Climate Change

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

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European Commission | Copernicus Europe's eyes on Earth | ECMWF

2019 Joint Satellite Conference – AMS. 28 Sept – 4 Oct, Boston, US

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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)."

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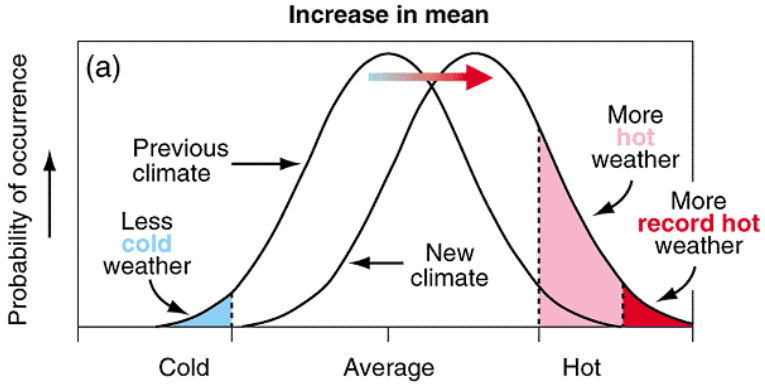
And the projections:

[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

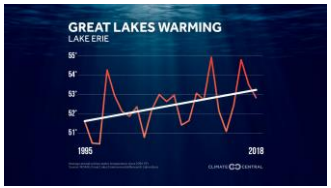
→ **Weather & climate extremes yield substantial socio-economical and human losses.**

→ **It is important to <u>implement and make use of tools that can monitor and warn about meteorological and climate extremes</u>,**

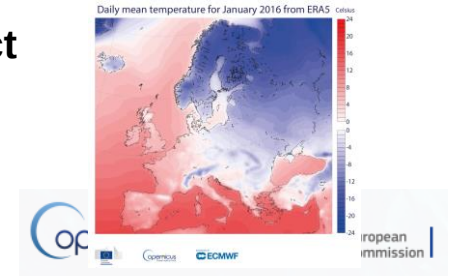
- **Mitigate and prevent losses.**
- **Provide policy and decision makers with a quantitative measure of extreme characteristics, allowing them to act upon scientifically based data.**

Two of these tools are:

1) **<u>Observational climate data records</u> based on satellite and in-situ based data**



2) **<u>Reanalysis:</u> enable us to put observed high-impact weather and extreme events in a long-term historical context**



Reanalysis produced at ECMWF

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Atmosphere/land *including ocean waves*

1) 1979 - 1981 FGGE	2) 1994 - 1996 ERA-15	3) 2001 - 2003 ERA-40	4) 2006 - … ERA-Interim	5) 2016 - … ERA5

