

Beyond the Combined Drought Indicator: Recent Advances in EDO/GDO Drought Monitoring.

Drought Team
Joint Research Centre – European Commission

Amazon Week
5 June 2026



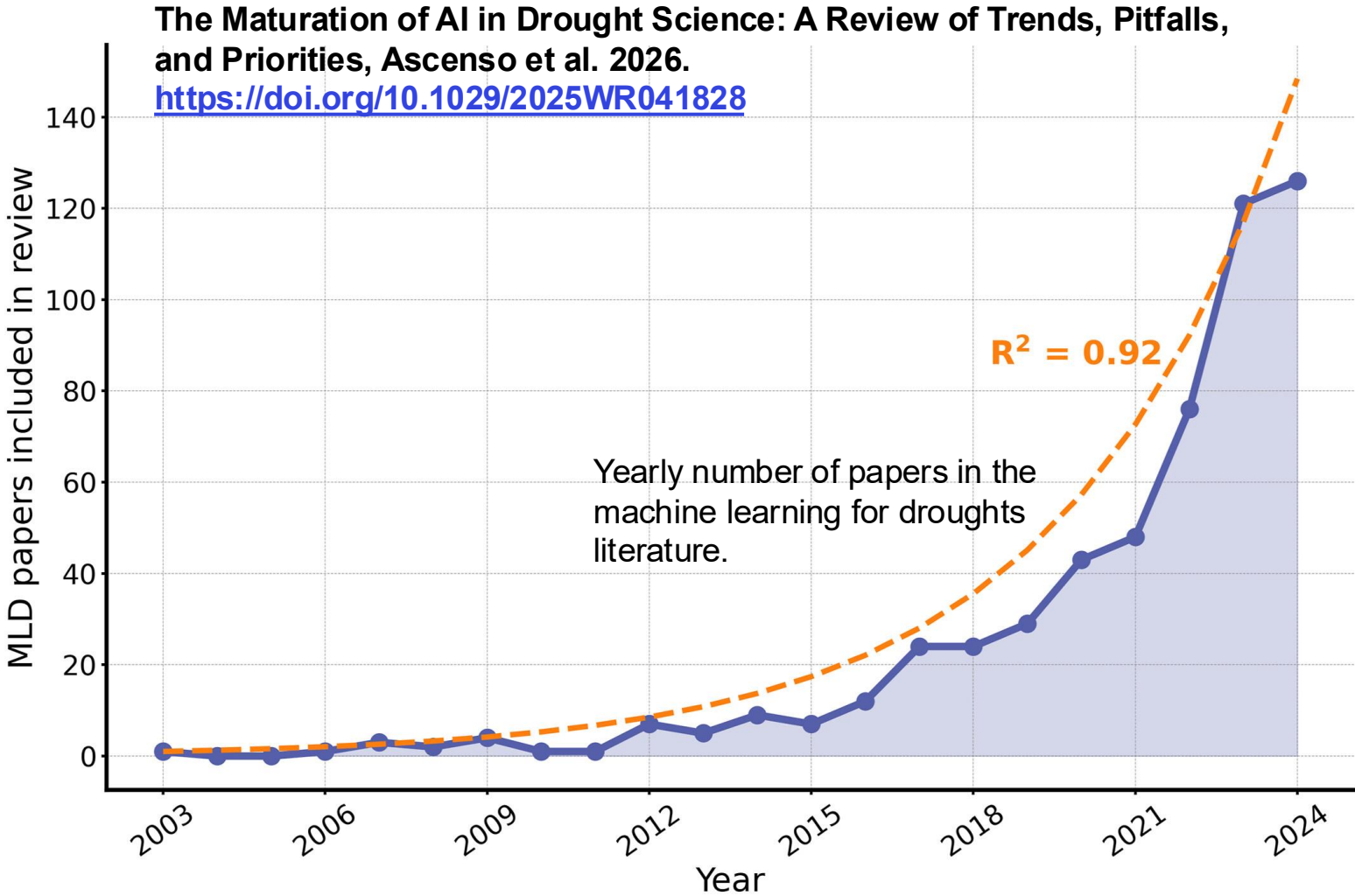
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MANAGEMENT
SERVICE

Beyond the Combined Drought Indicator: Recent Advances in EDO/GDO Drought Monitoring



From our flagship drought indicator (CDI) to new Ai- and machine-learning-based monitoring and forecasting products

Beyond the Combined Drought Indicator: Recent Advances in EDO/GDO Drought Monitoring



Recent Developments:

- Meteorological drought tracking
- Forecasting indicators for unusually wet/dry and warm/cool conditions
- Heatwave monitoring
- The European Drought Impact Database (EDID)
- AI-powered drought chatbot

