

Physical drivers of the 2015 August moisture-modulated heatwave over the Iberian Peninsula: a lagrangian analysis

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INTRODUCTION

- **Thermal stress** is intensifying worldwide, with atmospheric **humidity** exacerbating **heat** effects on human well-being.
- The heat and moisture **sources** of these extremes, as well as the relative contributions of **adiabatic**, **diabatic**, and **advective** processes in temperature anomalies, have not been widely studied.



GOAL: To determine the **physical processes** contributing to the temperature anomaly of the 2 – 12 August 2015 **moisture-modulated heatwave** over the Iberian Peninsula, along with its heat and non precipitable moisture **sources**, in order to improve our understanding of the mechanisms underlying these events.

DATA & METHODOLOGY

• DATA:

-Zhang et al. (2025) moisture-modulated heatwaves dataset → P_{99} of the lethal heat stress index T_s

$$T_s = T_w + 4.5 \left(1 - \left[\frac{RH}{100} \right]^2 \right)$$

-6-hourly 30 million air parcels' trajectories from the global outputs of the **FLEXPART v10.4** model.

- **ERA5** reanalysis

• METHODOLOGY:

• **LATTIN** tool [1] → **Lagrangian** moisture and heat **tracking** :

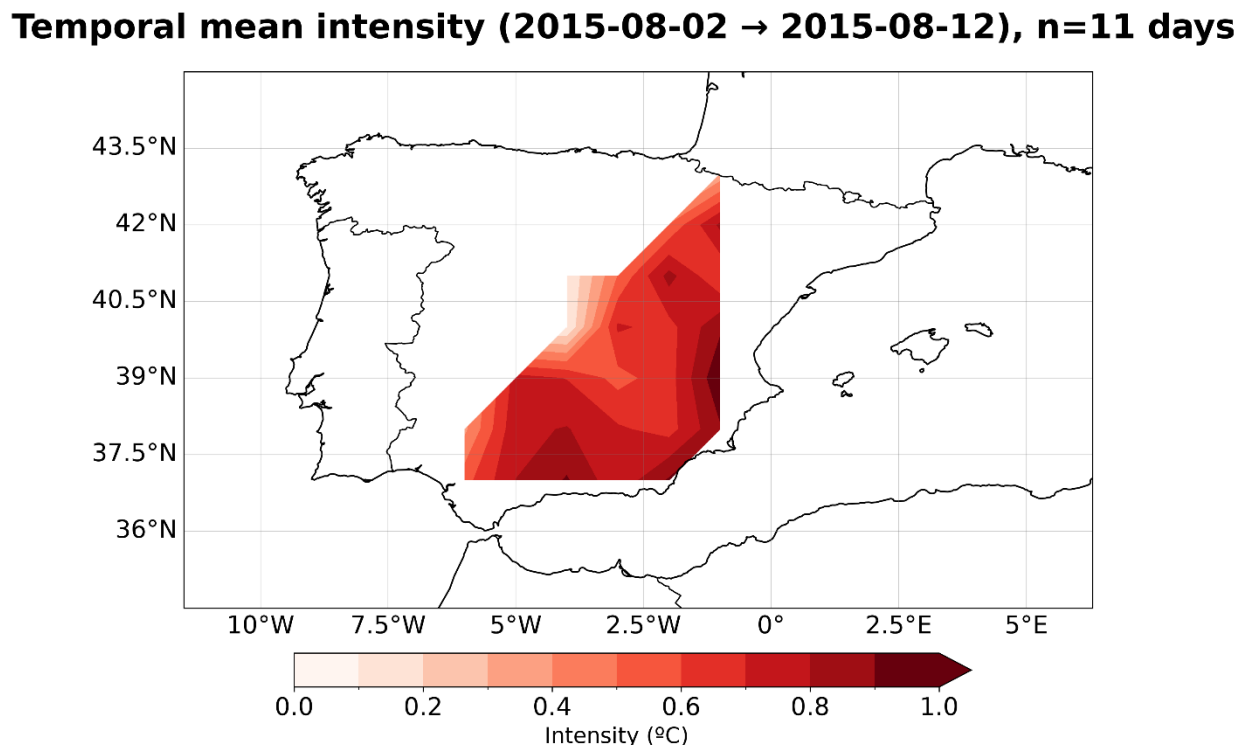
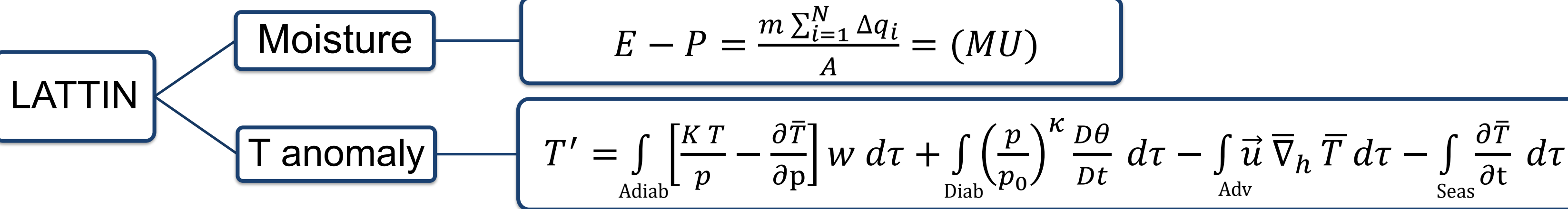


