



**Barcelona  
Supercomputing  
Center**  
*Centro Nacional de Supercomputación*

# **Atribución mediante storylines de los forzantes termodinámicos de escala sinóptica asociados al evento de DANA de octubre de 2024 sobre Valencia, España**

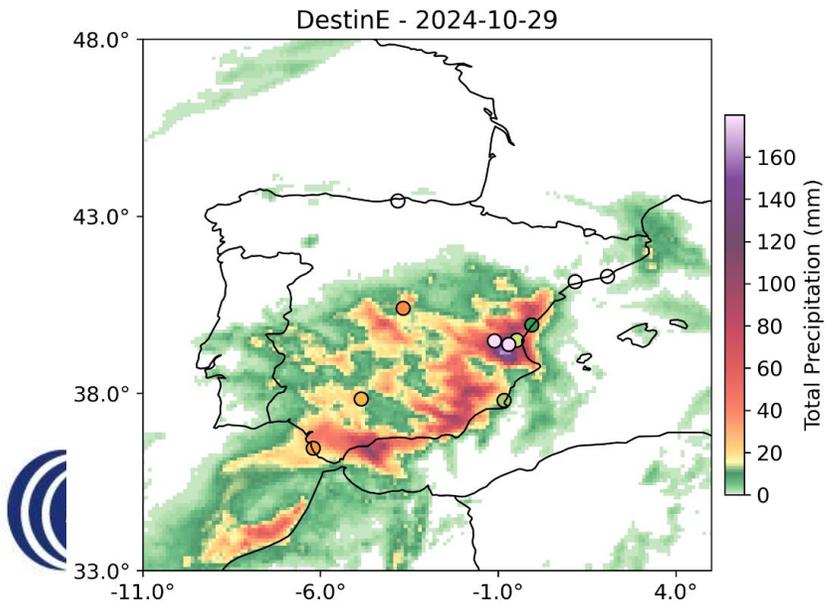
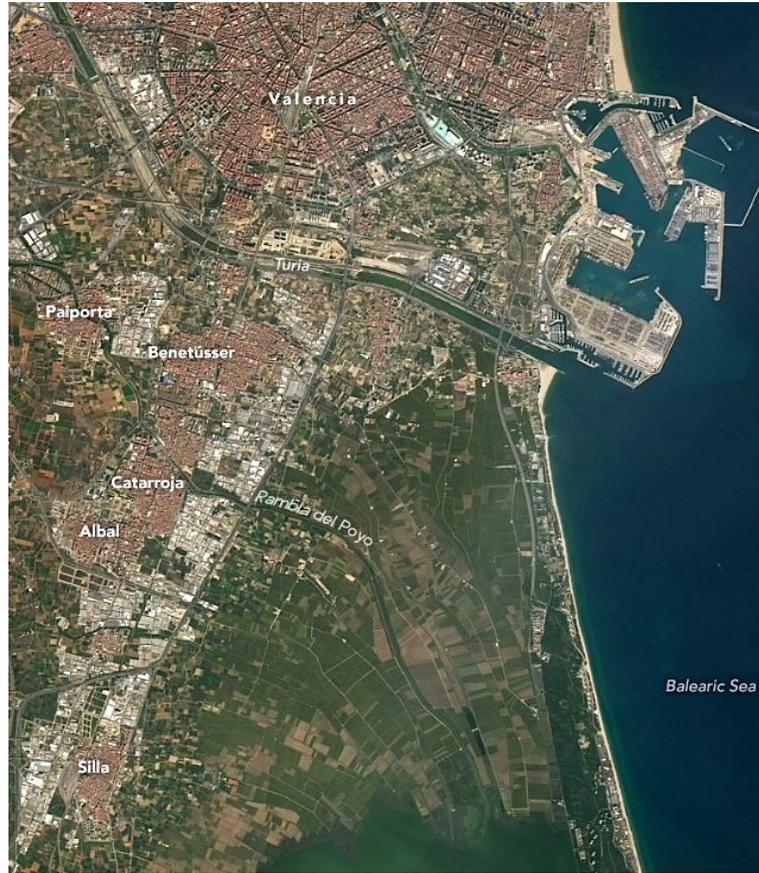
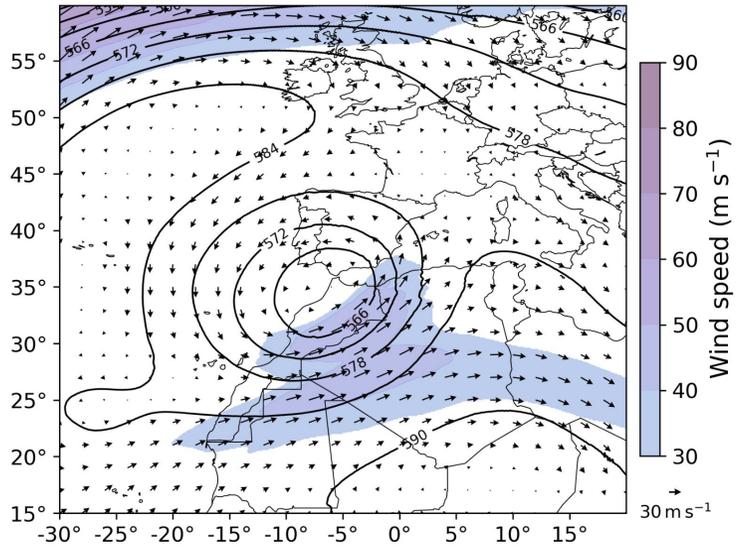
Diego Campos, Katherine Grayson, Ramiro Saurral, Sebastian Beyer, Amal John, Matías Olmo, and Francisco Doblas-Reyes

Earth Sciences Department, Barcelona Supercomputing Center

25/02/2026

XXXVII Jornadas de la AME - Málaga - Febrero 2026

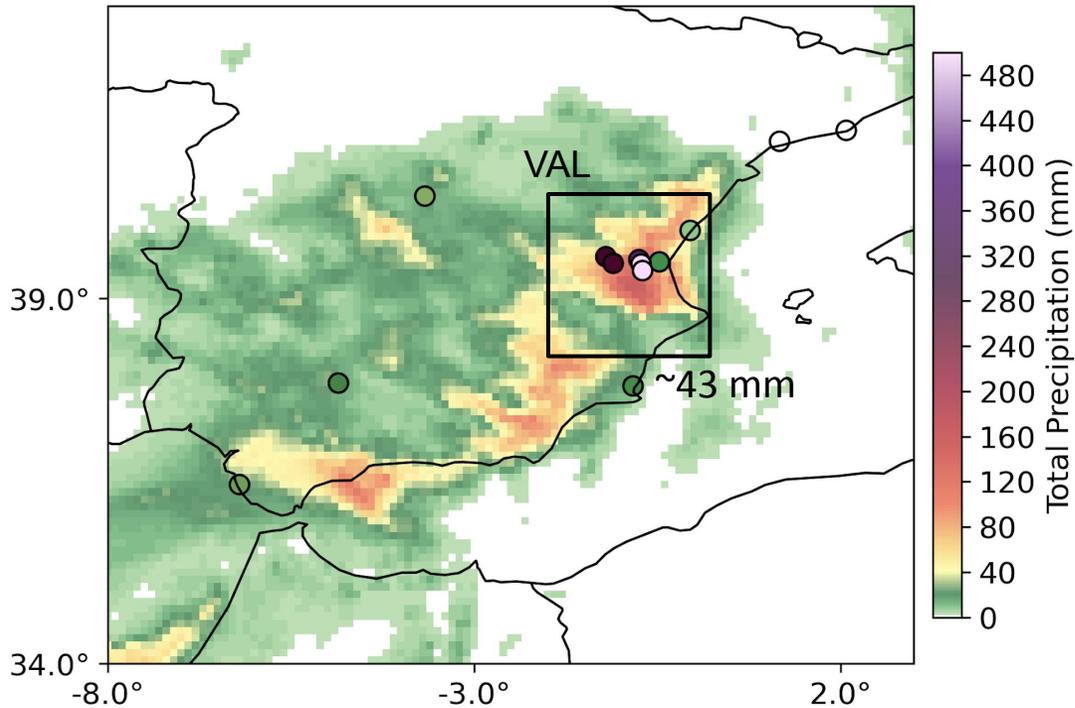
# Motivation



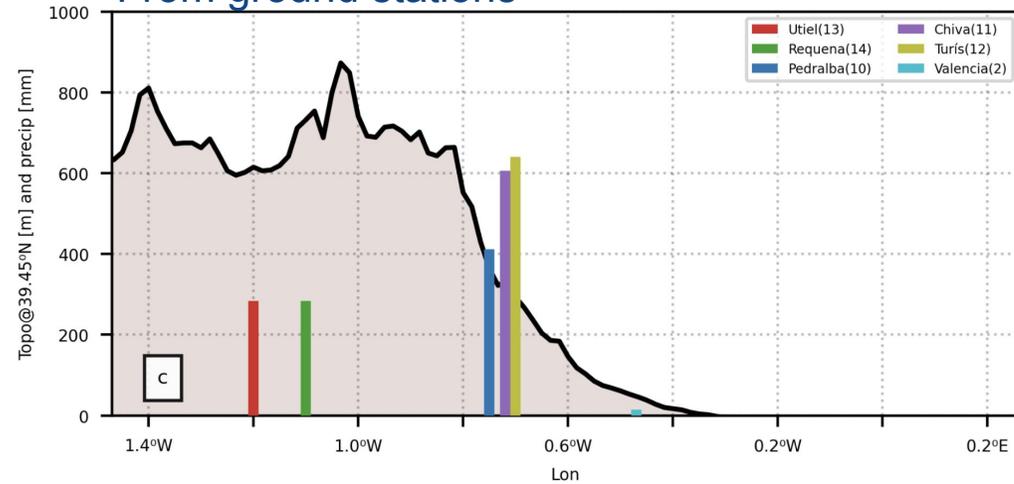
Landsat 8, from NASA Earth Observatory

# Observed and simulated precipitation

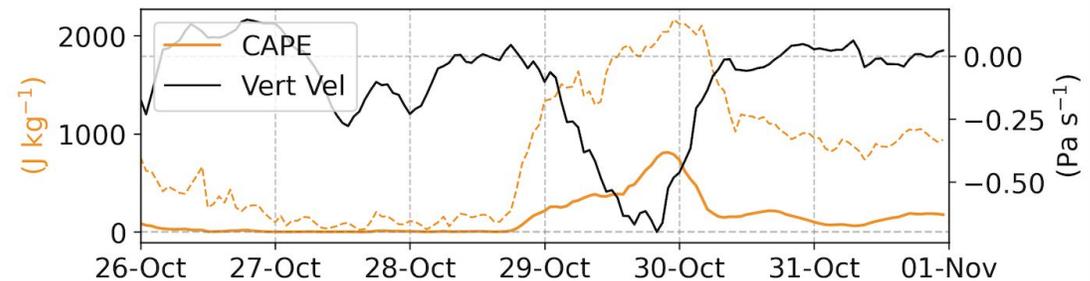
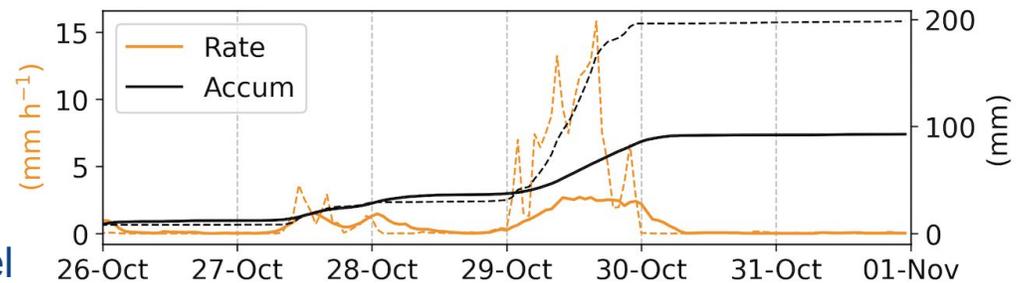
DestinE - 2024-10-29



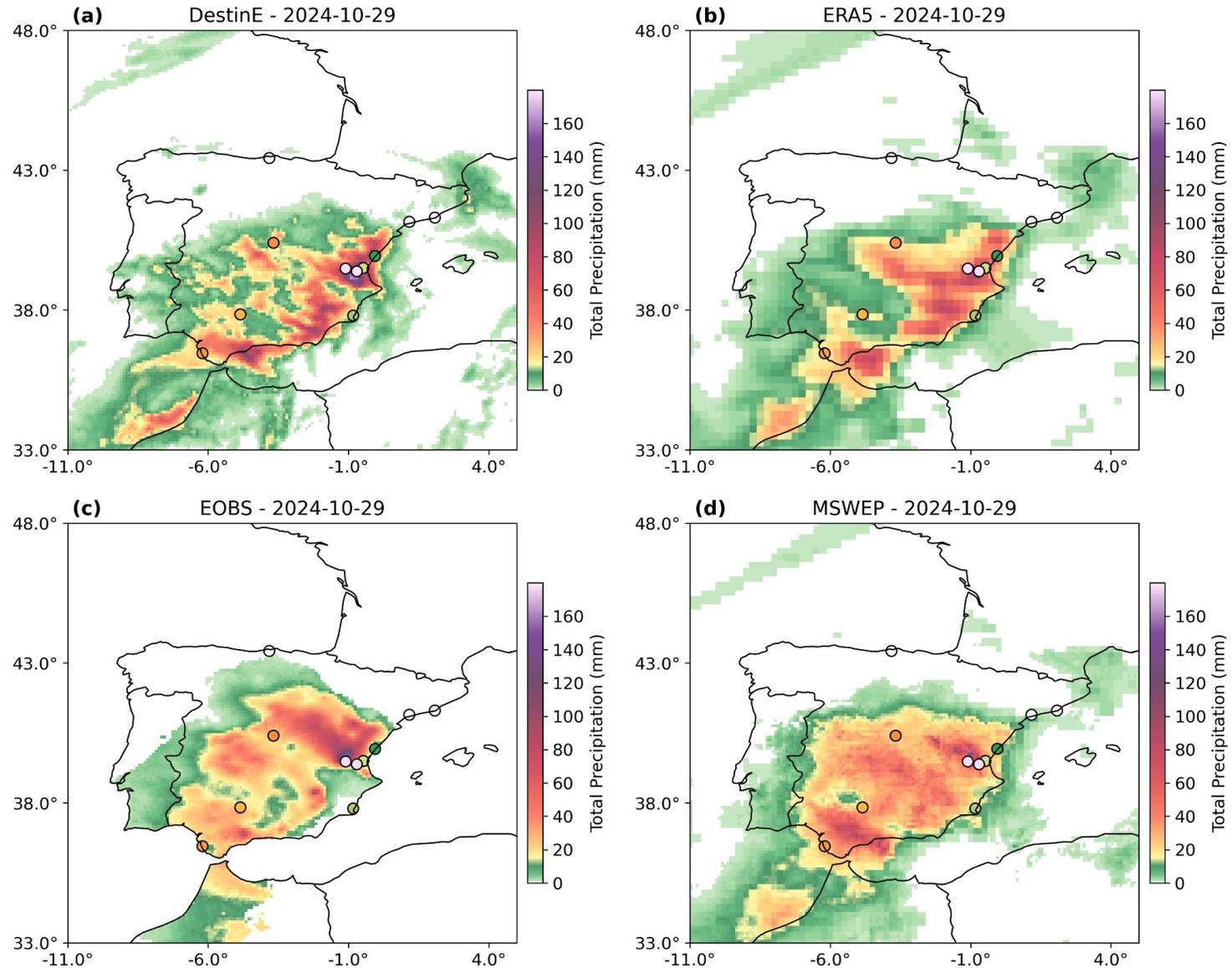
From ground stations



From the model

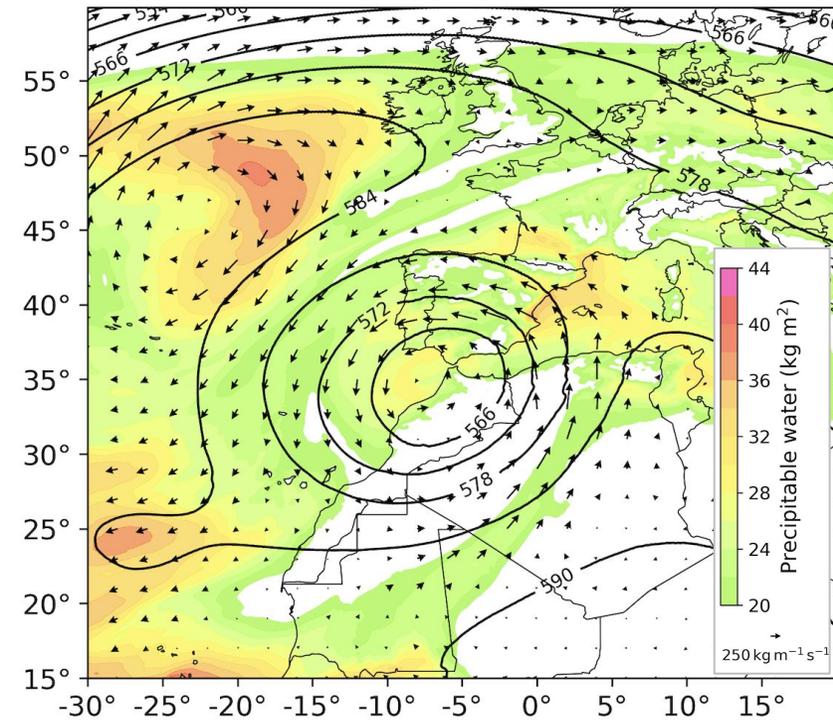


# Observed and simulated precipitation



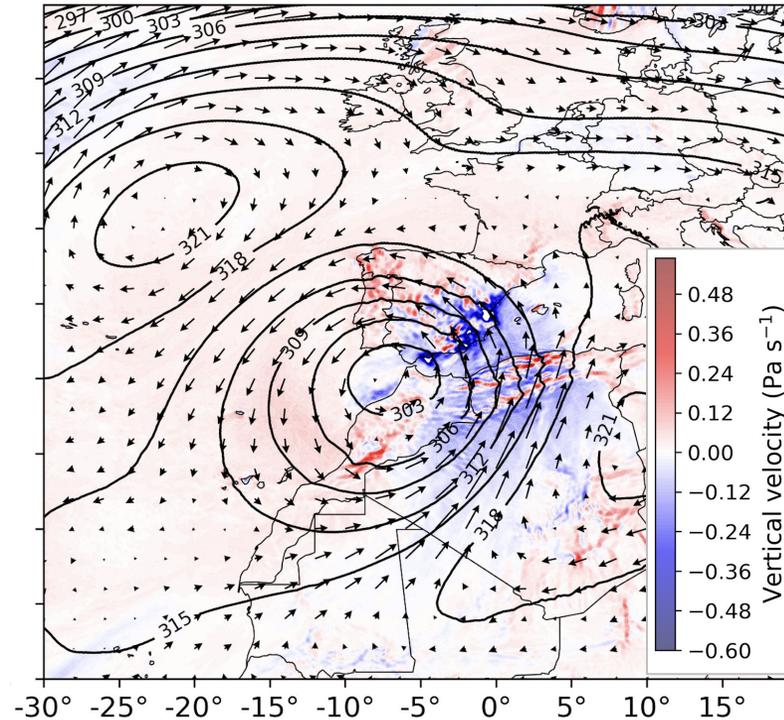
# Synoptic environment

### 500-hPa GPH, PW, IVT



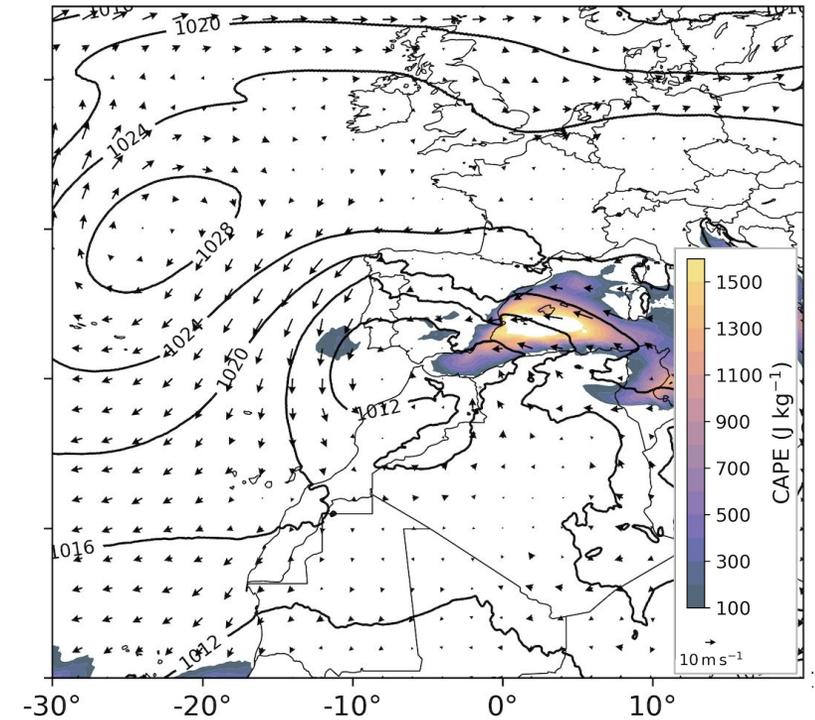
High values of PW in the Med  
An AR-like from the south

