



Climate Change

Reanalysis and climate data records as a supporting tool for global extremes monitoring

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Introduction

Weather & Climate extremes

IPCC 5th Assessment Report (WG 1 Glossary):

"An extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations."

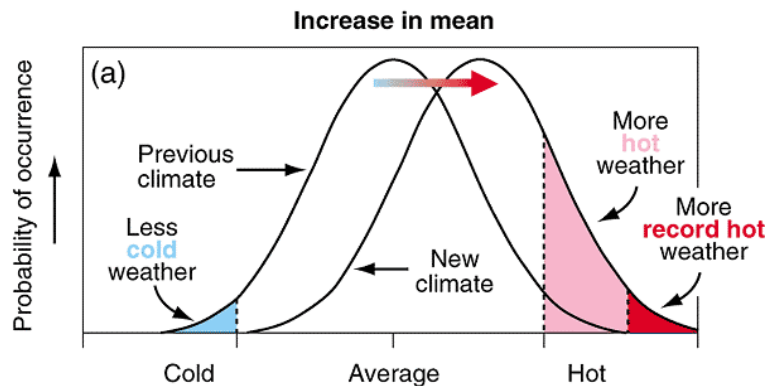
"When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season)."



Introduction

And the projections:

- [1] "confidence has increased that some weather events and extremes will become more frequent, more widespread or more intense during the 21st century".
- [2] "Climate extremes often have severe impacts on societies and ecosystems. Different types of extremes, such as heat waves and droughts, are expected to increase in frequency and intensity along with anthropogenic climate change".
- [3] "The cost of inaction can be very high. For ex, the WMO estimates that alone droughts cost just in the EU 7.5 billion of USD/year".
- [4] "Anthropogenic warming is anticipated to increase soil moisture drought in the future".



[1] IPCC Fourth Assessment Report (IPCC, 2007)

[2] Seneviratne, S. I., and Coauthors, 2012: Changes in climate extremes and their impacts on the natural physical environment. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, C. B. Field et al., Eds., Cambridge University Press, 109–230.

[3] Gerber, Nicolas & Mirzabaev, Alisher. (2017). Benefits of action and costs of inaction: Drought mitigation and preparedness – a literature review.

[4] Samaniego, Luis, Thober, Stephan, Kumar, Rohini, Wanders, Niko, Rakovec, O, Pan, Ming, Zink, Matthias, Sheffield, Justin, Wood, Eric and Marx, Andreas (2018) Anthropogenic warming exacerbates European soil moisture droughts. *Nature Climate Change*, 8, 421-426.



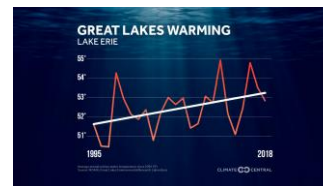
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Weather & Climate extremes in perspective

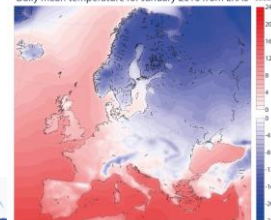
- Weather & climate extremes yield substantial socio-economical and human losses.
- It is important to implement and make use of tools that can monitor and warn about meteorological and climate extremes,
- Mitigate and prevent losses.
 - Provide policy and decision makers with a quantitative measure of extreme characteristics, allowing them to act upon scientifically based data.

Two of these tools are:

- 1) Observational climate data records based on satellite and in-situ based data
- 2) Reanalysis: enable us to put observed high-impact weather and extreme events in a long-term historical context



Daily mean temperature for January 2016 from ERA5



European
Commission

ECMWF

European
Commission





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Reanalysis produced at ECMWF