Ocean *including sea ice*

2006 ORAS3	2010 - … ORAS4	2016 - … ORAS5

Centennial *Coupled*

2013 - 2015 ERA-20CM/20C	2016 CERA-20C	2017 CERA-SAT

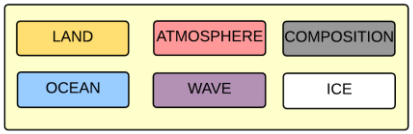
Enhanced land

2012 ERA-Int/Land	2014 ERA-20C/Land	ERA5L

Atmospheric composition

2008 - 2009 GEMS	2010 - 2011 MACC	2017 - … CAMS

Towards a coupled earth system



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

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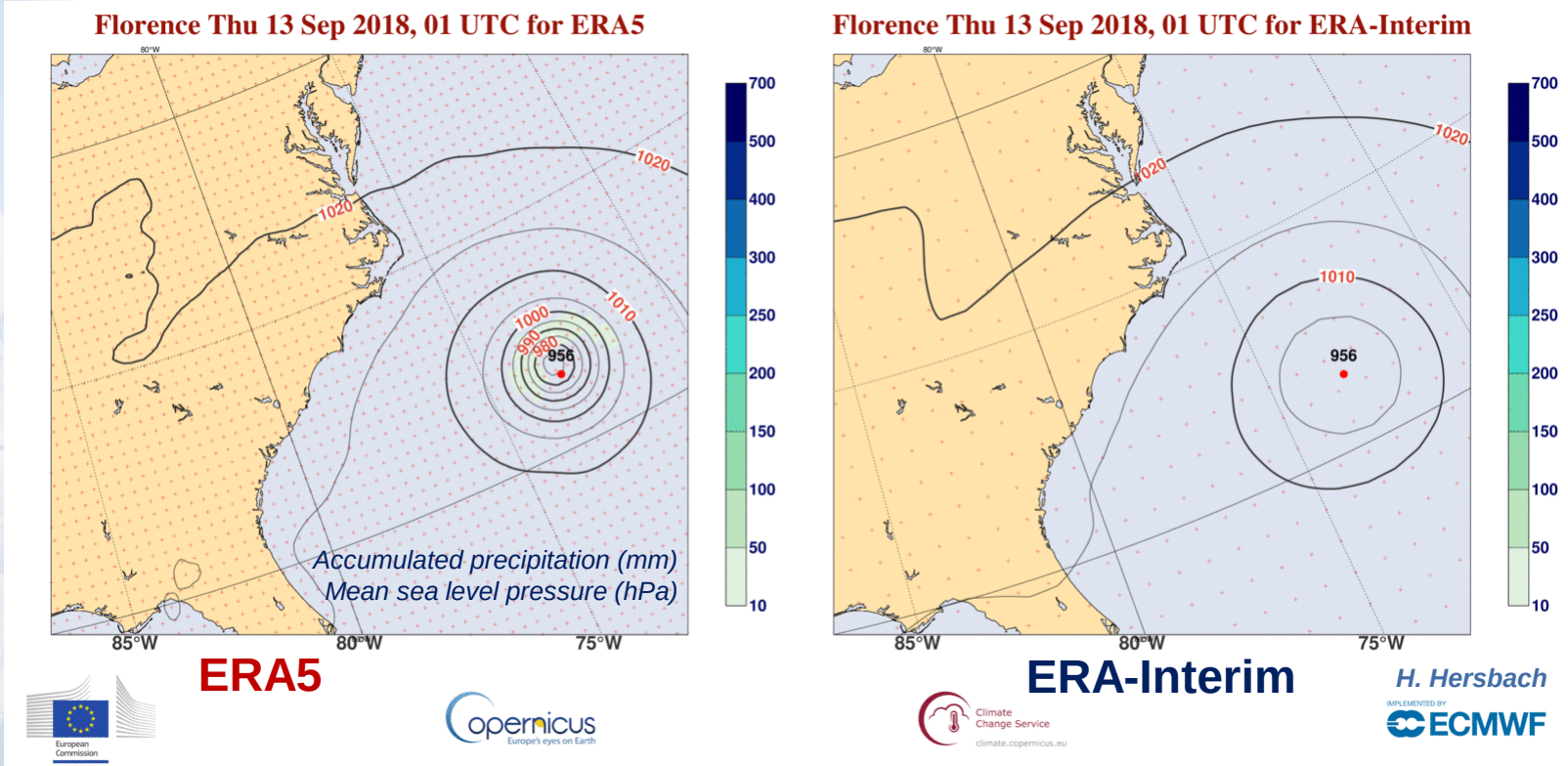

Essential Climate Variables

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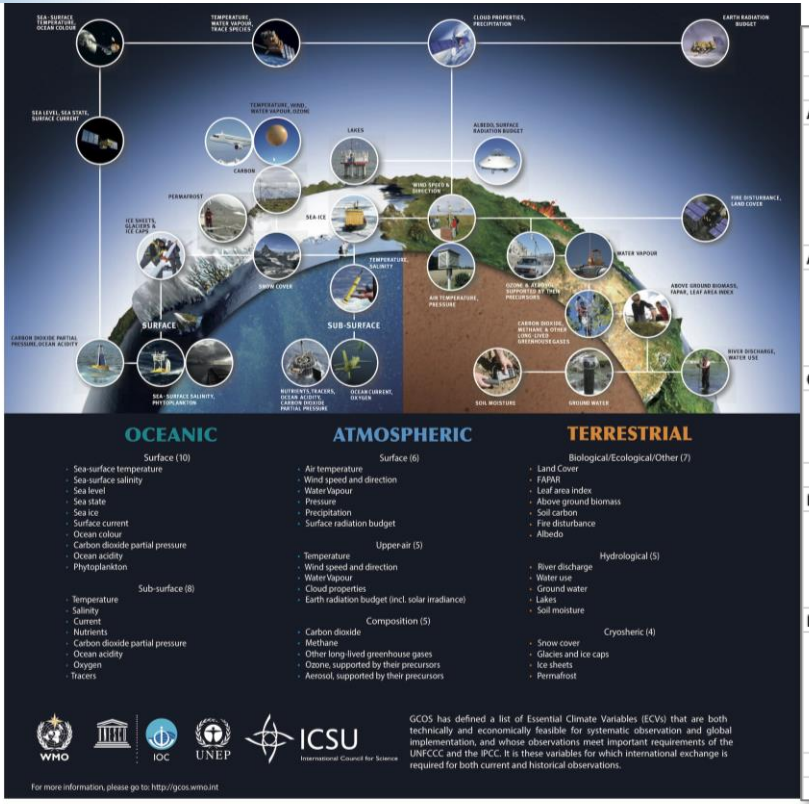