### 700-hPa GPH, Vert Vel, Winds



South-westerly flow interacts with  
the topography (upward motion)

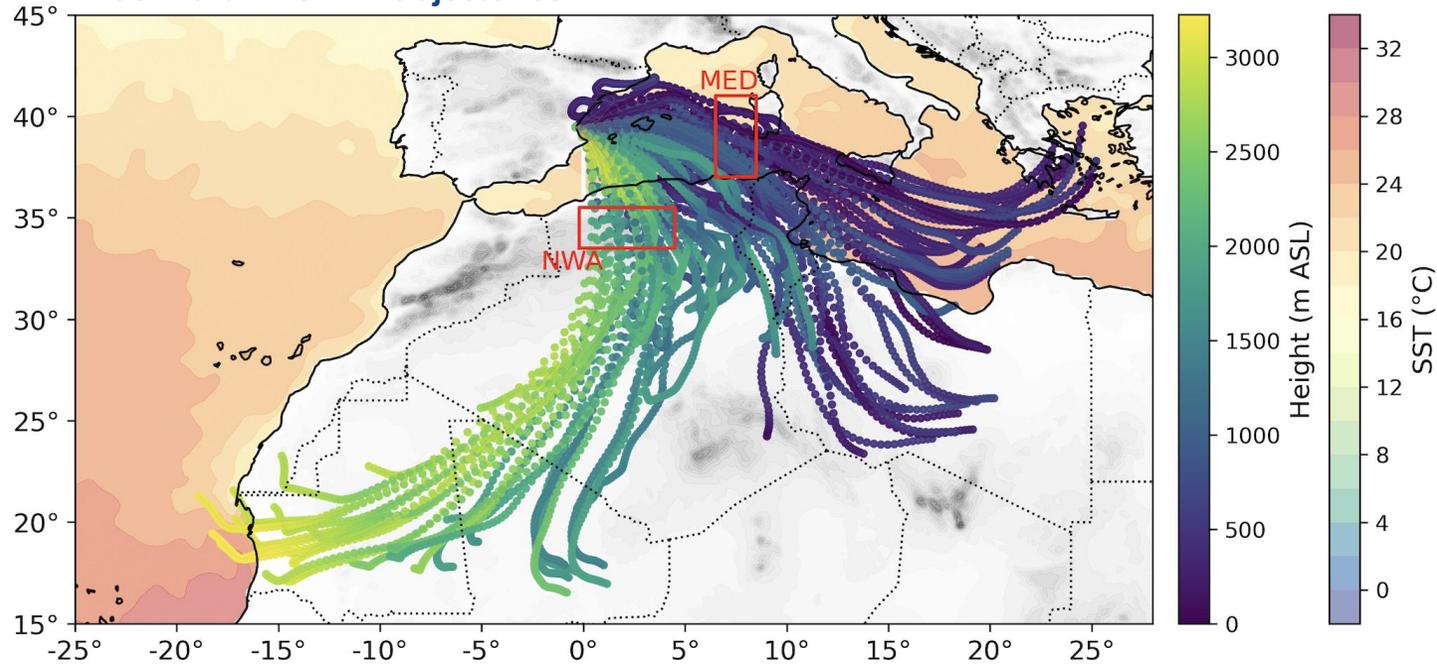
### SLP, CAPE



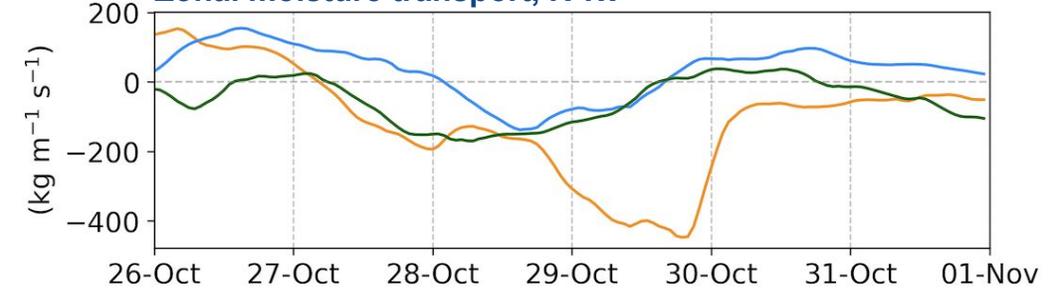
High values of CAPE in the Med

# Two sources of moisture

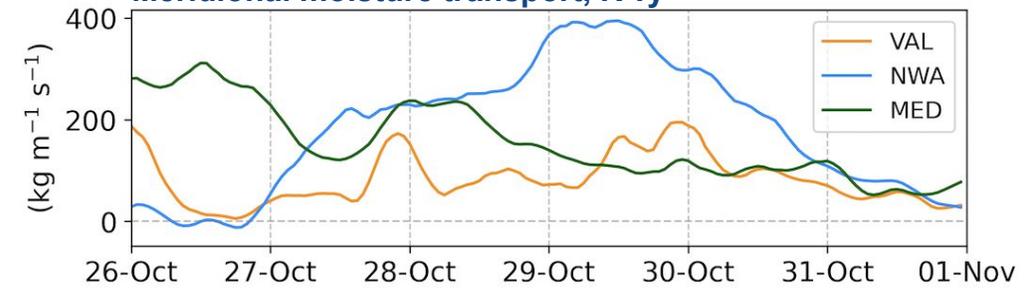
Backward HYSPLIT trajectories



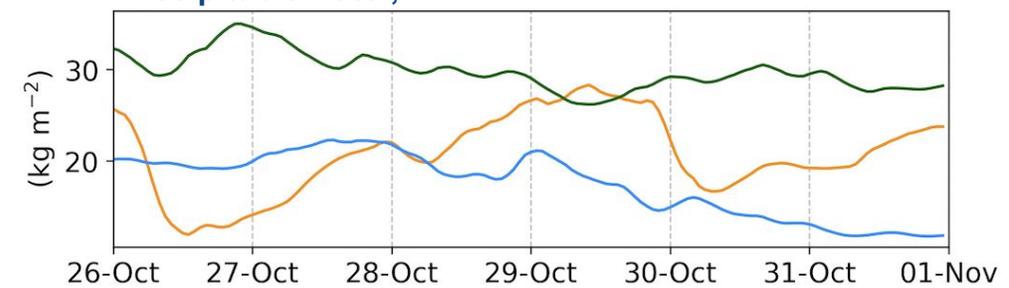
Zonal moisture transport, IVTx



Meridional moisture transport, IVTy



Precipitable water, PW



# Research question

## What was the role of global warming?

Diego Campos<sup>1,2</sup>, Katherine Grayson<sup>1</sup>, Ramiro Saurral<sup>1,3</sup>, Sebastian Beyer<sup>4</sup>, Amal John<sup>4</sup>, Matías Olmo<sup>1</sup>, and Francisco Doblas-Reyes<sup>1,5</sup>

1, Earth Sciences Department, Barcelona Supercomputing Center, Barcelona, Spain

2, Facultat de Física, Universitat de Barcelona, Barcelona, Spain.

3, Centro de Investigaciones del Mar y la Atmósfera, CONICET-Universidad de Buenos Aires

4, Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung (AWI), Bremerhaven, Germany.

5, Institució Catalana de Recerca i Estudis Avançats, Barcelona, Spain

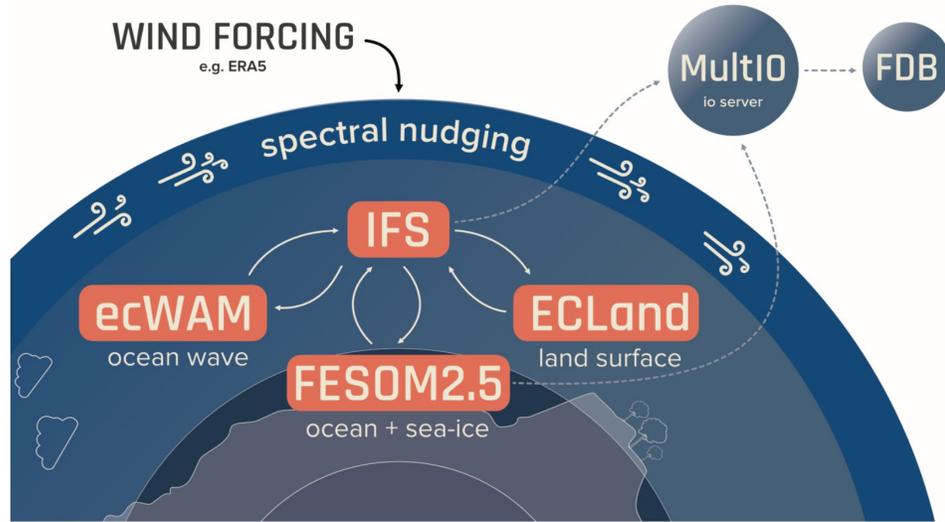
(Under review in WCD)

We wanted to say something about:

(i) The climatological context

(ii) The differences between a factual and a counterfactual scenario

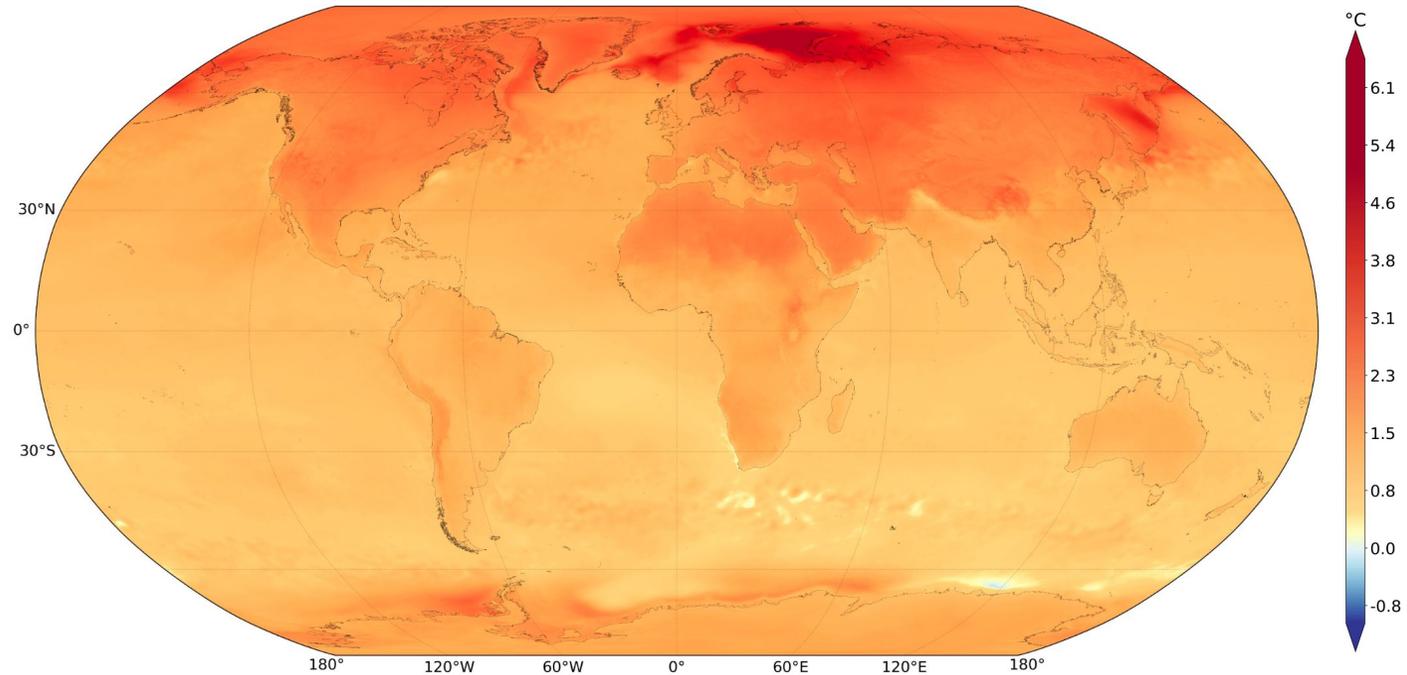
# The storyline approach



**Factual scenario:** experiment with transient forcing (2017-present) from CMIP6-SSP3-7.0

**Counterfactual scenario:** experiment with fixed forcing (~1950) from CMIP6-historical

Mean surface temperature, Factual – Counterfactual (2018-2023)

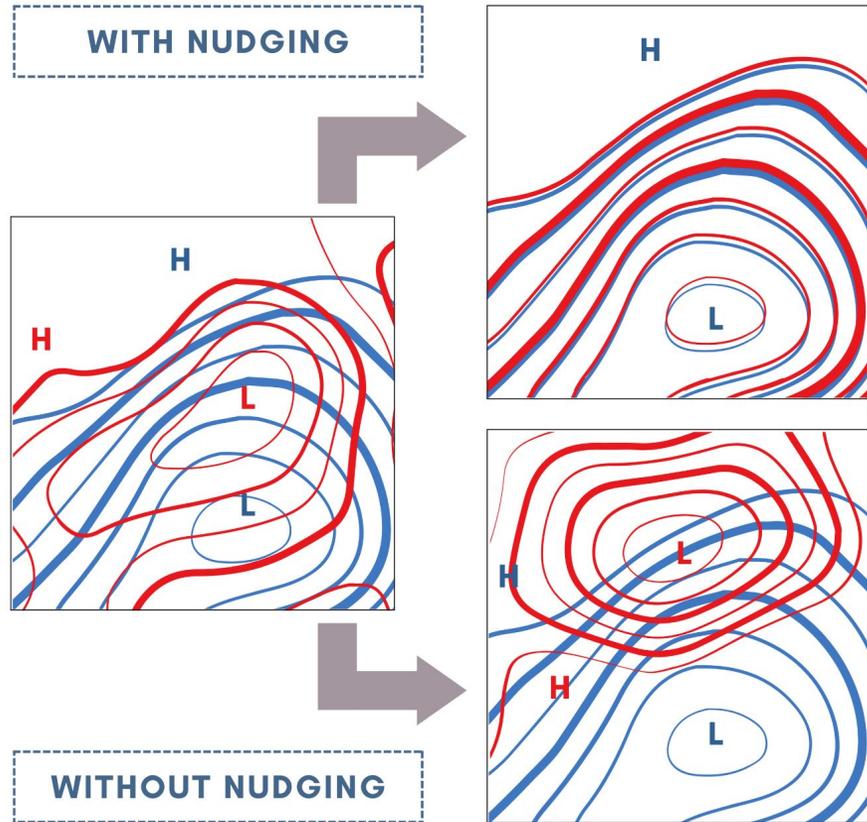


(John et al., under review)

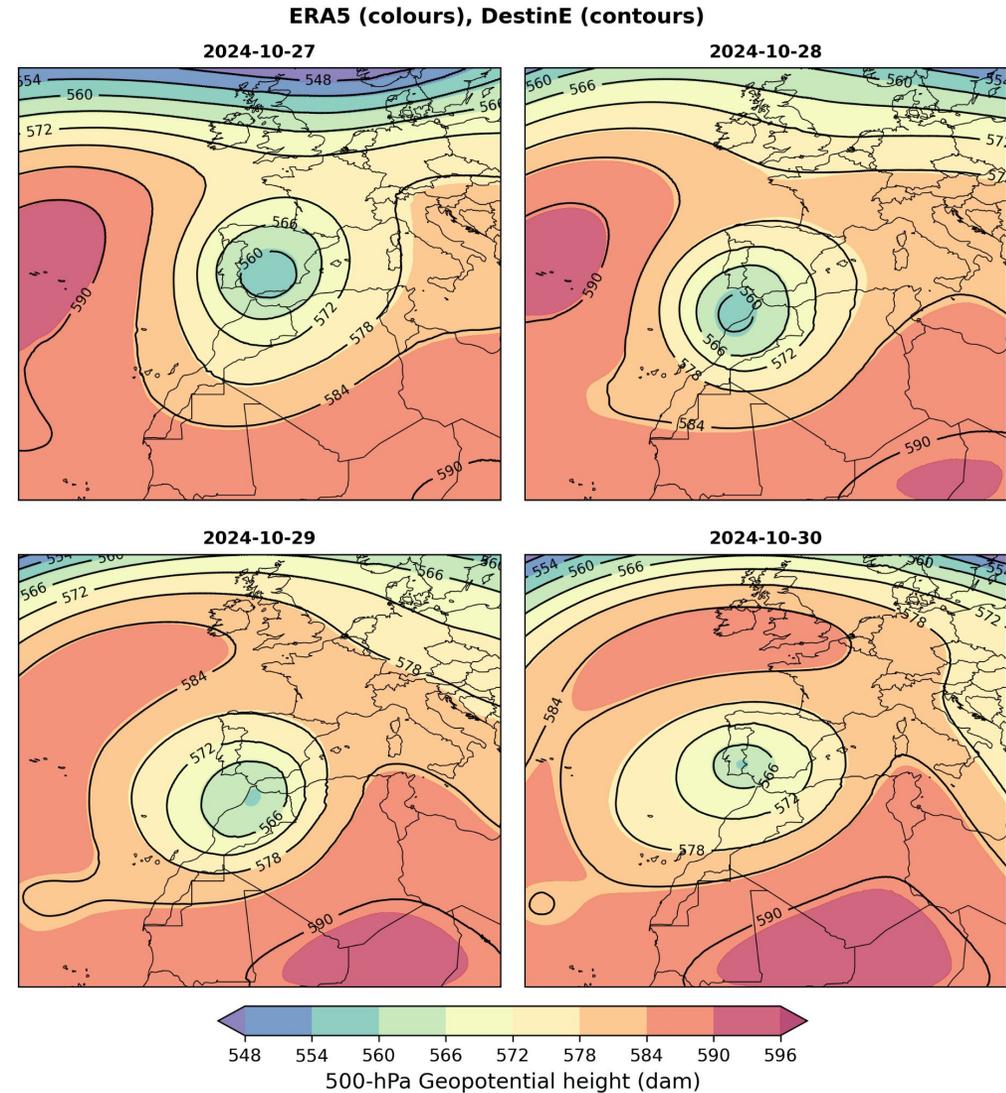
Global hourly outputs from 2017 to the present at ~9 km horizontal resolution.

