TOWARDS A HOLISTIC UNDERSTANDING OF DROUGHT IMPACTS ON ECOSYSTEM FUNCTIONING

GEWEX open science conference

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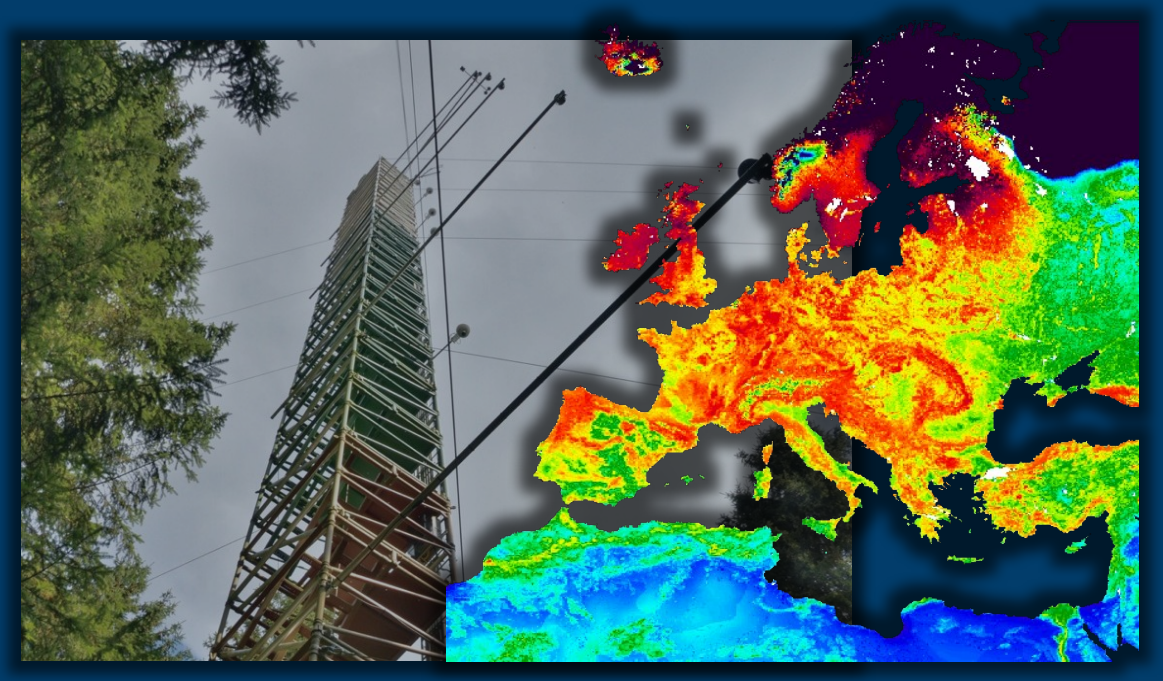

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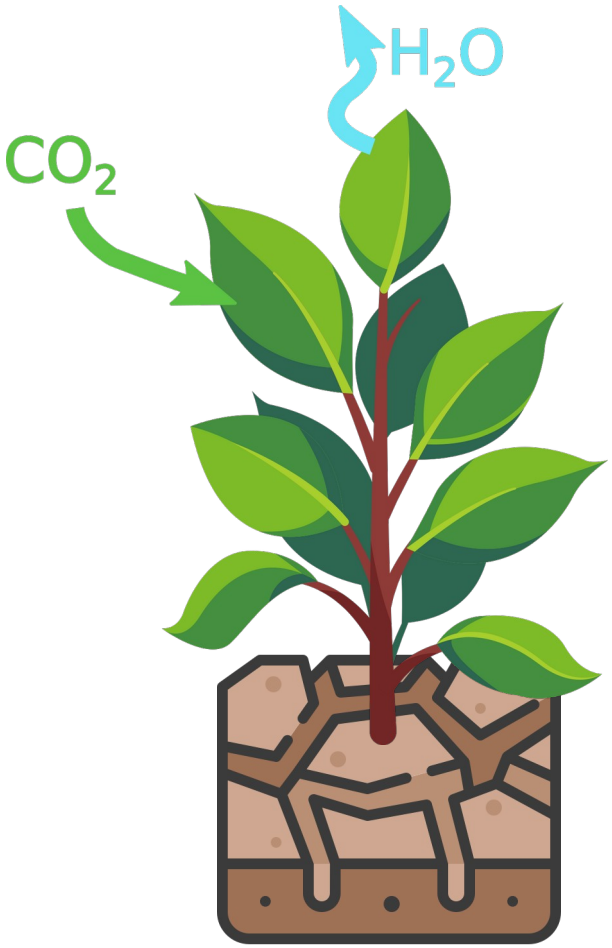
SCIENTIFIC BACKGROUND

