

# Circulation versus background warming: drivers of European hot and wet extremes since 1980

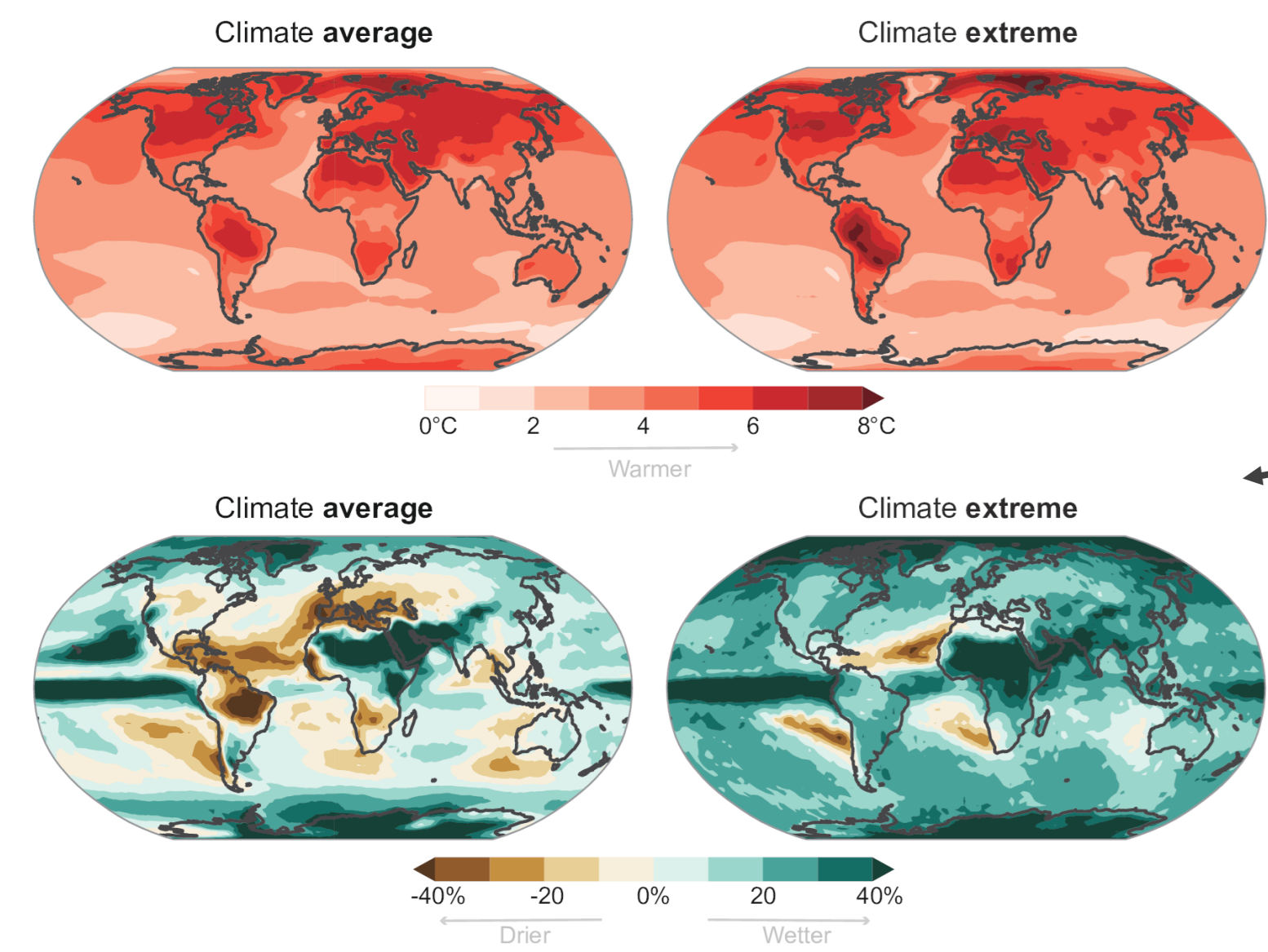
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This is me!