5 ensemble members

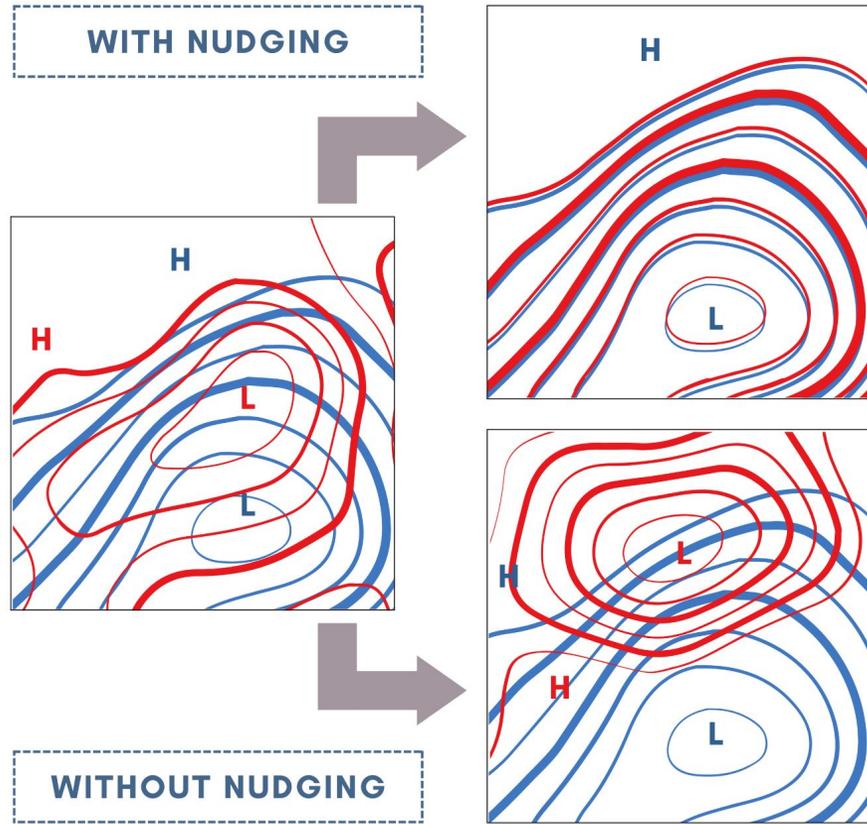
# Global simulations with spectral nudging



(John et al., under review)

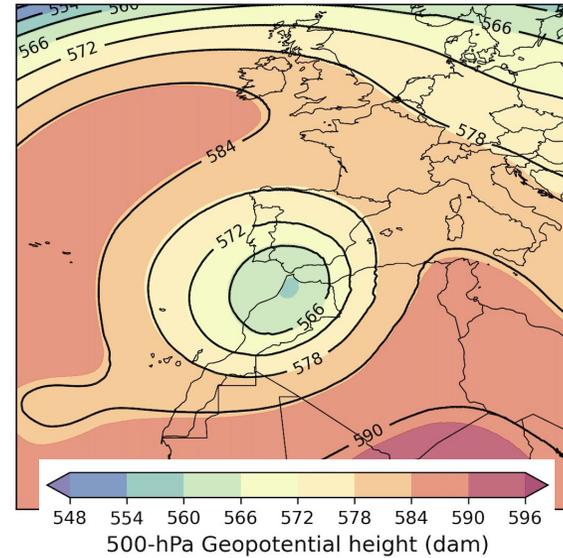


# Global simulations with spectral nudging

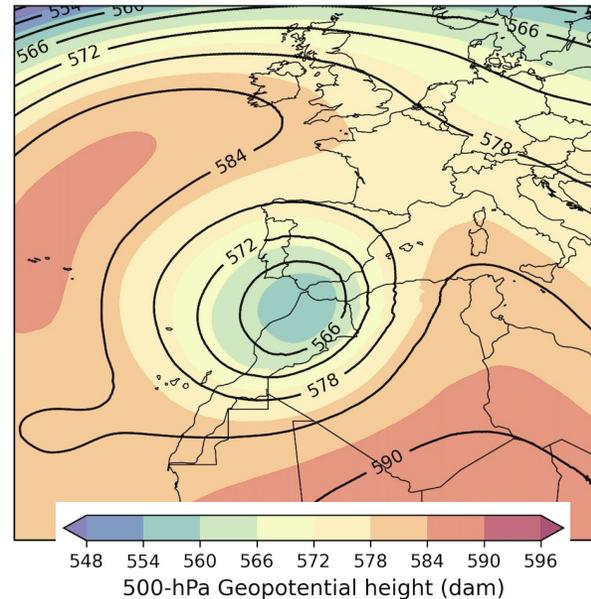


(John et al., under review)

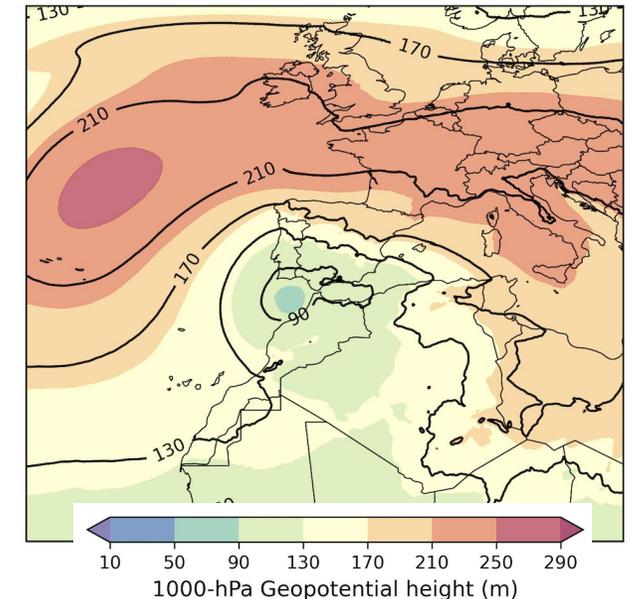
ERA5 (colours), DestinE (contours)



Counter (colours), Factual (contours)

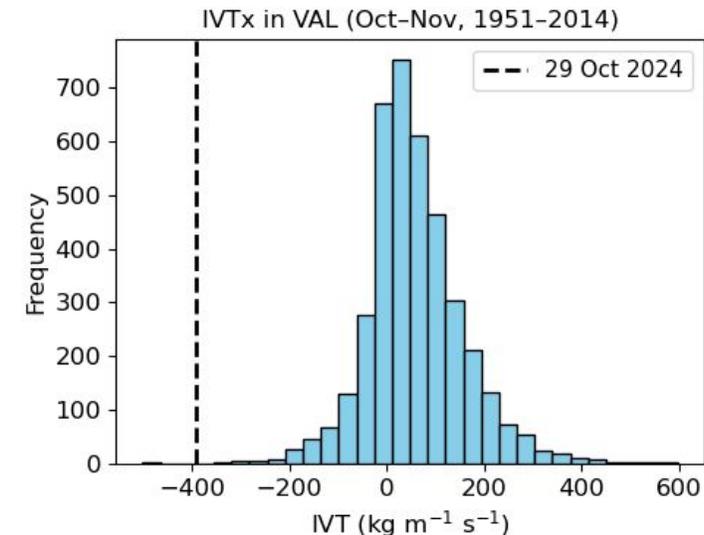
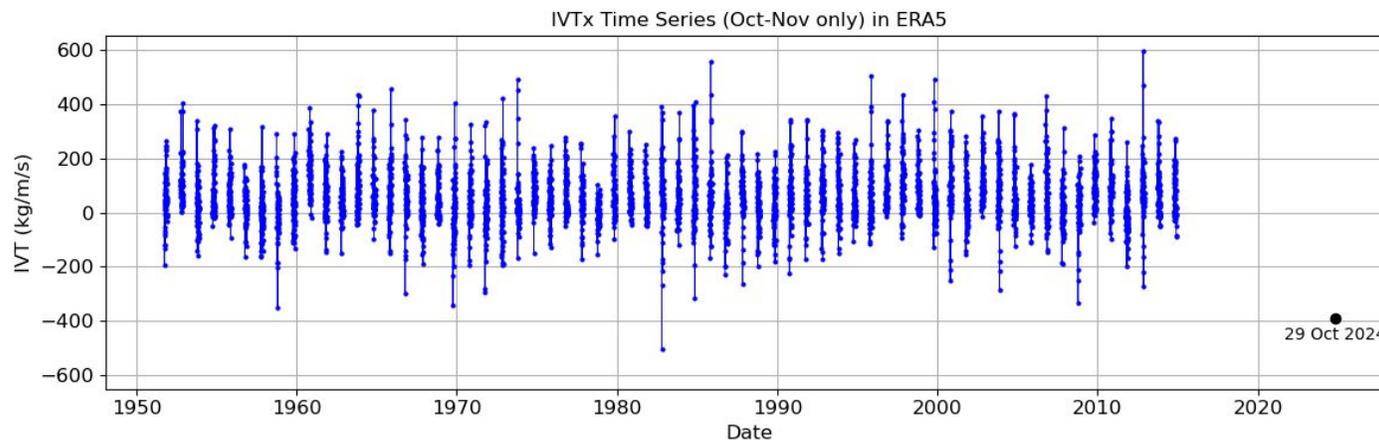


Counter (colours), Factual (contours)

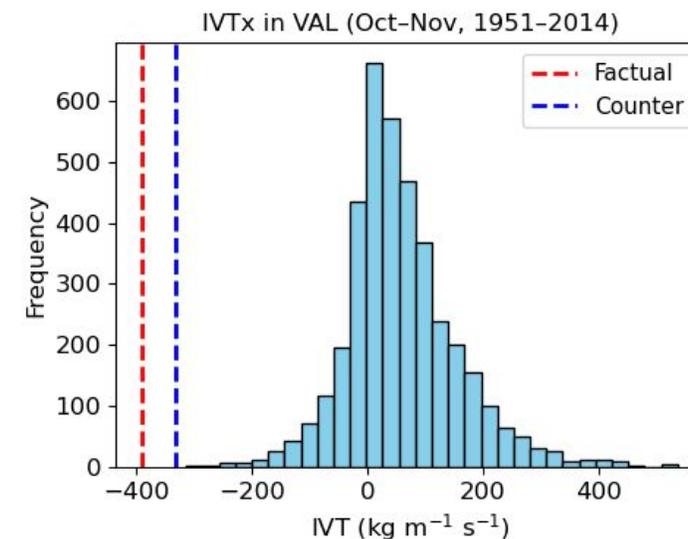
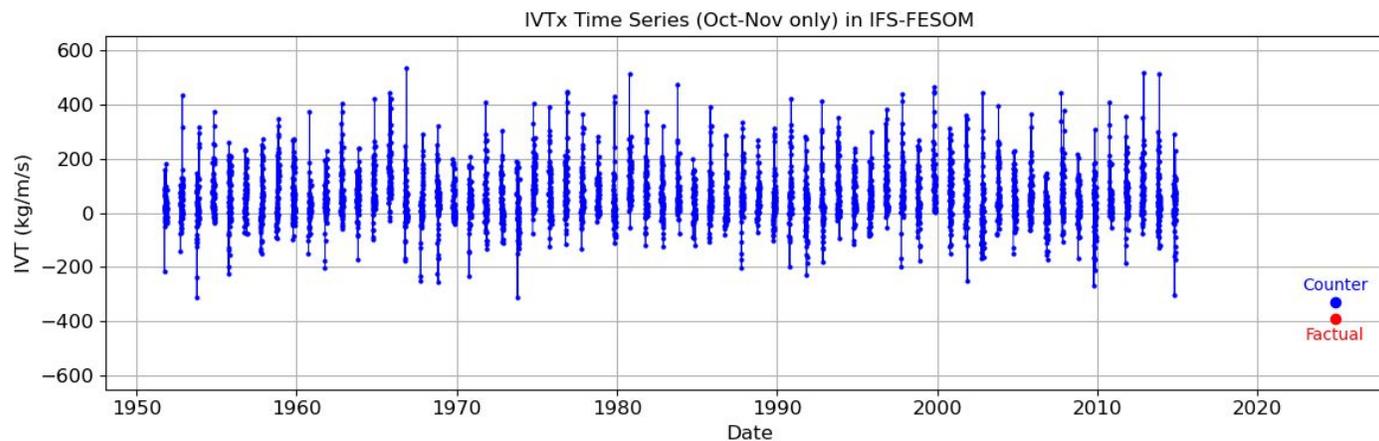


# The climatological context

ERA5



IFS-FESOM

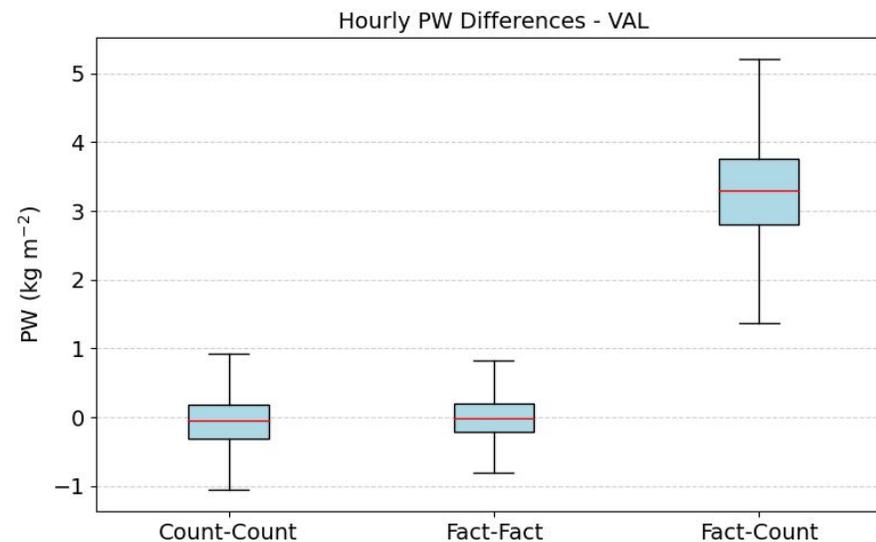
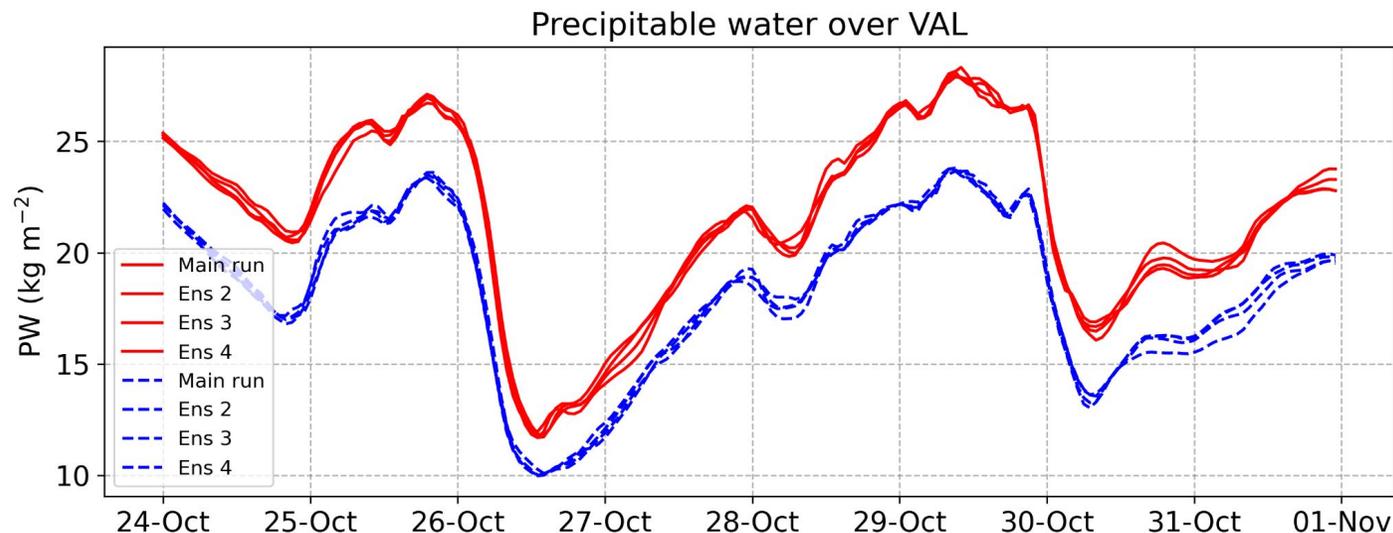


# The use of ensemble members

Using 5 ensemble members in each scenario.

Ensemble members were made changing the nudging initialisation time.

