Alongside the long warm period, there was an extended period of drought. Parts of central and northern Europe were the most affected, with seasonal precipitation totalling less than 80% of normal levels for spring, summer and autumn, spanning the main growing and harvesting period. The impact of this drought included agricultural losses and water restrictions, with low water levels in rivers causing restrictions to shipping.

Zooming in on fires in Sweden
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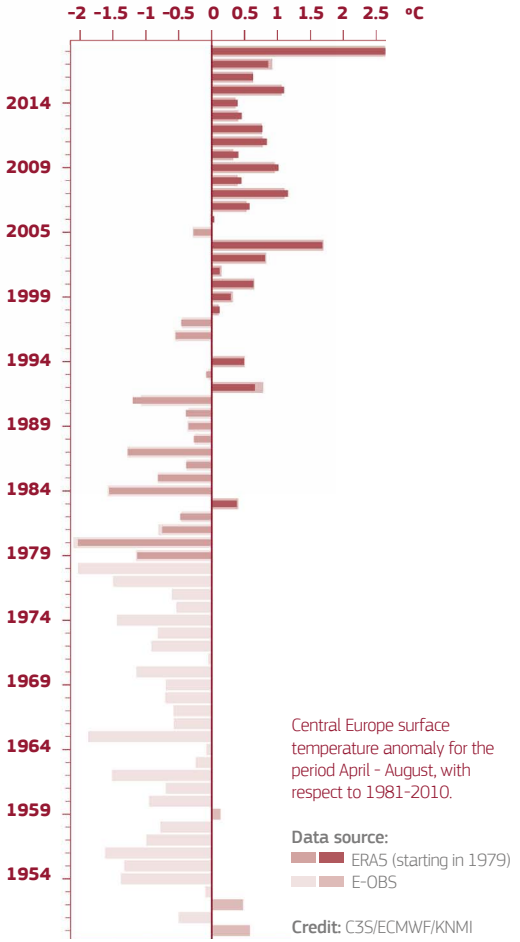
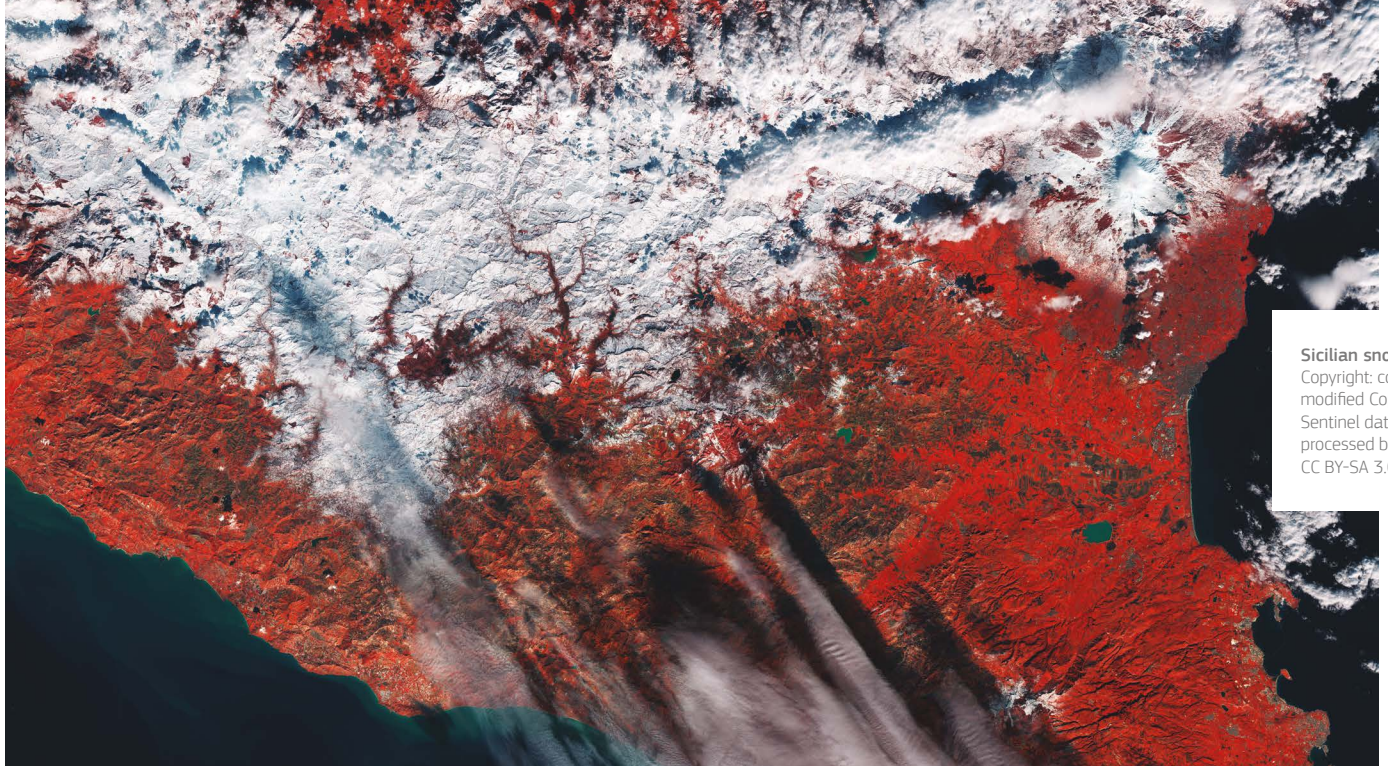


