



Climate Change

Data-driven climate communication – the European State of the Climate 2019

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ECMWF, Copernicus Climate Change Service (C3S)

UEF2020, 1-4 June #WFH



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Climate Change



Three periods of exceptionally warm weather led to record-breaking high temperatures



One of the wettest Novembers on record brought precipitation of up to four times the normal amounts



River discharge

Across Europe, river discharge was lower than average for two thirds of the year.



Heat and cold stress

The number of days with high heat stress levels are increasing in both northern and southern Europe.



Satellites

Providing information about the Earth's surface and its atmosphere from spaceborne orbit.



Model-based estimates

Using the laws of physics and statistics to build large-scale models of environmental indicators.



Reanalysis

Using a combination of observations and computer models to recreate historical climate conditions.



In situ

Measurements from an instrument located at the point of interest, such as a land station, at sea or in an aeroplane.



11 of the 12 warmest years have occurred since 2000

Greenhouse gas concentrations

The amount of a gas contained in a certain volume of air.



CO₂ increase by about

0.6% per year ▲

in atmospheric concentrations

CH₄ increase by about

0.4% per year ▲

in atmospheric concentrations



Concentrations (column-averaged mixing ratios) estimated from satellite data for CO₂ and CH₄ covering 2003–2019



Climate Change

Data-driven climate information for communication

REPORT CLIMATE CHANGE
European temperature

KEY MESSAGES

- 2019 was the warmest year on record, very closely followed by 2014, 2015 and 2018.
- 11 of the 12 warmest years in Europe have occurred since 2000.
- The whole of Europe was warmer than average, except for a few small areas.
- The largest annual temperature anomalies were in central and eastern Europe.
- All seasons were warmer than average, with summer being the fourth warmest since at least 1979.
- Annual mean minimum and maximum daily temperatures were warmer than average almost everywhere in Europe, with maximum temperatures generally showing larger anomalies than minimum temperatures.

2019 in context

Europe annual temperature anomalies 1979-2019

Data source: ERA5 Reference period: 1981-2010

European Climate Change Service
European Centre for Medium-Range Weather Forecasts
Copernicus
ECMWF

European surface air temperature anomaly for the annual average from 1979 to 2018, relative to the annual average for the 1981-2010 reference period.
Data source: ERA5-CRUI Copernicus Climate Change Service (C3S)/ECMWF/KNMI

Temperatures over Europe show long-term warming trends since 1979 for both the annual and seasonal averages, though the rate of change and the time at which a clear trend emerges differ for the different time periods. The annual mean temperature shows that 2019 was the warmest on record for the ERA5 dataset, at over 1.2°C above average, but closely followed by 2014, 2015 and 2018. According to ERA5, 11 of the 12 warmest years in Europe have occurred since 2000.

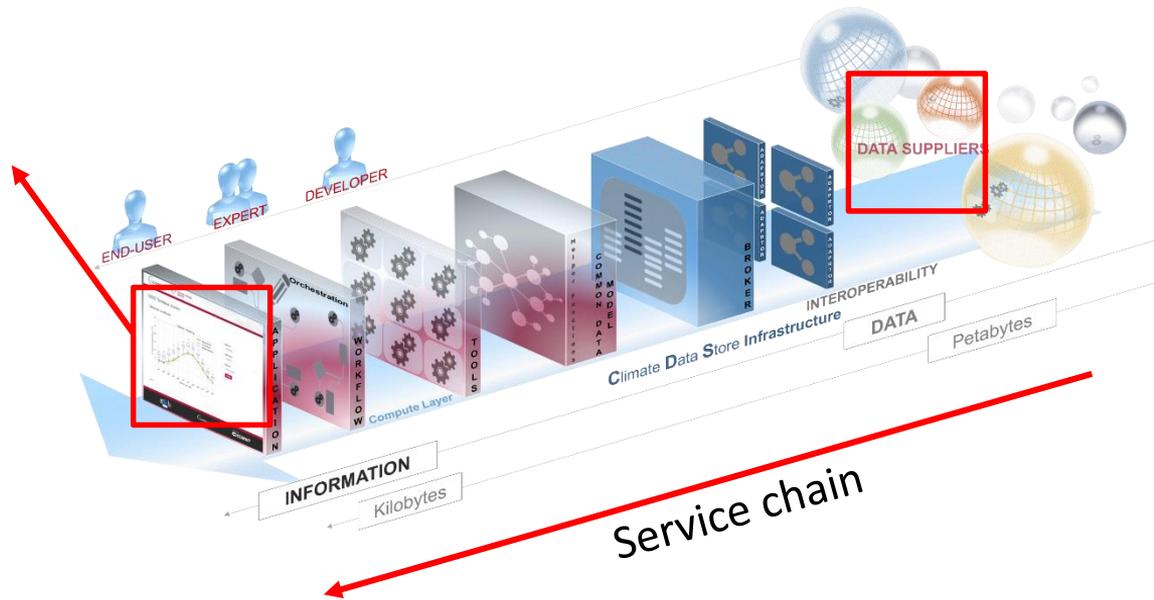
More information on the longer-term perspective can be found in the [Temperature Indicator](#).