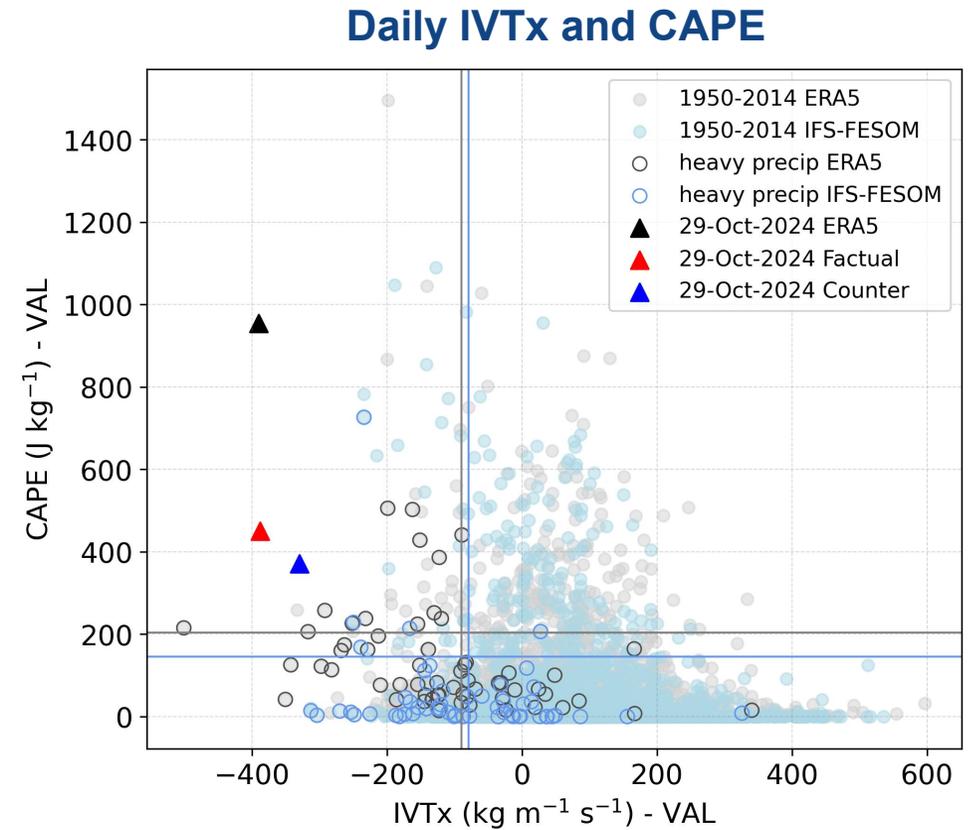
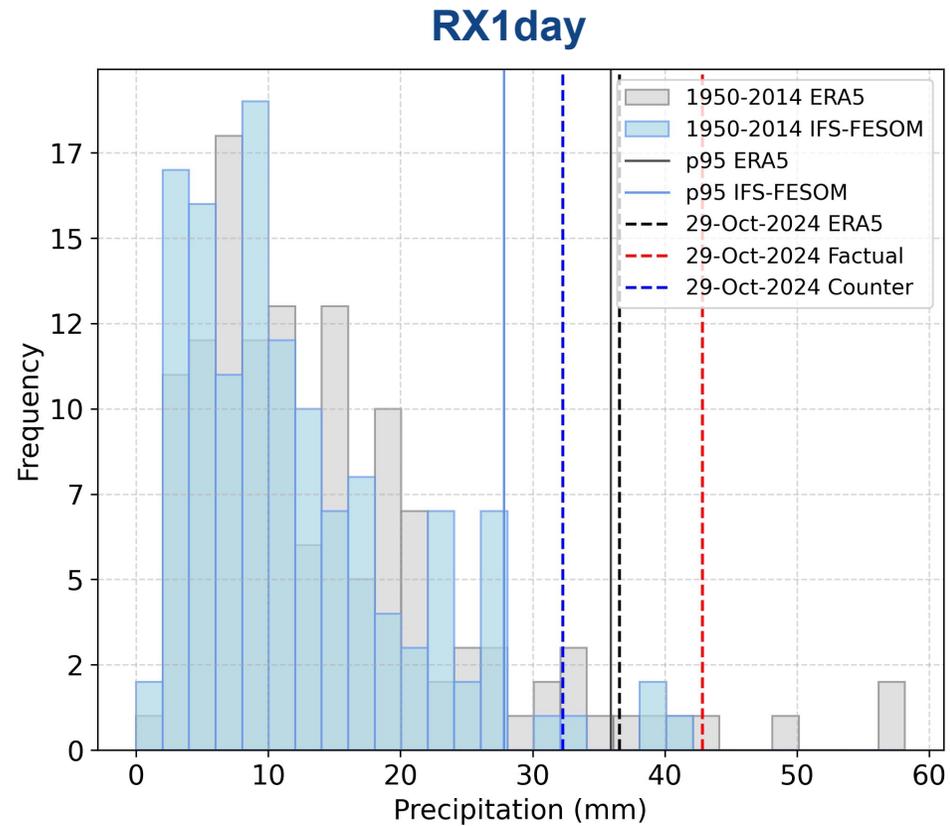
Hourly differences between members were calculated.



(after van Garderen et al. 2021)

# Climatological context

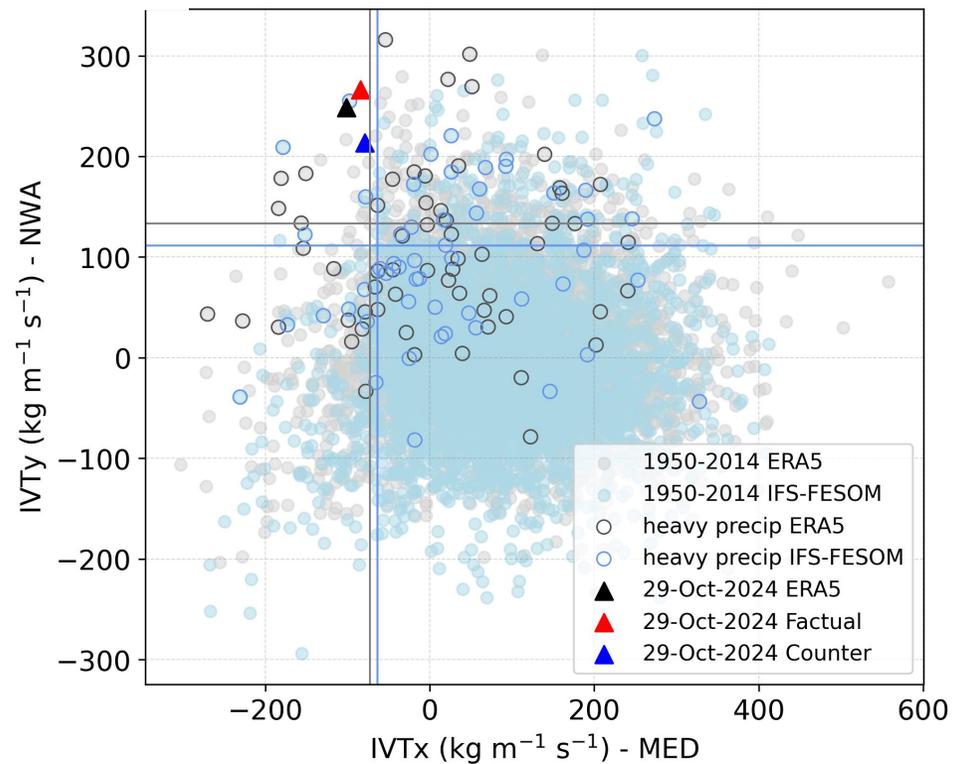
Using the Oct-Nov daily data from ERA5 and IFS-FESOM (free run) from 1951-2014



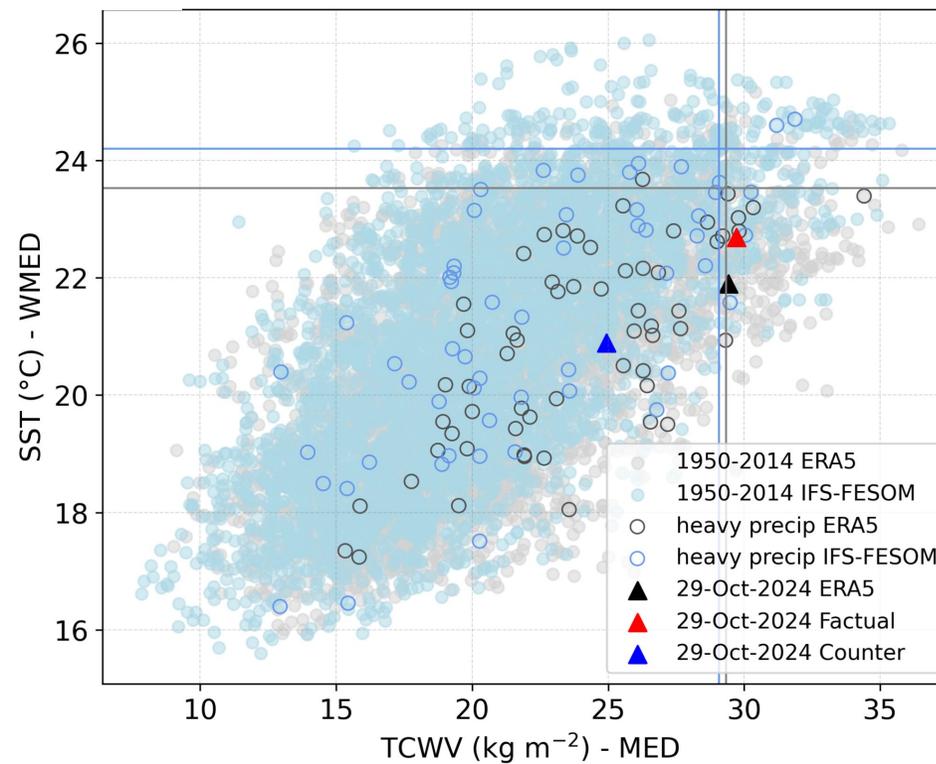
# Climatological context

Using the Oct-Nov daily data from ERA5 and IFS-FESOM (free run) from 1951-2014

### 3-day mean IVTx and IVTy

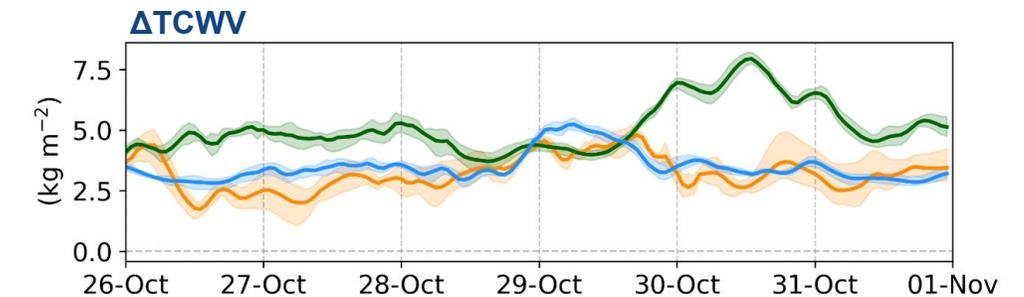
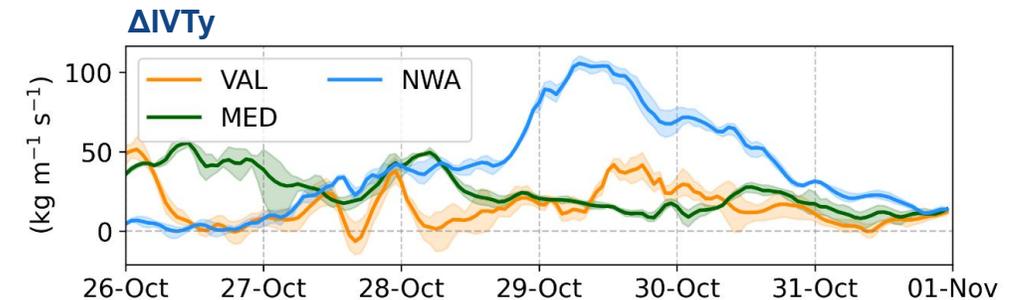
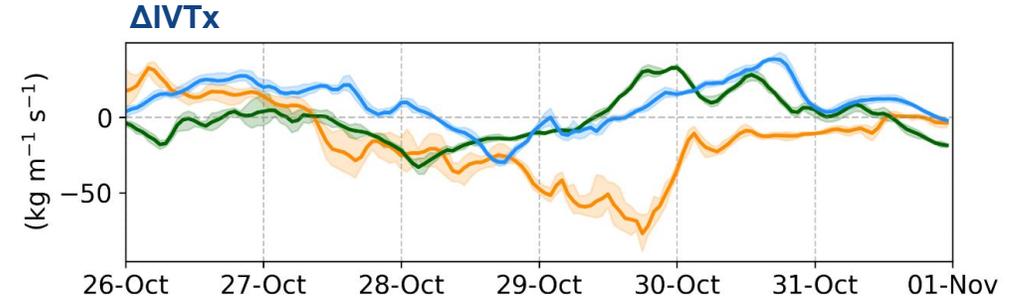
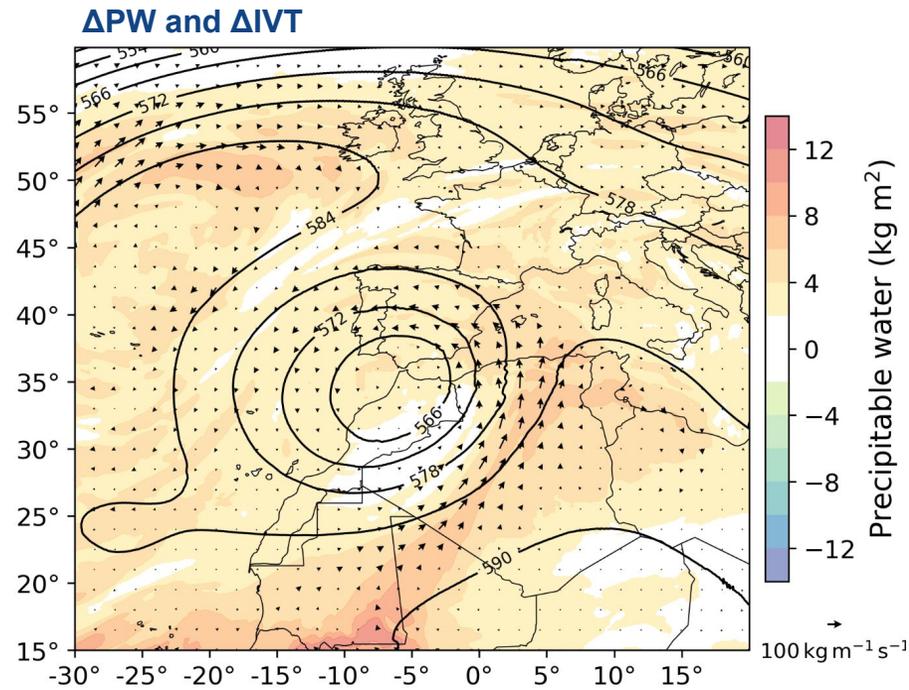


### 3-day mean PW and SST

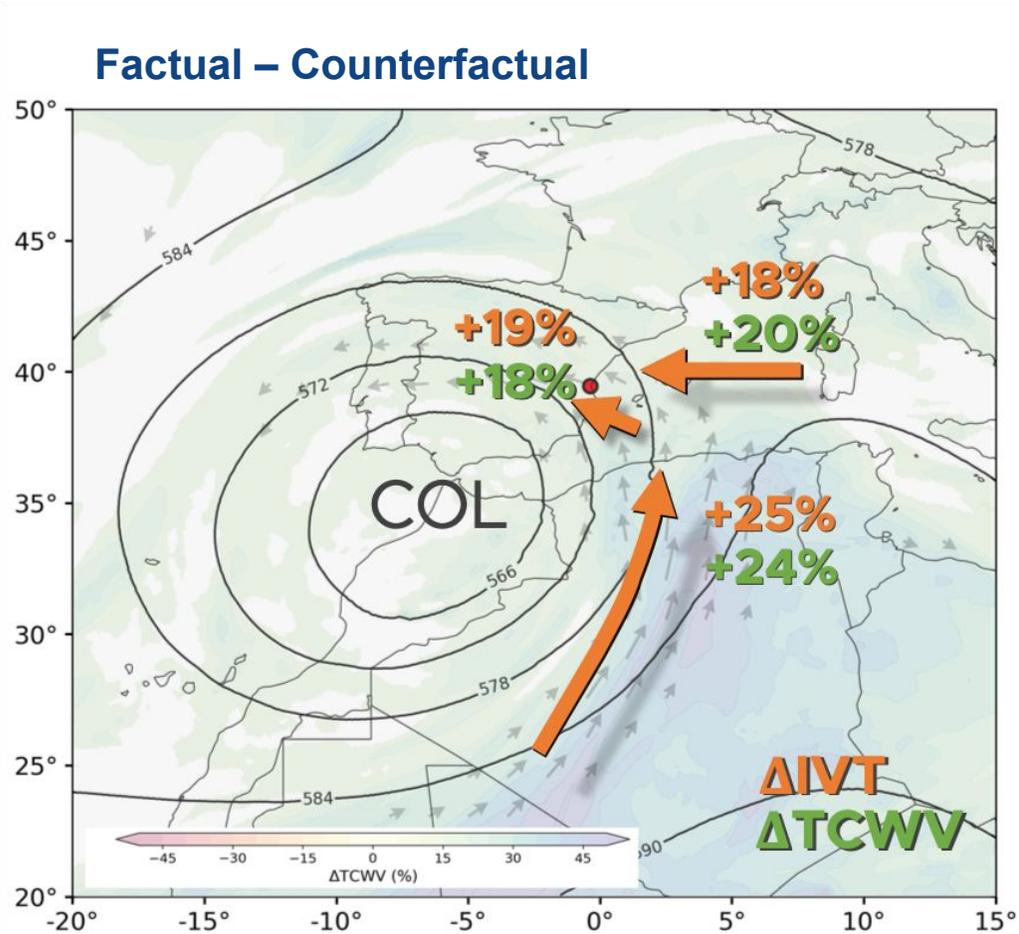


# Attribution: Factual – Counterfactual

## Moisture content and transport

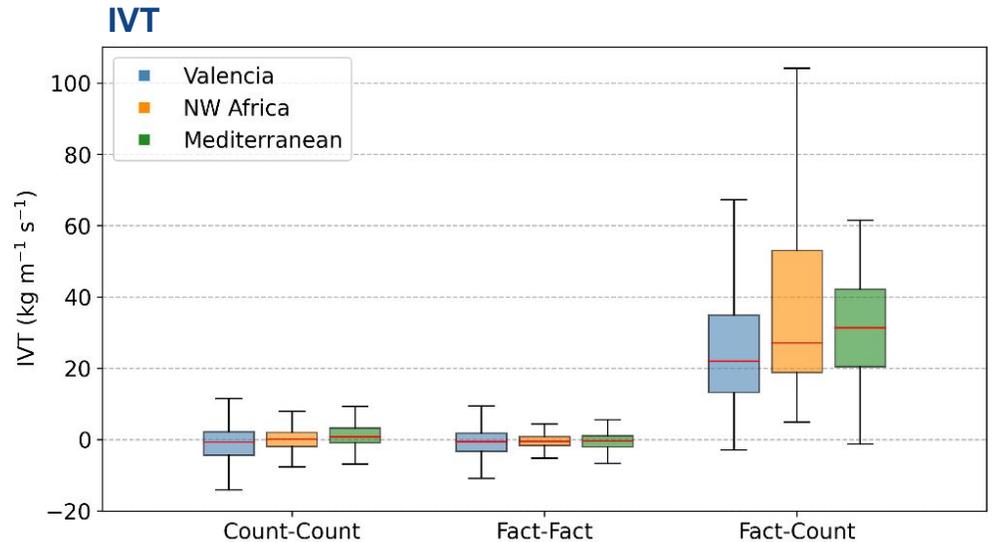
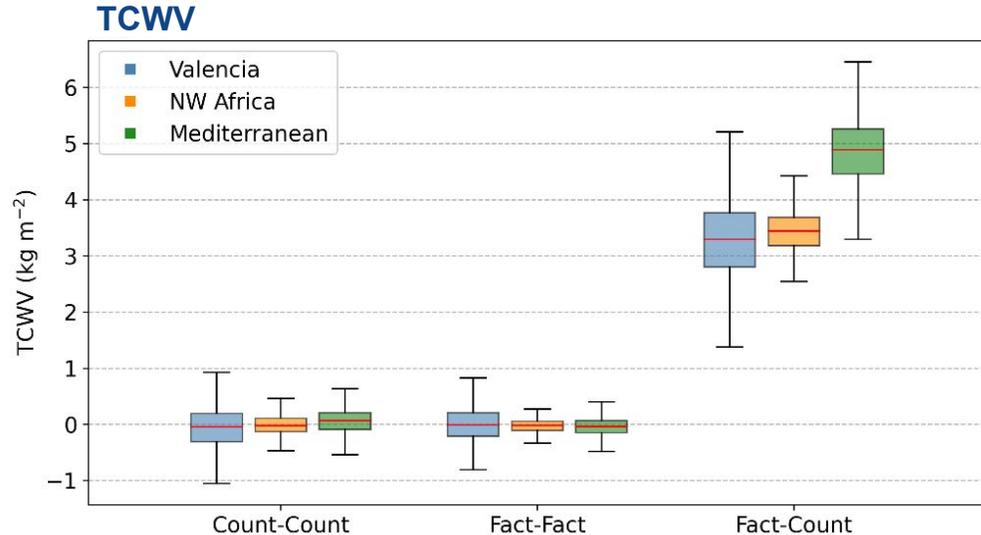