- The functioning of an ecosystem to cycle water, energy and carbon is affected by extreme hydro-meteorological conditions
- Climate change increases the frequency and severity of droughts in Europe



→ **How exactly does ecosystem functioning respond to a drier environment?**

→ **When and how does a water deficit in the soil propagate to vegetation processes?**

Kühn et al. 2021; Lehner et al. 2017;

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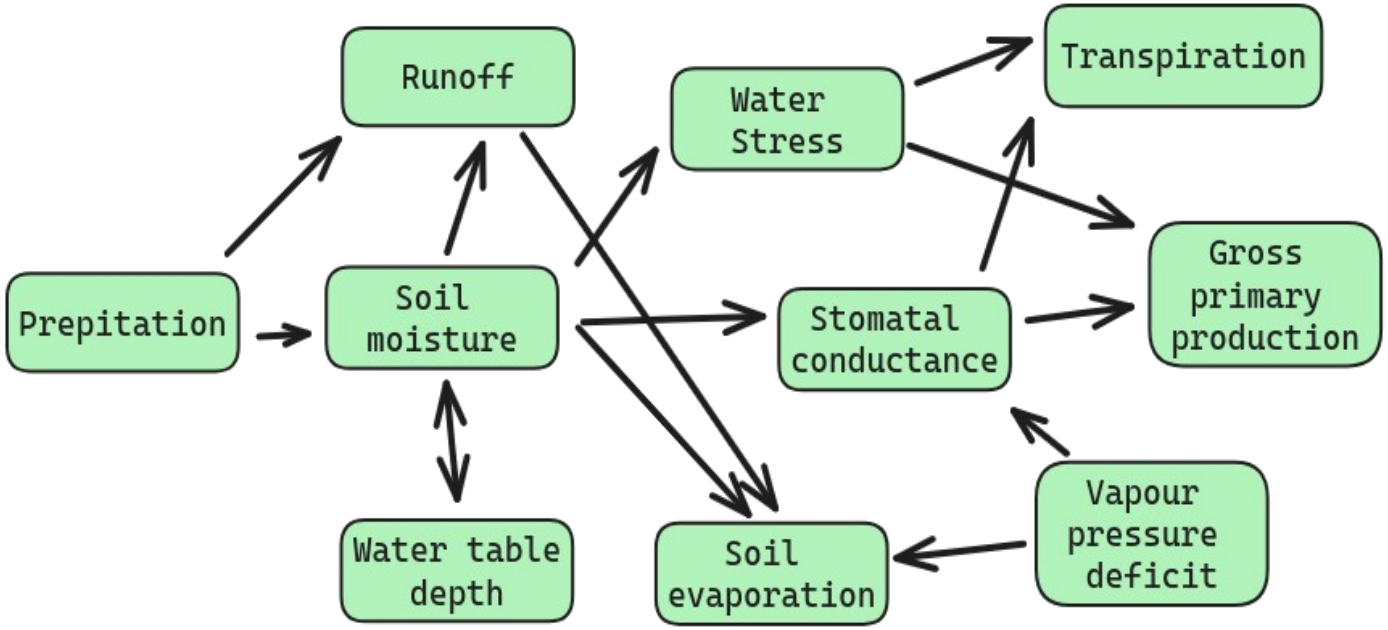
DROUGHT PROPAGATION SCHEME

- Water (and its deficit) propagates through the Earth system
- However, the propagation effects are mediated by local conditions, such as soil and vegetation type



→ **When and how water deficits propagate to affect vegetation function is not well understood**

Poppe Terán et al. (in preparation)