			C3S_312a				
				C3S_312b			
		GCOS	2017	2018	2019	2020	2021
Atmospheric physics							
	Precipitation	4.3.5		Lot 1			
	Surface Radiation Budget	4.3.6					
	Water Vapour	4.5.3					
	Cloud Properties	4.5.4					
	Earth Radiation Budget	4.5.5					
Atmospheric composition							
	Carbon Dioxide	4.7.1	Lot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

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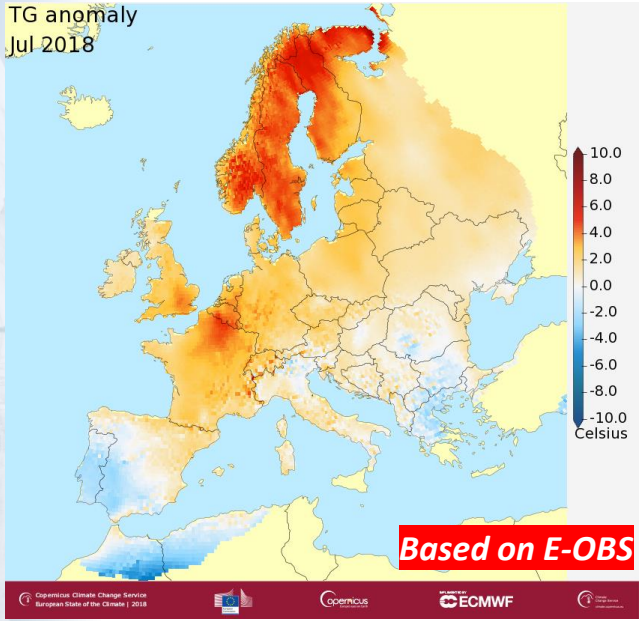
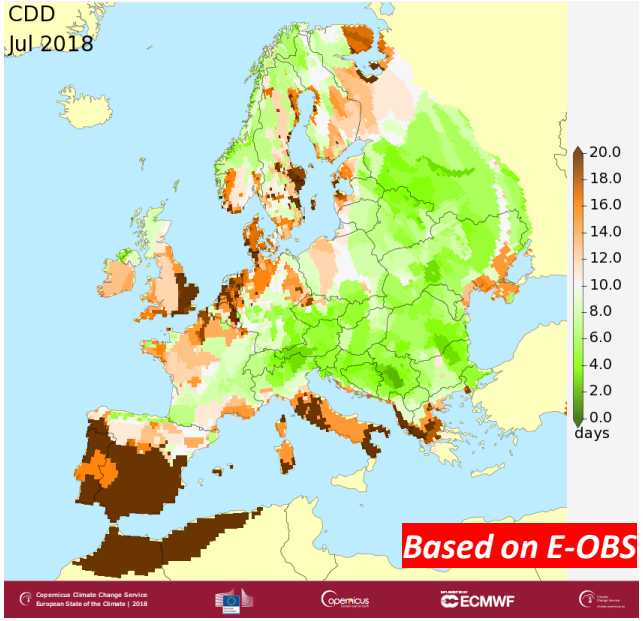
Mean air temperature anomaly for July 2018 with respect to 1981-2010



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

However

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



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

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Heatwave & drought in Northern Europe – July 2018

