PROGRAMME OF THE EUROPEAN UNION

Copernicus

European Commission

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

Drought Team

Joint Research Centre – European Commission

Amazon Week

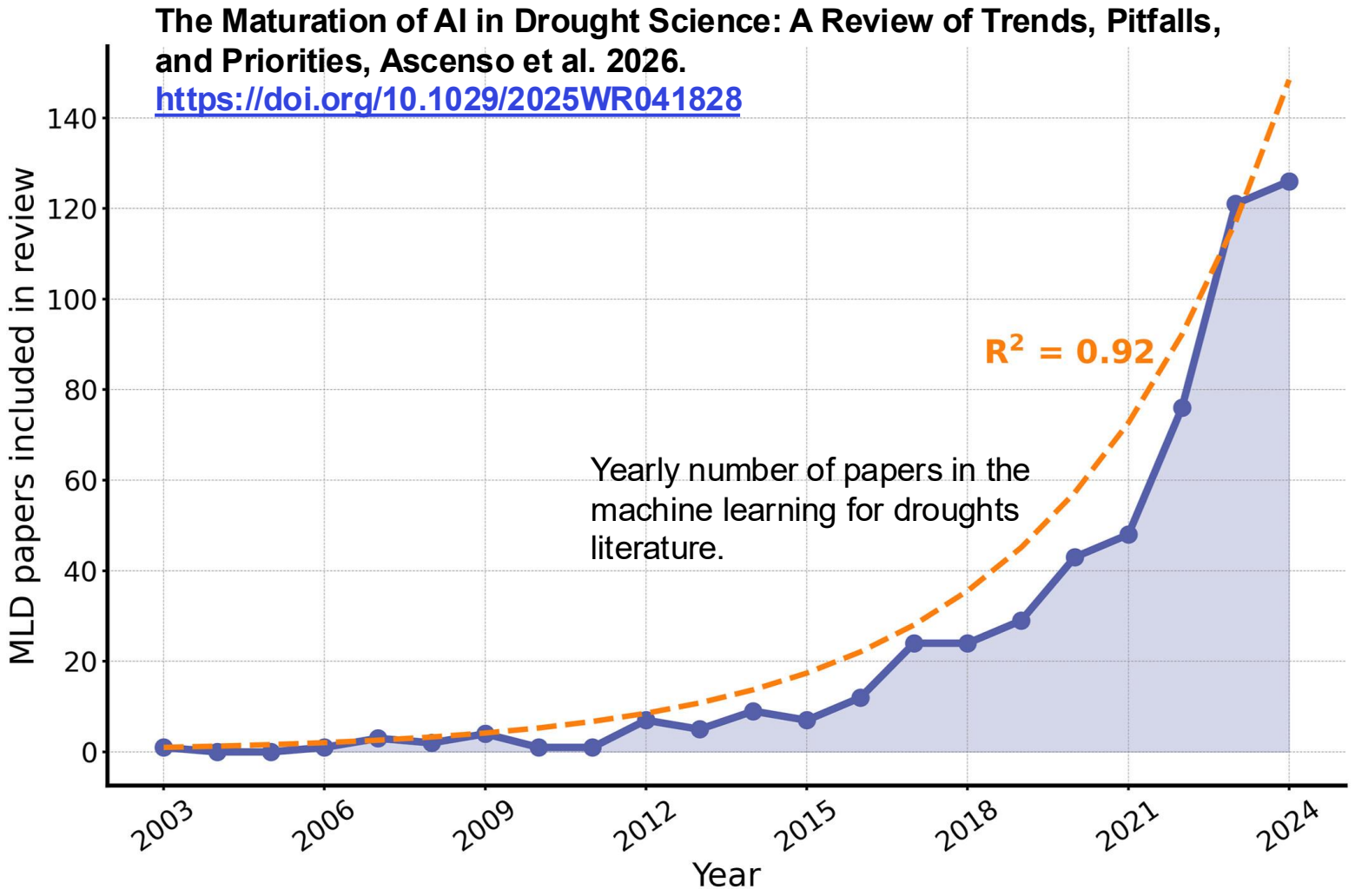
5 June 2026

COPERNICUS EMERGENCY 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

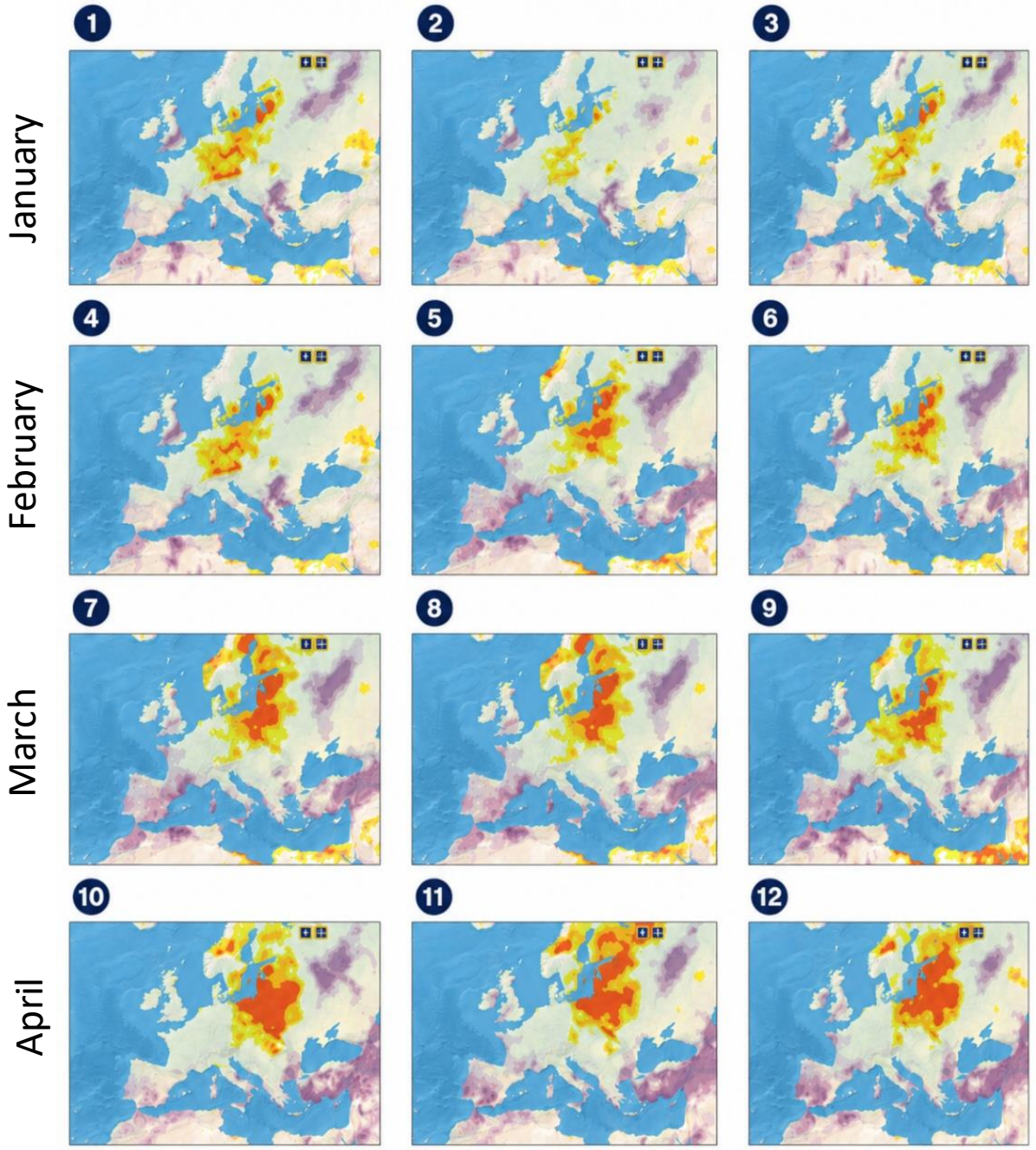


Recent Developments:

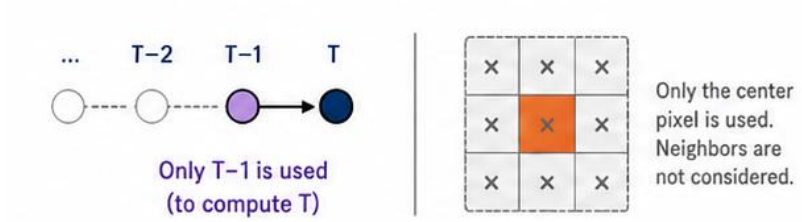
- Meteorological drought tracking
- Forecasting indicators for unusually wet/dry and warm/cool conditions
- Heatwave monitoring
- The European Drought Impact Database (EDID)
- AI-powered drought chatbot

Monitoring: Indicator for Meteorological Drought Tracking