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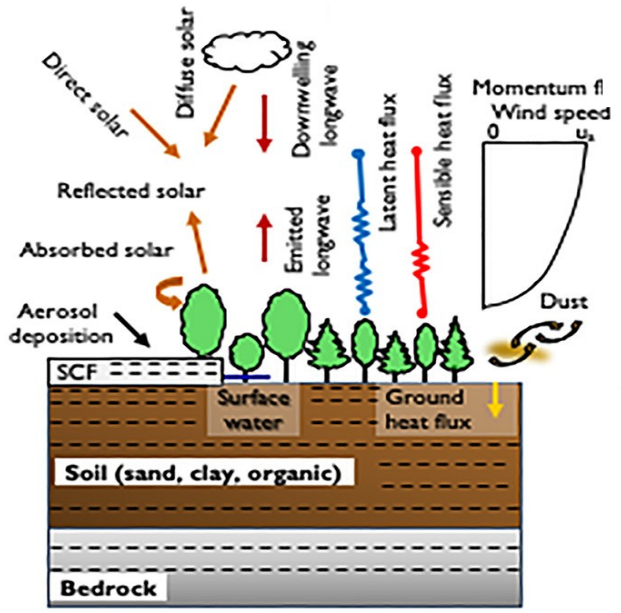
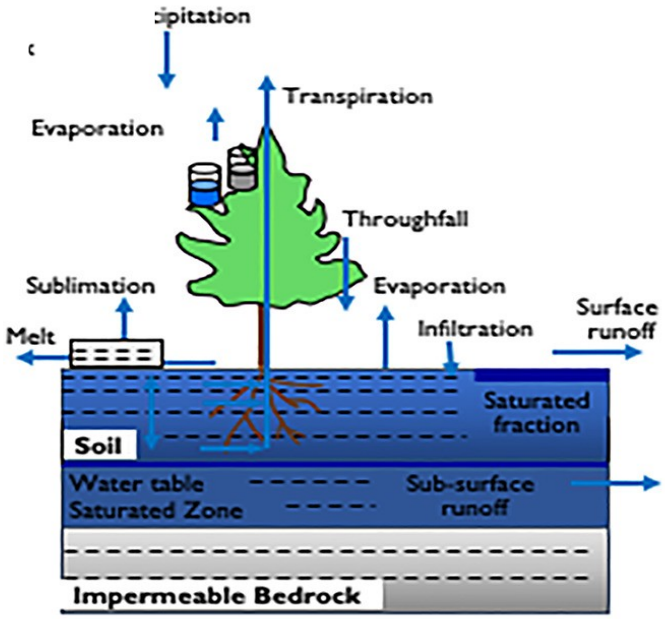
LAND SURFACE MODELING

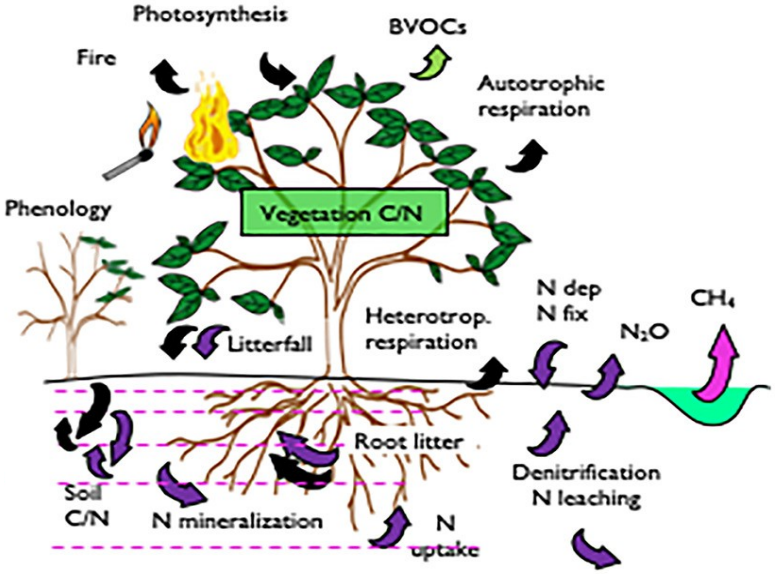
Energy cycle



Water cycle



Carbon cycle



Fisher and Koven 2020; Lawrence et al. 2019;

