

Atmospheric blockings  
and downstream  
Mediterranean cyclones

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# Motivation

- Heavy rainfall has been associated with Mediterranean Cyclones (MCs)
- Atmospheric Blocking:
  - Long-lasting, quasi stationary, self-sustaining system
  - Impact on the predictability of weather extremes (e.g. heatwaves, droughts)
- The connection between blocking and MCs has been understudied – addressing this can provide information on predictability



Damage from Ianos in Karditsa, Greece

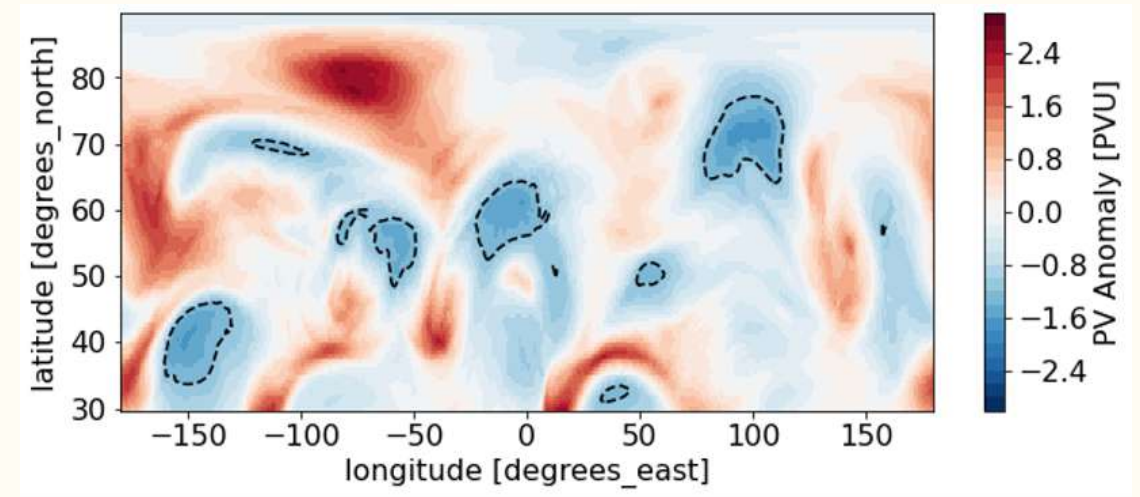
**Aim:** Quantify how often MCs develop downstream of atmospheric blocks over the Euro-Atlantic region and how different cyclone characteristics are impacted



# Detecting Atmospheric Blocking

- ERA5 data for 1979-2020
- Vertically averaged Potential Vorticity (PV) between 500-150 hPa
- Track blocks as persistent negative PV anomaly
  - Closed contours below a threshold
- Ensure quasi-stationarity and persistence
  - 85% two-sided overlap between closed contours of successive time steps for at least 5 days

[Steinfeld, D., 2020: ConTrack - Contour Tracking. GitHub, adapted from the original index proposed by Schwierz, et al., 2004]