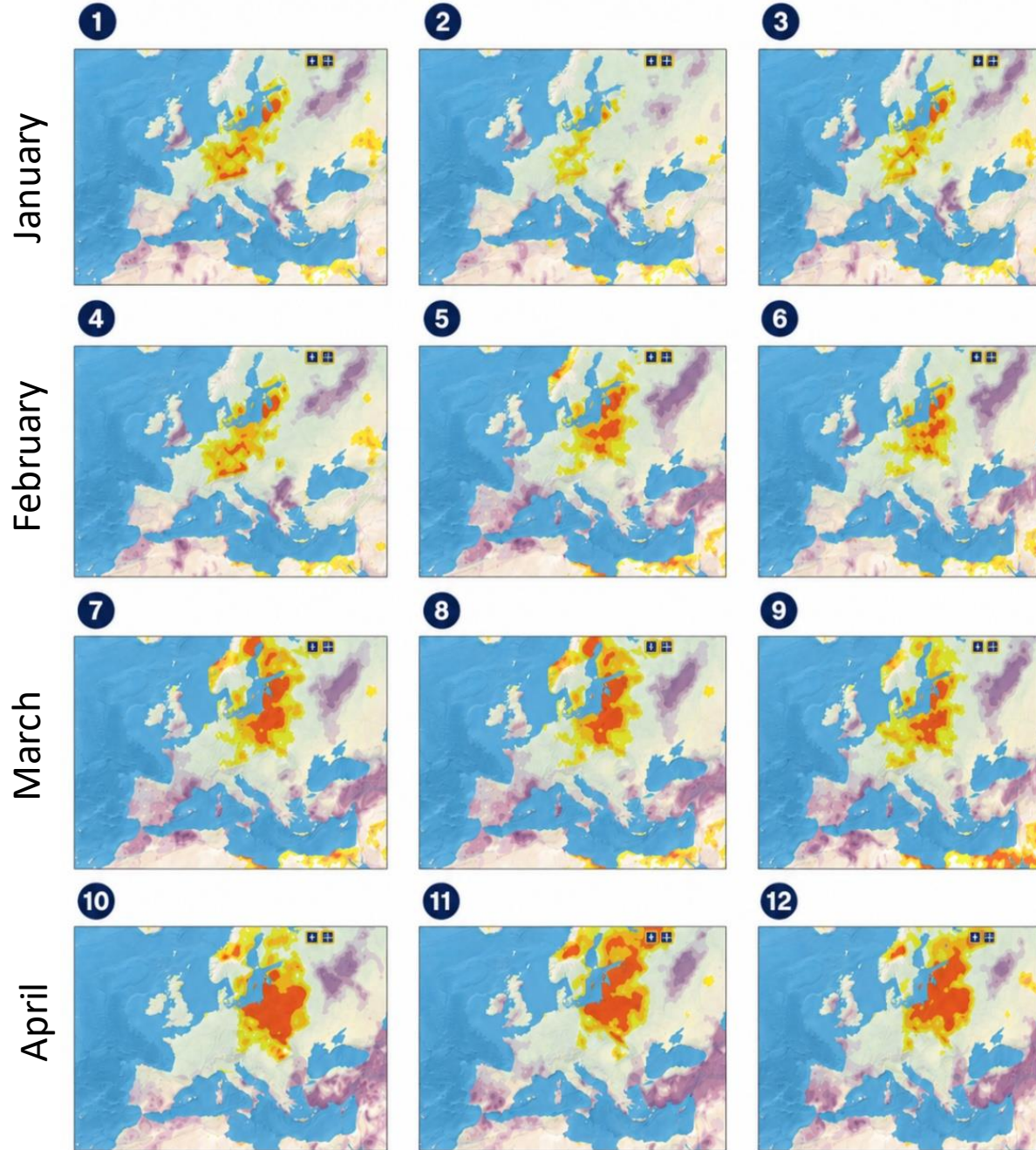


Monitoring: Indicator for Meteorological Drought Tracking



Droughts Are
Not Snapshots:
Tracking Their
Evolution in
Space and
Time

Standardized Precipitation Index, 3-month (SPI-3). Jan-Apr 2026



Droughts Are Not Snapshots: Tracking Their Evolution in Space and Time

CDI v4 decision table

Current indicators at T

Previous CDI at T-1

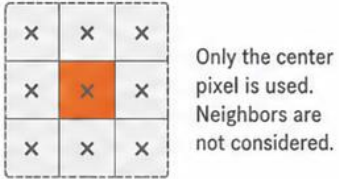
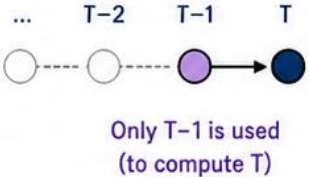
		A			B			C			D	E	F			G	H
Drought indicators	zSPI	=0			=1			=0			=1						
	zSM	> -1			> -1			≤ -1			> -1	≤ -1	≤ -1			> -1	≤ -1
		≤ -0.5	(-0.5;-0]	>0	≤ -0.5	(-0.5;-0]	>0										
zFAPAR		> -1			> -1			> -1			≤ -1	≤ -1	> -1			≤ -1	≤ -1
		≤ -0.5	(-0.5;-0]	>0	≤ -0.5	(-0.5;-0]	>0	≤ -0.5	(-0.5;-0]	>0			≤ -0.5	(-0.5;-0]	>0		
CDI _{t-1}																	
CDI conditions in the previous 10-day period	No Drought	No Drought			Watch			No Drought (SPI1>0.5) AND (SPI3>0)	Warning (SPI1>0.5) AND (SPI3>0)	No Drought	Alert	Warning			Alert		
	Recovery	Recovery			Watch			Warning			Alert			Alert			
	Watch	Recovery			Watch			Warning			Alert			Alert			
	Warning/Temporary Soil Moisture Recovery	Warning	Temp. SM R.	Recovery	Warning	Temp. SM R.	Watch	Warning			Alert			Alert			
Alert/Recovery	Alert	Temp. FAPAR R.	Recovery	Alert	Temp. FAPAR R.	Watch	Alert	Temp. FAPAR R.	Warning	Alert			Alert	Temp. FAPAR R.	Warning	Warning	
		Recovery*			Watch*			Warning*			Alert			Warning*			