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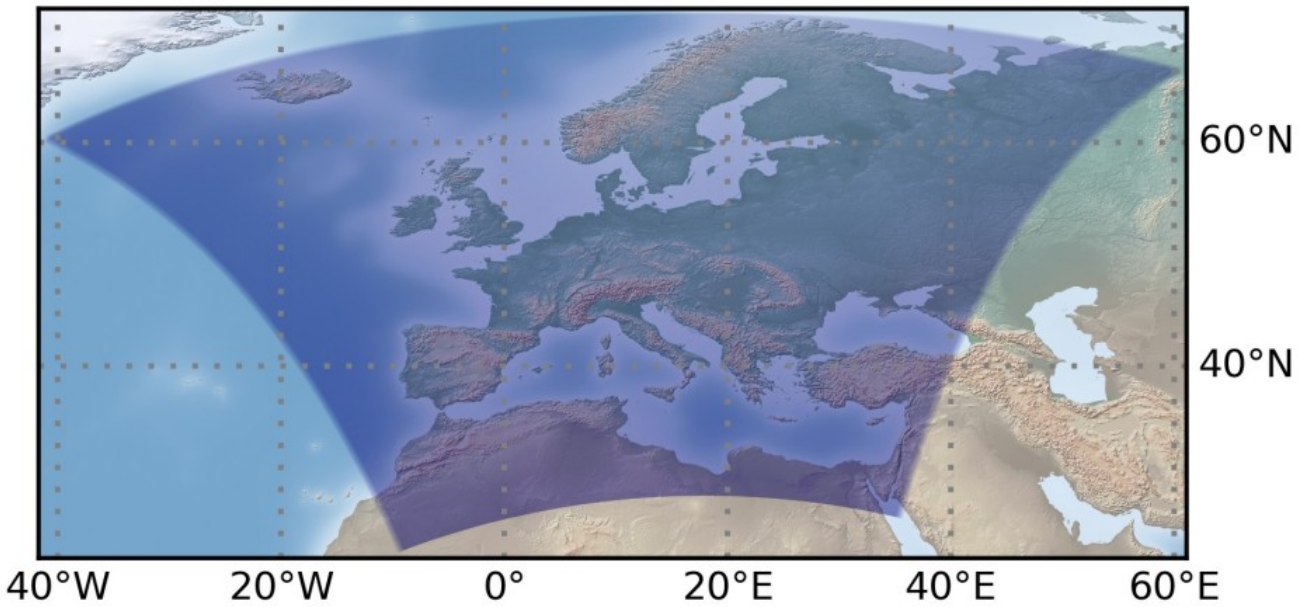
EUROPEAN CLM5 MODEL



- Consistent 3 km resolution
- Simulation years: 1995 - 2018
- > 1500 simulation years of spin-up
- Continuously improved and updated (eCLM version):
  - Static input data (SoilGrids)
  - Atmospheric forcings
  - PFT development

Naz et al. 2020; Poppe Terán et al. 2023;

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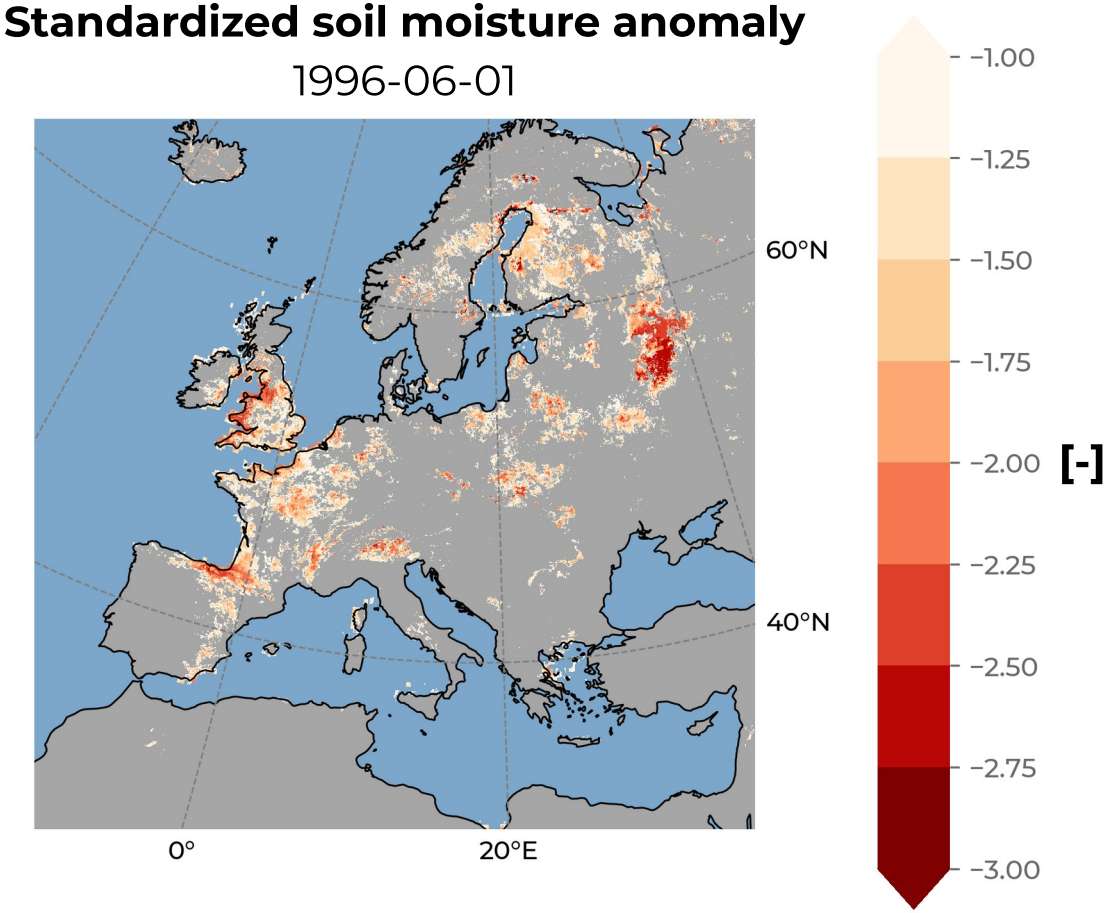
IDENTIFYING SOIL DROUGHT CONDITIONS