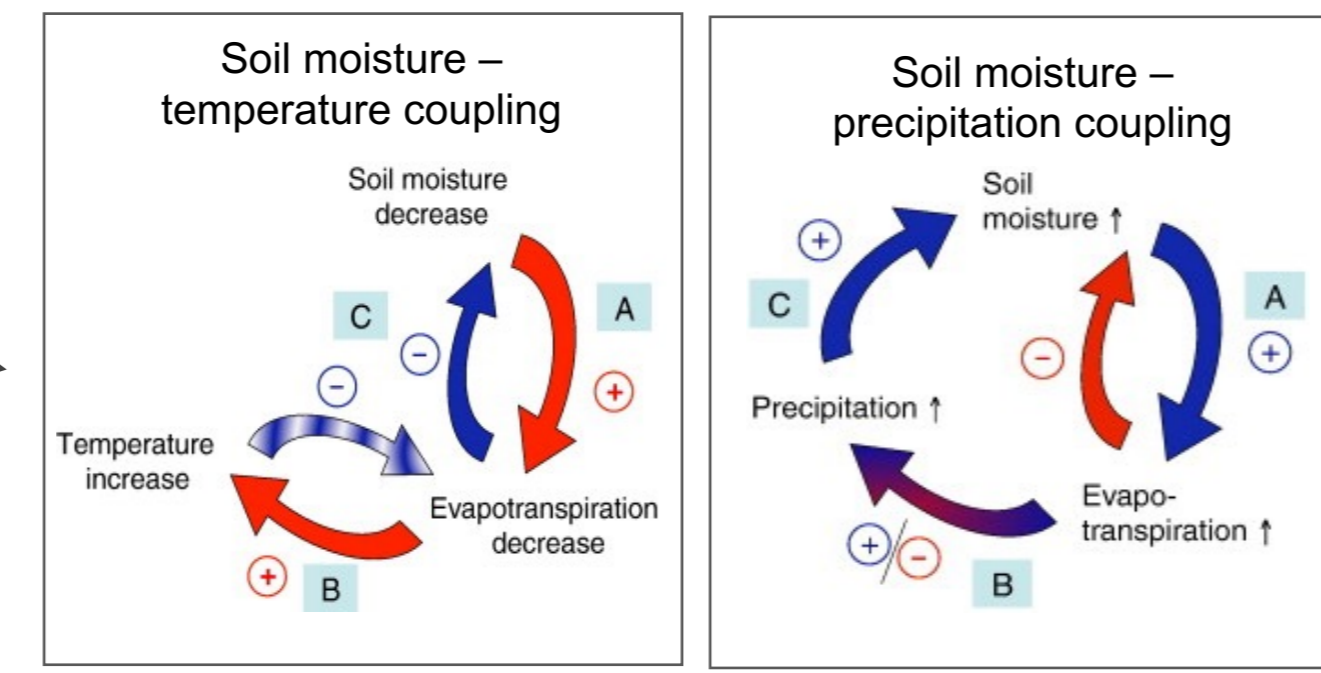


## Background



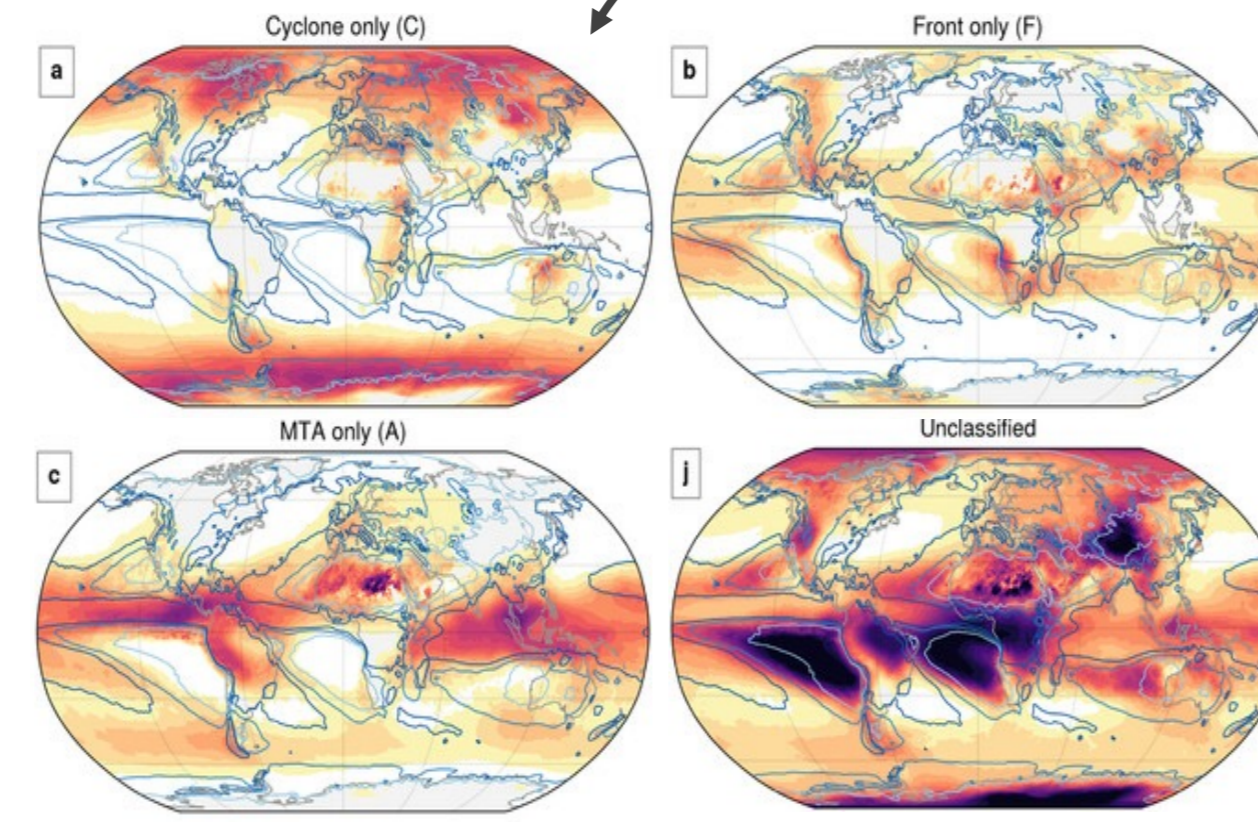
Climate warming exacerbates hot and wet extremes