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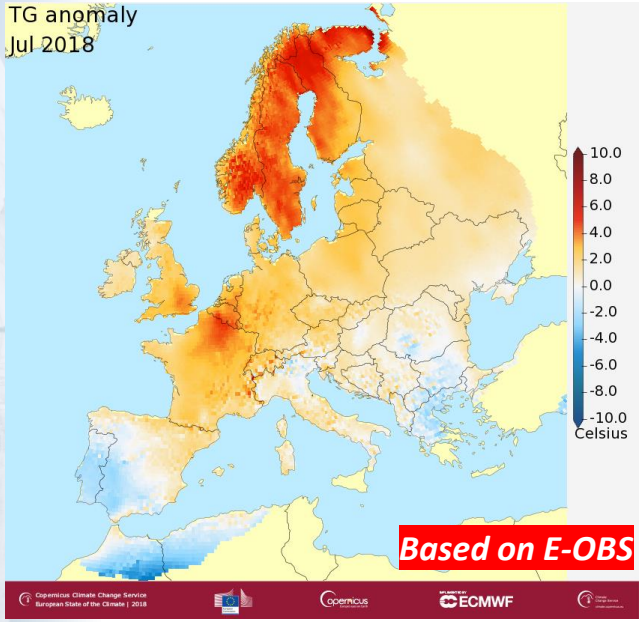
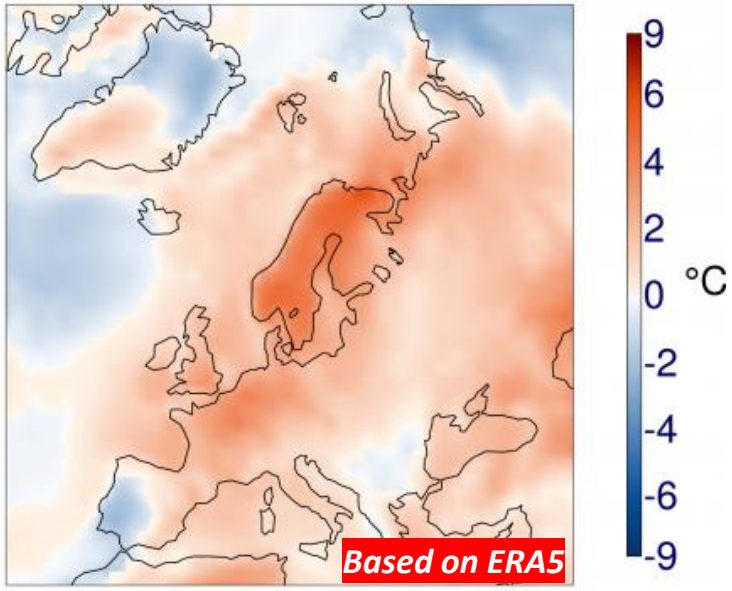


Credit: Copernicus Climate Change Service (C3S)/KNMI.

Mean air temperature anomaly for July 2018 with respect to1981-2010.



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

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Heatwave & drought in Northern Europe – July 2018

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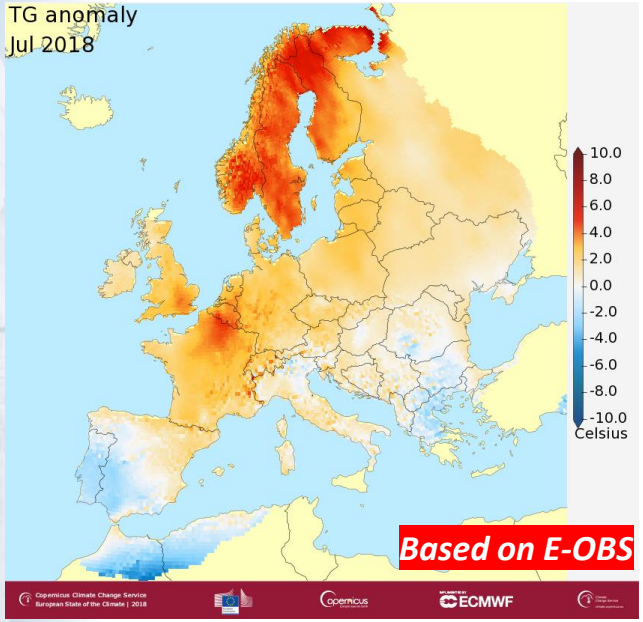
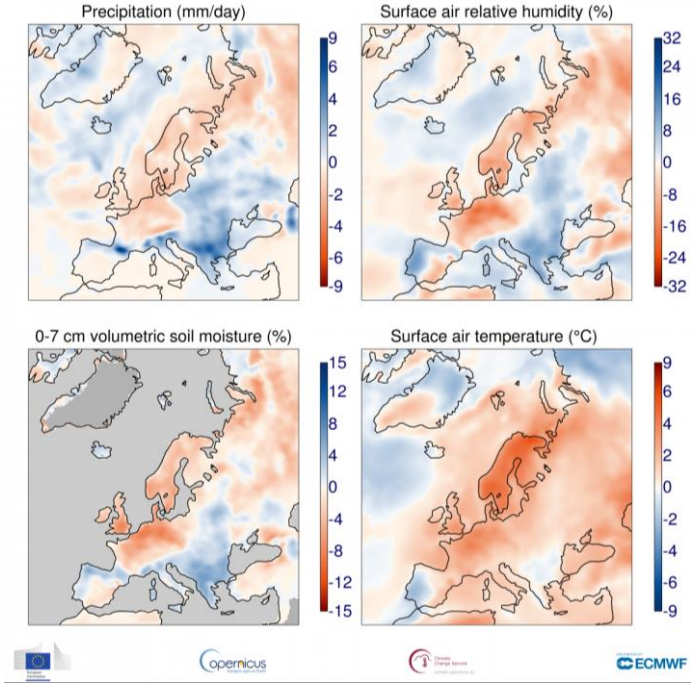
Mean air temperature anomaly for July 2018 with respect to 1981-2010