Standardized soil moisture anomaly

1996-06-01



- Calculate standardized anomalies for eco-hydrological variables (1995 - 2018)
  - Based on local (grid cell) distributions
  - Soil moisture, vegetation water stress and gross primary production…
  - Indicating dry and wet (or productive and unproductive) conditions across Europe

Poppe Terán et al. (in preparation)

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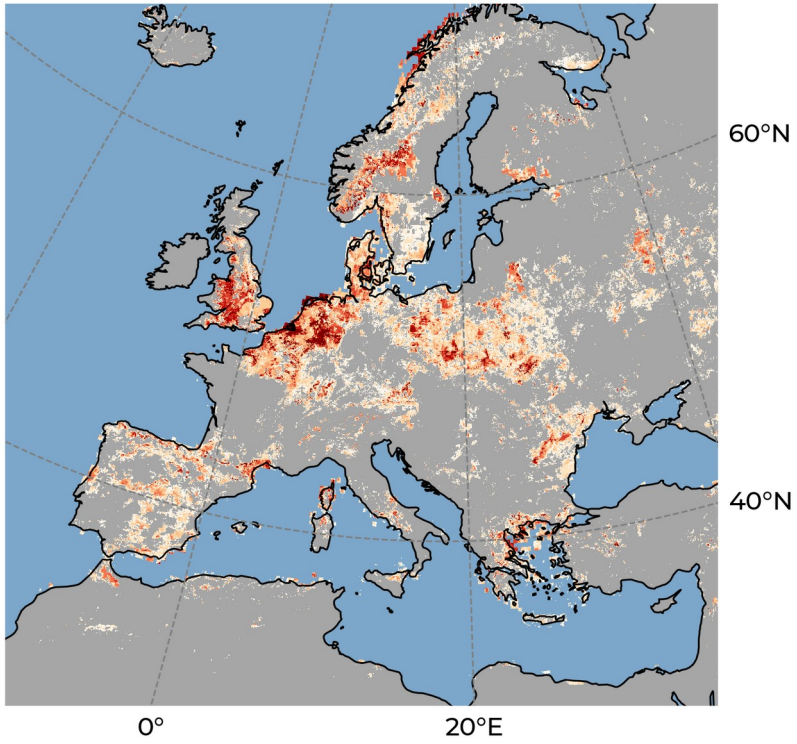
IDENTIFYING ECOLOGICAL DROUGHT CONDITIONS