Climate extremes are governed by thermodynamic...



Land-Climate interactions, adapted from Seneviratne et al. 2010

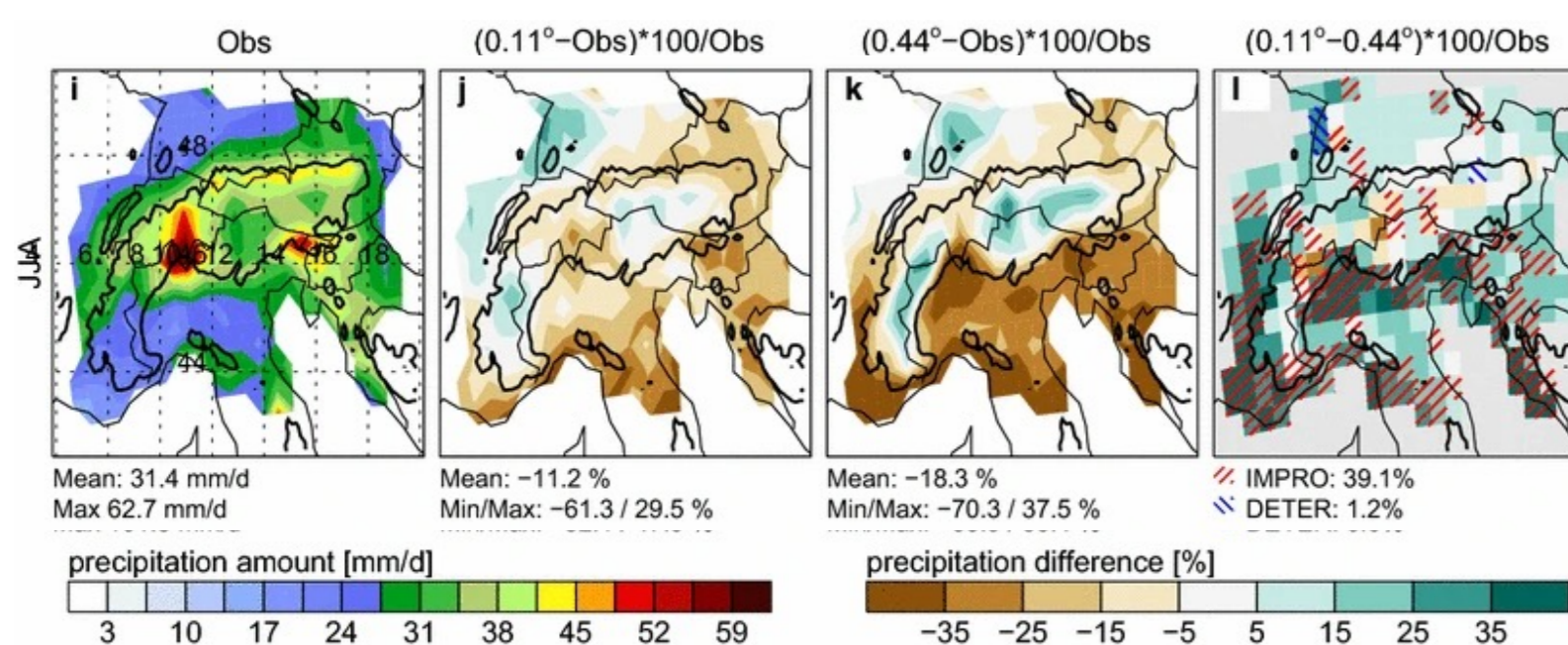
...and dynamic factors.