# Attribution: Moisture content and transport



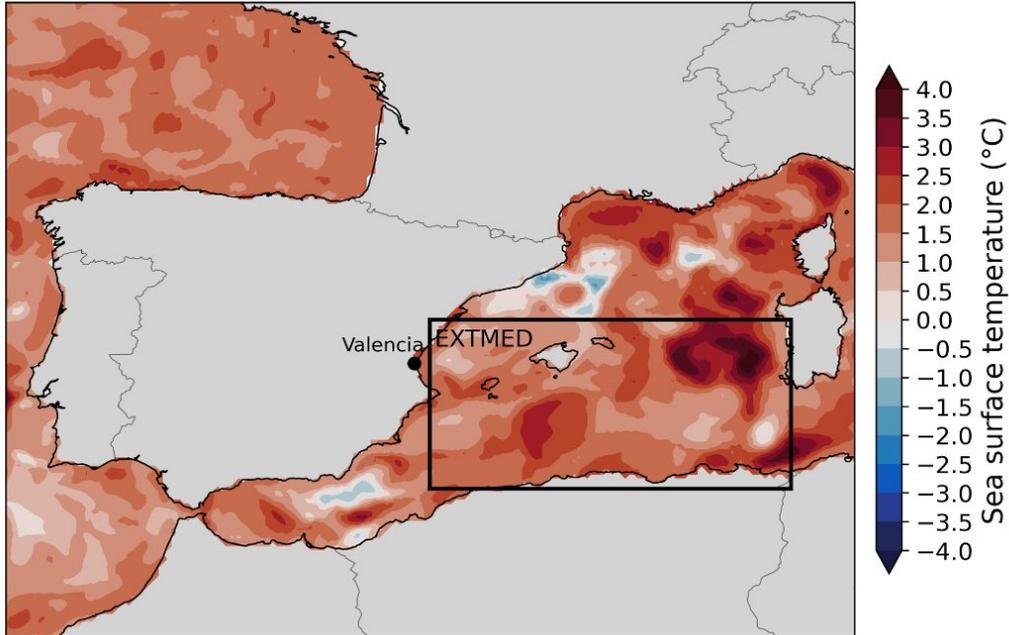
$$\frac{\text{Factual} - \text{Counterfactual}}{\text{Counterfactual}} \times 100$$

## Signal-to-noise ratio

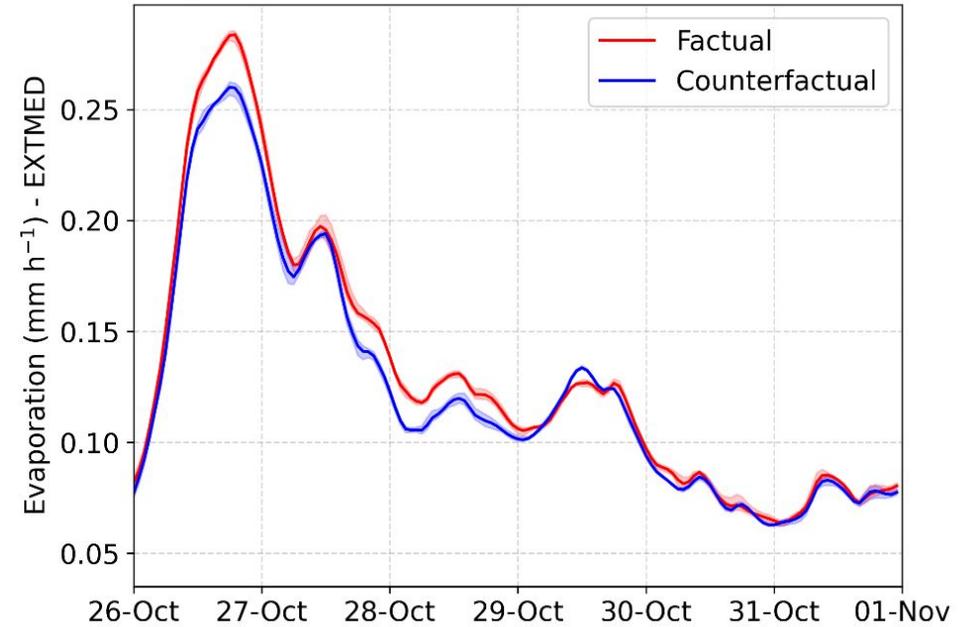


# Attribution: Evaporation

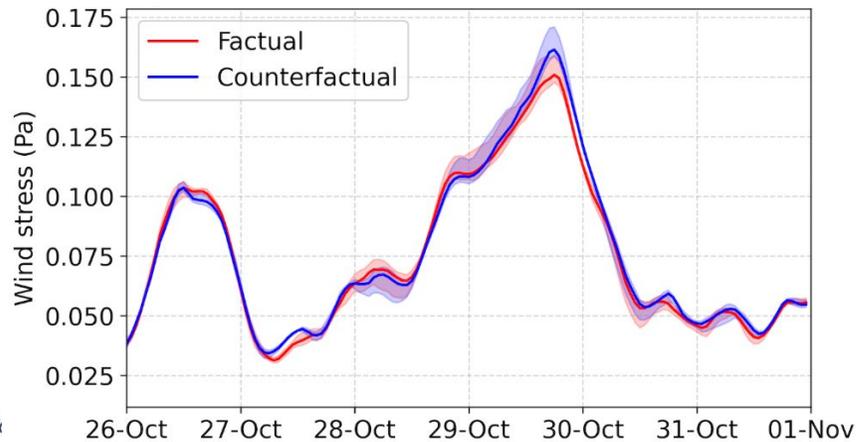
24-29 Oct mean  $\Delta$ SST



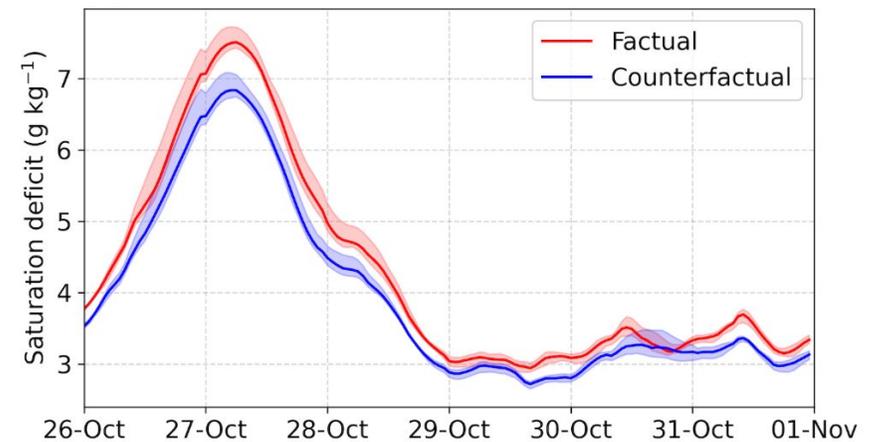
Evaporation



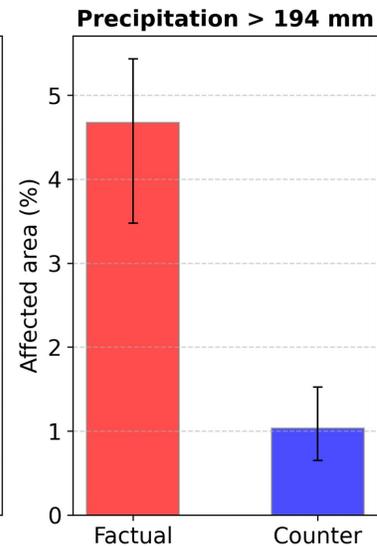
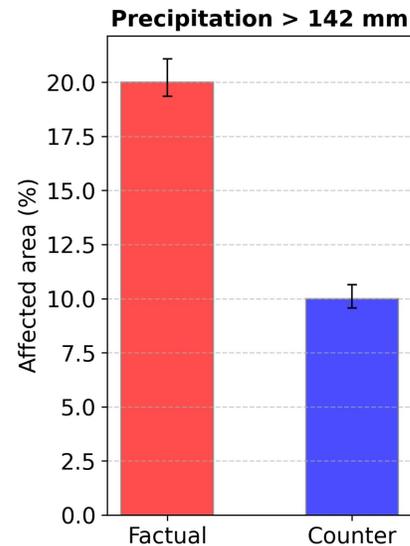
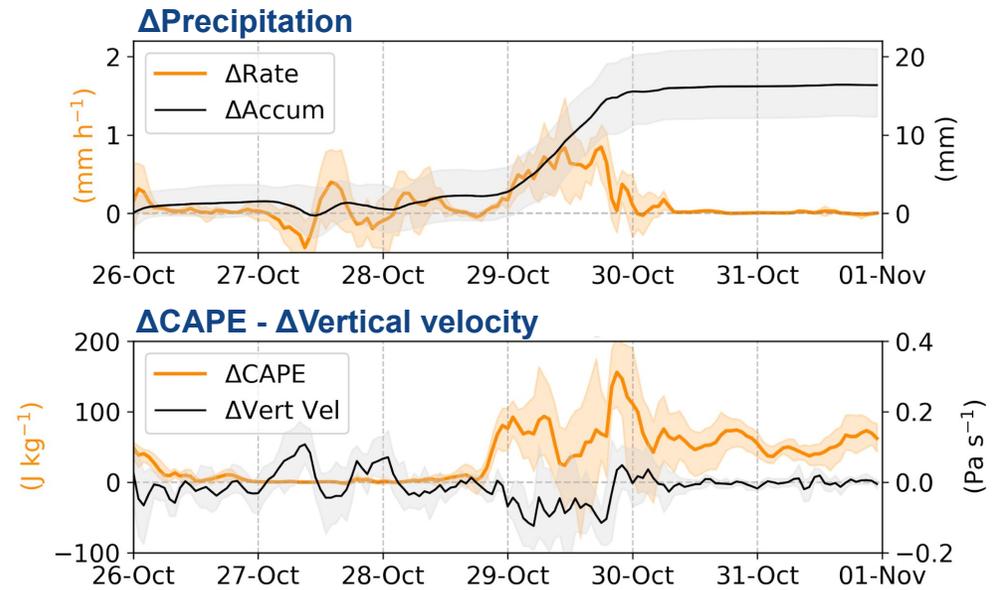
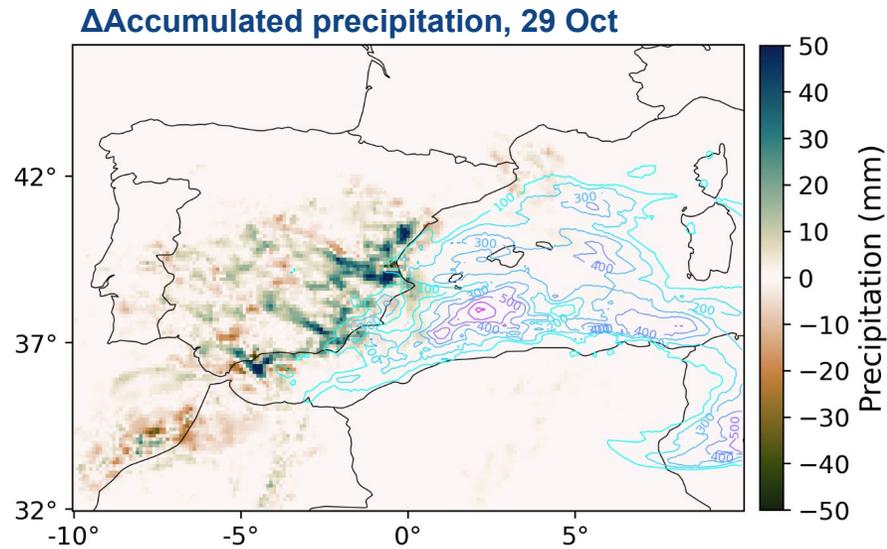
Wind stress



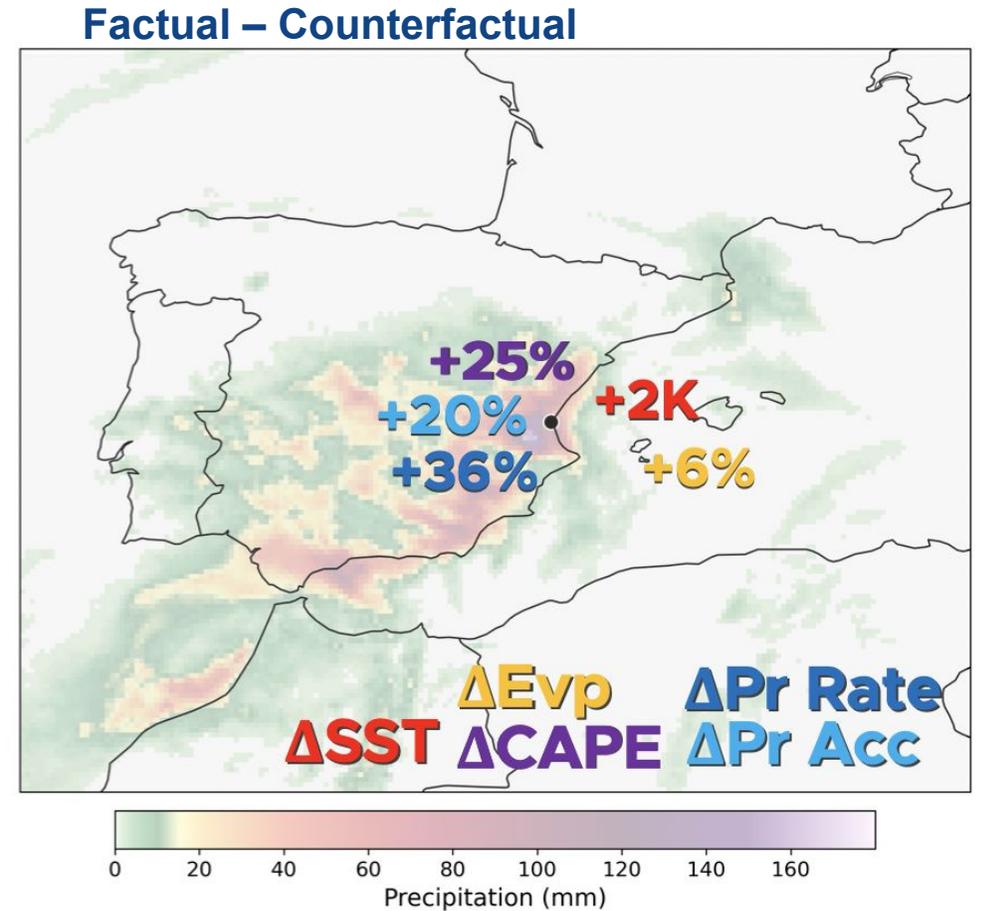
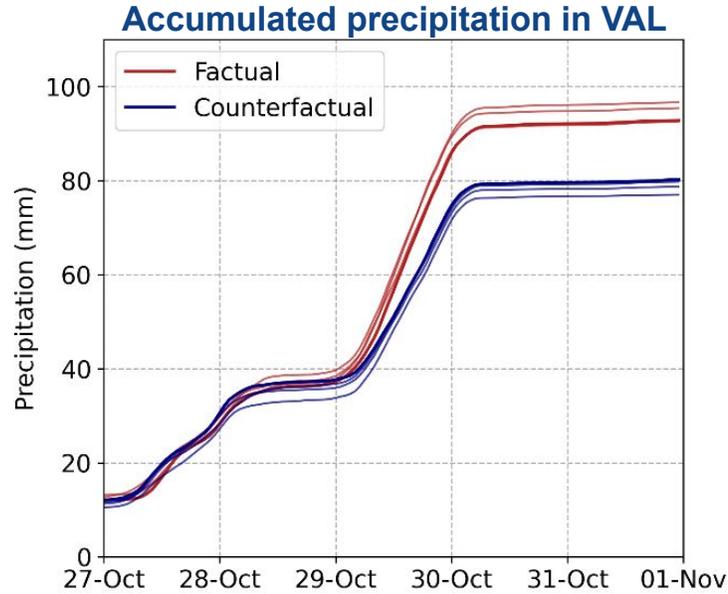
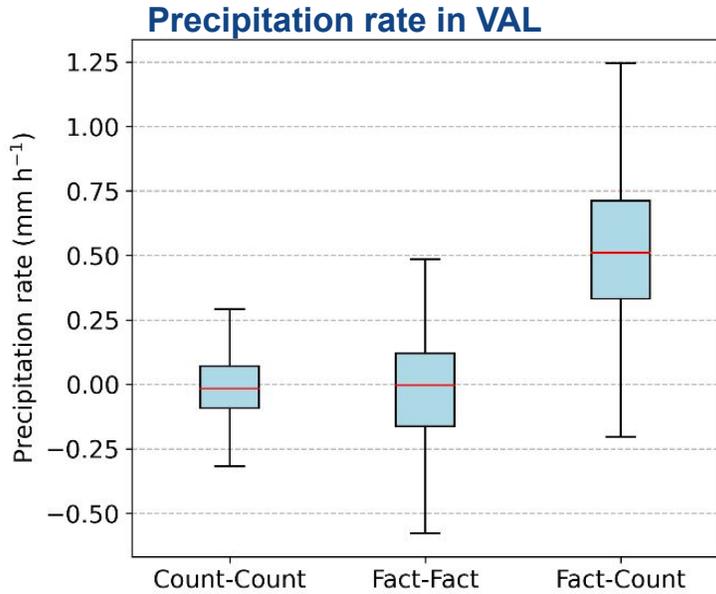
Saturation deficit