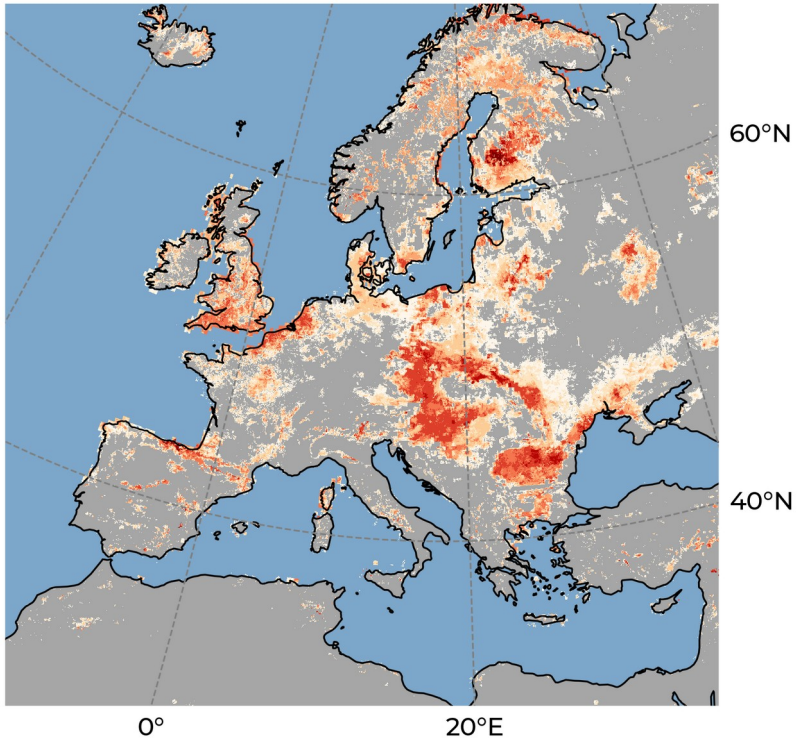
Standardized carbon uptake anomaly

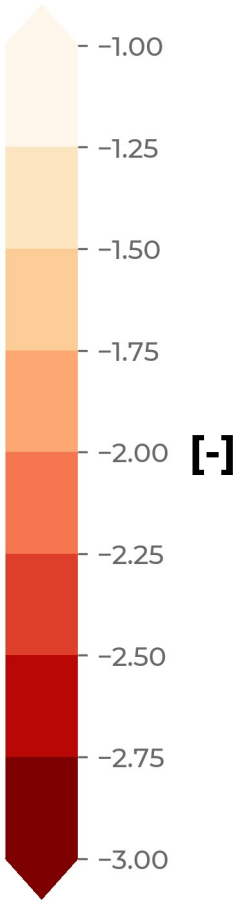
1996-06-01



Standardized water stress anomaly

1996-06-01





- ➔ **Soil droughts do not directly mean there is water stress and vice versa**
- ➔ **Carbon uptake apparently decoupled from water stress**

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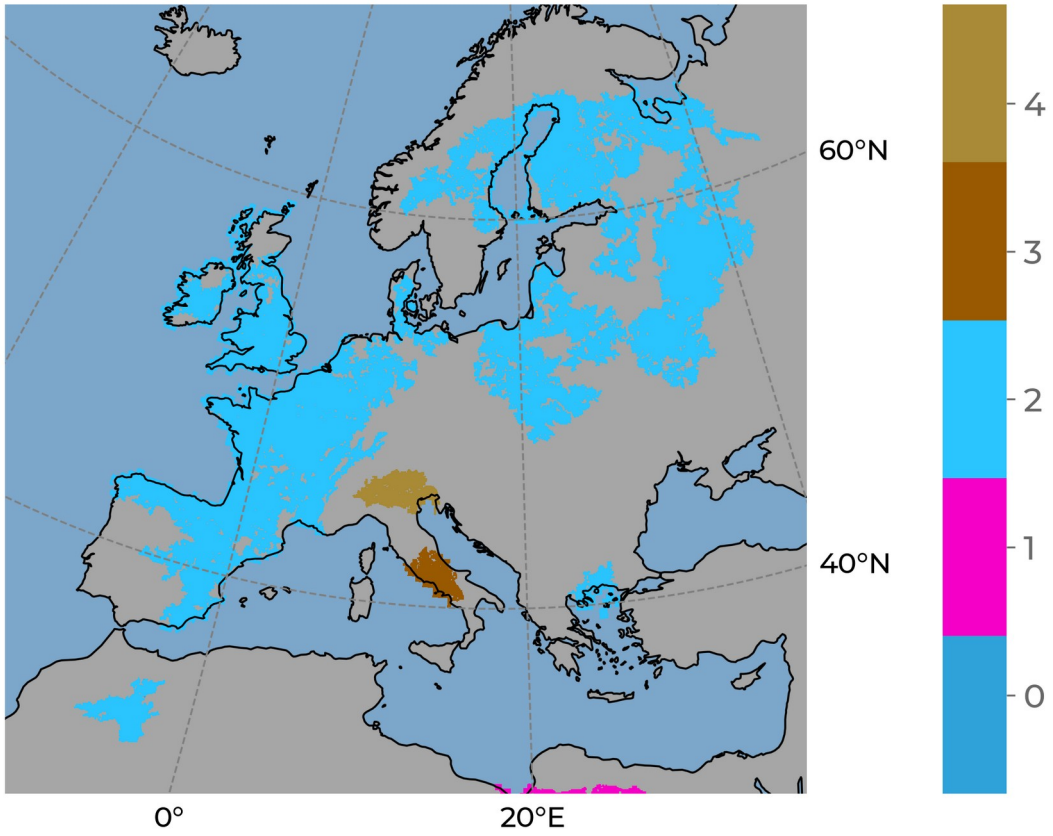
CLUSTERING DROUGHT EVENTS