Annual temperature

2019 mean surface temperature anomaly - ERA5 2019 mean surface temperature anomaly - E-OBS

Surface air temperature anomaly for 2019 relative to the annual average for the 1981-2010 reference period. Data source: ERA5 (left), E-OBS (right)
Credit: Copernicus Climate Change Service (C3S)/ECMWF/KNMI

Mean temperatures for 2019 were above the 1981-2010 average across almost all of continental Europe. The largest anomalies were found in central and eastern parts of Europe. Below-average temperatures were recorded only in small areas of northern Europe.



Quality Assured information and tools for users ranging from scientists to practitioners and policy makers.



Climate
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European state of the climate

published annually in April since 2018



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Climate Change

European state of the climate – Summary

Copernicus
Europe's eyes on Earth

EUROPEAN STATE OF THE CLIMATE 2019 SUMMARY

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THE CLIMATE IN 2019 OVERVIEW

A review of annual and seasonal conditions in Europe and the European Arctic compared to the long-term average.

European annual temperature anomalies 1979-2019 (°C)

Surface air temperature anomaly for Europe, relative to 1981-2010. Data source: ERA5. Credit: Copernicus.

11 of the 12 warmest years have occurred since 2000

European temperature

Over the last four decades, temperatures in Europe have shown a clear warming trend.

In 2019, the annual temperature for Europe was the highest on record, though closely followed by 2014, 2015 and 2018. It was warmer than average over almost the whole of Europe. Central and eastern areas saw the most above-average temperatures; it was cooler than average only over a very small part of northern Europe.

All seasons were warmer than average. Summer was the fourth warmest since at least 1979, with temperatures in some areas as much as 3°C to 4°C higher than normal. Two intense heatwaves in June and July brought record-breaking temperatures to some European countries.

The annual means of both minimum and maximum daily temperatures were above average almost everywhere in Europe, with maximum temperatures generally showing larger anomalies than minimum temperatures.

1981-2010

Soil moisture values in 2019 were the second lowest since at least 1979

European wet and dry conditions

There is no clear trend in annual precipitation for Europe, and 2019 values were close to average. The number of precipitation days was up to 30 days more than average in the north, west and south, whereas central and eastern Europe saw below-average values.

In winter, spring and summer, precipitation was below average in the southwest, however, this changed during autumn and December when for large parts of this region it became much above average.

Soil moisture shows a downward trend, with values for 2019 being the second lowest since at least 1979. Most of continental Europe saw below-average soil moisture throughout the year, especially in central Europe during summer and in the southeast during autumn. During autumn, parts of western, northern and southern Europe saw soil moisture anomalies becoming closer to or even above average, concurrent with the above-average precipitation in these regions.

1981-2010 1991-2010

Cooler and more sea ice than in recent years

European Arctic

The European sector of the Arctic has seen an upward trend in temperature and a downward trend in sea ice cover over the last 40 years. 2019 saw surface air temperatures over sea and land at 0.9°C above average. However, as the 14th warmest in the 41-year dataset, the year was relatively cold compared to recent years, with the lowest annual temperature since 2010.

At the end of July, all-time temperature records were broken in northern Scandinavia when a short heatwave travelled across Europe. It also led to record surface melting in Greenland. However, the summer season as a whole had temperatures relatively close to average.

Sea ice extent was lower than average, as it has been consistently for the past 15 years, but markedly above the values recorded in six of the preceding seven years.