Central Europe surface temperature anomaly for the period April - August, with respect to 1981-2010.

Data source:
ERA5 (starting in 1979)
E-OBS

Credit: C3S/ECMWF/KNMI



Sicilian snow
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Italy and the Mediterranean
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Wet conditions in southern Europe

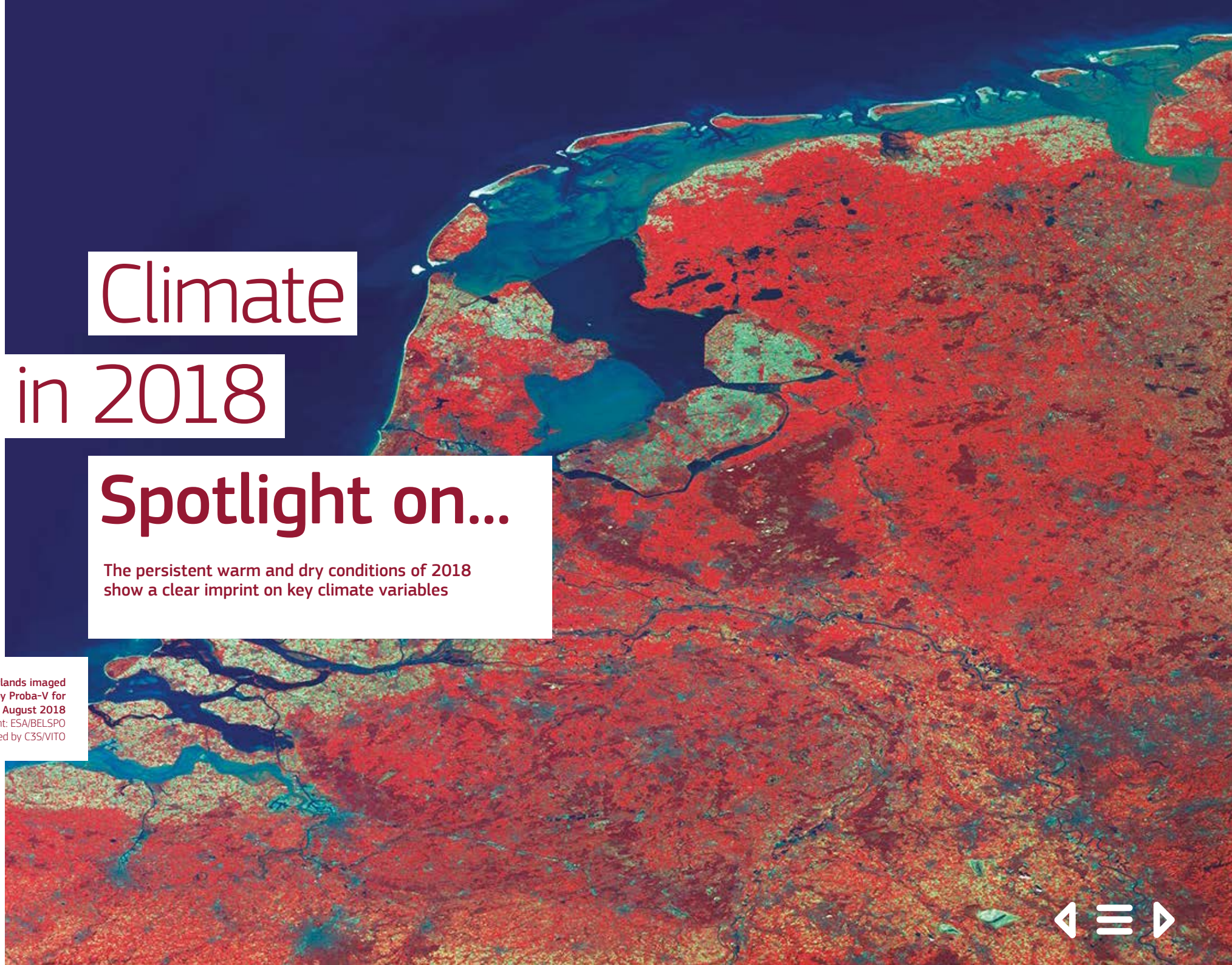
Southwest Europe experienced one of the wettest springs of the last 70 years