- **Rationale:** Every drought point in a given event has a similar set of drivers
- Parameterized, three-dimensional clustering (latitude, longitude, time)
- For now, only the years 1996 - 1997
- Drought points connected through time and/or space are grouped to event clusters

Cammalleri and Toreti 2023;

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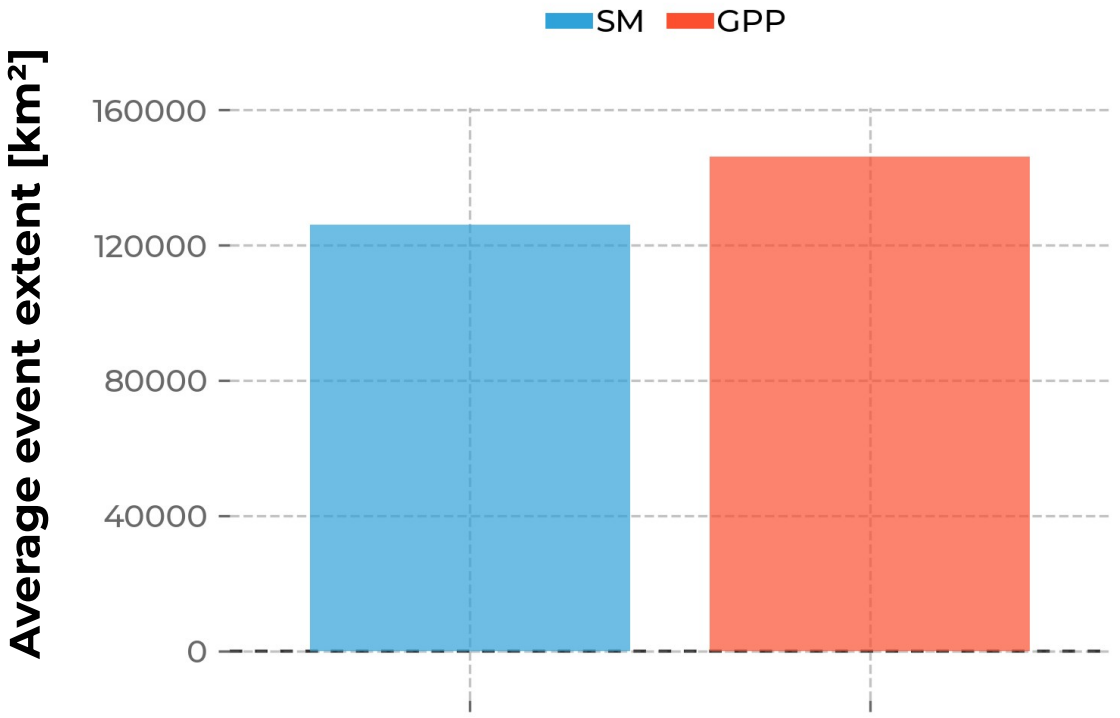
LINKING ECO-HYDROLOGICAL DROUGHT EVENTS

Event statistics (1996 - 1997)



- Negative GPP events are more widespread and larger than SM events
- However, complex interactions with other variables and time lags have to be considered

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OUTLOOK

- Different anomaly aggregation windows (3-, 6-, and 12-monthly)
- Include further variables (e.g. heatwaves) and years
- Long-term (>20 years) of drought statistics and trends
- Calculate additional drought event indices (e.g., lag between drought emergence and ecosystem response)
- Explore different strategies for event clustering method
- Systematic analysis of the drought propagation graph

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THANKS YOU FOR YOUR ATTENTION!

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