What CDI captures

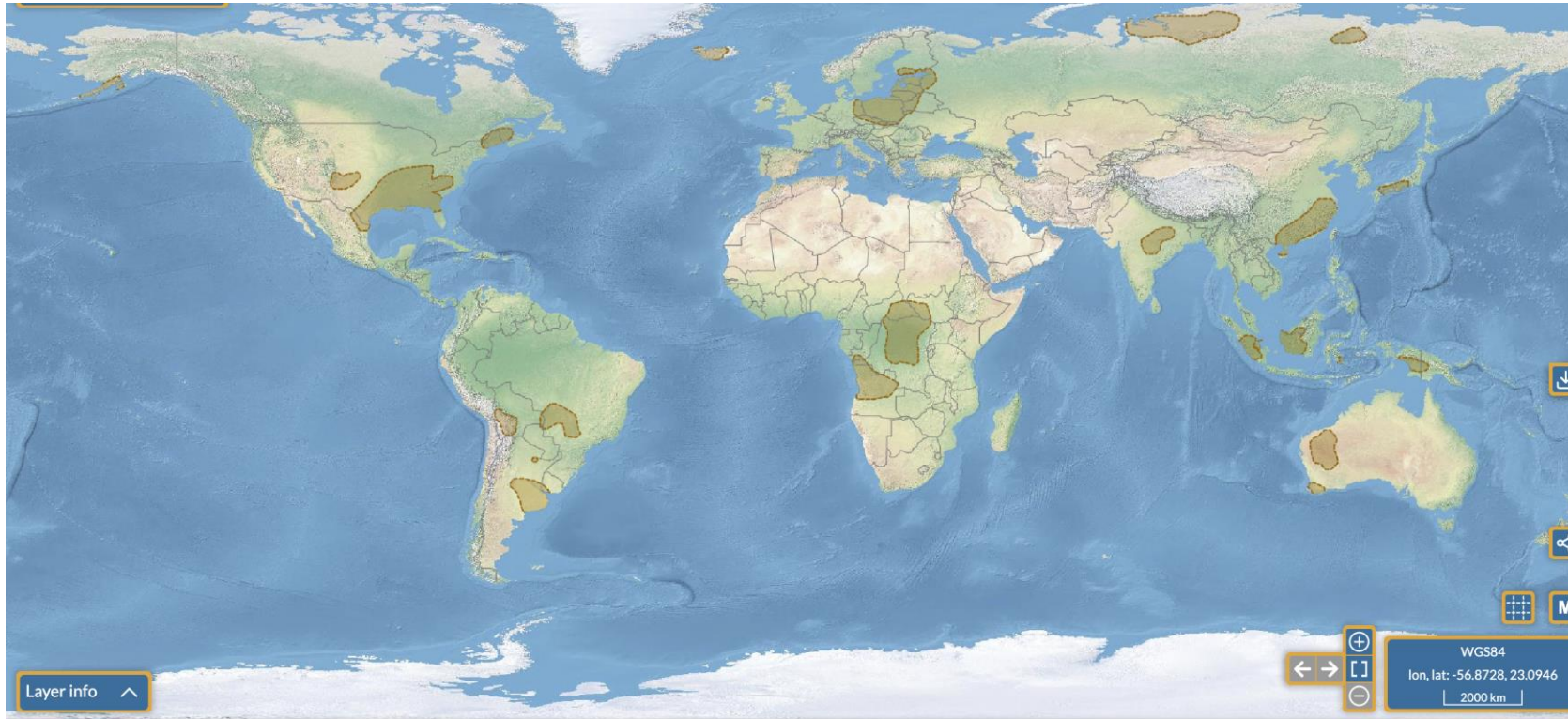
- ✓ Uses the current status of 3 indicators at time T
- ✓ Uses the CDI class from the previous 10-day period (T-1)
- ✓ Represents some temporal persistence and transition rules

What CDI misses

- ✗ Temporal memory is limited to only one previous time step
- ✗ No spatial proximity or connectivity between neighboring pixels
- ✗ Evolution is pixel-based, not tracked as a continuous drought event



Detecting & tracking droughts



CDI:

What was this same pixel doing in the previous dekad?

Drought Tracking:

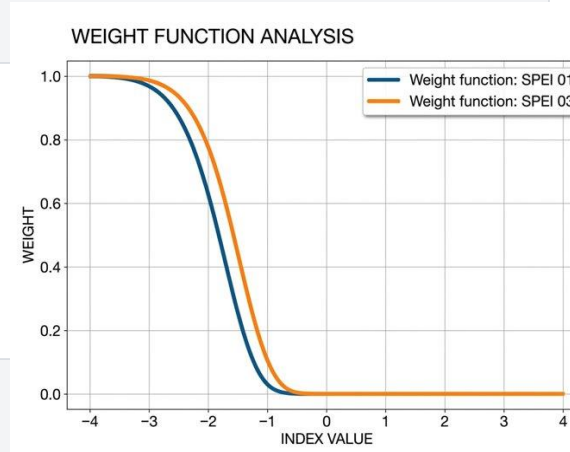
Is this drought area connected to other drought areas through space and time, forming an evolving drought event?

The new drought tracking method moves from **classifying drought conditions at each pixel and time step** to **tracking drought as a connected spatiotemporal event**.

Methodological innovations of the drought tracker version 2

PHASE 1 — PRE-PROCESSING

- Joint SPEI-01 and SPEI-03 inputs are independently weighted by a rescaled weight function $\omega(i; i_0)$
- Combined via element-wise maximum into a drought intensity $I(\omega_{\text{SPEI01}}, \omega_{\text{SPEI03}})$
- Spatially rescaled by a continuous Aridity Index map based on a climatological analysis



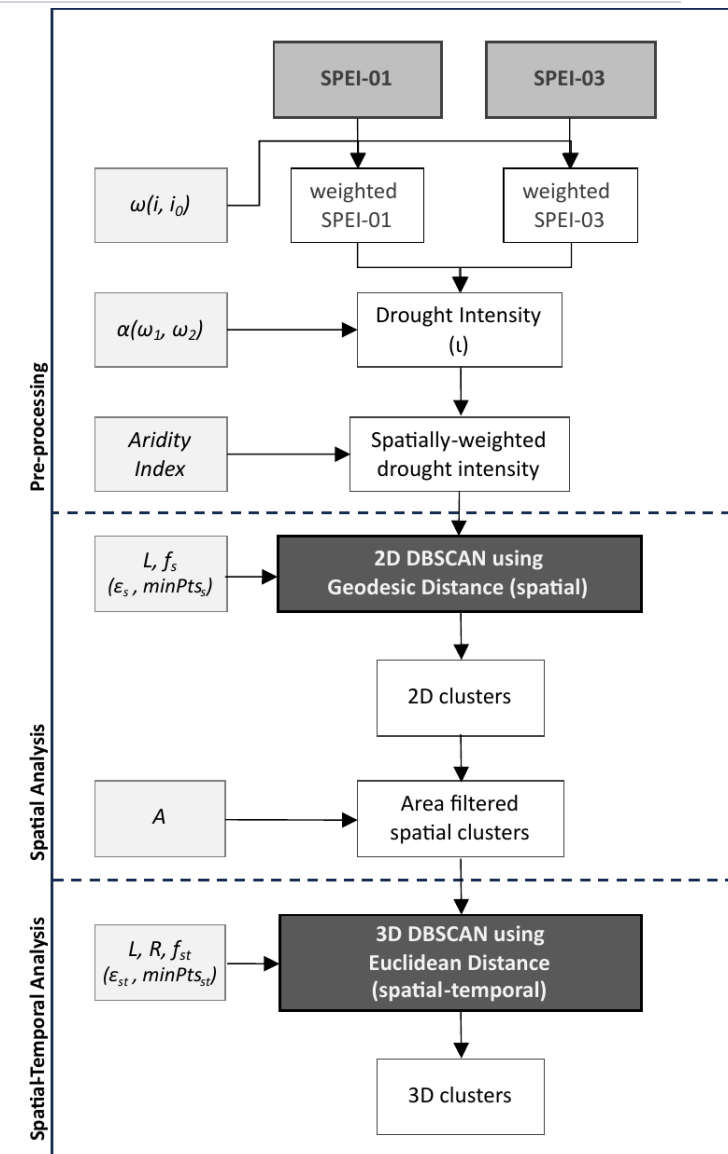
PHASE 2 — SPATIAL ANALYSIS

- 2D DBSCAN with Haversine geodesic distance at each time step
- Ellipse-based parameterisation of the search neighbourhood based in physically meaningful units (km)
- Concave-hull vectorisation and re-rasterization, followed by a minimum-area filter A in km^2