Atmosphere/land

1) 1979 - 1981
FGGE

2) 1994 - 1996
ERA-15

3) 2001 - 2003
ERA-40

4) 2006 - ...
ERA-Interim



5) 2016 - ...
ERA5

including ocean waves

Ocean

2006
ORAS3

2010 - ...
ORAS4

including sea ice

2016 - ...
ORAS5



Centennial

2013 - 2015
ERA-20CM/20C

Coupled

2016
CERA-20C

2017
CERA-SAT

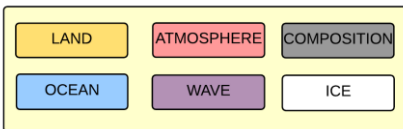
Enhanced land

2012
ERA-Int/Land

2014
ERA-20C/Land

Copernicus
Europe's eyes on Earth
ERA5L

Towards a coupled earth system



Atmospheric composition

2008 - 2009
GEMS

2010 - 2011
MACC

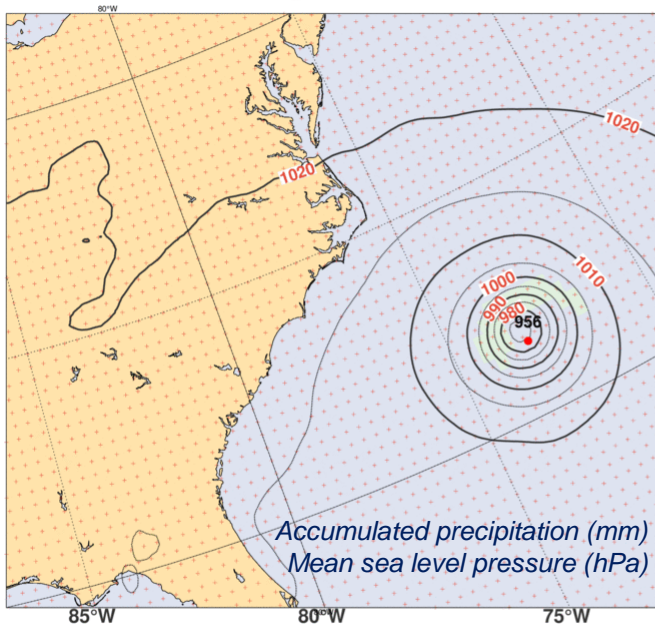
Copernicus
Europe's eyes on Earth
2017 - ...
CAMS



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Better model, more and better observations, higher resolution, hourly output

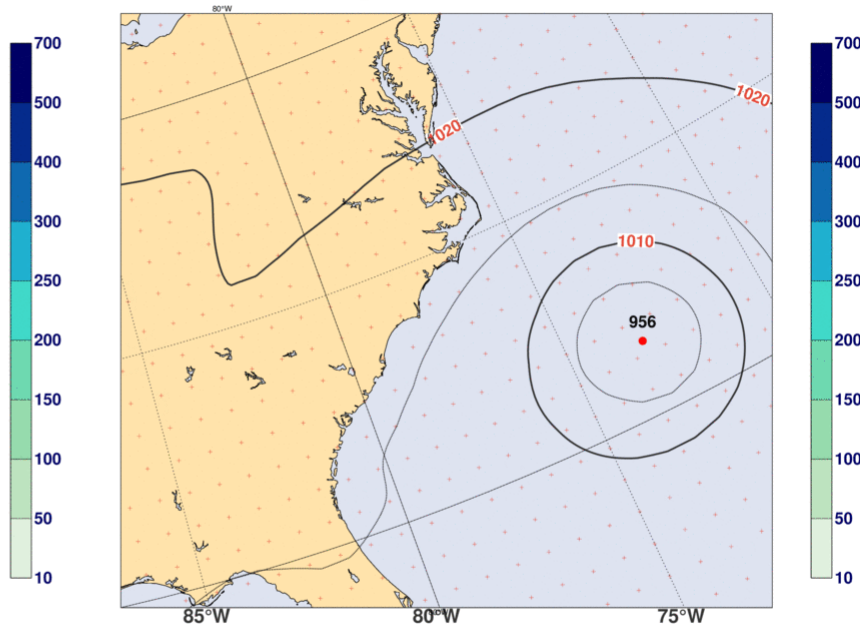
Florence Thu 13 Sep 2018, 01 UTC for ERA5