Figure 1: Spatial distribution of mean event intensity, represented by T_s exceedance, across the **target region** throughout the event.

RESULTS

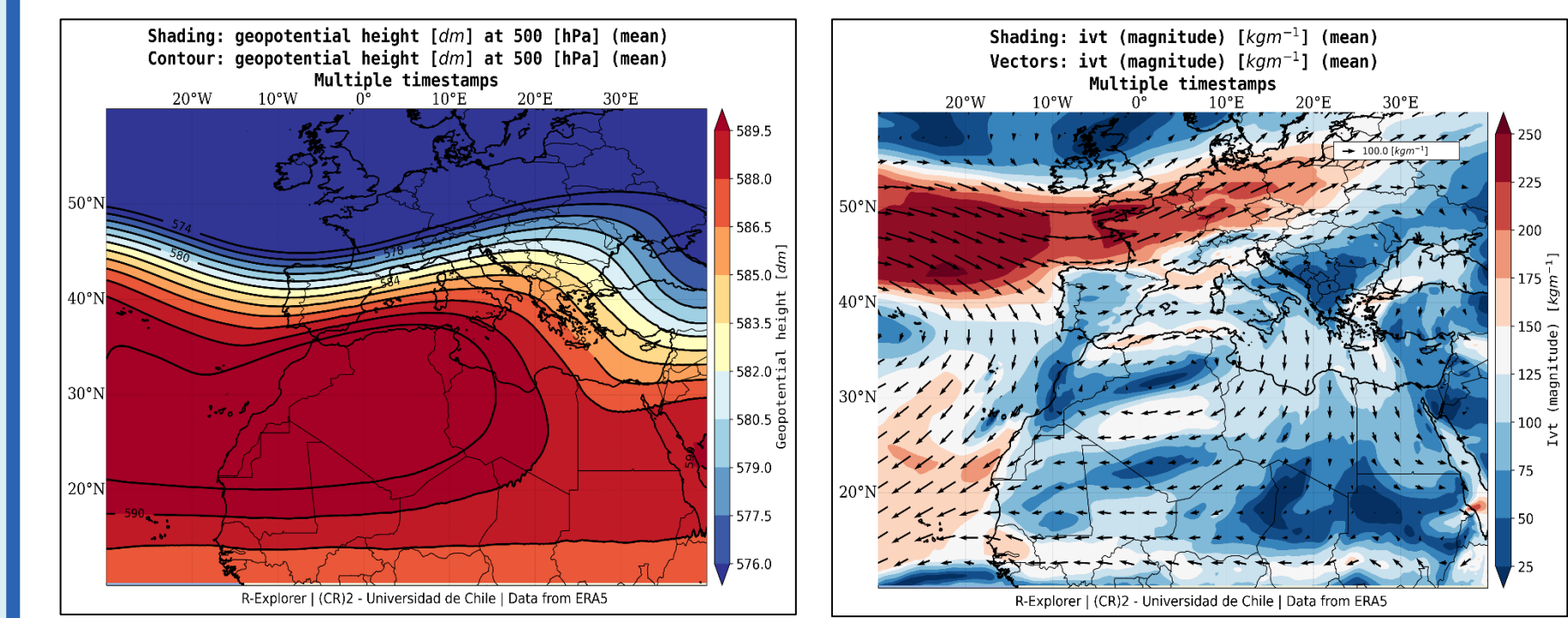


Figure 2: Synoptic analysis. The left picture shows the event mean 500 hPa geopotential whereas the right picture depicts the event mean integrated vapor transport IVT .