PHASE 3 — SPATIAL-TEMPORAL ANALYSIS

- 3D DBSCAN in cylindrical equal-area projection (km) with explicit temporal scaling (days)
- Spheroid neighbourhood $\{\epsilon_s, \epsilon_t\}$ and volume-derived minPts_{st}
- Outputs spatiotemporally coherent drought events

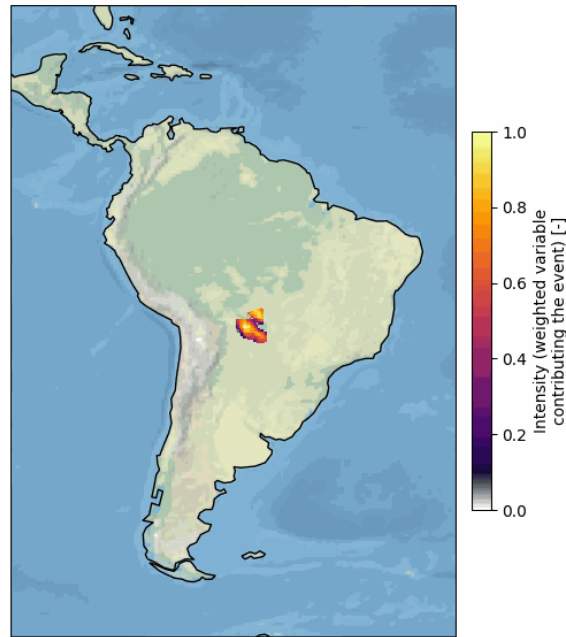
Schematic overview of the proposed methodological framework.



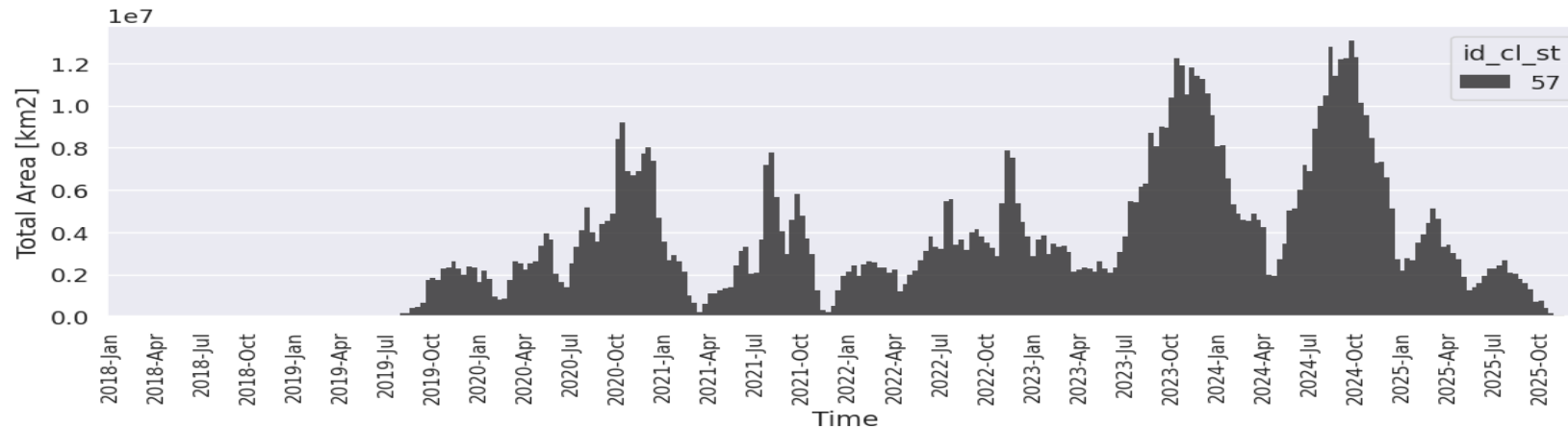
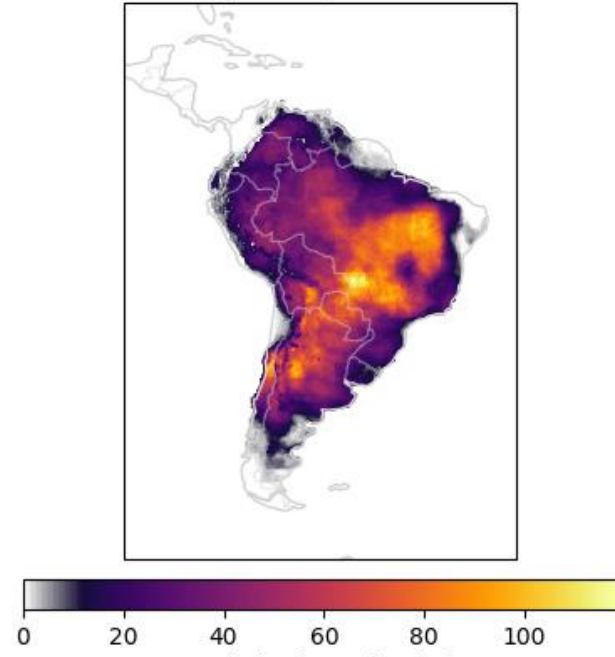




South America Mega-Drought 2019-2024 (ERA5)