1981-2010



Climate Change

European state of the climate – Main sections

WHAT WE DO / CLIMATE BULLETIN / EUROPEAN STATE OF THE CLIMATE / 2019 / EUROPEAN TEMPERATURE

ESOTC 2019 | CLIMATE IN 2019 | GENERAL

European temperature

2019 IN CONTEXT | ANNUAL TEMPERATURE | SEASONAL TEMPERATURES | MAXIMUM AND MINIMUM TEMPERATURES

KEY MESSAGES

- 2019 was the warmest year on record, very closely followed by 2014, 2015 and 2018.
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2019 in context

Europe annual temperature anomalies 1979-2019

DATA IN THIS SECTION

TYPES OF DATA USED | REFERENCE PERIOD:

1981-2010

ERAS SURFACE AIR TEMPERATURE
>

E-OBS SURFACE AIR TEMPERATURE
?
>

[Back to ESOTC home](#)

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Climate Change

European state of the climate – The data & CDS

WHAT WE DO / CLIMATE BULLETIN / EUROPEAN STATE OF THE CLIMATE / 2019 / ABOUT THE DATA AND ANALYSIS

ESOTC 2019 | CLIMATE IN 2019

About the data and analysis

DEFINITIONS | DATASETS

The following describes the data and analysis of the 'Climate in 2019' sections of the European State of the Climate in 2019. The 'about the data' sections for the global and European 'Climate Indicators' can be found on dedicated pages for each indicator.

Definitions

The definitions below are the generally used definitions. If other definitions are used, this is marked in the respective data section.

Annual definition
Annual values are based on averages or other statistics for the months January to December of each year.

Seasonal definition
Seasons are defined according to the boreal definition.

For maps showing seasonal values for 2019: winter, December 2018 - February 2019 (DJF); spring, March 2019 - May 2019 (MAM); summer, June 2019 - August 2019 (JJA); autumn, September 2019 - November 2019 (SON). For time series graphs, the same periods are used for previous years.

Region definitions

ERA5 surface air temperature, precipitation and soil moisture

Data | Documentation

ERA5 is a global atmospheric reanalysis from 1979 onwards, updated monthly with a delay of approximately two months. The resolution is hourly, but for this report the 'monthly means of daily means' are used. The native horizontal grid is ~31 km (reduced Gaussian grid N320), but data can be downloaded on a 0.25 deg regular lat/long grid. ERA5 is used for surface air temperature, precipitation, soil moisture and sea ice.

ERA5 surface air temperature

ERA5 surface air temperature is defined on all of the domain and over all surfaces, all values are shown.

Used in European temperature, European Arctic

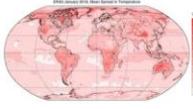
Home Search Datasets Applications Toolbox FAQ Live

ERA5 hourly data on single levels from 1979 to present

Overview Download data Documentation View

ERA5 is the fifth generation ECMWF atmospheric reanalysis of the global climate. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics. This principle, called data assimilation, is based on the method used by numerical weather prediction centres, where every so many hours (12 hours at ECMWF) a previous forecast is combined with newly available observations in an optimal way to produce a new best estimate of the state of the atmosphere, called analysis, from which an updated, improved forecast is issued. Reanalysis works in the same way, but at reduced resolution to allow for the provision of a dataset spanning back several decades. Reanalysis does not have the constraint of issuing timely forecasts, so there is more time to collect observations, and when going further back in time, to allow for the ingestion of improved versions of the original observations, which all benefit the quality of the reanalysis product.

The assimilation system is able to estimate biases between observations and to sift good-quality data from poor data. The laws of physics allow for estimates at locations where data coverage is low, such as for surface temperature in the Arctic. The provision of estimates at each grid point around the globe for each regular output time, over a long period, always using the same format, makes reanalysis a very convenient and popular dataset to work with.



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Publication date
2018-06-14

References
DOI: 10.24381/cds.adbb2d47

Related data

Essential climate variables for assessment of climate variability from 1979 to present

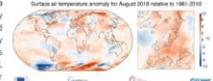
WARNING: Files for ERA5 adjusted surface air temperature were affected by an error in the processing, affecting mean and anomaly values for the period from 1979 to 2014. ERA5 and ERA-interim 12-month running mean statistics were affected by a minor bug. These problems have now been corrected. Users who have previously downloaded the affected data are advised to re-download the corresponding files - see documentation for more information.