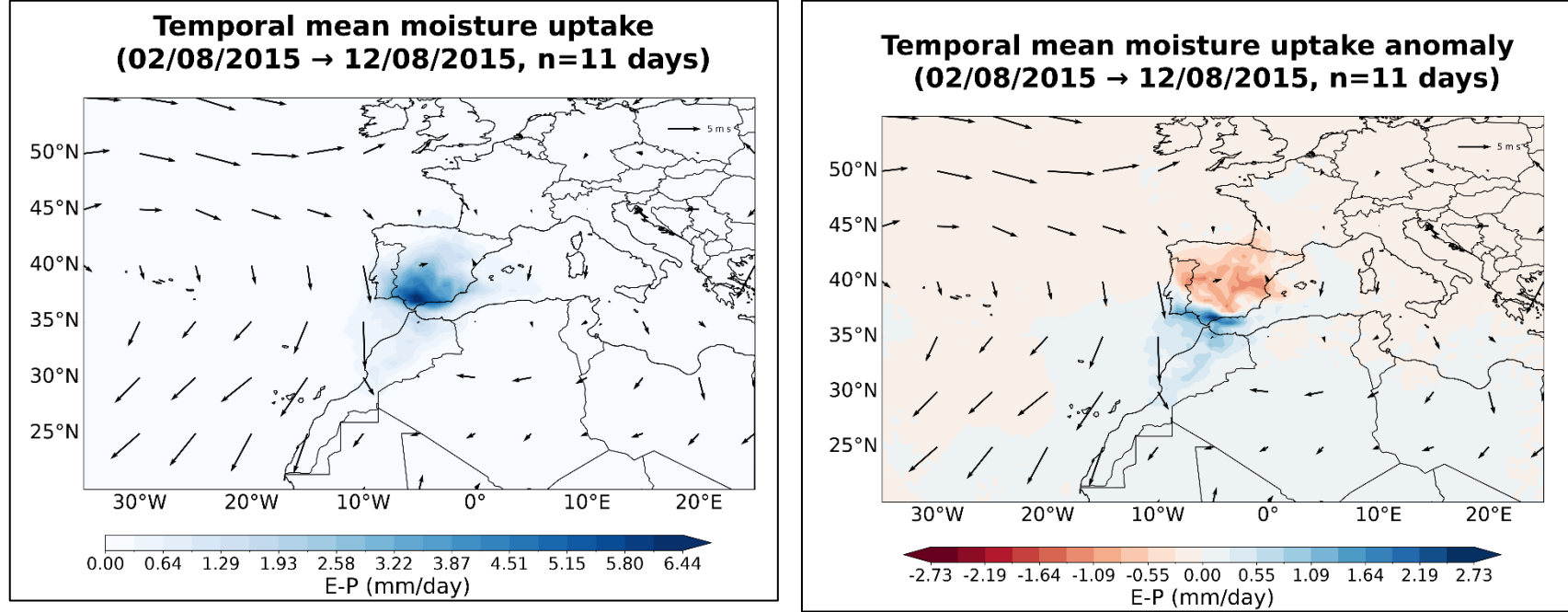


Figure 3: Footprint of event mean non precipitable moisture sources, expressed as E-P: evaporation minus precipitation (mm/day). The left picture shows mean moisture sources during the event, whereas the right graphic depicts their anomalies relative to 1980-2020 climatology.

Temporal mean heating (02/08/2015 → 12/08/2015, n=11 days)