Relative contribution of weather patterns to DJF precipitation: (a) cyclones, (b) fronts, (c) moisture transport axes (=atmospheric river like features), and (d) unclassified. Adapted from Konstali et al. 2024

Global maps of future changes in surface temperature (top panels) and precipitation (bottom panels) for long-term average (left) and extreme conditions (right). Adapted from FAQ 11.1 Figure 1 in IPCC, 2021: Chapter 11

The representation of heavy precipitation benefits from a higher resolution

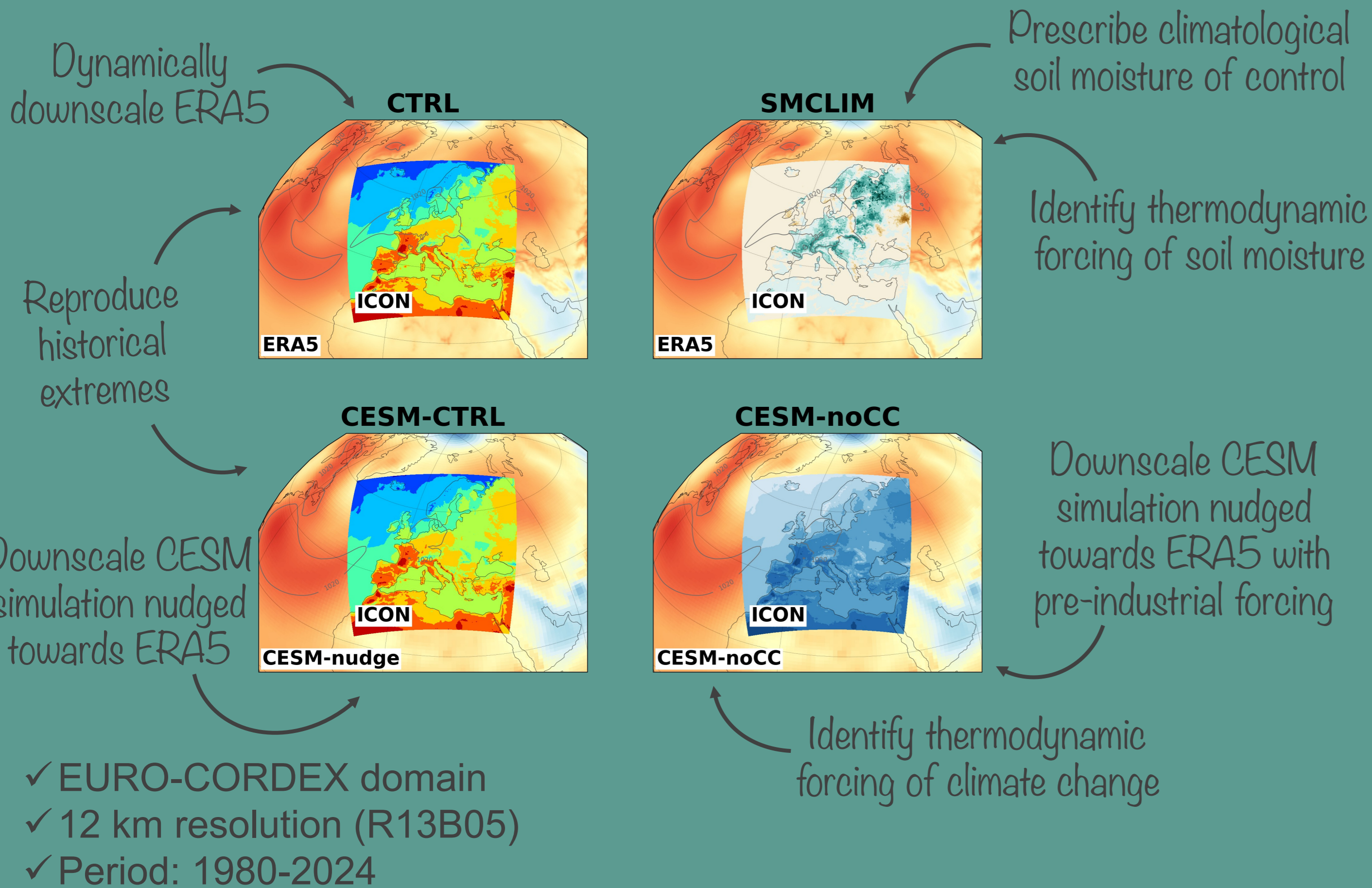


Observed extreme precipitation (mean of all values above the 97.5 percentile) in the Alps (first column). The second (third) column shows the relative biases in the multi-model-mean of eight different models of the EURO-CORDEX ensemble. Adapted from Prein et al. 2015