Intensity (weighted variable contributing the event)
2019-08-01



Cumulative intensity during the duration of the event




Layers  


Indicators Context Base







Forecast

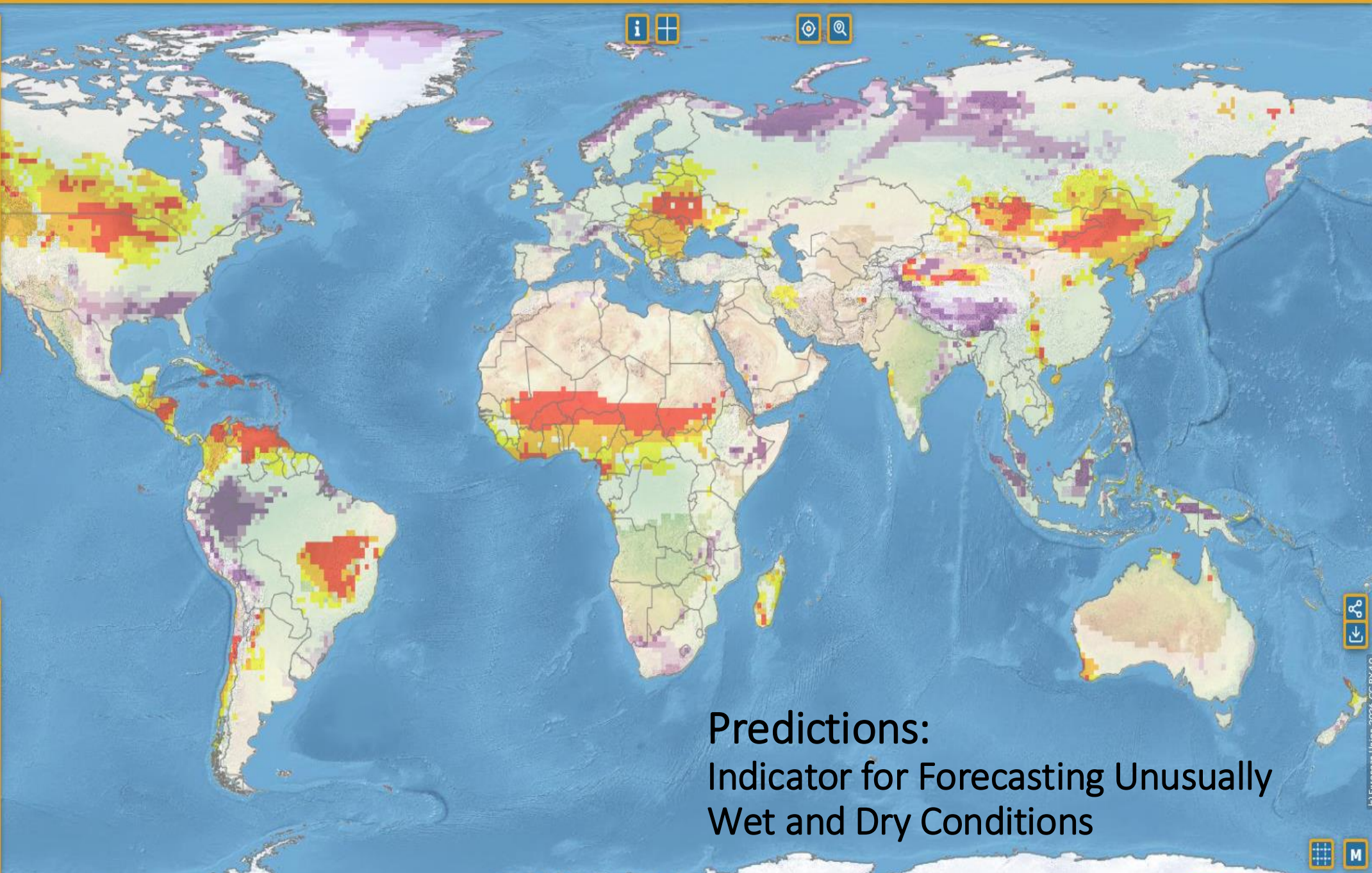
- Forecasts of Unusually Wet and Dry conditions (Multi-system)
1 month starting at 2026-05-01
- Forecasts of Unusual Warm and Cool Conditions (Multi-system)

Layer info 



Indicators Context Base

 Forecasts of Unusually Wet and Dry conditions (Multi-system)
1 month starting at 2026-05-01


					
Drier	Dry	Normal	Wet	Wetter	Wettest







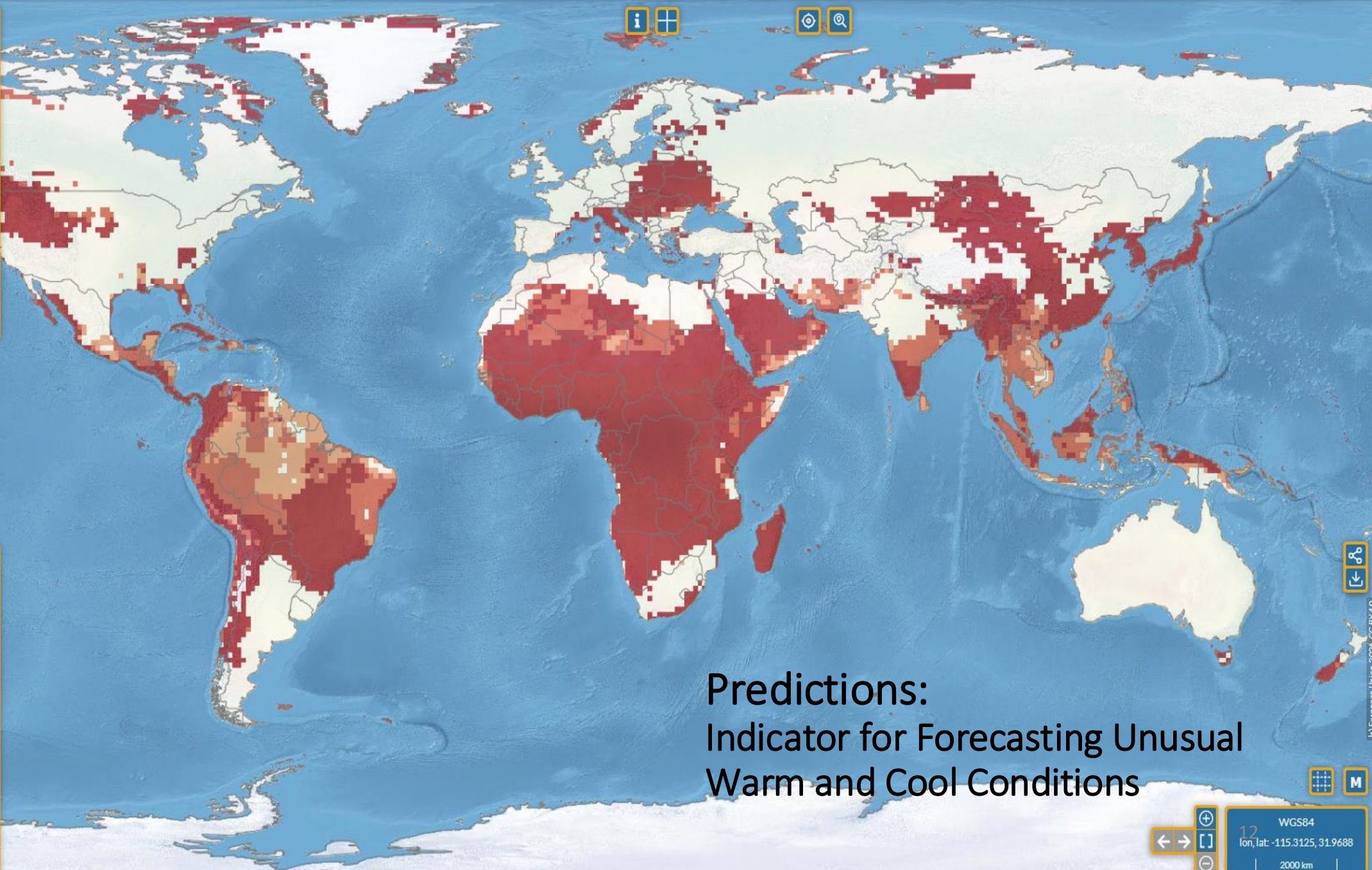
Predictions:
Indicator for Forecasting Unusually
Wet and Dry Conditions