# Attribution: Precipitation and instability

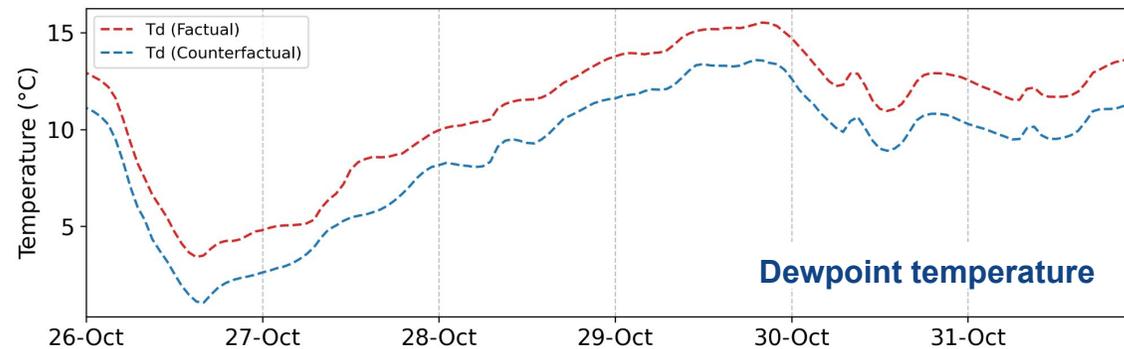
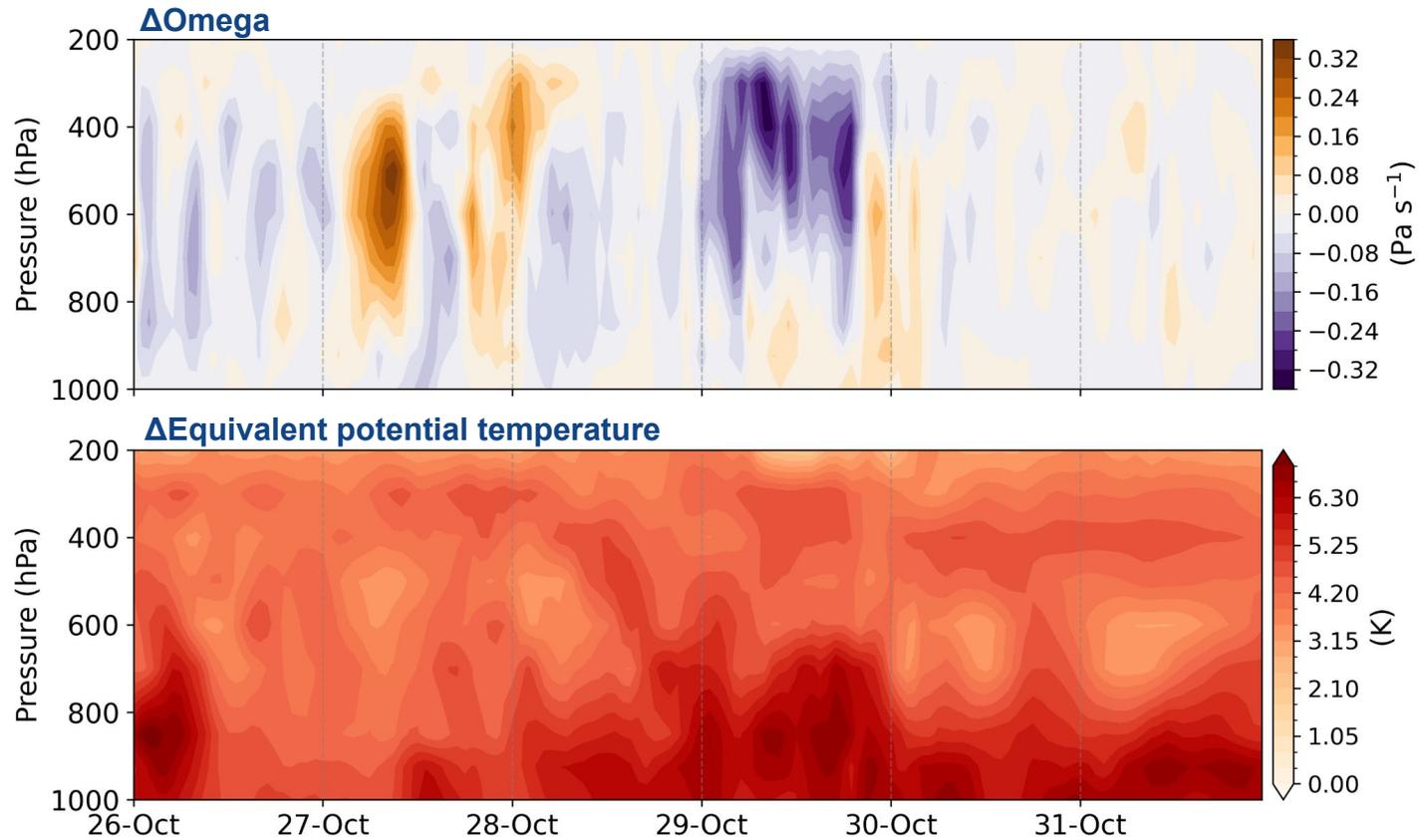


# Attribution: Precipitation and instability



$$\frac{\text{Factual} - \text{Counterfactual}}{\text{Counterfactual}} \times 100$$

# The precipitation amplification

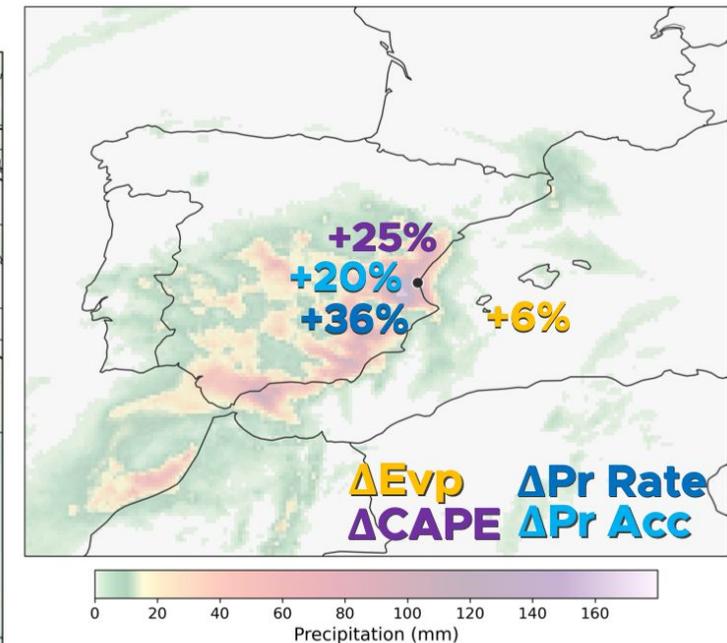
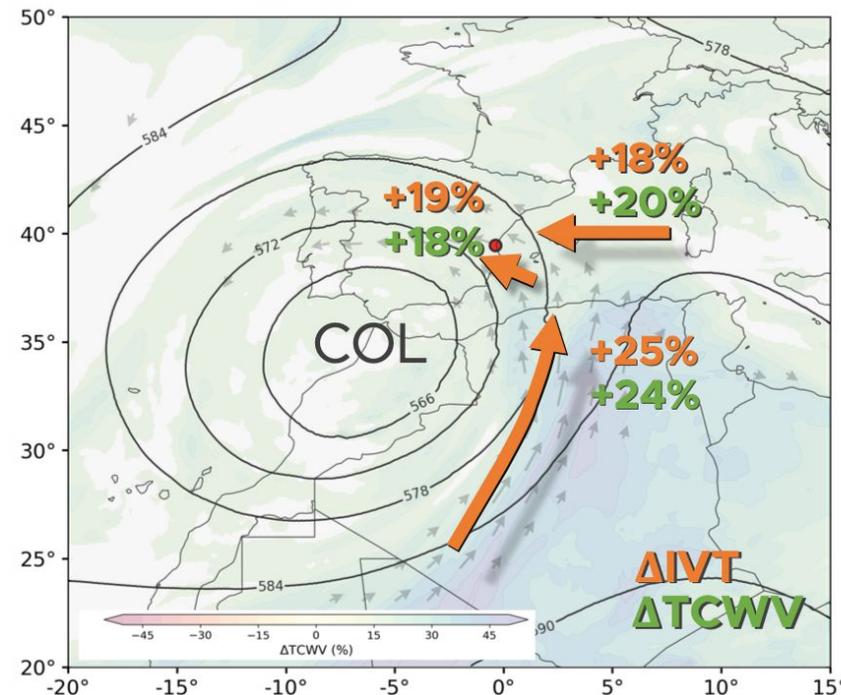


# Summary

The simulations from the DestinE ClimateDT initiative provide an opportunity to assess the thermodynamic response of climate change in any extreme event worldwide from 2018 (e.g., Grayson et al., 2026)

In the Valencia DANA event, the synoptic configuration alone was sufficient to produce an extreme event, but anthropogenic warming substantially intensified its magnitude.

A nonlinear amplification of precipitation is observed, suggesting a non-linear dynamical response, with latent heat release likely intensifying the updrafts.





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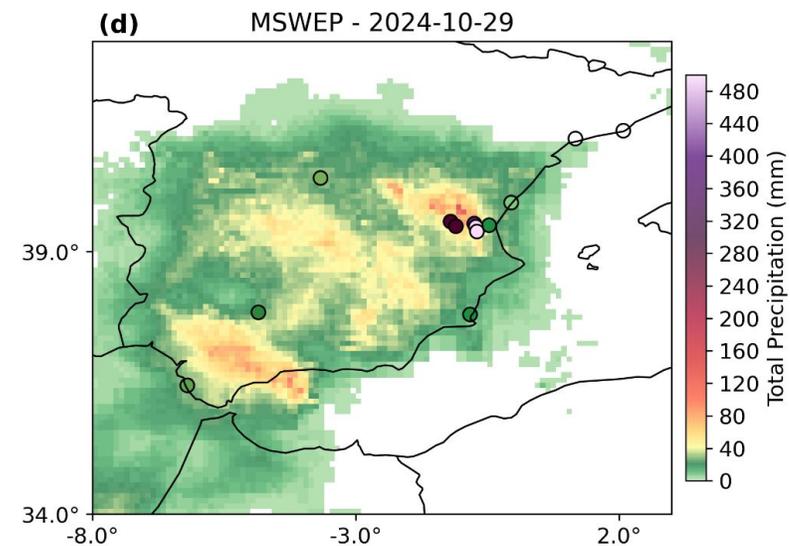
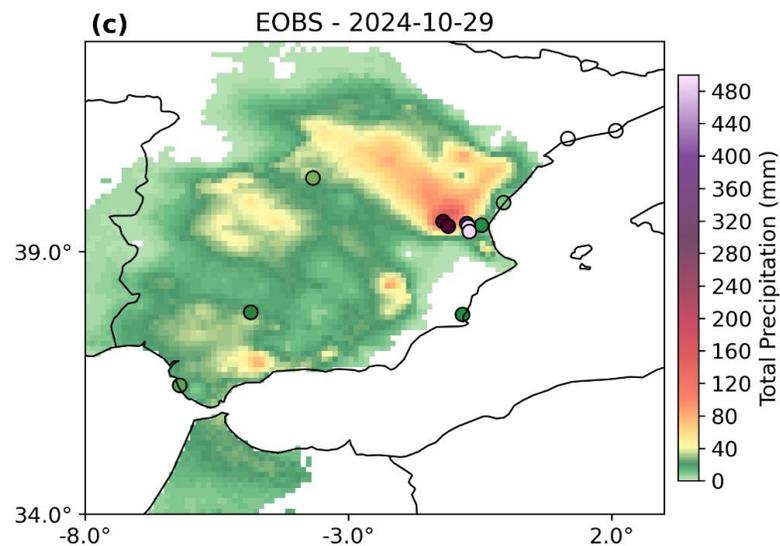
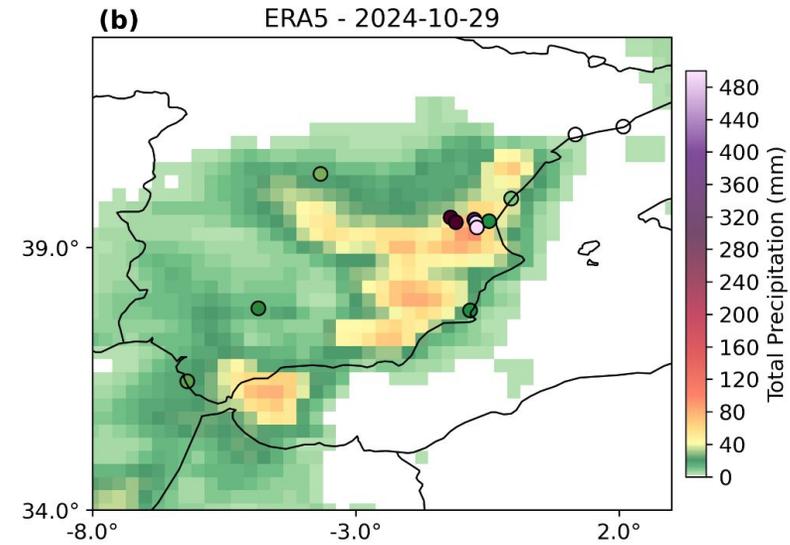
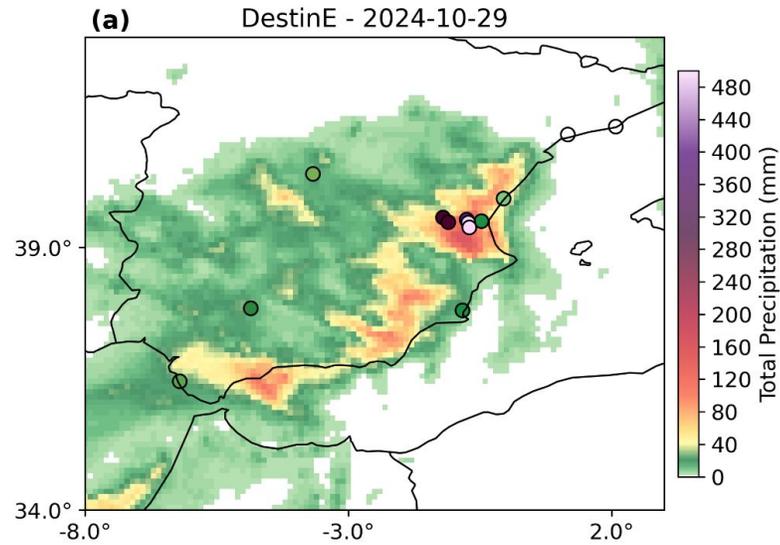
[diego.campos@bsc.es](mailto:diego.campos@bsc.es)

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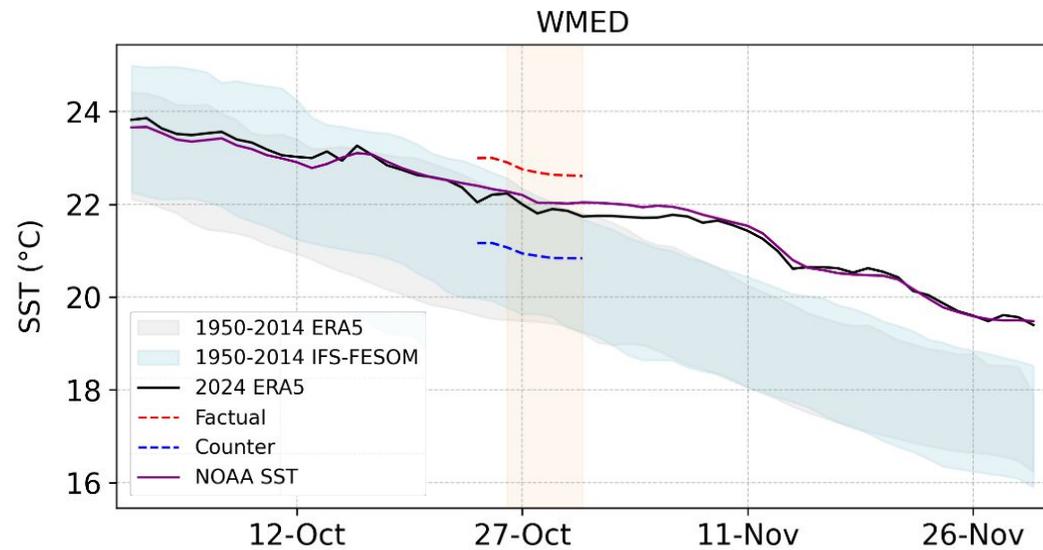
XXXVII Jornadas de la AME - Málaga - Febrero 2026