ERA5



Florence Thu 13 Sep 2018, 01 UTC for ERA-Interim



ERA-Interim





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Essential Climate Variables



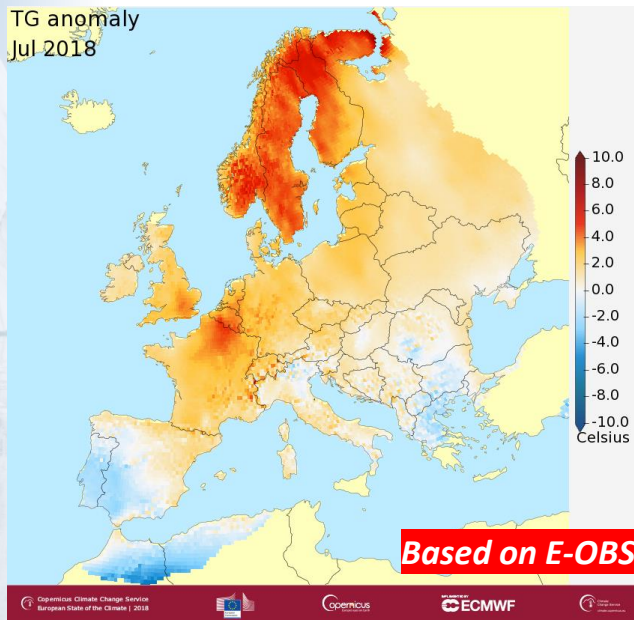
		C3S_312a		C3S_312b		
	GCOS	2017	2018	2019	2020	2021
Atmospheric physics						
Precipitation	4.3.5					
Surface Radiation Budget	4.3.6					
Water Vapour	4.5.3					Lot 1
Cloud Properties	4.5.4					
Earth Radiation Budget	4.5.5					
Atmospheric composition						
Carbon Dioxide	4.7.1	Lot 6				
Methane	4.7.2	Lot 6				
Ozone	4.7.4	Lot 4				Lot 2
Aerosol	4.7.5	Lot 5				
Ocean						
Sea Surface Temperature	5.3.1	Lot 3				
Sea Level	5.3.3	Lot 2				
Sea ice	5.3.5	Lot 1				Lot 3
Ocean Colour	5.3.7					
Land hydrology & cryosphere						
Lakes	6.3.4					
Glaciers	6.3.6	Lot 8				
Ice sheets and ice shelves	6.3.7					Lot 4
Soil moisture	6.3.16	Lot 7				
Land biosphere						
Albedo	6.3.9	Lot 9				
Land Cover	6.3.10					
Fraction of Absorbed Photosynthetically Active Radiation	6.3.11	Lot 9				Lot 5
Leaf Area Index	6.3.12	Lot 9				
Fire	6.3.15					
		2017	2018	2019	2020	2021



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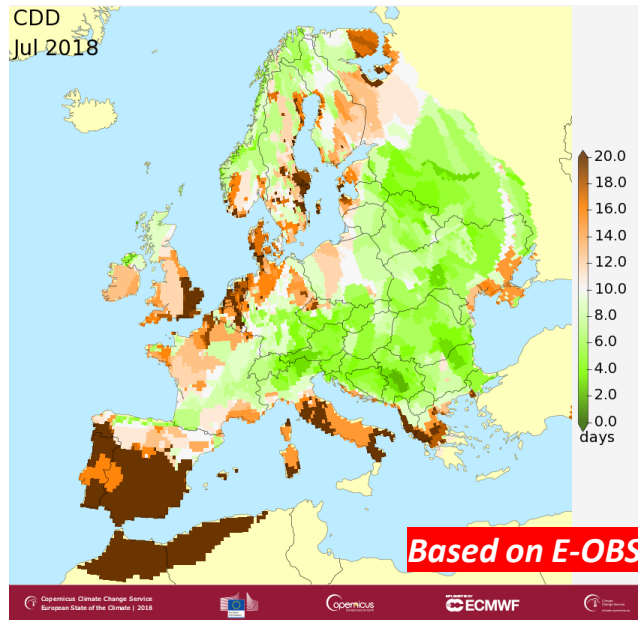
Drought & heatwave in Northern Europe – July 2018

Mean air temperature anomaly for July 2018 with respect to 1981-2010



Credit: Copernicus Climate Change Service (C3S)/KNMI.

Largest number of Consecutive Dry Days in July 2018 (using the 1 mm/day threshold).



Credit: Copernicus Climate Change Service (C3S)/KNMI.