The south of Europe - in particular the regions bordering the Mediterranean coast - experienced a wetter-than-average year. The southwest had one of the two wettest springs since at least 1950. In the southeast, the summer was one of the six wettest of the last 70 years. The south as a whole experienced many heavy rainfall events. One example was ex-hurricane Leslie, which hit the Iberian Peninsula in October. It was the strongest storm in the region since 1842 and led to heavy rainfall across northern Spain and southwestern France.

Climate in 2018

Spotlight on...

The persistent warm and dry conditions of 2018 show a clear imprint on key climate variables



Netherlands imaged by Proba-V for August 2018

Sunset in orbit
Copyright: NASA

Climate in 2018

Spotlight on...

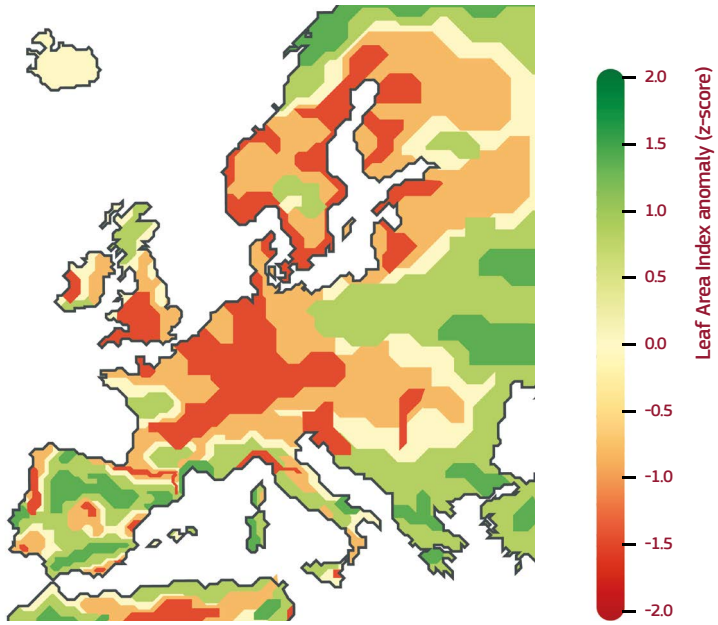
Smoke from fires in Sweden
Copyright: contains modified Copernicus Sentinel data (2018), processed by ESA

Sunshine duration

Sunshine duration in 2018 was exceptionally high across many parts of Europe. Some areas of central and northern Europe experienced up to 40% more sunshine hours than average, and in Germany it was the sunniest year on record. Only in southern Europe was sunshine duration below average.