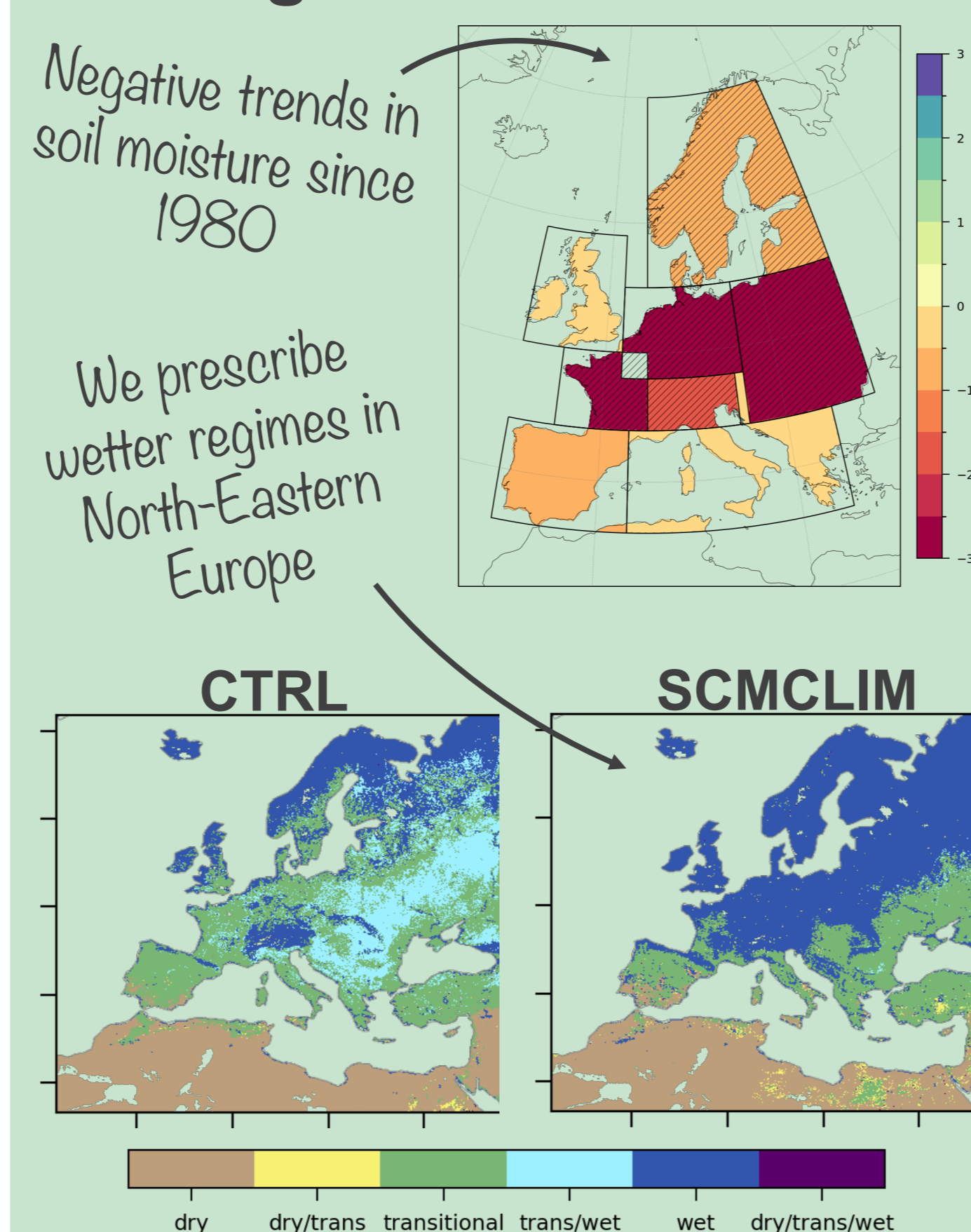
## Research Questions

- How big were the respective contributions of thermodynamic and dynamic drivers to historical hot and wet extremes over Europe?
- What role did land-atmosphere feedbacks play in the formation of these climate extremes?