However

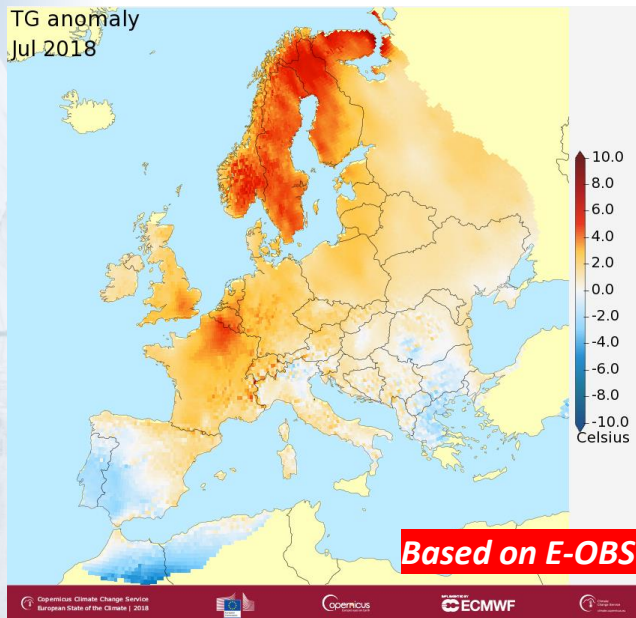




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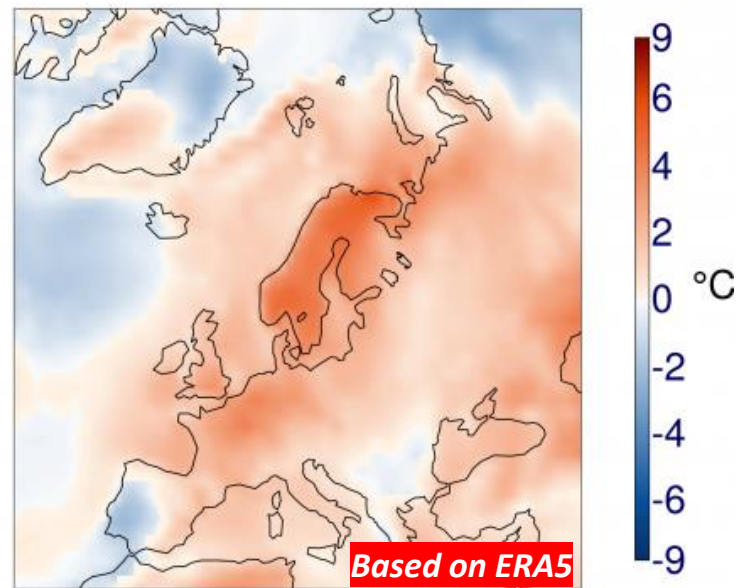
Heatwave & drought in Northern Europe – July 2018

Mean air temperature anomaly for July 2018 with respect to 1981-2010



Credit: Copernicus Climate Change Service (C3S)/KNMI.

Mean air temperature anomaly for July 2018 with respect to 1981-2010.



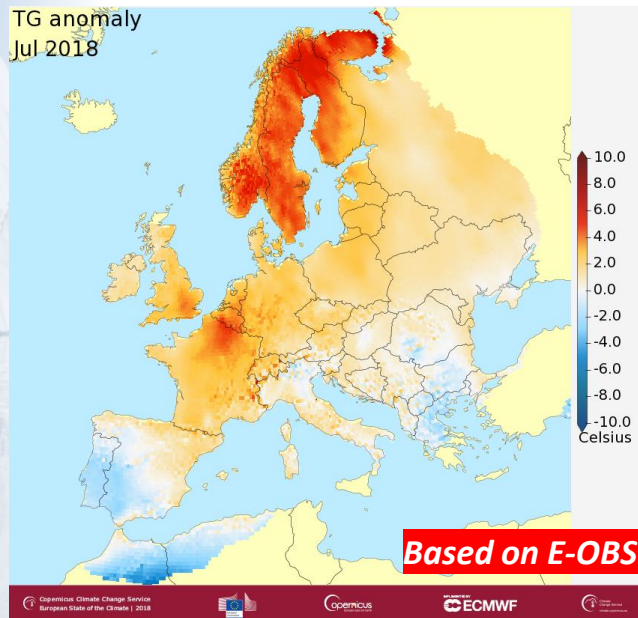
Credit: ECMWF, Copernicus Climate Change Service (C3S).