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

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



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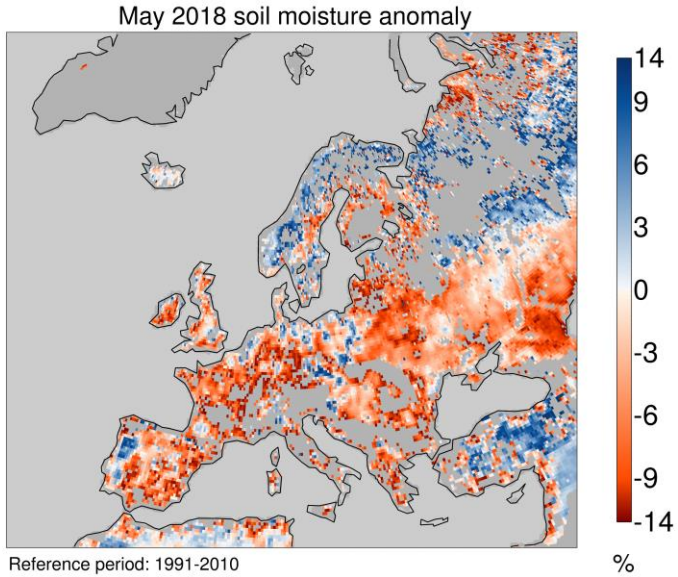
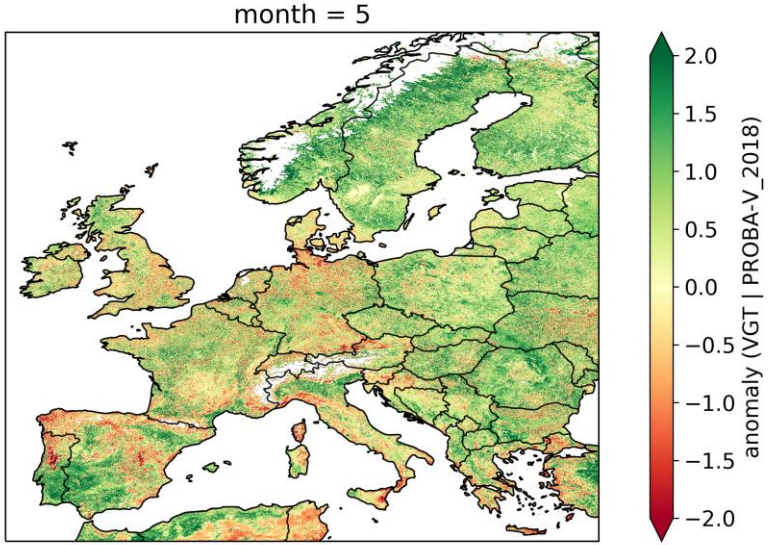
Heatwave & drought in Northern Europe – July 2018