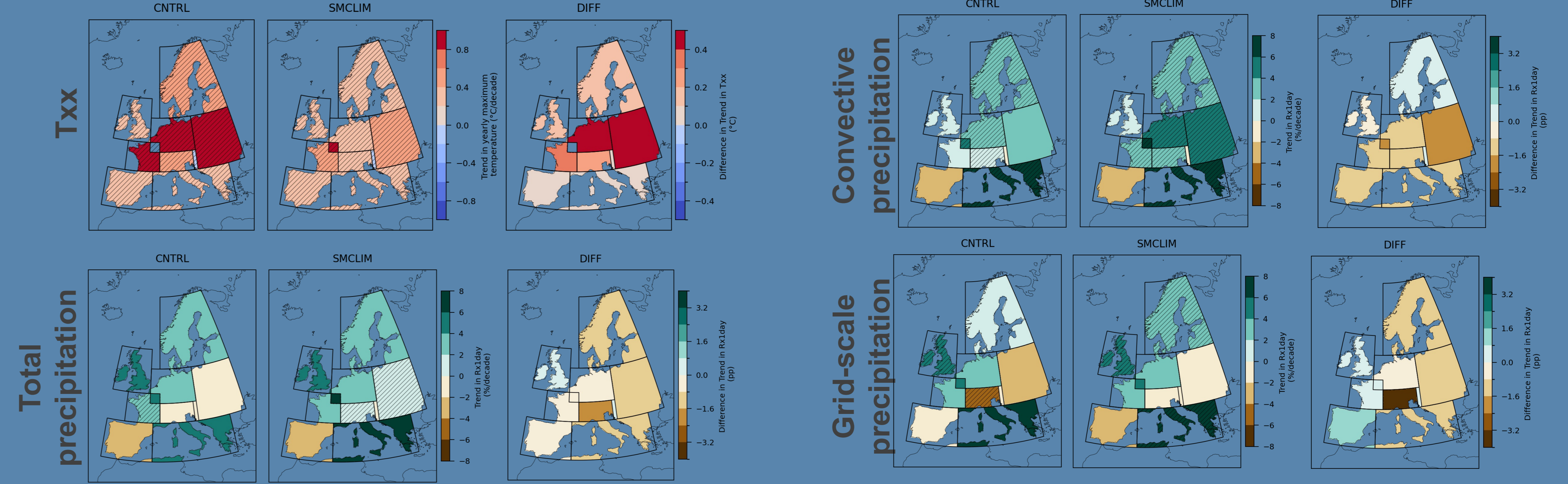
## Factorial simulations with ICON-CLM



## Changes in soil moisture

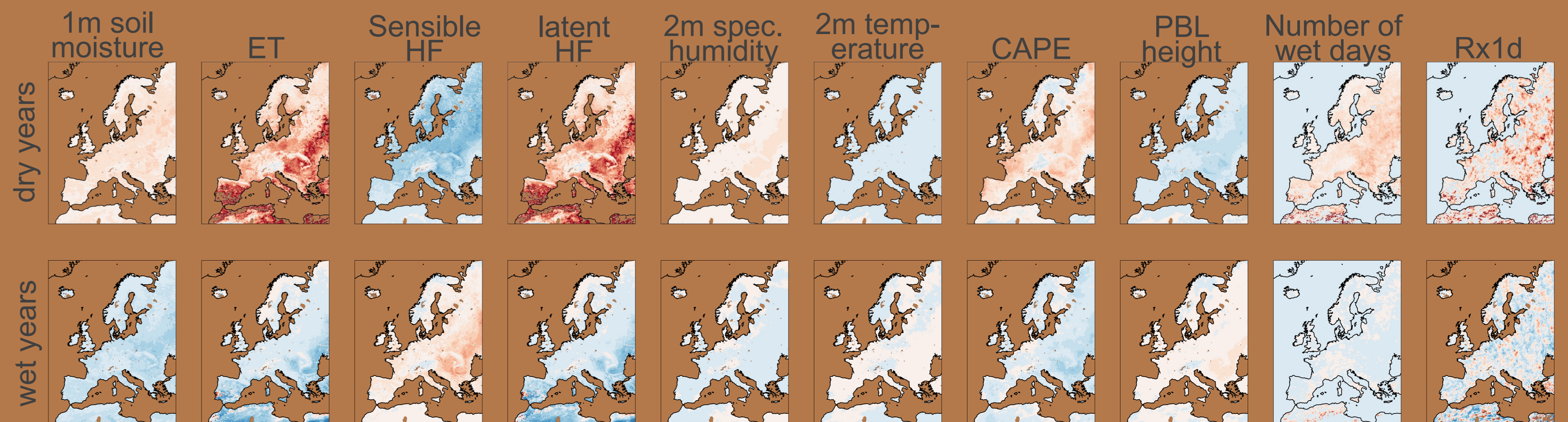


## Soil moisture influence on summer trends in hot and wet extremes since 1980



Trends in maximum temperatures have been exacerbated by negative soil moisture trends while heavy precipitation has been rather mitigated. Convective precipitation seems to respond most strongly to changes in soil moisture.

## Mechanisms via which soil moisture modifies summer extremes



There is a non-linear response where we change the soil moisture regime. Previously dry years in CTRL show more ET, latent heatflux, and humidity. More soil moisture leads to cooler near surface temperatures, more wet days and higher precipitation sums. In dry years, the effects are weaker.

## Key Messages

- Trends in extreme temperatures have been thermodynamically enhanced by soil moisture drying
- Trends in heavy precipitation have been dampened by drying in soil moisture, especially in North-Eastern Europe
- Convective precipitation seems to respond most strongly to changes in soil moisture
- Once a regime change in soil moisture happens, hot and wet extremes are significantly affected
- Soil moisture influenced hot and wet extremes via moisture and heat fluxes to the atmosphere, modifying moisture and energy availability

## Open questions

- How does convection parameterization affect soil-moisture – precipitation coupling?
- How do the compensating effects of more cooling versus more moisture with increasing soil moisture affect convective precipitation?