Layers  

Indicators Context Base



Forecast 








- Forecasts of Unusually Wet and Dry conditions (Multi-system)  
- Forecasts of Unusual Warm and Cool Conditions (Multi-system)  
2026-06, issued on 2026-05





Layer info 

Indicators Context Base

 Forecasts of Unusual Warm and Cool Conditions (Multi-system)
2026-06, issued on 2026-05 

	Warmer		Normal		Cooler
	Warmest				Coolest

 Both warm and cool

 No data

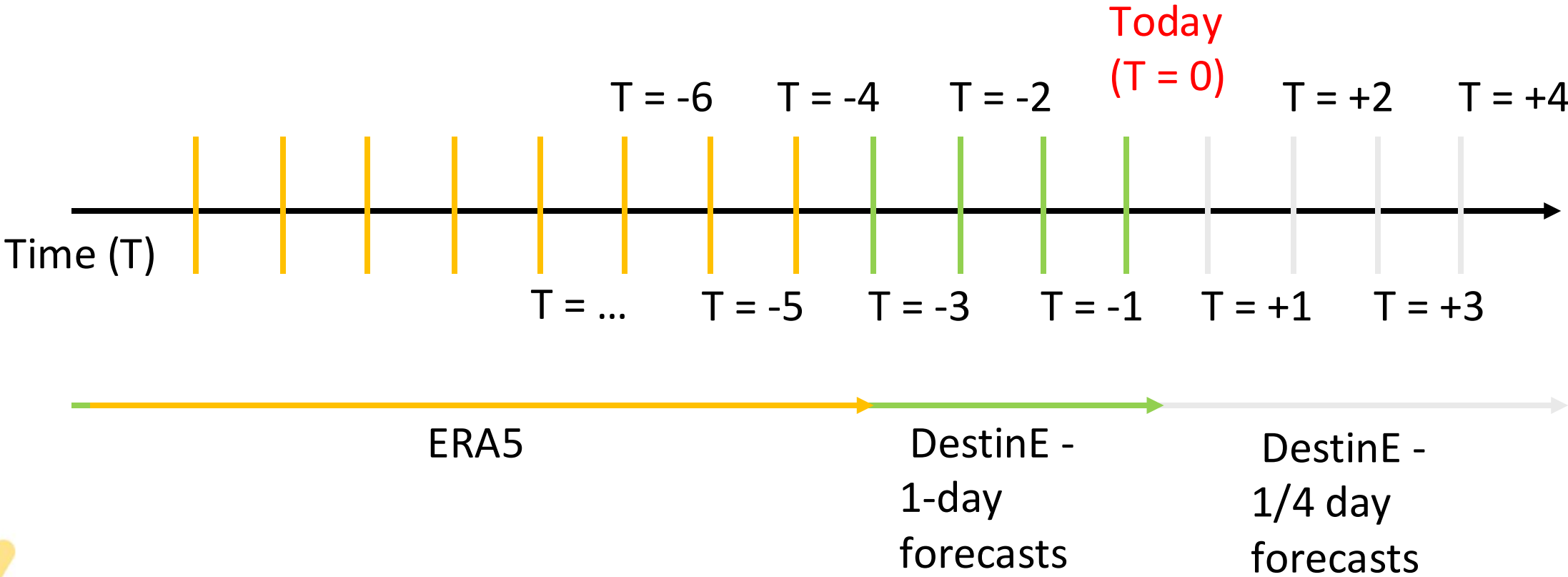
5

Predictions:
Indicator for Forecasting Unusual
Warm and Cool Conditions

WGS84
lon, lat: -115.3125, 31.9688
2000 km

Extension of warm/cold spell monitoring using Destination Earth – Extreme Digital Twin



20-03-2022



10-08-2022



25-07-2022



29-10-2022



Heatwaves monitoring in urban areas with high resolution Land surface Temperature (LST) data