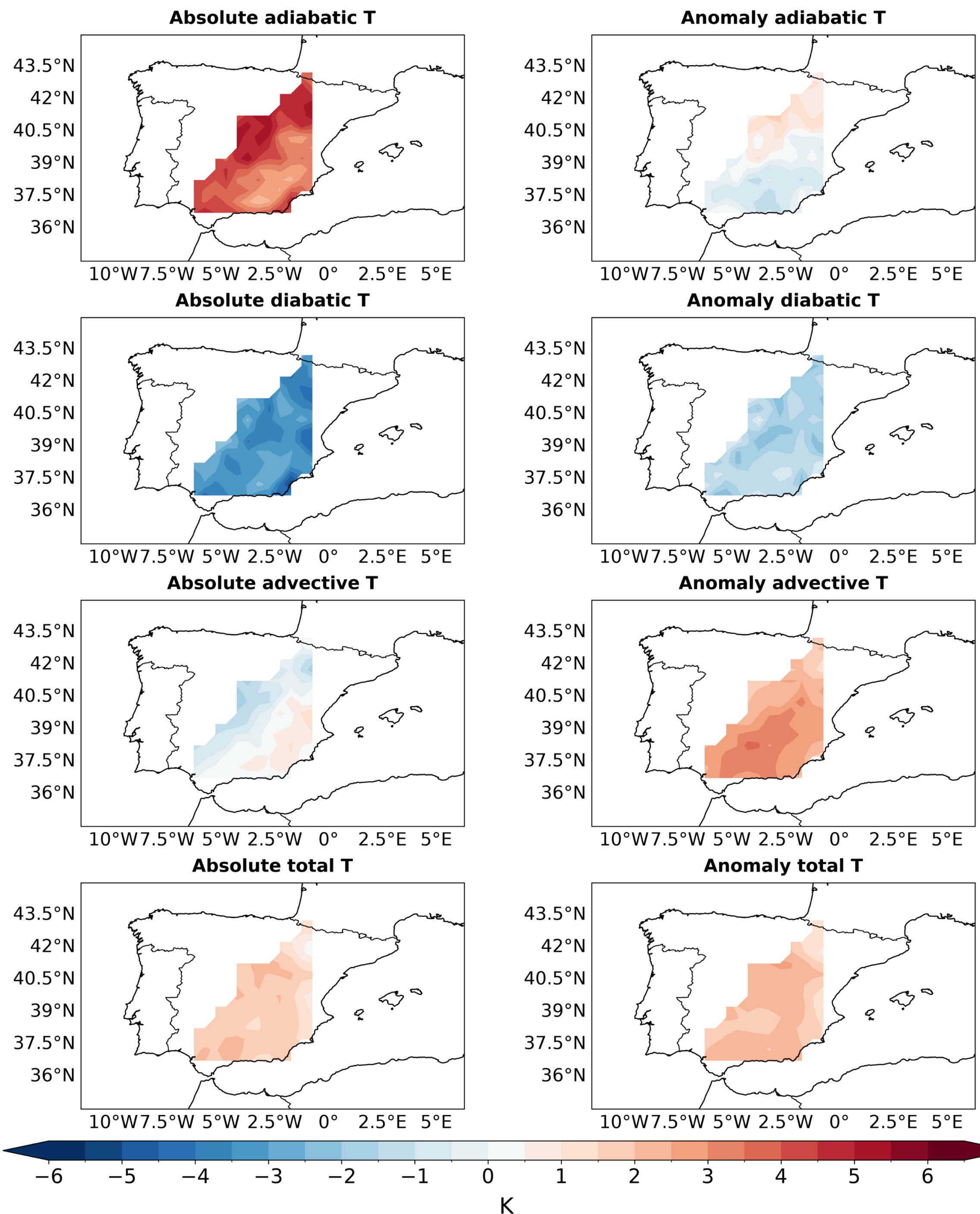


Figure 4: Temperature anomaly decomposition (K). The first column shows the event mean absolute contribution of each process to the temperature anomaly, whereas the second column depicts the corresponding anomalies relative to a 1980-2020 climatology.

Average footprints of temperature anomaly sources (2015-08-02 → 2015-08-12, n=11 days)