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



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 (SPI-1>0.5) AND (SPI-3>0)	Warning !(SPI-1>0.5) AND (SPI-3>0)		No Drought	Alert	Warning		Alert	
	Recovery															
	Watch	Recovery			Watch			Warning			Alert					
	Warning/ Temporay Soil Moisture Recovery	Warning	Temp. SM R.	Recovery	Warning	Temp. SM R.	Watch									
		Recovery*			Watch*											
	Alert/ fAPAR Recovery	Alert	Temp. fAPAR R.	Recovery	Alert	Tempo. fAPAR R.	Watch	Alert	Temp. fAPAR R.	Warning			Alert	Temp. fAPAR R.	Warning	
		Recovery*			Watch*			Warning*					Warning*			

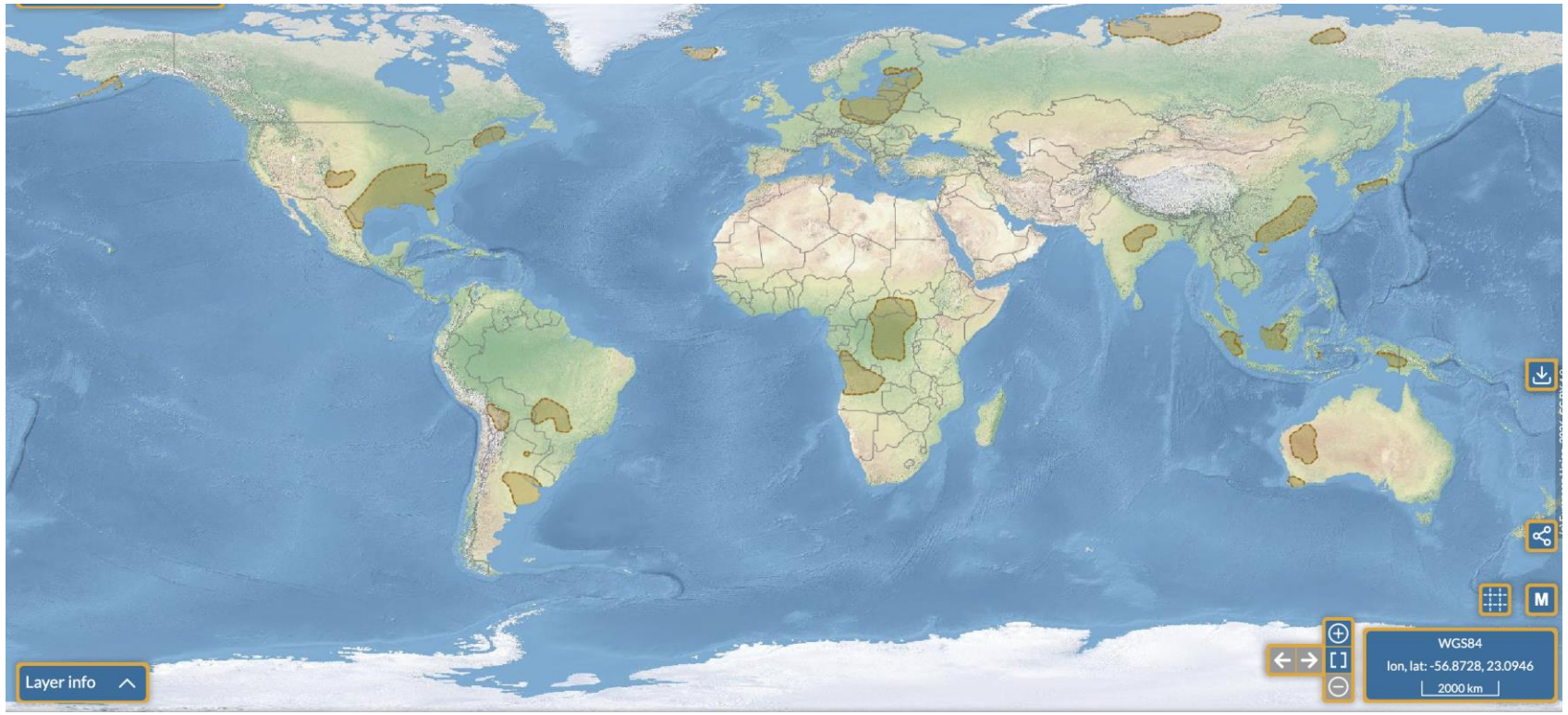
What CDI captures

- 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?