Wildfire activity

High temperatures, low precipitation and dry vegetation meant fire danger was much higher than average in many parts of northern Europe, particularly in Scandinavia and around the Baltic Sea. In these regions, the annual levels of wildfire emissions were the highest on record (starting in 2003). In Sweden, the fires were considered to be the most serious in the country's modern history.



Leaf Area Index anomalies for August 2018 as estimated from satellites. **Data source:** VGT/PROBA-V (PROBA-V_2018 anomaly given a climatology from VGT) **Credit:** C3S/VITO

Alpine glaciers

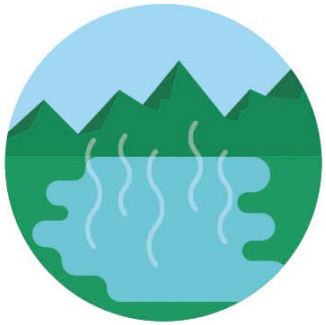
Globally, glacier mass loss has been significant over the past few decades, with the European Alps being one of the regions where glaciers are shrinking the most. Although 2018 started with a snow-rich winter, the exceptionally long, warm and sunny summer turned the year into another one with extreme mass loss for the Alpine reference glaciers.

Vegetation and land surface

The drought in northern and central Europe can be clearly seen in measurements of soil moisture and vegetation cover from satellites. The anomalies in soil moisture and vegetation started in early summer around the Baltic Sea and spread across northern and central Europe over the next few months. Some regions saw large anomalies in soil moisture even until the end of the year.

Lake surface temperatures

The summer surface water temperatures of European lakes were the highest since at least 1995, at 0.8°C above average. This is higher than the temperature anomaly of +0.7°C across all 923 reference lakes worldwide. The largest positive anomaly was Lake Constance in Germany at +1.7°C; Lake Thingvallavatn in Iceland had the largest negative anomaly of -0.7°C.



River discharge

Across Europe, river discharge was higher than average for January to April, but below average for the next seven to eight months. In October, river discharge reached its lowest level since at least 1991. At its lowest, 36% of the European river system was in low flow. By December, the average discharge across Europe was back to normal.

Greenland surface melt
Copyright: Andrew Sole - University of Sheffield

Sea ice opening north of Greenland

Although Arctic sea ice cover shows large seasonal variability, the area north of Greenland tends to have stable conditions of thicker and older sea ice coverage, especially during the winter months. However, in late February 2018, very warm air and strong winds entered this region, and a larger area of open water formed within the ice pack. This is the first year, since the start of satellite observations in 1979, that this has happened in winter.

Climate Indicators

The headline climate indicators show the long-term evolution of several key climate variables. These can be used to assess the global and regional trends of a changing climate.

The arrows show the long-term increasing ▲ or decreasing ▼ trend of these indicators.

Svalbard Archipelago

Climate Indicators

Antarctic sunset from Sentinel-3b
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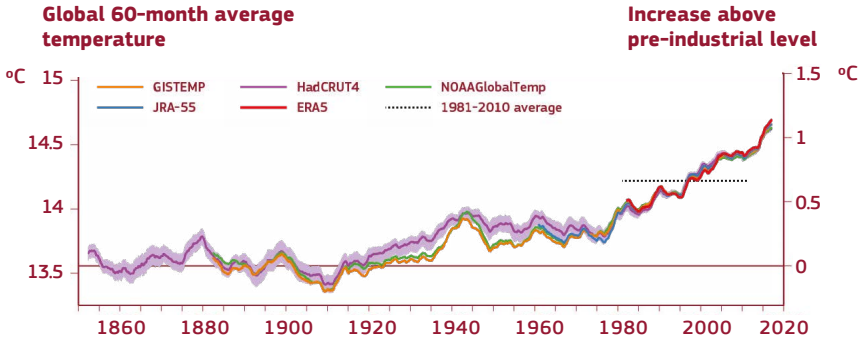