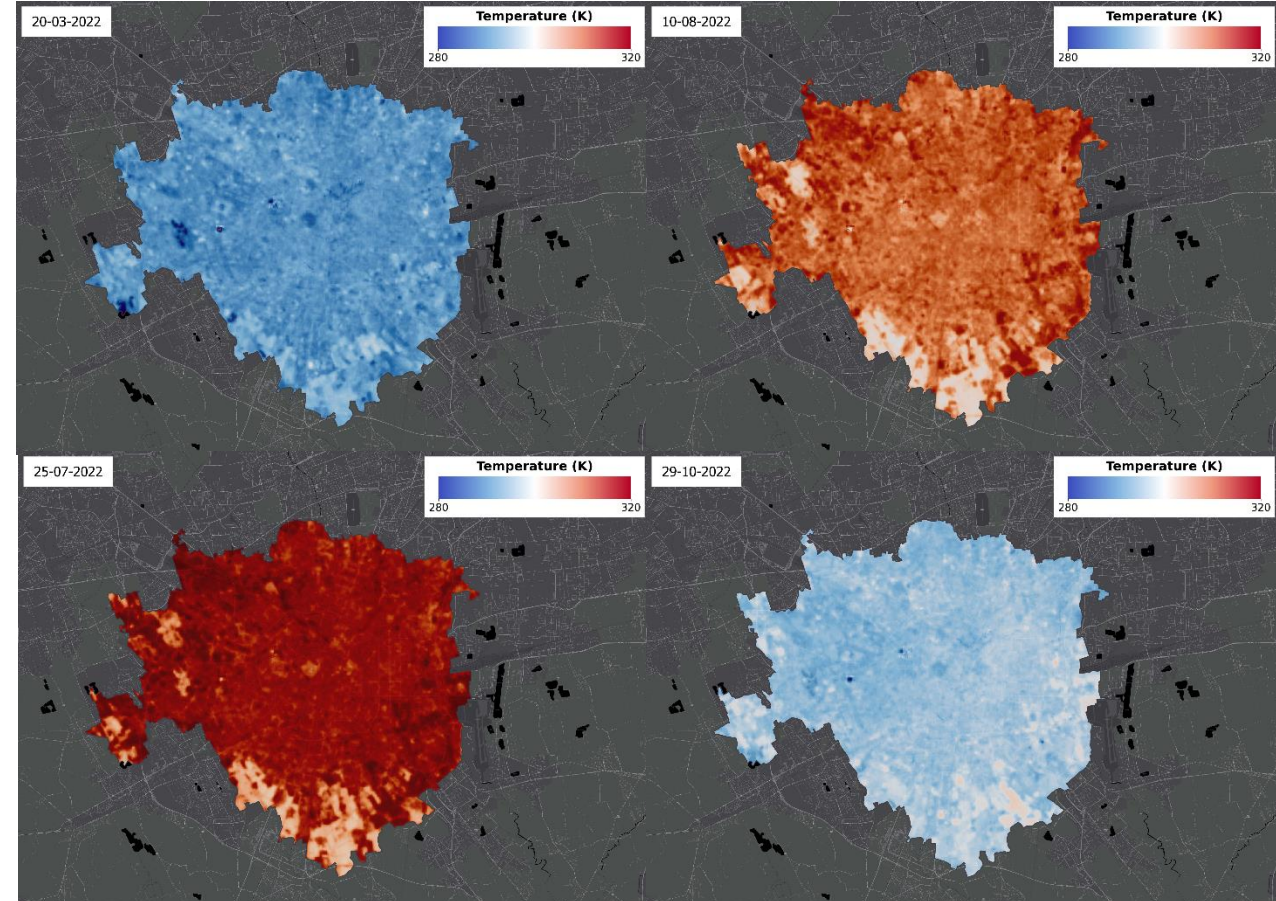
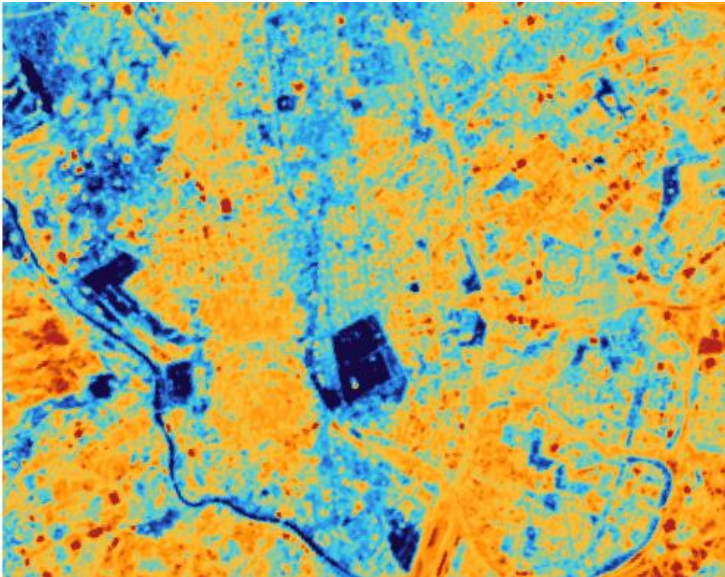


Purpose:

Heatwave monitoring in urban areas using AI/ML convolutional models for ERA5 downscaling

Data used:

- **Current:** Landsat 8 and 9 thermal data (TIRS bands 10–11), providing a combined effective revisit of approximately 8 days
- **Future:** LSTM Copernicus (50 m native thermal resolution, ~1–4 day revisit over Europe, expected launch 2028)



Status: preparation of training dataset and test on Constellr LST precision product in September (acquisition during summer 2026)





PROGRAMME OF THE
EUROPEAN UNION



Home European Observatory Global Observatory Risks and Impacts Data Reference

edid

European Drought Impact Database

OVERVIEW

REGIONAL

SEARCH

EXPERT COLLABORATION ABOUT



<https://drought.emergency.copernicus.eu/tumbo/edid>



- **Systematic collection of drought impact data.**
- **More than 13.000 georeferenced records of drought impacts from Europe, and across different sectors, covering a time window from 1970 to 2020.**