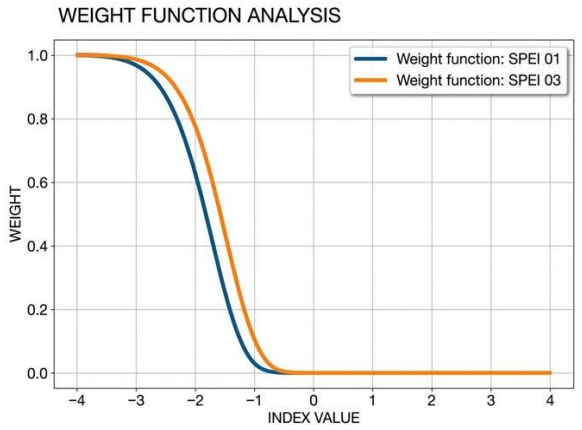
Drought Tracking:
Is this drought area connected to other drought areas through space and time, forming an evolving drought event?

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 $\iota(\omega_{SPEI01}, \omega_{spei03})$
- Spatially rescaled by a continuous Aridity Index map based on a climatological analysis



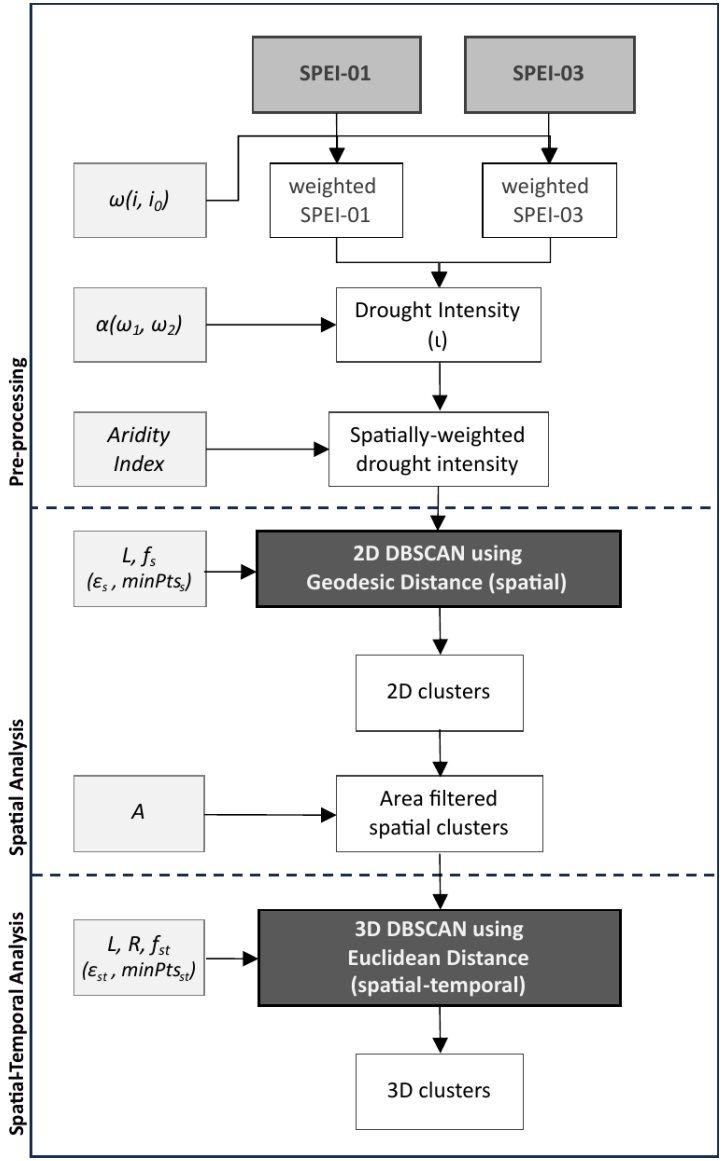
PHASE 2 — SPATIAL ANALYSIS

- 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 km²

PHASE 3 — SPATIAL-TEMPORAL ANALYSIS

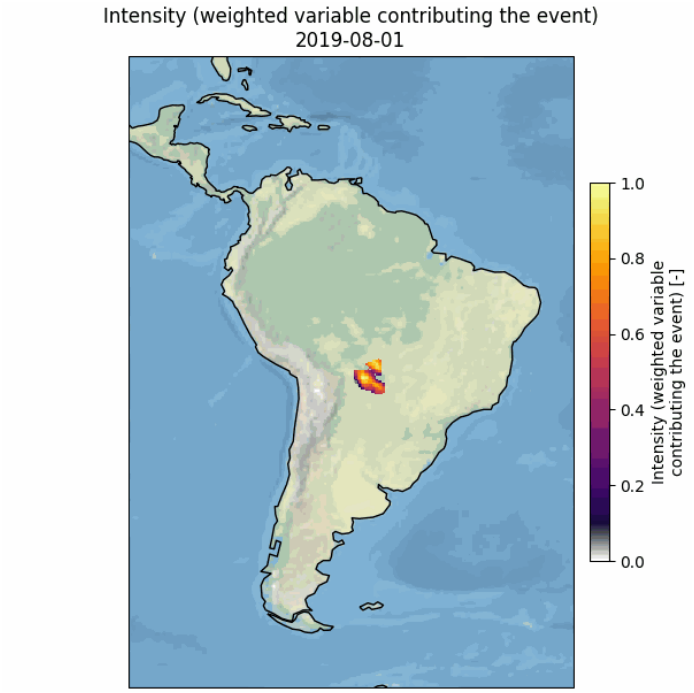
- 3D DBSCAN in cylindrical equal-area projection (km) with explicit temporal scaling (days)
- Spheroid neighbourhood $\{\varepsilon_s, \varepsilon_t\}$ and volume-derived $minPts_{st}$
- Outputs spatiotemporally coherent drought events

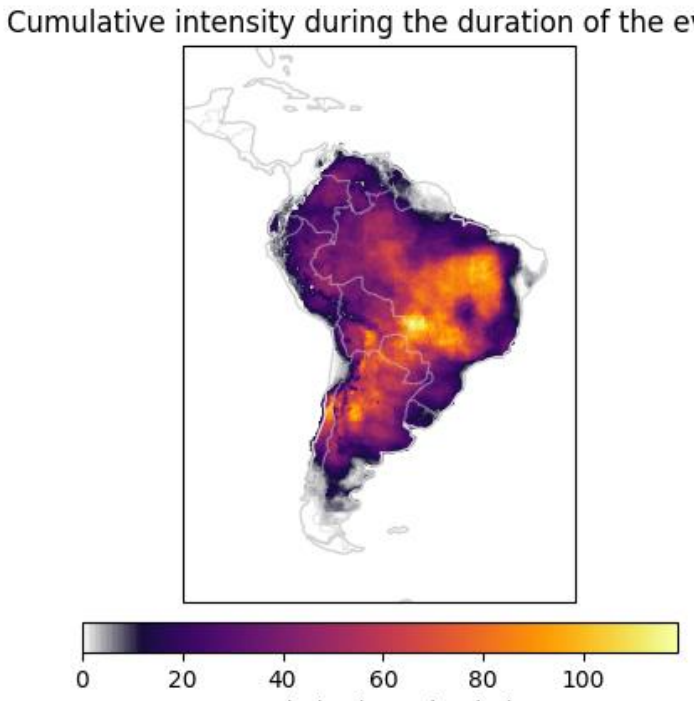
Schematic overview of the proposed methodological framework.