Global surface air temperature (left-hand axis) and estimated change since the pre-industrial era (right-hand axis) according to different datasets. **Credit:** C3S/ECMWF

Greenhouse gases

The estimated net surface fluxes of the greenhouse gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) into the atmosphere have been increasing during recent decades. Anthropogenic emissions of CO_2 have been partly compensated for by a natural uptake by oceans and vegetation. It is estimated that, across Europe as a whole, vegetation acts as a sink for CO_2, but the scale of this sink relative to the rest of the world has been decreasing since the 1990s.

• Concentrations (column-averaged mixing ratios) estimated from satellite data for CO_2 and CH_4 covering 2003 to 2018. Estimated net flux data for CO_2, N_2O, CH_4 covering 1979, 1996, 2000 to 2018

Annual increase in atmospheric concentrations:

- CO_2: about 0.6%/year
- CH_4: about 0.4%/year

Current net emissions at the Earth's surface:

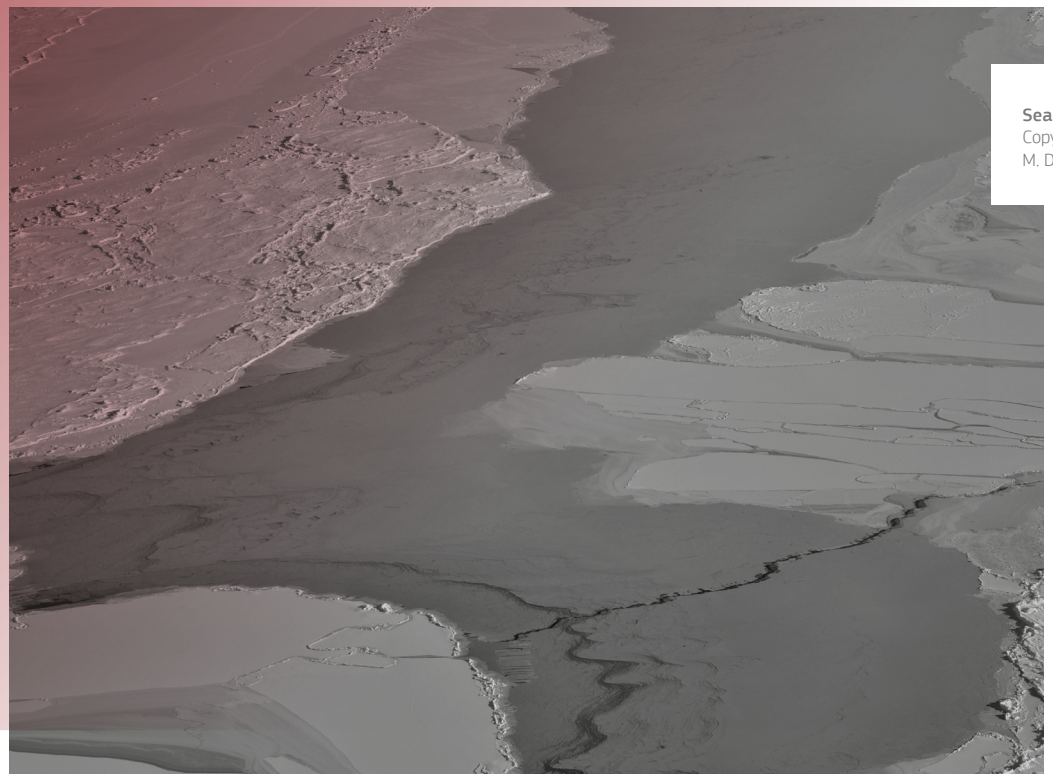
- CO_2: about 5 PgC/year
- CH_4: about 420 TgC/year
- N_2O: about 18 TgN/year