Overview Download data Documentation View

The Essential Climate Variables for assessment of climate variability from 1979 to present dataset contains a selection of climatologies, monthly anomalies and monthly mean fields of Essential Climate Variables (ECVs) suitable for monitoring and assessment of climate variability and change. Selection criteria are based on accuracy and temporal consistency on monthly to decadal time scales. The ECV data products in this set have been estimated from climate reanalyses ERA-Interim and ERA5, and, depending on the source, may have been adjusted to account for biases and other known deficiencies. Data sources and adjustment methods used are described in the Product User Guide, as are various particulars such as the baseline periods used to calculate monthly climatologies and the corresponding anomalies.

The CES monthly climate bulletin (<https://climate.copernicus.eu/climate-bulletins>) provides an assessment of the monthly state of the climate with an emphasis on the European geographical domain. This data record is used as the basis for these monthly bulletins.

More details about the products are given in the Documentation section.



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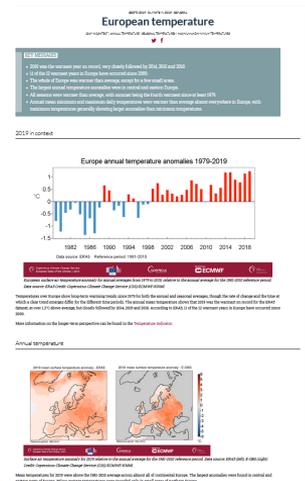
Related data

Thermal comfort indices derived from ERA5 reanalysis

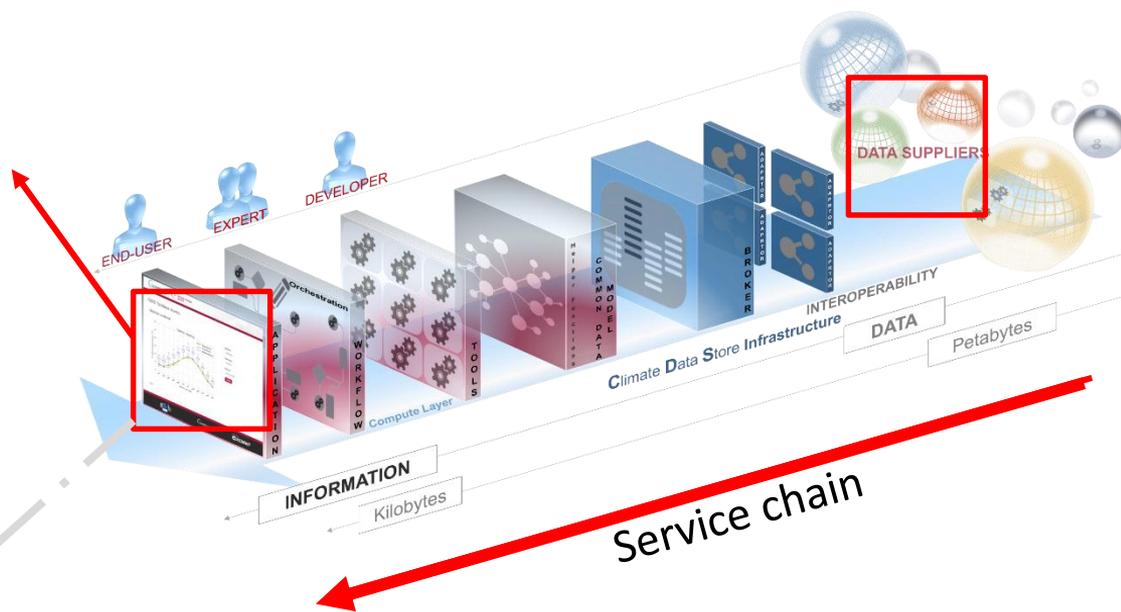


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Adding links in the chain



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Quality Assured information and tools for users ranging from scientists to practitioners and policy makers.