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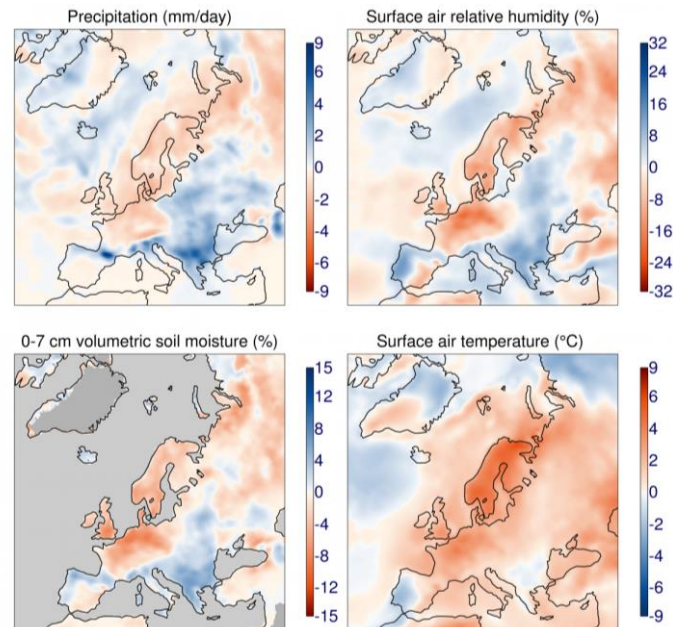
Heatwave & drought in Northern Europe – July 2018

Mean air temperature anomaly for July 2018 with respect to 1981-2010



Credit: Copernicus Climate Change Service (C3S)/KNMI.

Mean (hydrological) anomaly for July 2018 with respect to 1981-2010



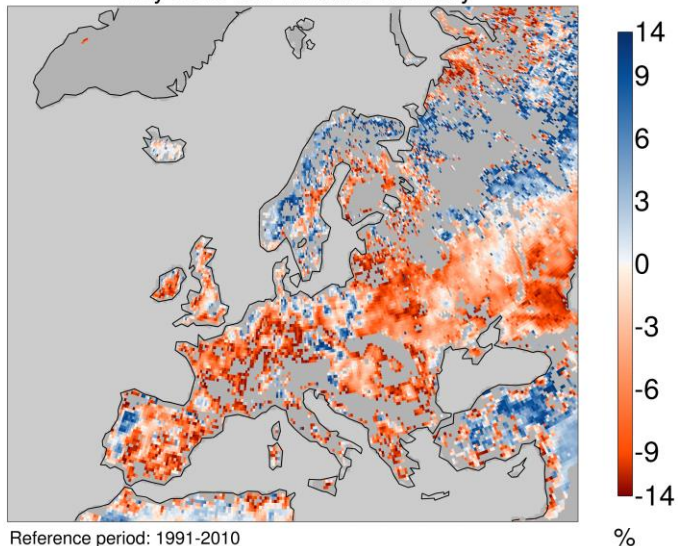


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Heatwave & drought in Northern Europe – July 2018

2018 monthly mean soil moisture anomaly with respect to 1991-2010

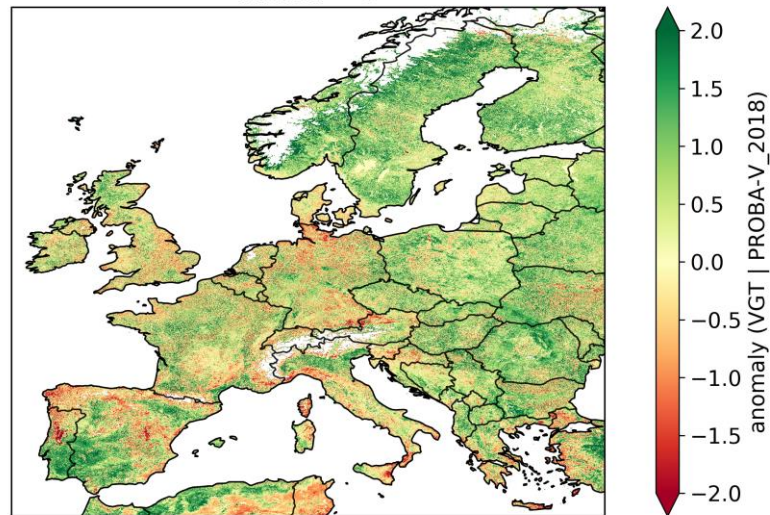
May 2018 soil moisture anomaly



Credit: Copernicus Climate Change Service (C3S)/EODC.