Surface temperature

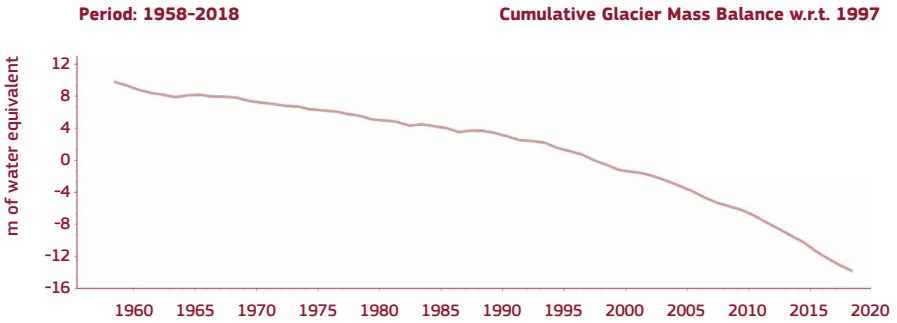
The aim of the Paris Agreement is to hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and to pursue efforts to limit it to 1.5°C. The latest five-year average global temperature is the highest on record, and shows warming of around 1.1°C.

• Five temperature datasets covering all or parts of 1850 to 2018

- Globally: around 1.1°C increase since pre-industrial era
- Europe: almost 2.0°C increase since latter half of the 19th century



Sea ice
Copyright: ESA - M. Davidson



Cumulative annual mass balance from 41 reference glaciers distributed globally. Values are shown relative to 1997.
Data source: WGMS **Credit:** C3S/WGMS

Sea ice

In the Arctic, sea ice cover shows a downward trend that becomes prominent after the year 2000. In the Antarctic, however, there is considerable variability, with no clear trend. In this region, periods of markedly above-average sea ice cover occurred from 2007 to 2009, and from 2013 to 2015, but the cover has been substantially below average since September 2016.

- Sea ice data record covering 1979 to 2018

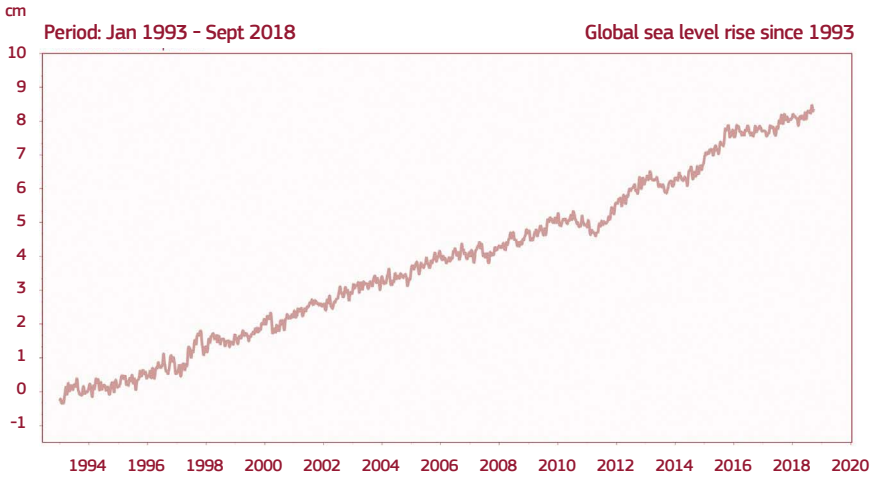
- Arctic: 2016 maximum and 2012 minimum area lowest on record
- Antarctic: 2017 maximum and minimum area lowest on record

Glaciers

Both globally and in Europe, glaciers are seeing a strong and continued loss of ice mass. Since 1997, the monitored glaciers in Europe have lost 8 to 25 m of mass; with a regional average of around 16 tonnes of freshwater per square metre. In the 20th century, the rate of mass loss was lower, including some periods of mass gain at both a regional and decadal scale.