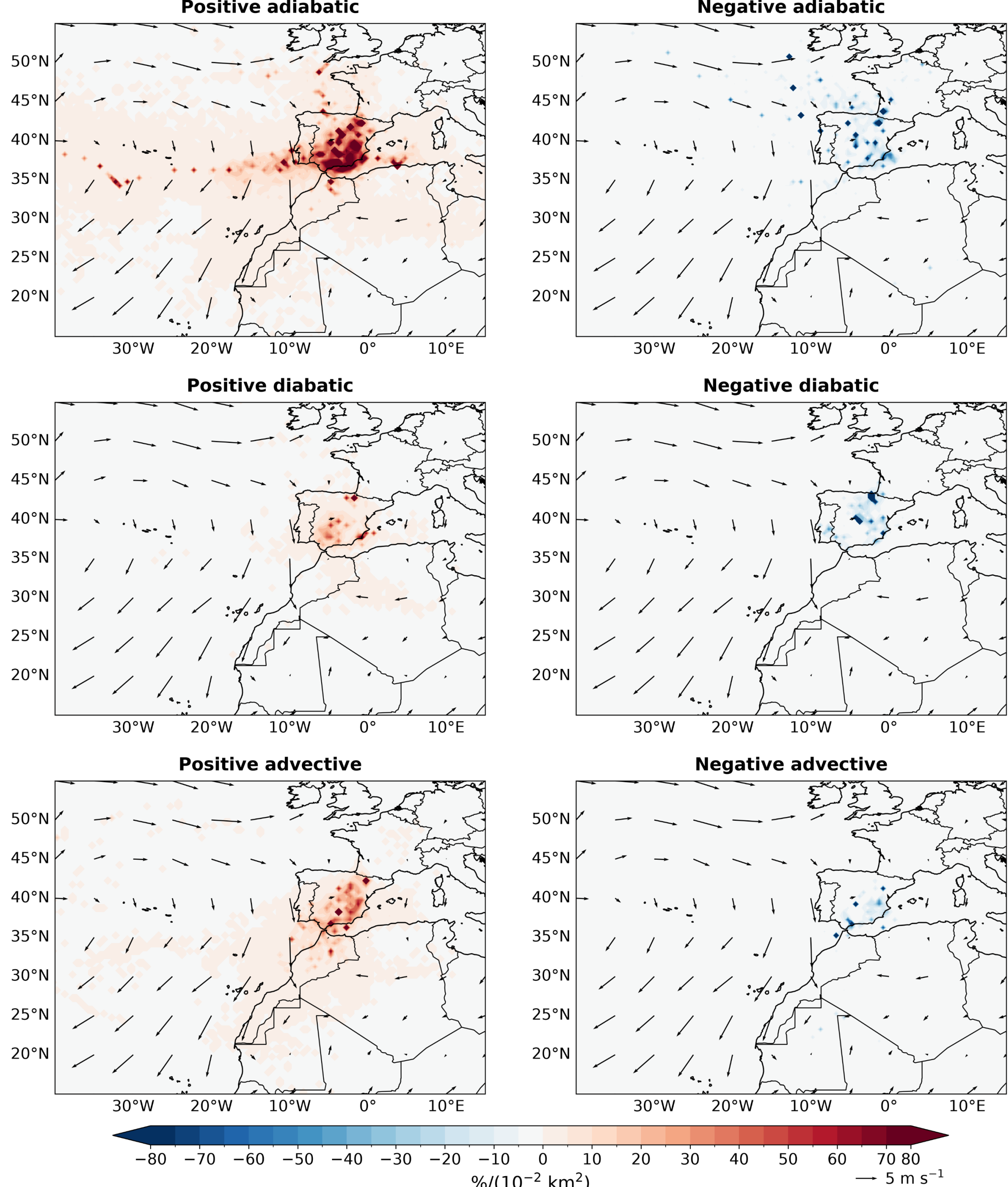


Figure 5: Footprints of temperature anomaly sources . Spatial contribution (%) of grid cells to the temperature anomaly components within the target region, expressed per $10^{-2} km^2$. The maps show the 6-hourly mean spatial distribution of positive (left column) and negative (right column) adiabatic, diabatic and advective sources during the event. Arrows indicate the mean 10 m wind flow.

CONCLUSIONS

- **Adiabatic** warming, associated with enhanced subsidence under high pressure conditions specially in the mid troposphere, was the principal contributor to the temperature anomaly, consistent with Röthlisberger and Papritz (2023). Nevertheless, **advection** showed the strongest positive anomalies, and thus probably reduced advective cooling was an additional important factor.
- **Temperature anomalies** were mainly generated **locally** over the Iberian Peninsula, with the positive **adiabatic** contribution also showing a **westward** component.
- **Moisture uptake** patterns are coherent with **reduced advective cooling**, showing anomalously lower values over most of the Iberian Peninsula, while enhanced uptake is observed over the southern part. Together with weakened 10 m winds, this can be linked to weakened advection under the **Azores High** circulation, favouring the persistence of heat anomaly.

BIBLIOGRAPHY

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