Climate Change

CDS applications – solidifying the connection data → info

Login/register
 Your feedback helps us to improve the service

C3S monthly climate bulletin explorer

Overview Application Documentation Source code

This application delivers an interactive version of the monthly Copernicus climate bulletins on temperature. It allows the user to explore the dataset beyond the aggregated regions - the globe and Europe - that are covered in the bulletin. It presents a map showing monthly average temperature anomalies over the entire globe, with respect to the period 1981-2010. When clicking on one of the highlighted regions, time-series of temperature anomalies averaged over the selected region are shown.

The maps and graphs generated are based on the Essential Climate Variables for assessment of climate variability from 1979 to present dataset.

List of user-selectable parameters

- Year and month: from Jan 2019 to present

Description of the graphical output

The application presents a map of the globe with monthly average temperature anomalies displayed for the chosen year and month, which the user may select from a dropdown menu located at the top of the application. Selectable regions on the map are highlighted by thicker borders; selecting a region generates a timeseries of monthly and 12-month averages over the selected region. The selectable national/regional layer may be changed by zooming in and out on the main map, showing in sequence Eurostat NUTS 0 administrative levels and European regions (NUTS 2).

More details about the products are given in the Documentation section.

INPUT VARIABLES

Name	Units	Description
Surface air temperature anomaly 12-month average	K	12 months running mean anomalies of the air temperature at surface with respect to 1981-2010
Surface air temperature anomaly monthly	K	Monthly anomalies of the air temperature at surface with respect to 1981-2010

OUTPUT VARIABLES

Name	Units	Description
Surface air temperature anomaly 12-month average	K	12 months running mean anomalies of the air temperature at surface with respect to 1981-2010
Surface air temperature anomaly monthly	K	Monthly anomalies of the air temperature at surface with respect to 1981-2010



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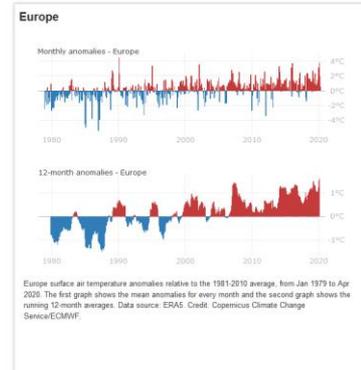
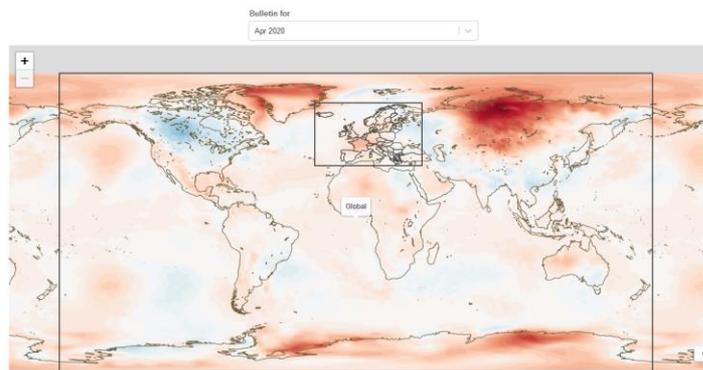
Publication date