European Drought Impact Database

OVERVIEW

REGIONAL

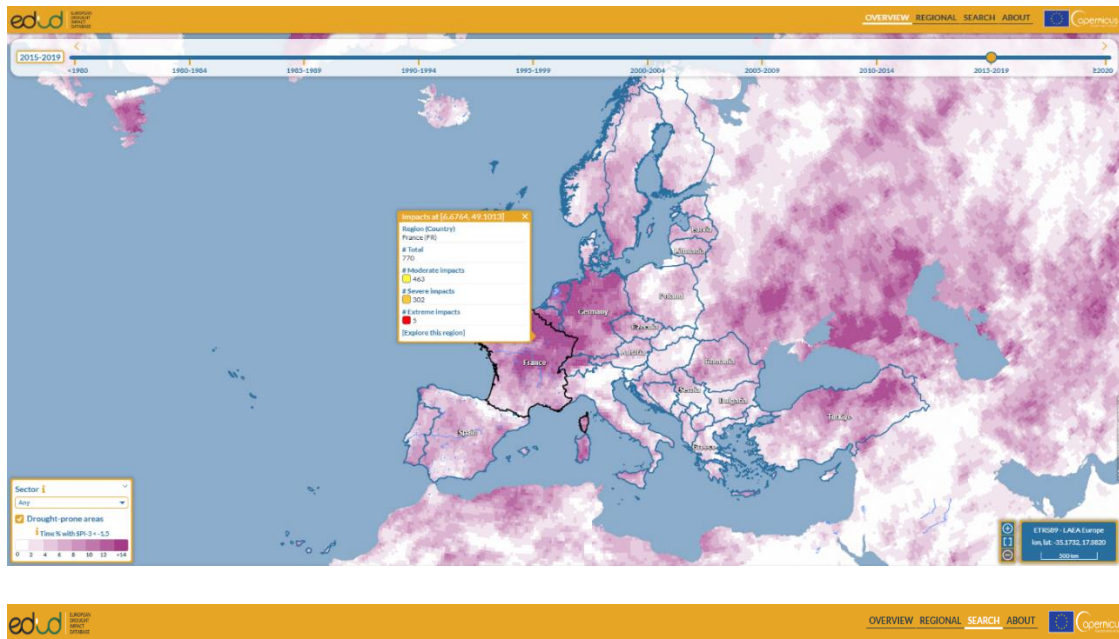
SEARCH

EXPERT COLLABORATION ABOUT



The European Drought impact Database version 2.0

<https://drought.emergency.copernicus.eu/tumbo/edid>



EDID - Search drought impact records

Drought impact record 41676

Sector: Ecosystems - Terrestrial

Severity: Extreme

Time span: From 2019-01-01 until 2019-12-31

Description: The repeated droughts have had a significant impact on France's forests. In the coniferous forests of the Vosges and the Jura, reddening and desiccation phenomena have been observed, linked to the large water deficit associated with more frequent periods of intense heat. In the Haut-Rhin, at least 300,000 m³ of fir trees have withered. On widespread trees, the proliferation of harmful insects such as bark beetles has been observed, eventually leading to the death of conifers.

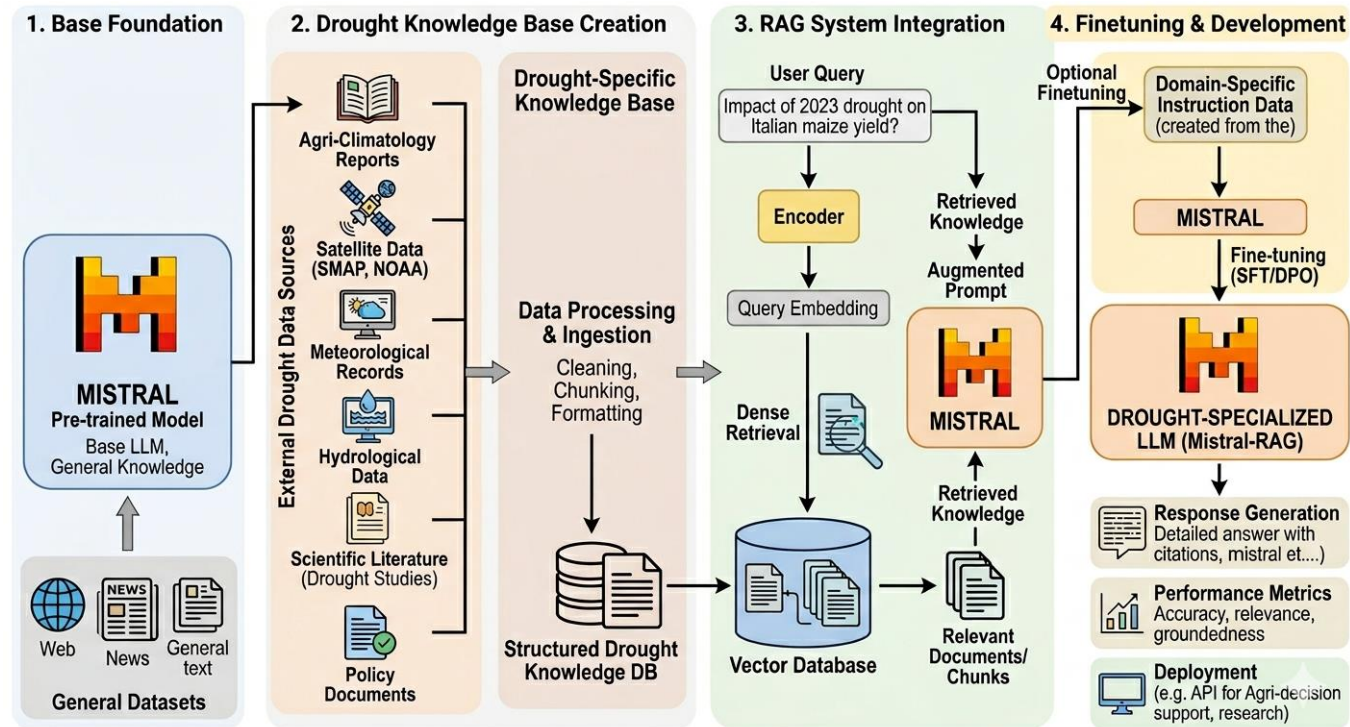
Reference: La chaîne météo (18/07/2019): "Sécheresse 2019: atténuation de la sécheresse de surface". <https://actu.la.chaine-meteo.com/actualite-meteo/2019-08-13/secheresse-2019-attenuation-de-la-secheresse-de-surface-35672>

Sources: EDI

Record created on 2020-11-03, last updated on 2020-11-03

Location: Map showing the location of the record in France, with a zoomed-in view of the Haut-Rhin region. Affected countries: France. Affected NUTS1: Bourgogne-Franche-Comté, Grand Est. Affected NUTS2: Alsace, Franche-Comté, Lorraine. Affected NUTS3: Haut-Rhin, Jura, Vosges.





Develop an AI-powered Drought Chatbot to support users of the Copernicus European and Global Drought Observatories (EDO and GDO) in understanding, accessing, and interpreting drought monitoring and forecasting information through transparent, evidence-based, and user-oriented interactions.



Thank you



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