2018 monthly mean LAI anomaly with respect to a PROBA-V mean value

month = 5



Credit: Copernicus Climate Change Service (C3S)/VITO.



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Monthly climate bulletins – 4th to 6th of each month

Implemented by ECMWF as part of The Copernicus Programme

Climate Change Service

News Events Press Tenders Help & Support

ABOUT US WHAT WE DO DATA SEARCH

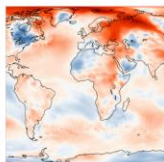
WHAT WE DO ► CLIMATE BULLETIN

Climate bulletins

Through our monthly maps, we present the current condition of the climate using key climate change indicators. We also provide analysis of the maps and guidance on how they are produced.

HIGHLIGHTS OF THE LATEST MONTHLY SUMMARIES MONTHLY CLIMATE UPDATE FEATURED STORY MONTHLY SUMMARIES

Monthly summaries



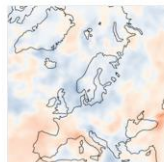
Surface air temperature

This series of monthly maps and charts, generated from ERA-interim data, covers



Sea ice

We produce sea-ice maps every month. Based on ERA-interim reanalysis data, these provide near real-time



Hydrological variables

This series of monthly maps and charts, based on ERA-interim data, covers several



Surface in-situ monitoring for Europe

Monthly and yearly State-of-the-European-climate reports provided

Monthly climate update

15TH OCTOBER 2018

In Europe, it was the warmest September on record. Portugal and western Spain were particularly warm.

Iceland, Ireland and Scotland saw generally cooler than average temperatures.

Japan was hit by two devastating storms, Jebi and Trami following rains, landslides, floods and record-breaking heat this year.

Strong tropical cyclone Mangkhut caused at least 134 fatalities in the Philippines, Hong Kong and China.



Featured story

29TH OCTOBER 2018



A stormy September

One of the **warmest summers on record** has come to an end with a September full of storms. Modelling of historic storms can help us prepare for such events. We use two of the recent storms to demonstrate the improvements we have made with the release of our new **dataset**.

[Read more](#)

➤ climate.copernicus.eu/climate-bulletins





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Remarks & conclusions

Increase of weather and climate extremes in future → crucial to implement monitor tools and early warning systems.

ECMWF/C3S, under the European Copernicus programme, develops reanalysis and observational climate data records.

- Generation of CDRs based on 22 ECVs
- ERA5 reanalysis
- NRT climate tools are to be implemented and made available

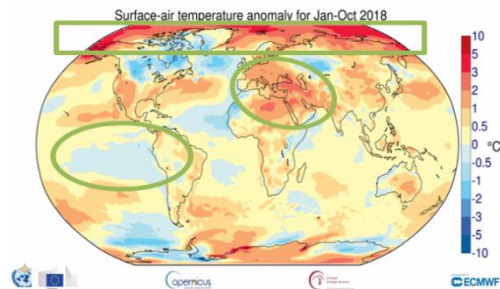
ECMWF/C3S monitors climate at monthly time scales.

- Using ERA5 1981-2010 as reference period
- Using E-OBS as longer observational reference
- Combining with satellite data records

Eventually better / more specialized reanalysis will replace current one to monitor extreme events.

- ERA5-Land, Arctic, UERRA reanalysis.

WMO climate statement: past 4 years warmest on record





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THE END - thank you!

ECMWF: <https://www.ecmwf.int>

Copernicus Climate Change Service (C3S): <https://climate.copernicus.eu/>

C3S Climate Bulletins: <https://climate.copernicus.eu/climate-bulletins>

C3S reanalysis: <https://climate.copernicus.eu/climate-reanalysis>



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