- Reference glacier network with more than 30 years of ongoing observations

- Globally: more than 20 m of observed loss in ice thickness since 1960s
- Europe: observed loss in ice thickness since 1960s ranges between 2 m in southwestern Scandinavia and 34 m in the Alps



Daily globally averaged mean sea level since January 1993. The data have been adjusted for glacial isostatic adjustment (the movement of land in response to historic glaciers). **Data source**: CMEMS Ocean Monitoring Indicator based on the C3S sea level product. **Credit:** C3S/Copernicus Marine Environment Monitoring Service (CMEMS).

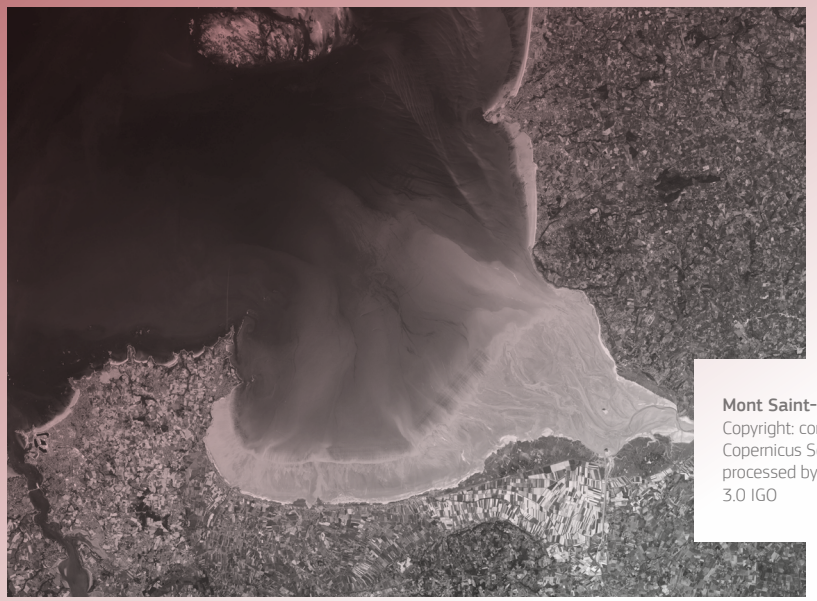
Sea level

Over the last 25 years, the global mean rise in sea level has been 3.3 ± 0.4 mm/yr; a total increase of around 8 cm. About 30% of this rise can be attributed to ocean thermal expansion, the other 70% being due to land ice melt. Regional trends can deviate considerably from the global mean. For example, in Europe, the sea level changes differ between the open ocean and coastal areas due to various geophysical processes.

- Sea level data record covering January 1993 to September 2018

During last 25 years:

- Globally: mean sea level increase of around 3.3 mm/year
- Europe: mean sea level increase of 1-2 mm/year in most coastal areas



Mont Saint-Michel, France
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Vital environmental data 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 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 (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.

The Copernicus Climate Change Service (C3S)

The Copernicus Climate Change Service (C3S) combines observations of the climate system with the latest scientific research to develop authoritative, quality-assured information about past, current and future states of the climate in Europe and worldwide.

The Copernicus Atmosphere Monitoring Service (CAMS)

The Copernicus Atmosphere Monitoring Service (CAMS) provides continuous data and information on atmospheric composition to help policymakers, businesses and citizens address these environmental concerns.

With contributions from

C3S, CAMS, Copernicus EMS, CMEMS, CEA/LSCE (France), CLS (France), DMI (Denmark), DWD (Germany), ECMWF, EEA, EODC (Austria), ESA, EUMETSAT CM SAF, GCOS, JAXA (Japan), KNMI (Netherlands), NASA (USA), NILU (Norway), NIES (Japan), Met Norway, SRON (Netherlands), University of Reading (United Kingdom), University of Zurich (Switzerland), TNO (Netherlands), TU Wien (Austria), University of Bremen (Germany), University of Leicester (United Kingdom), VanderSat (Netherlands), VITO (Belgium), VU Amsterdam (Netherlands), WGMS (Switzerland)

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