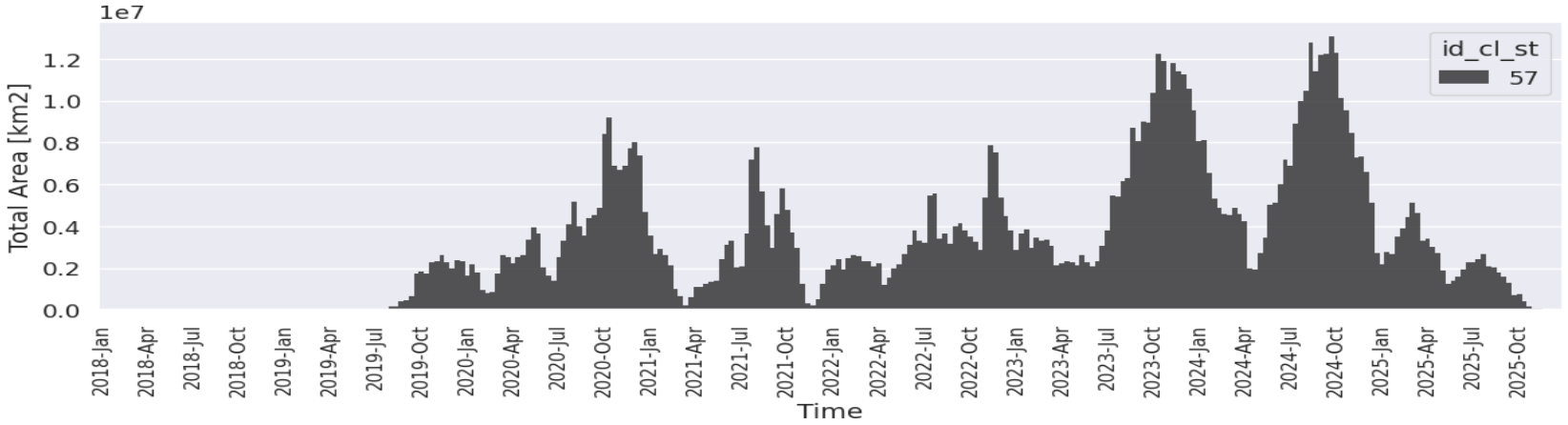


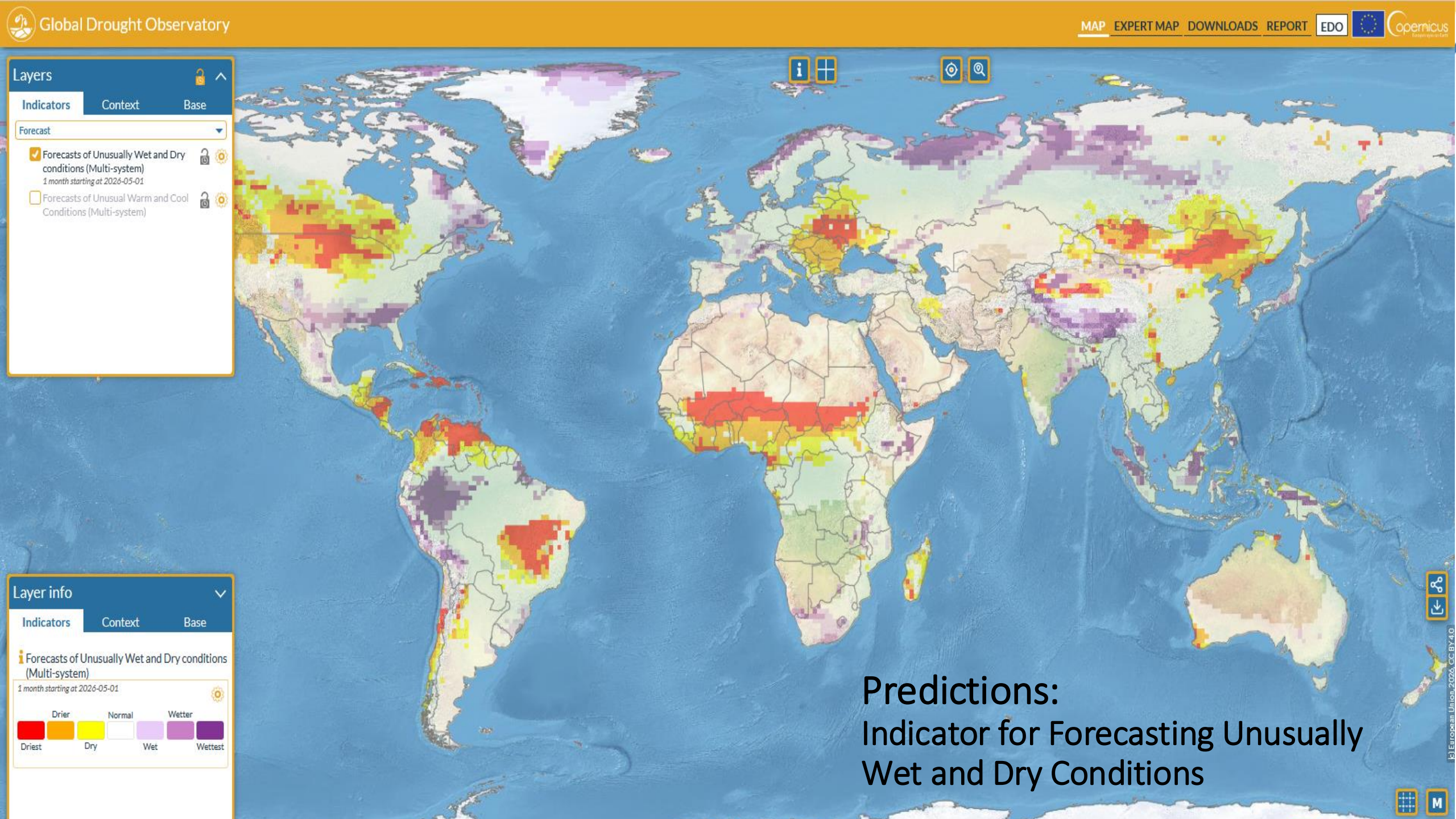
Preliminary Results