# Observed and simulated precipitation

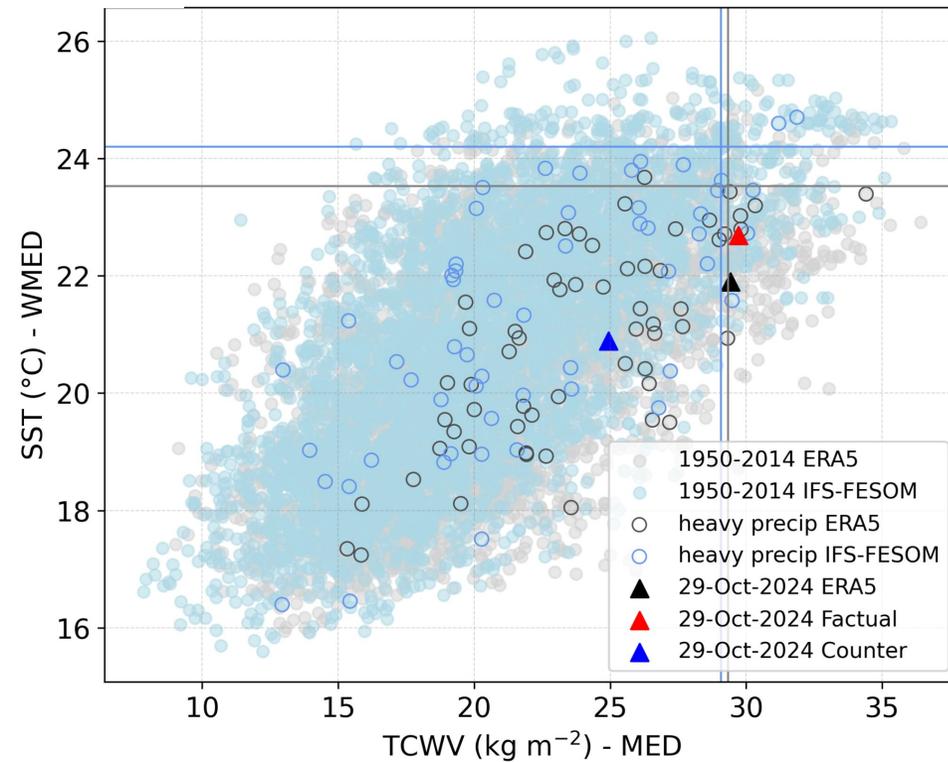


# Climatological context

Using the Oct-Nov daily data from ERA5 and IFS-FESOM (free run) from 1950-2014

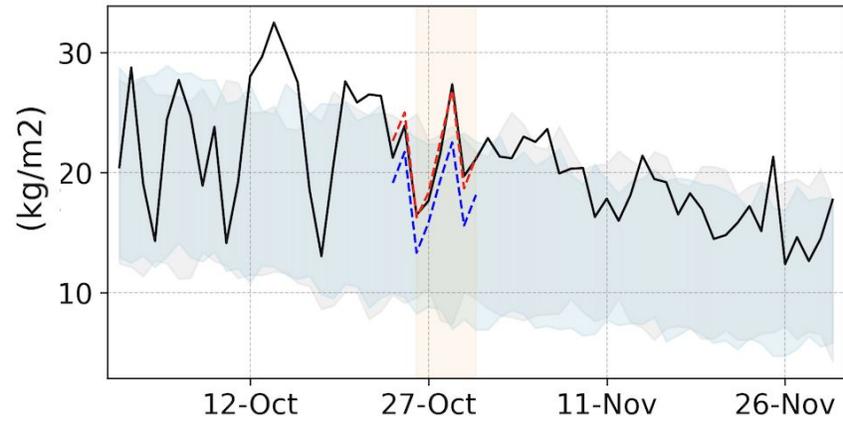


## 3-day mean PW and SST

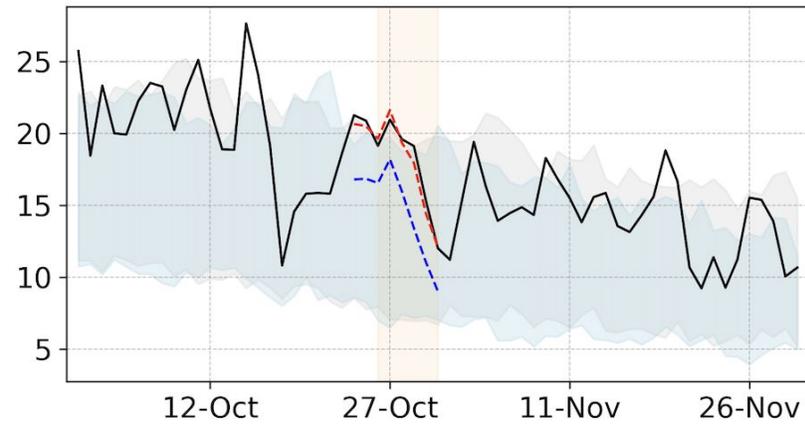


# Climatological context

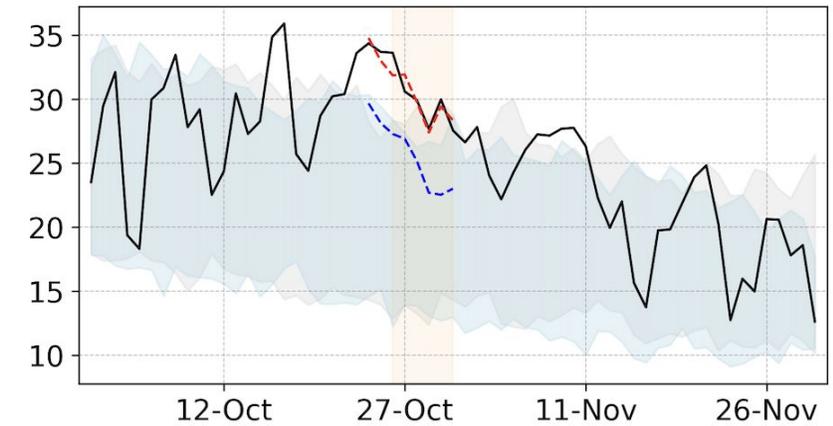
VAL



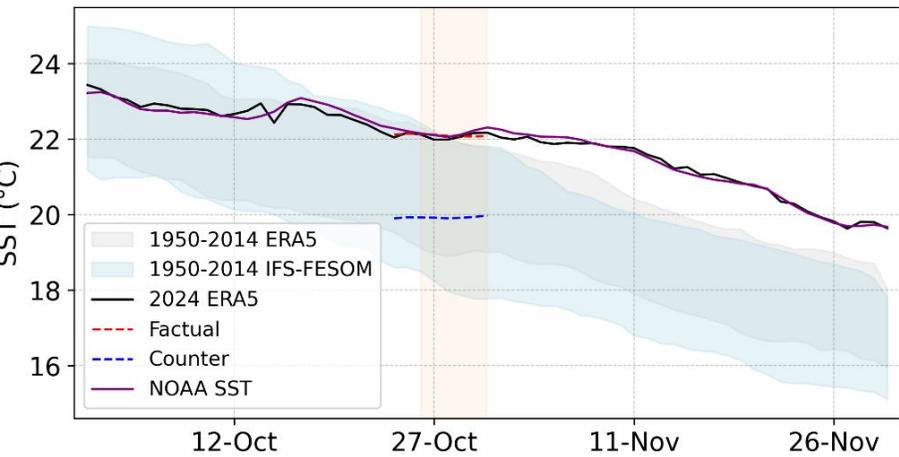
NWA



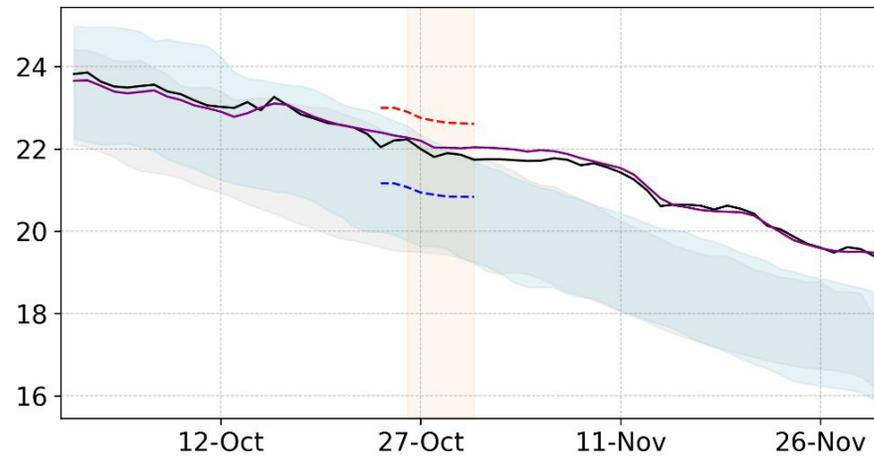
MED



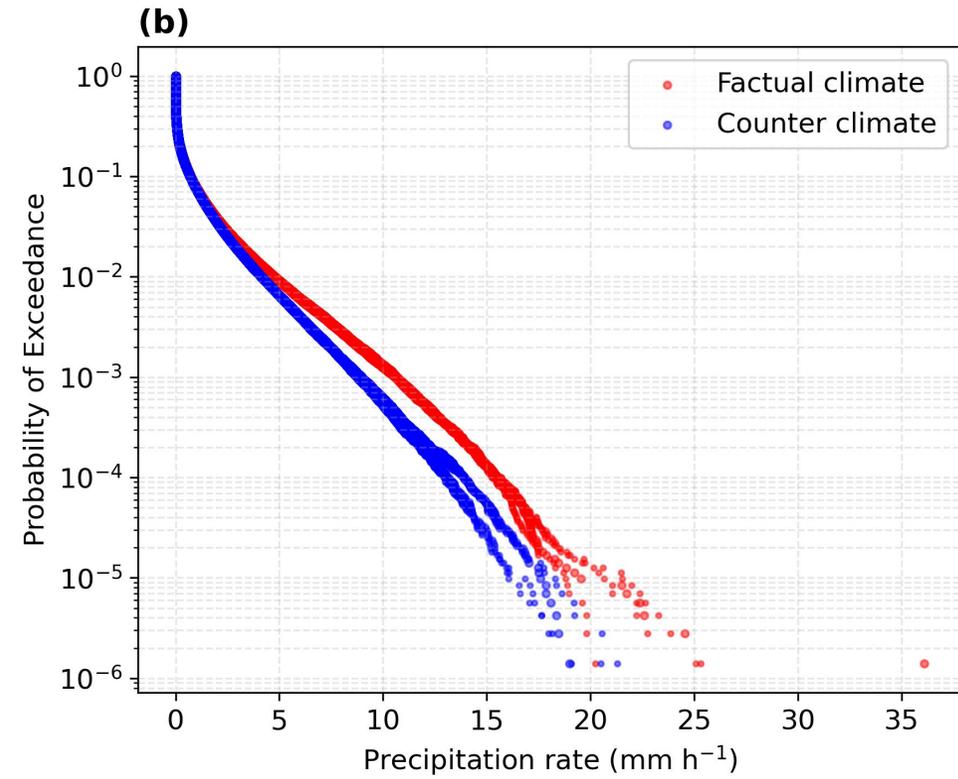
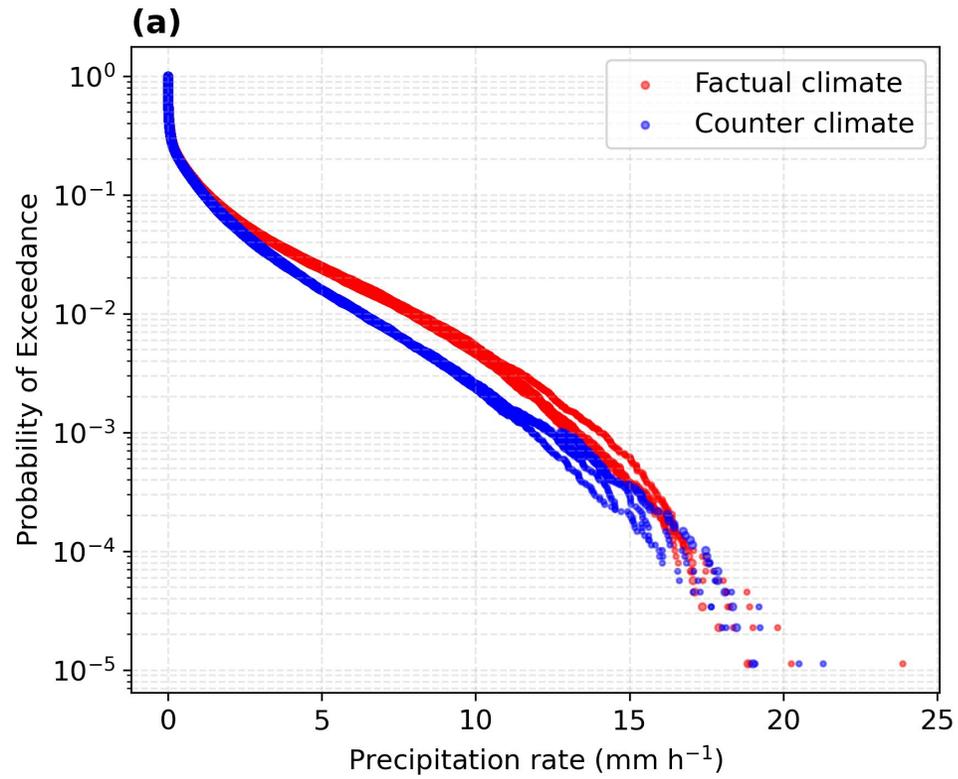
MED



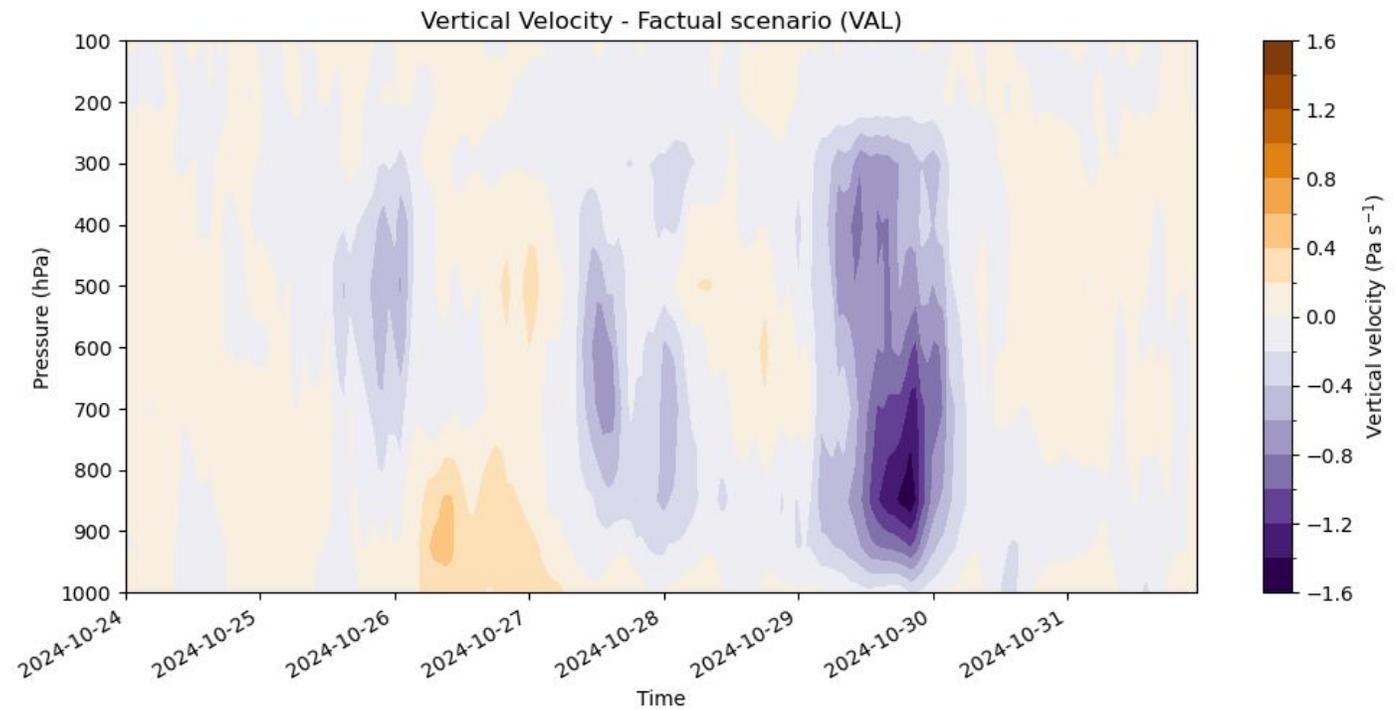
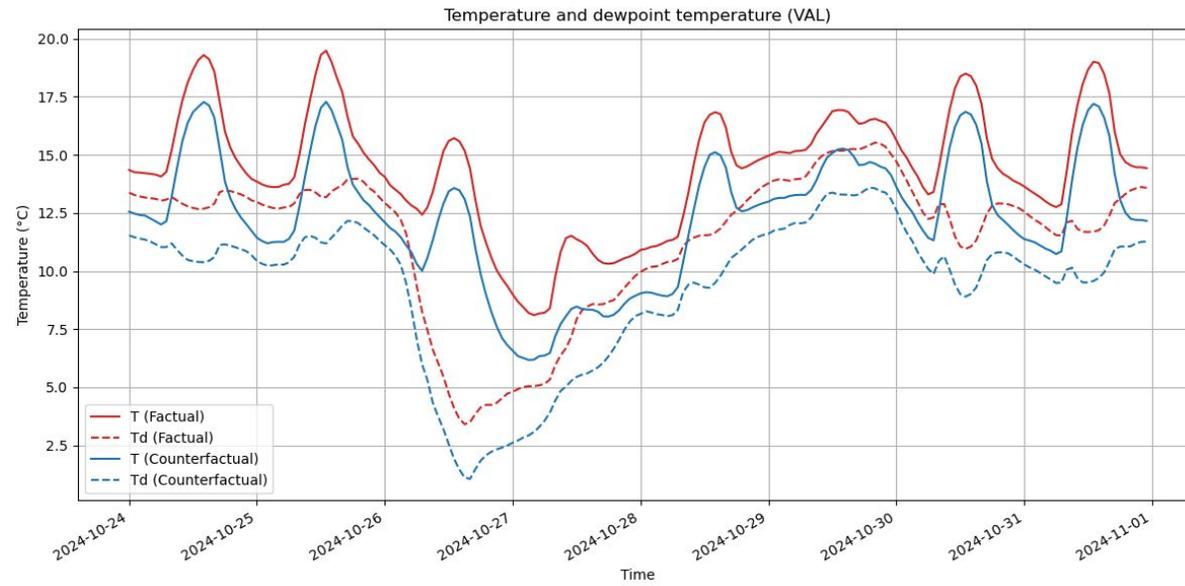
WMED



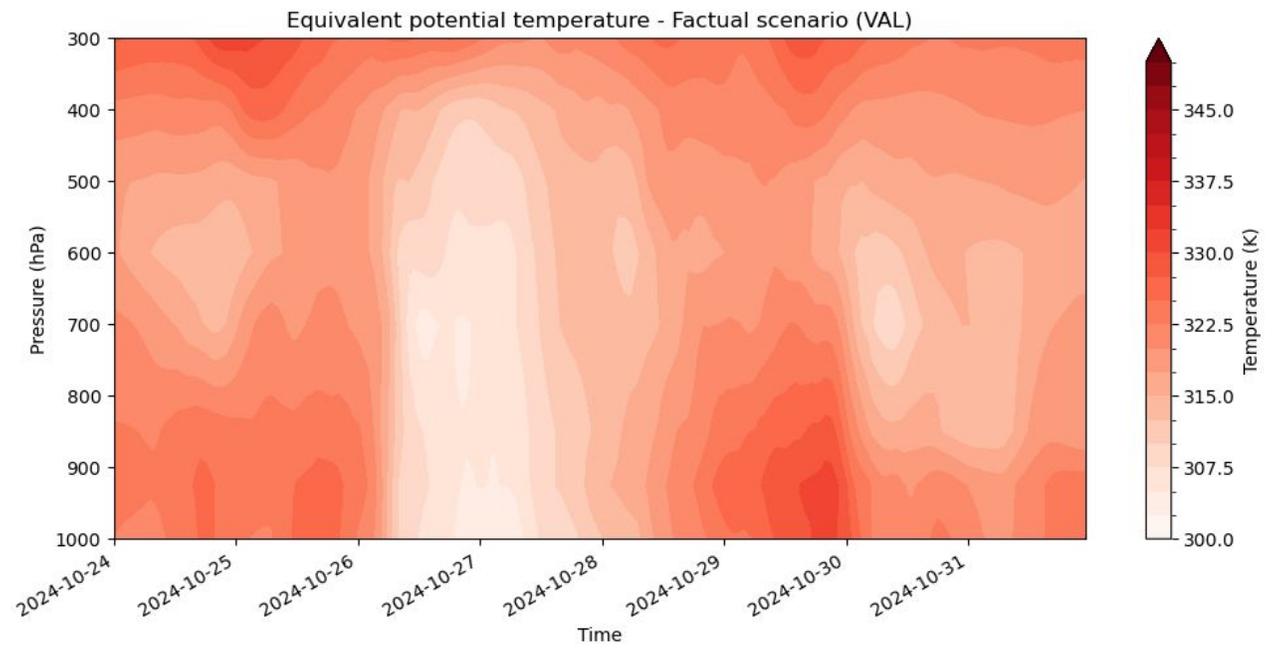
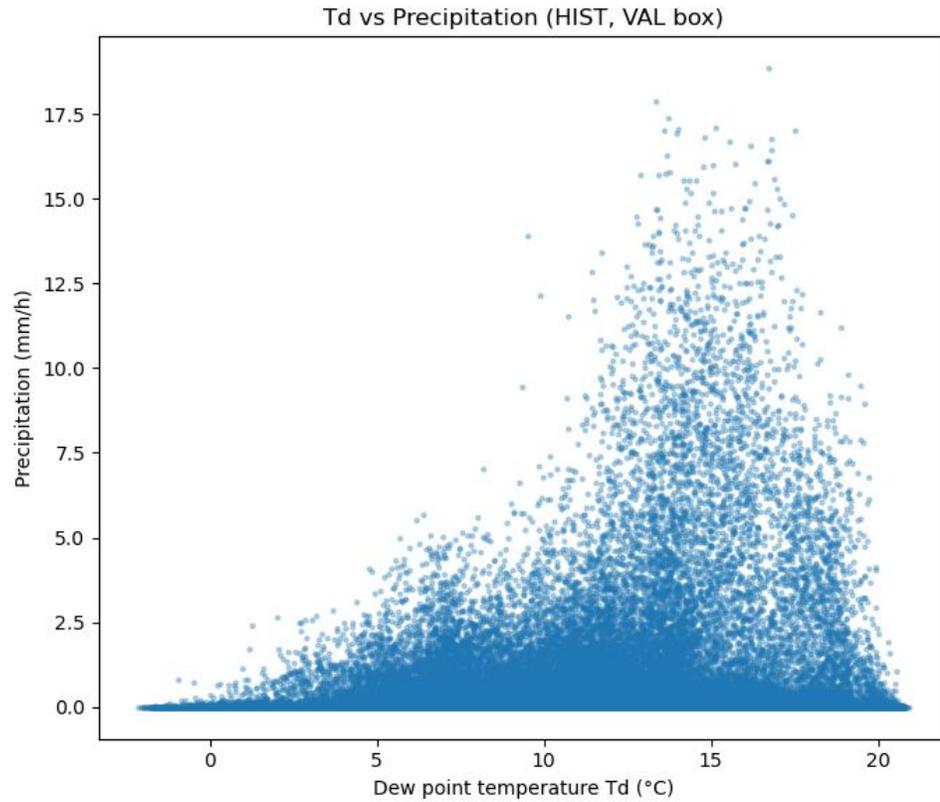
# Hourly precipitation