2019-10-25

Related applications

Climate Data Store - C3S monthly climate bulletin explorer

Surface air temperature anomalies relative to 1981-2010



V2 in development

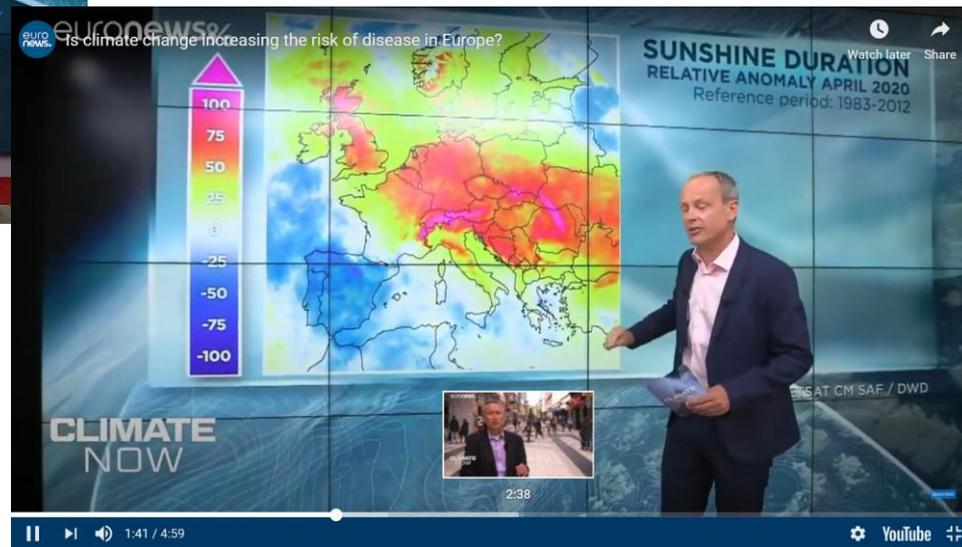


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Communicating beyond C3S – EURONEWS Climate Now



“warmest winter on record in Europe”



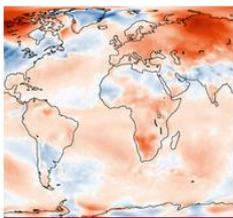
➤ <https://www.euronews.com/programs/climate-now>





Climate
Change

Increasing relevance for target stakeholders



Surface temperature



Greenhouse gas concentrations



Greenhouse gas fluxes



Vegetation



Wildfires



Sunshine duration and clouds



Sea ice



Glaciers



Glaciers and sea level



Lake surface temperatures



River discharge



Heat and cold stress



Sea level



Ice sheets

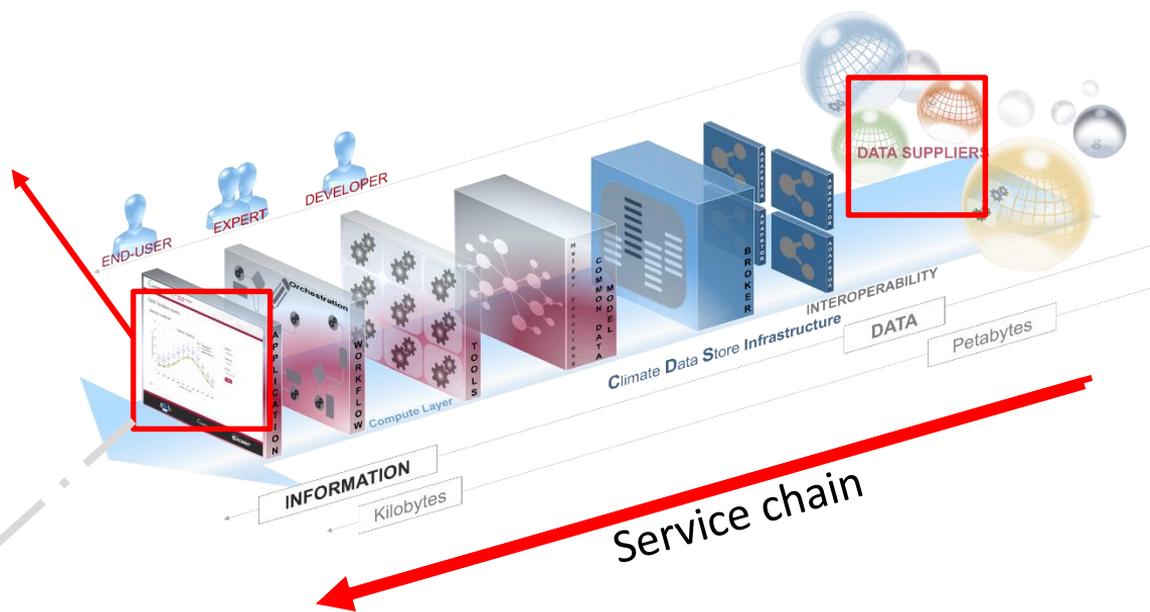
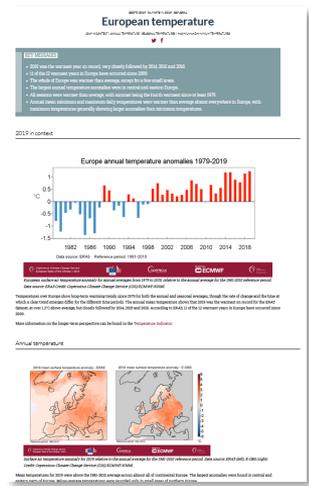


Greenland ice sheet



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Questions?



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