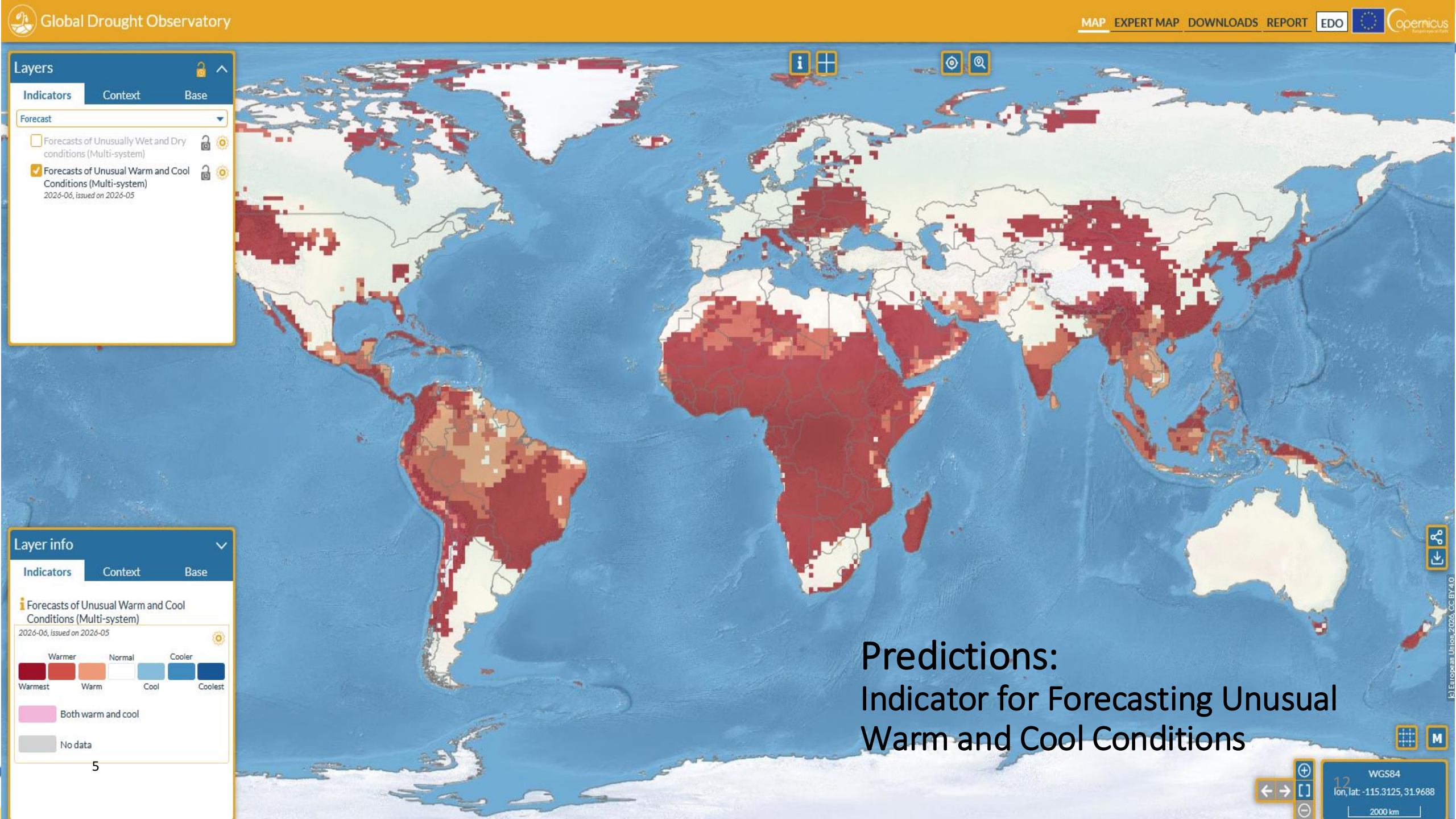
South America Mega-Drought 2019-2024 (ERA5)