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



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

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



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

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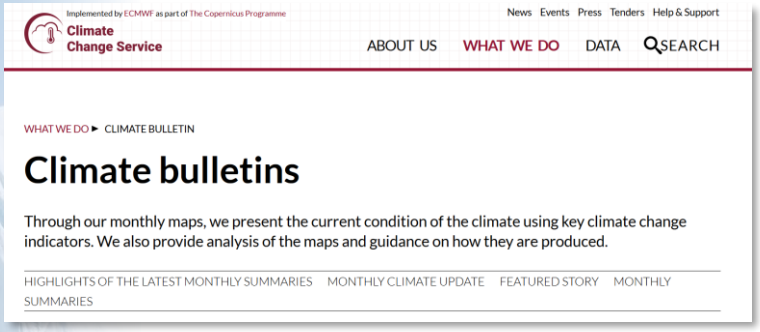
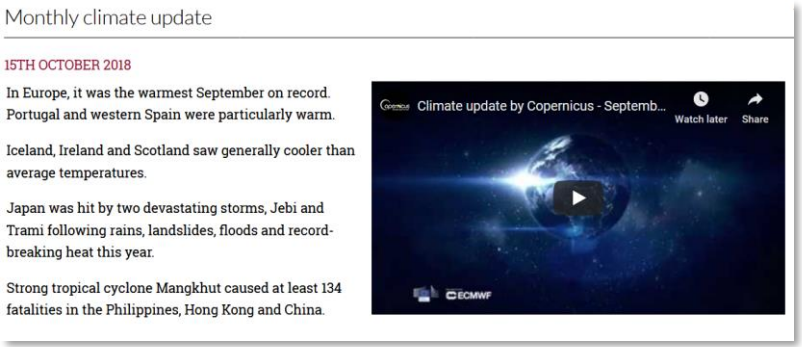
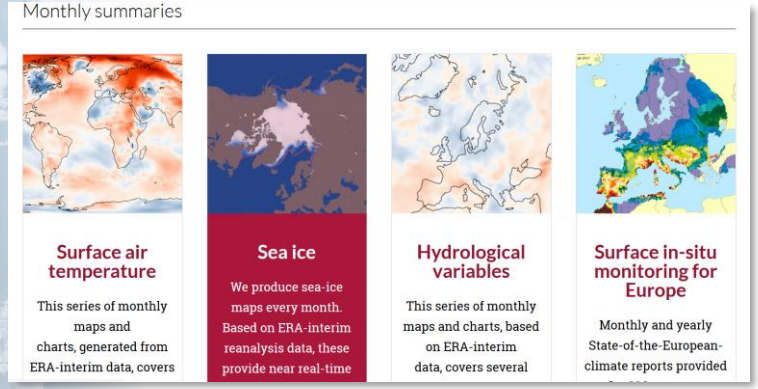
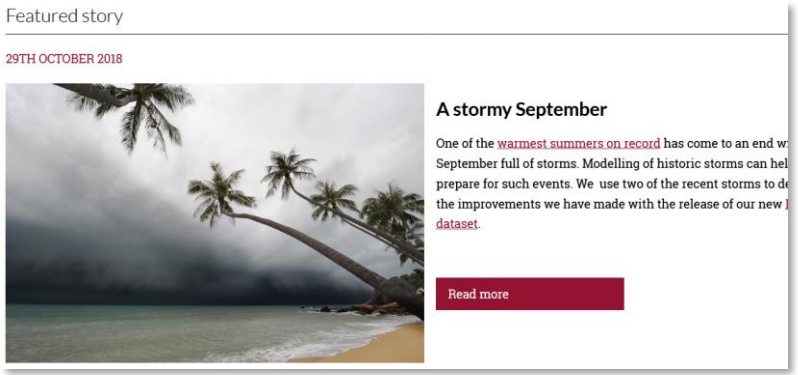
Monthly climate bulletins – 4th to 6th of each month









➢ **climate.copernicus.eu/climate-bulletins**

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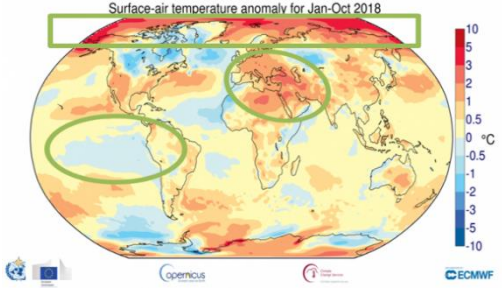
Remarks & conclusions

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

WMO climate statement: past 4 years warmest on record



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.

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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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