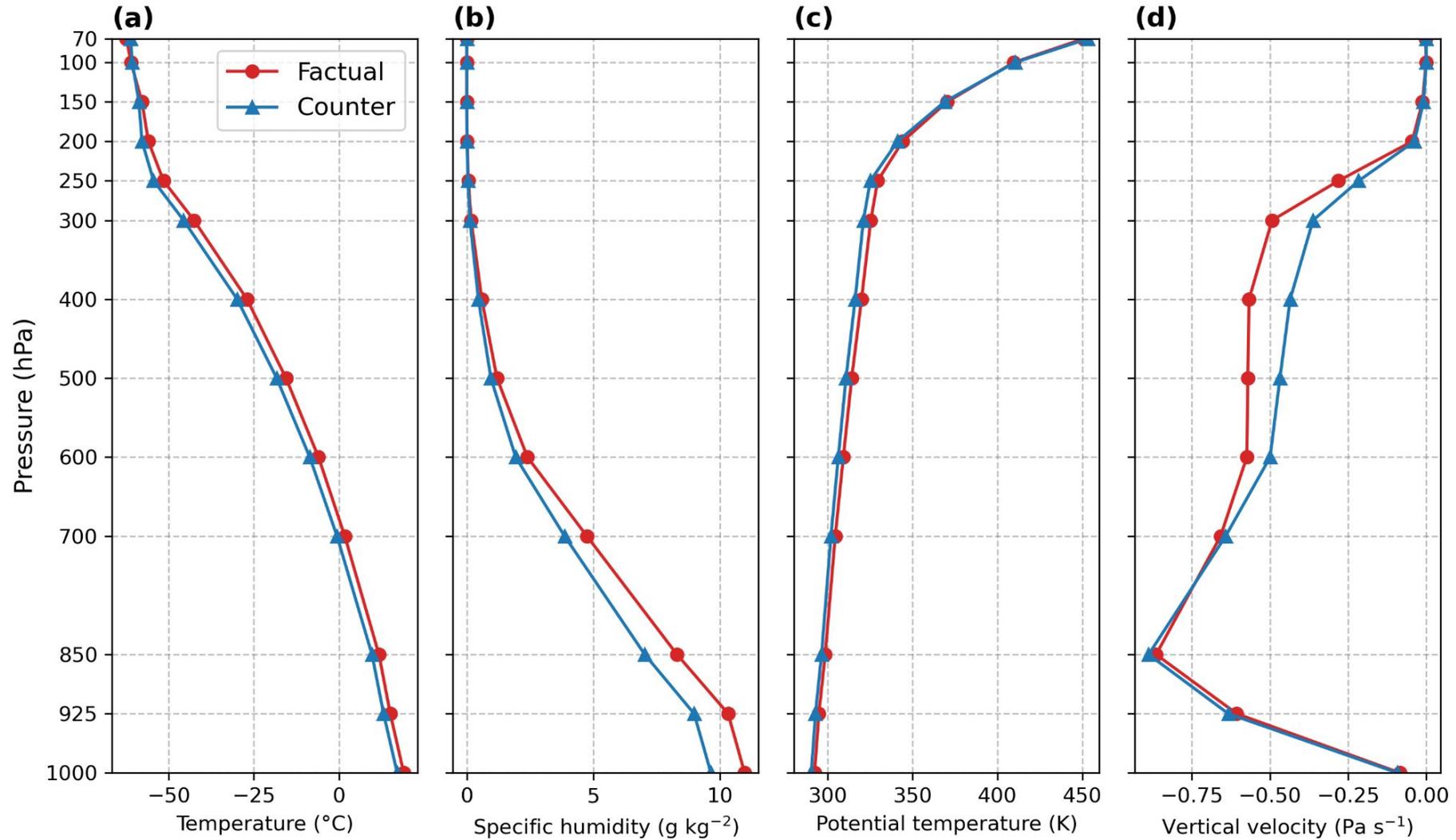
# Td and Omega



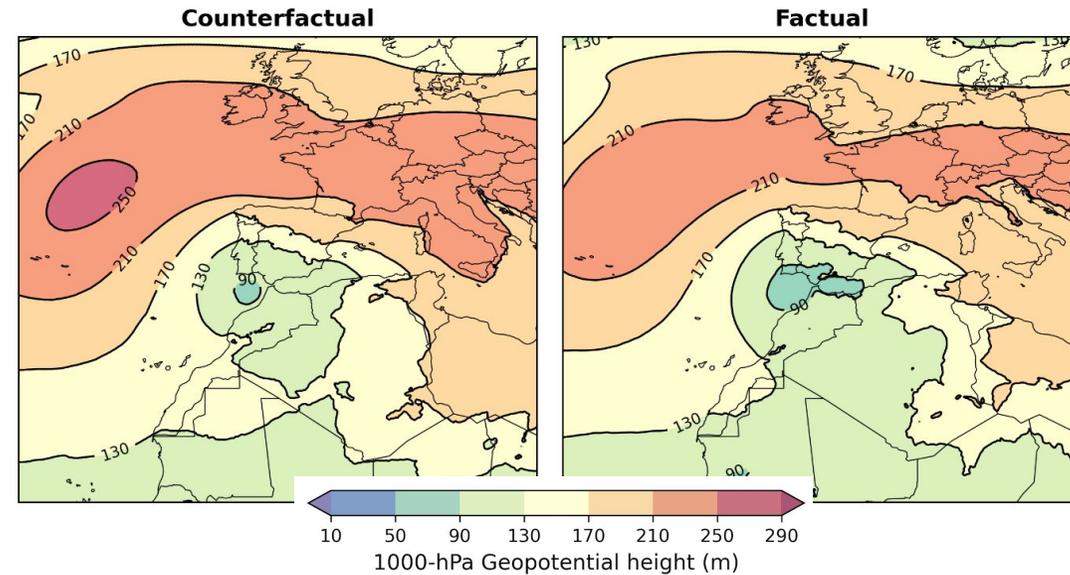
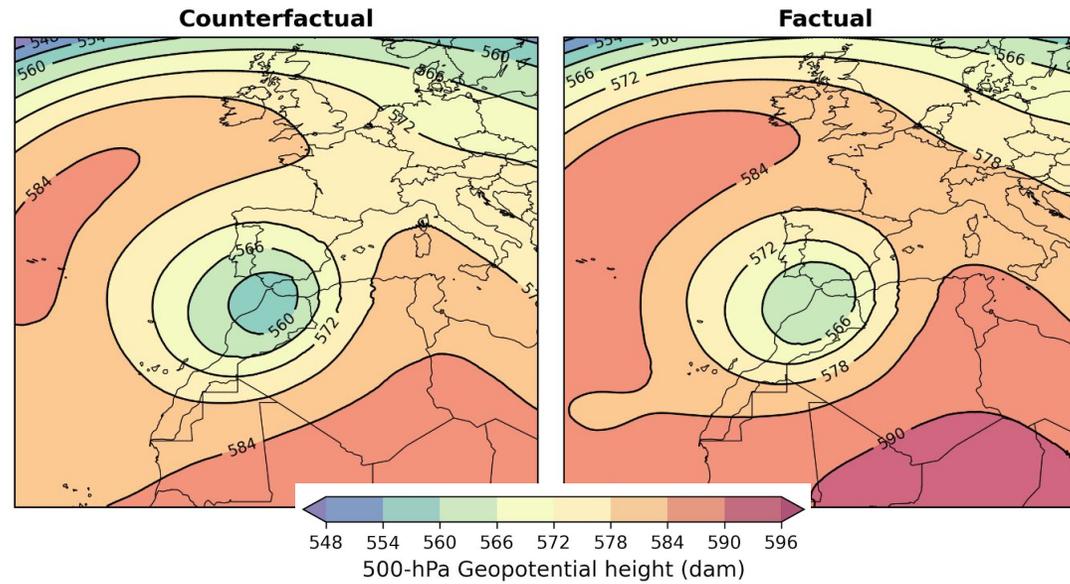
# Td and precip



# Vertical profiles

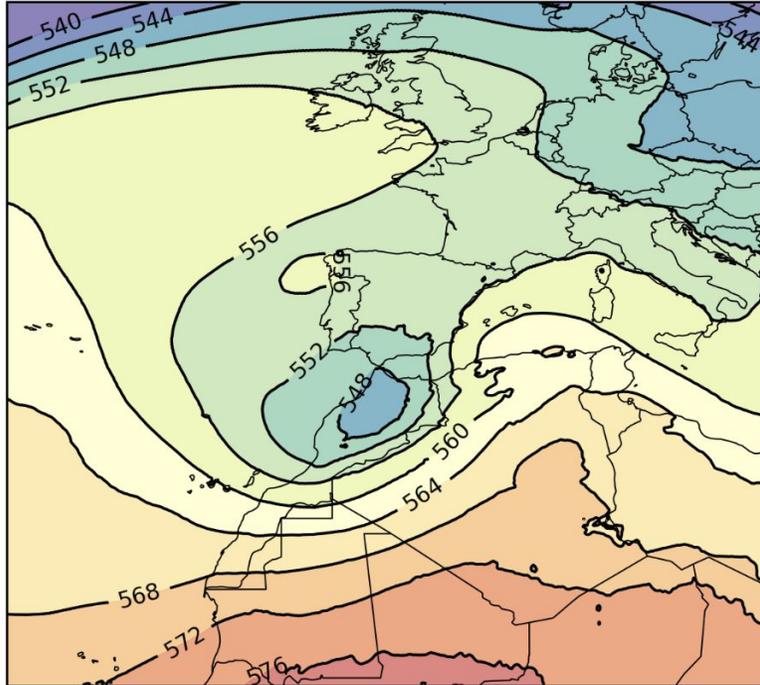


# Geopotential height

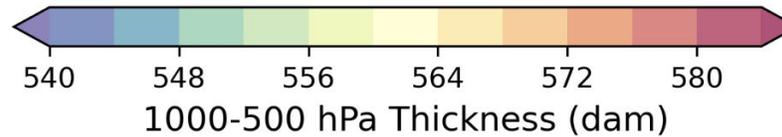
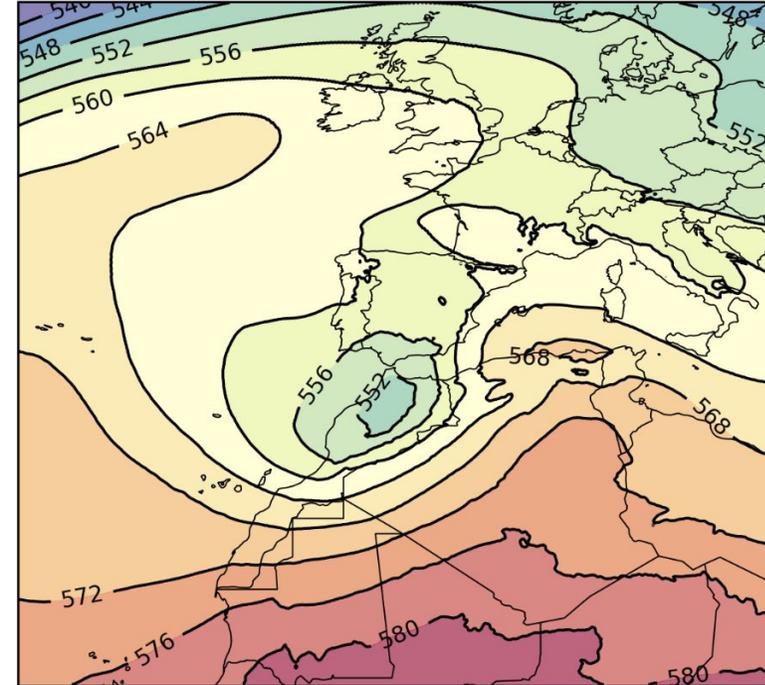


# Thickness

Counterfactual

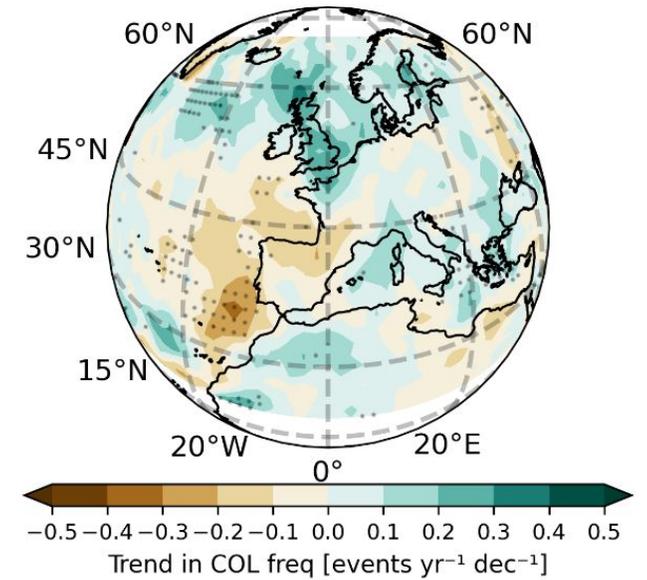
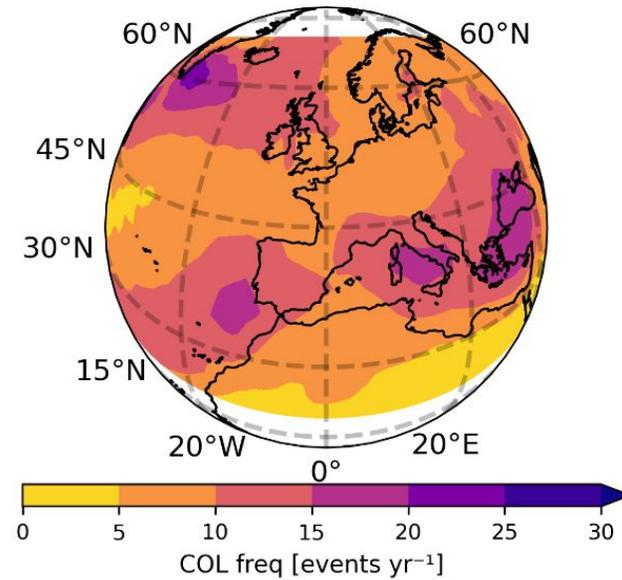
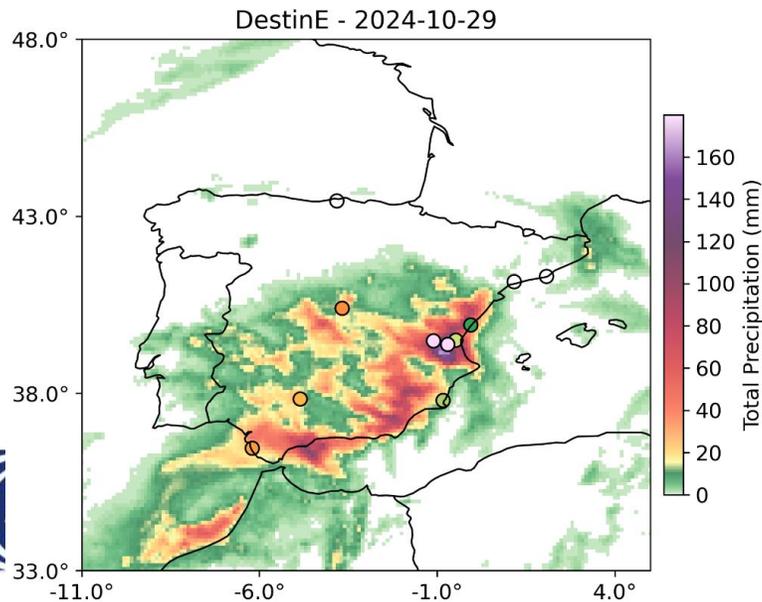
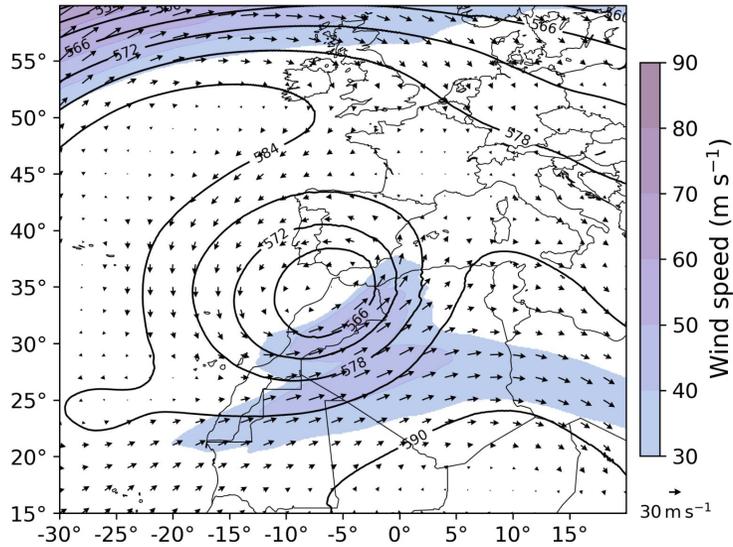


Factual



# What happened in Valencia?

In late October 2024, a COL affected the southwestern Iberian Peninsula, a region that is a “hotspot” for COLs.



(Saurral et al., 2025)