Global Drought Observatory
MAP
EXPERT MAP
DOWNLOADS
REPORT
EDO
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
Normal
Wetter
Driest
Dry
Wet
Wettest
Predictions:
Indicator for Forecasting Unusually Wet and Dry Conditions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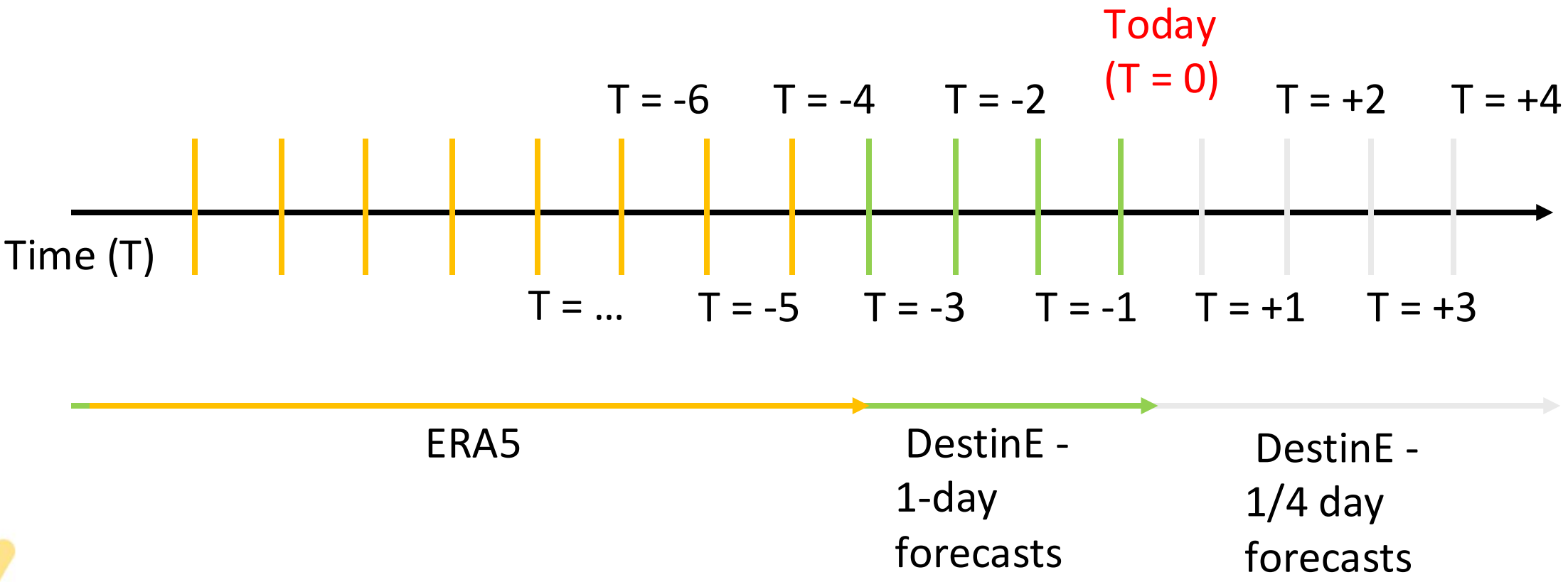
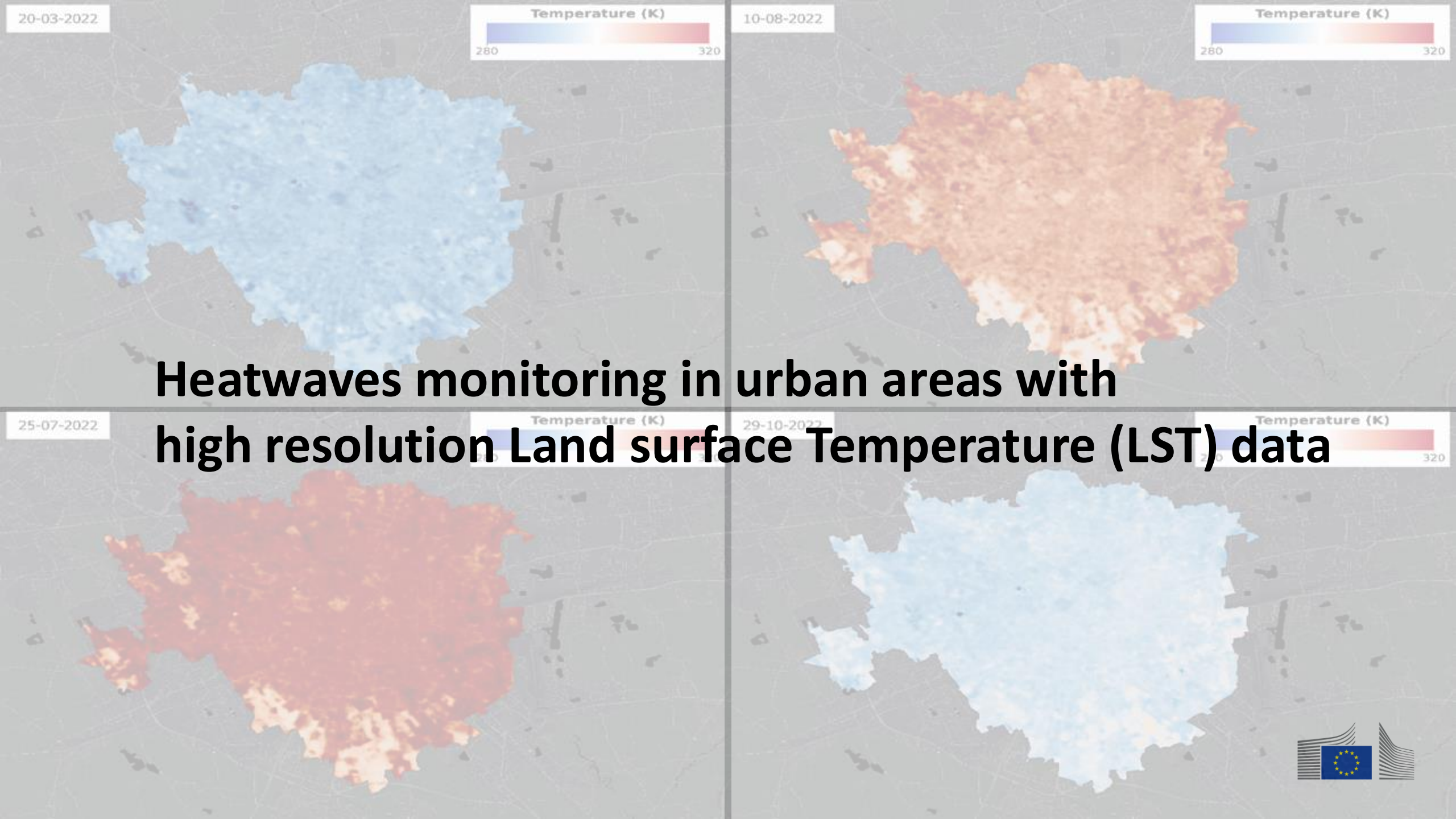
Forecasts of Unusually Wet and Dry conditions (Multi-system)
Forecasts of Unusual Warm and Cool Conditions (Multi-system)
2026-06, issued on 2026-05
Layer info
Indicators
Context
Base
Forecasts of Unusual Warm and Cool Conditions (Multi-system)
2026-06, issued on 2026-05
Warmer
Normal
Cooler
Warmest
Warm
Cool
Coolest
Both warm and cool
No data
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





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

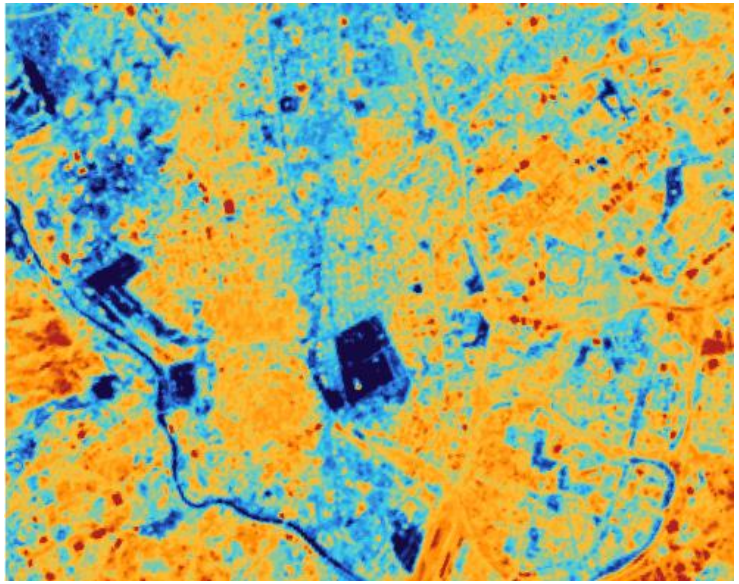
Purpose:

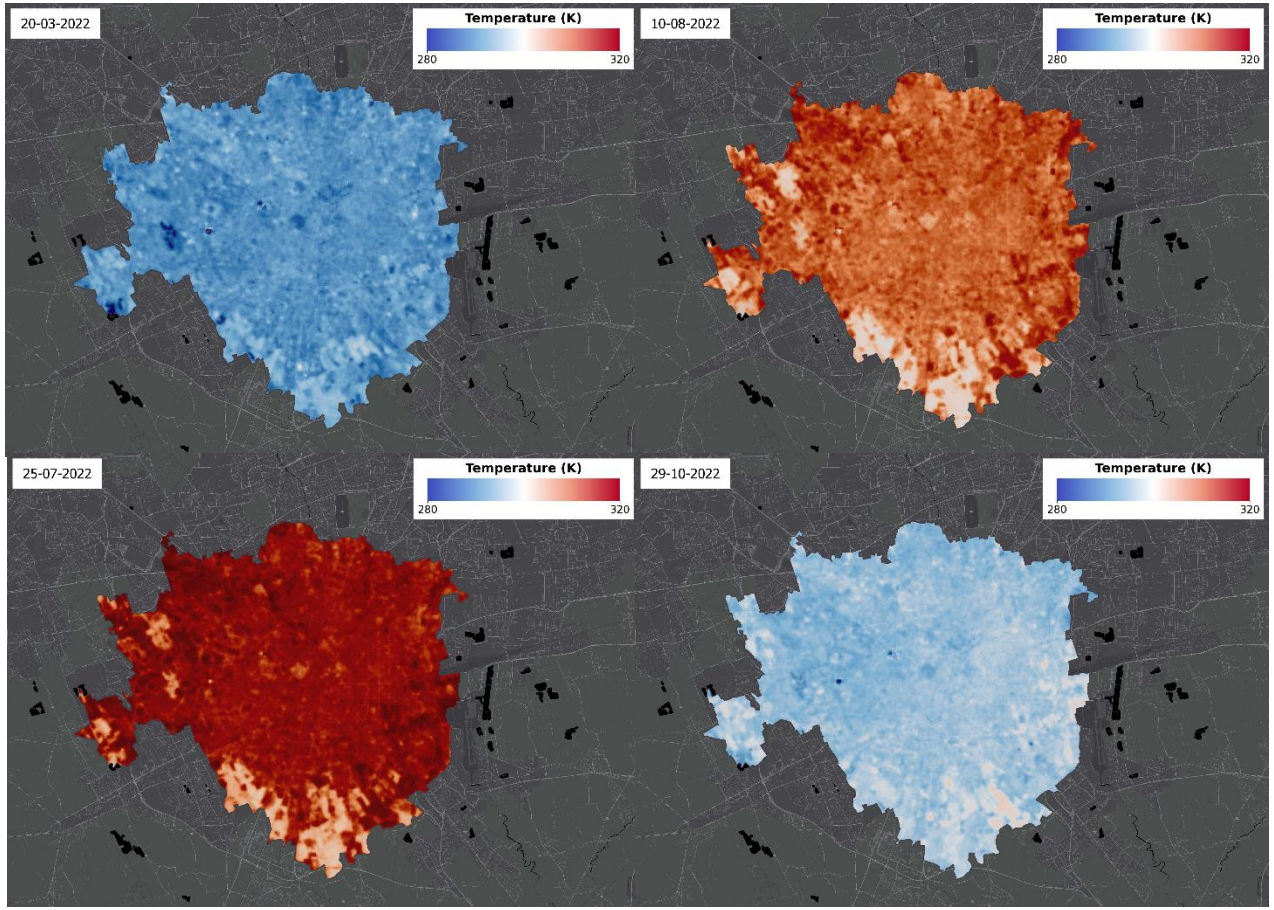
Heatwave monitoring in urban areas using AI/ML convolutional models for ERA5 downscaling

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)

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

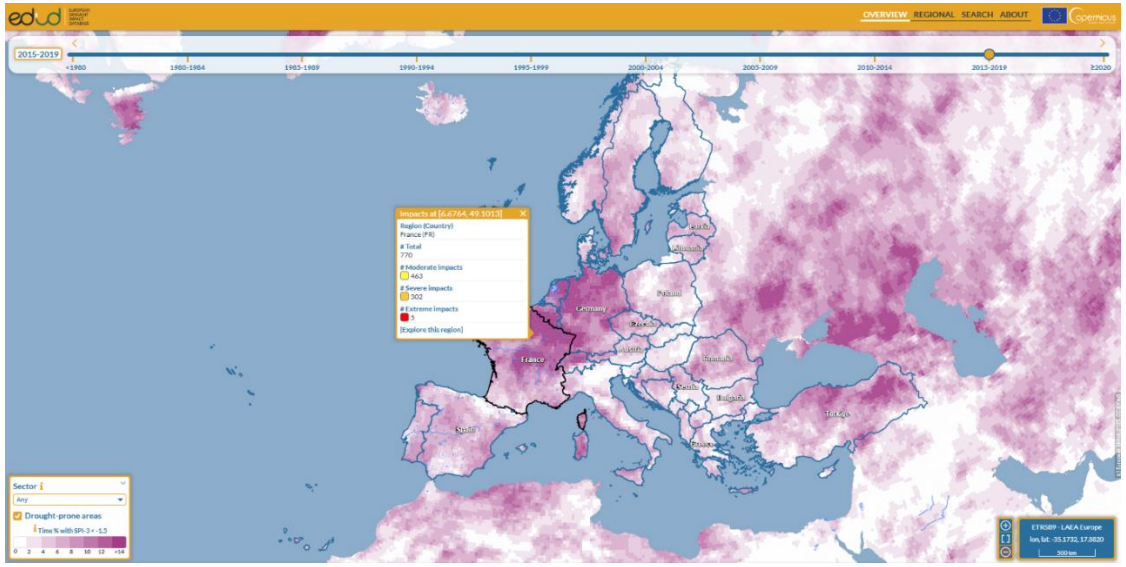
- **Systematic collection of drought impact data.**

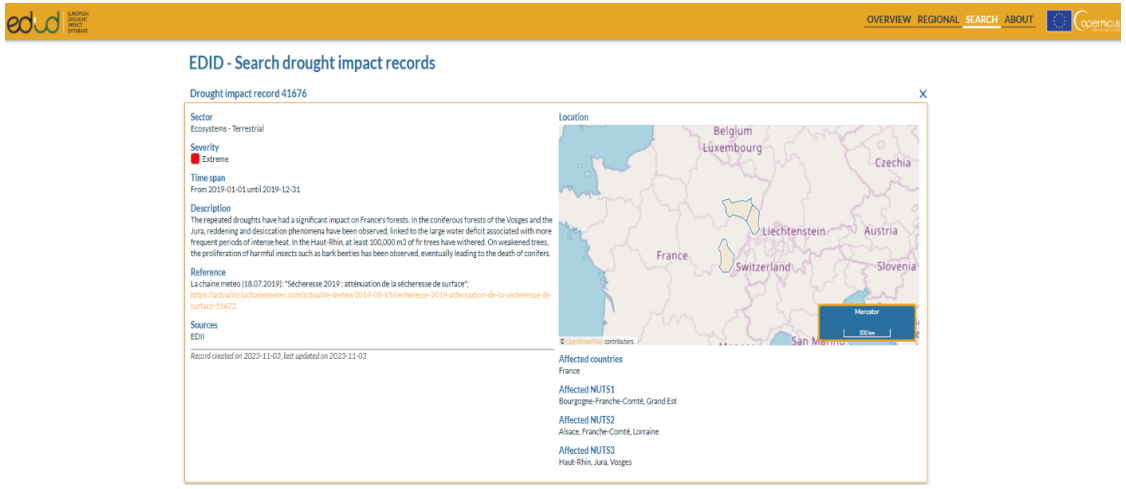
- **More than 13.000 georeferenced records of drought impacts from Europe, and across different sectors, covering a time window from 1970 to 2020.**

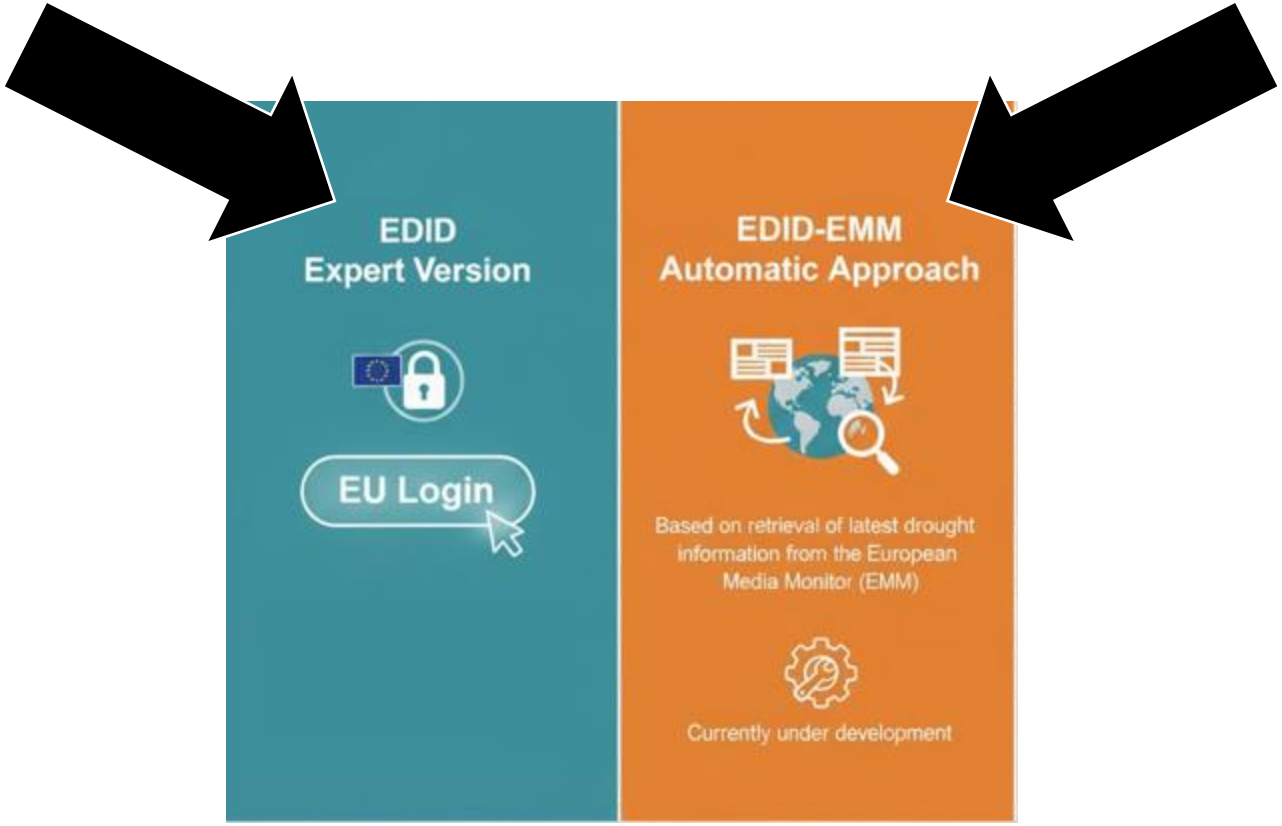
https://drought.emergency.copernicus.eu/tumbo/edid

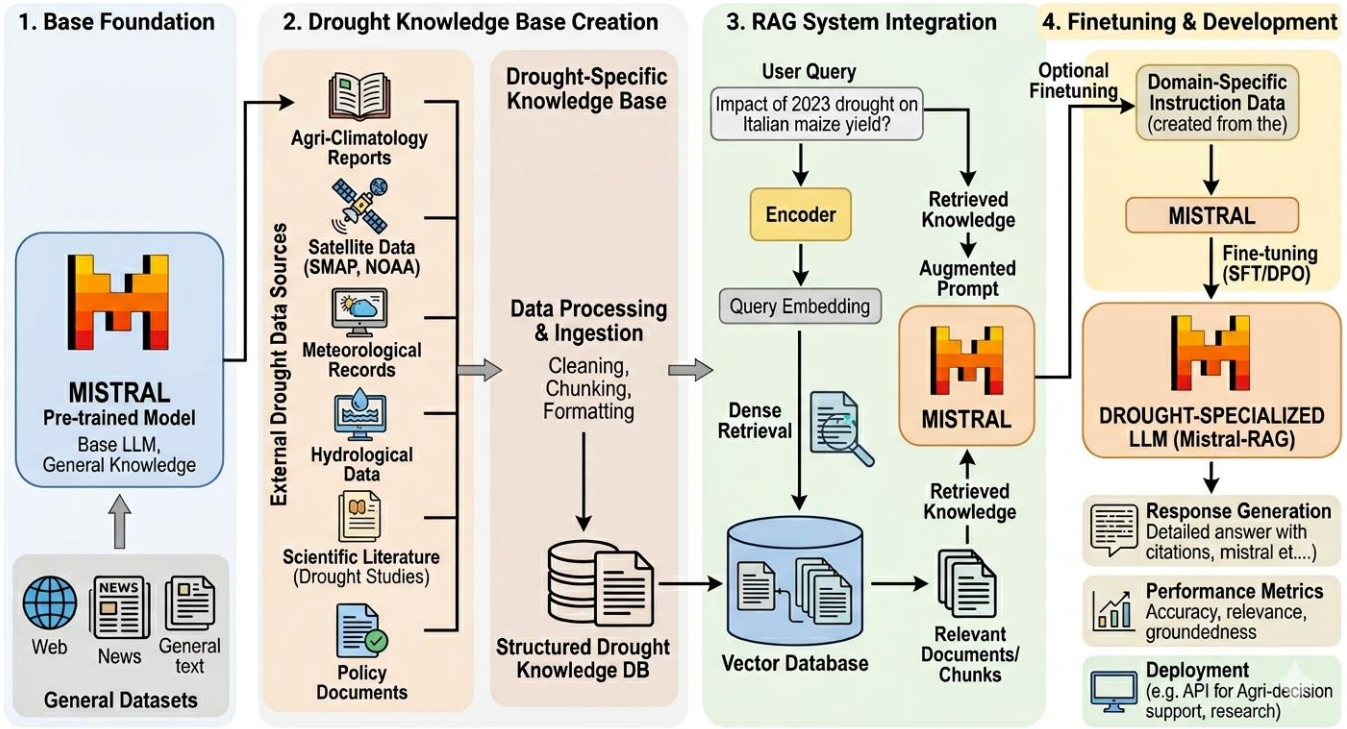
The European Drought impact Database version 2.0

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









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