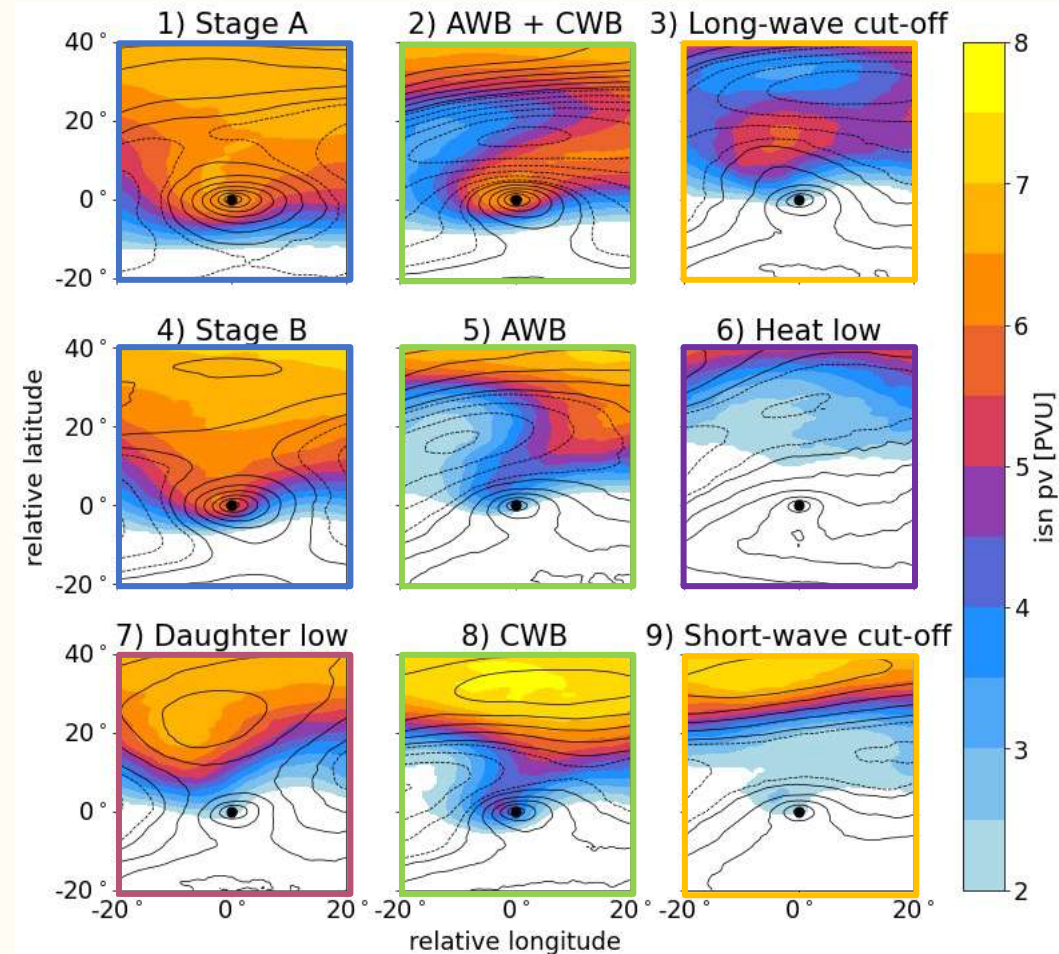
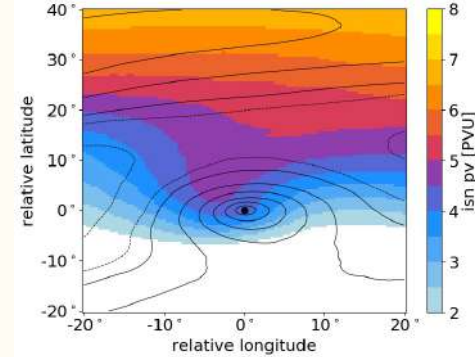
# Mediterranean Cyclones

- Composite tracks of confidence level 5 [*Flaounas et al., 2023*]
- Classified into different clusters with distinct PV characteristics using a SOM algorithm [*Givon et al., 2023* (under review)]

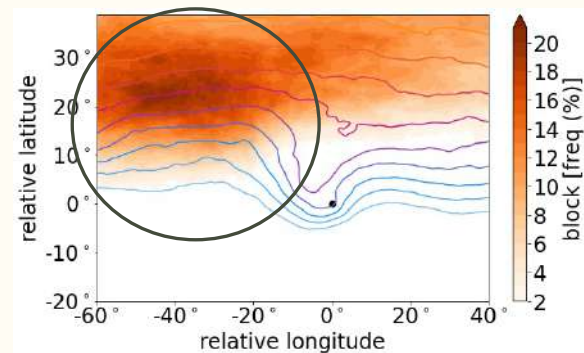
## Connection:

- How many cyclones had a blocking event upstream in a relative domain around the cyclone center?

Solid line: MSLP < 1015 hPa  
Dashed line: MSLP >= 1015 hPa

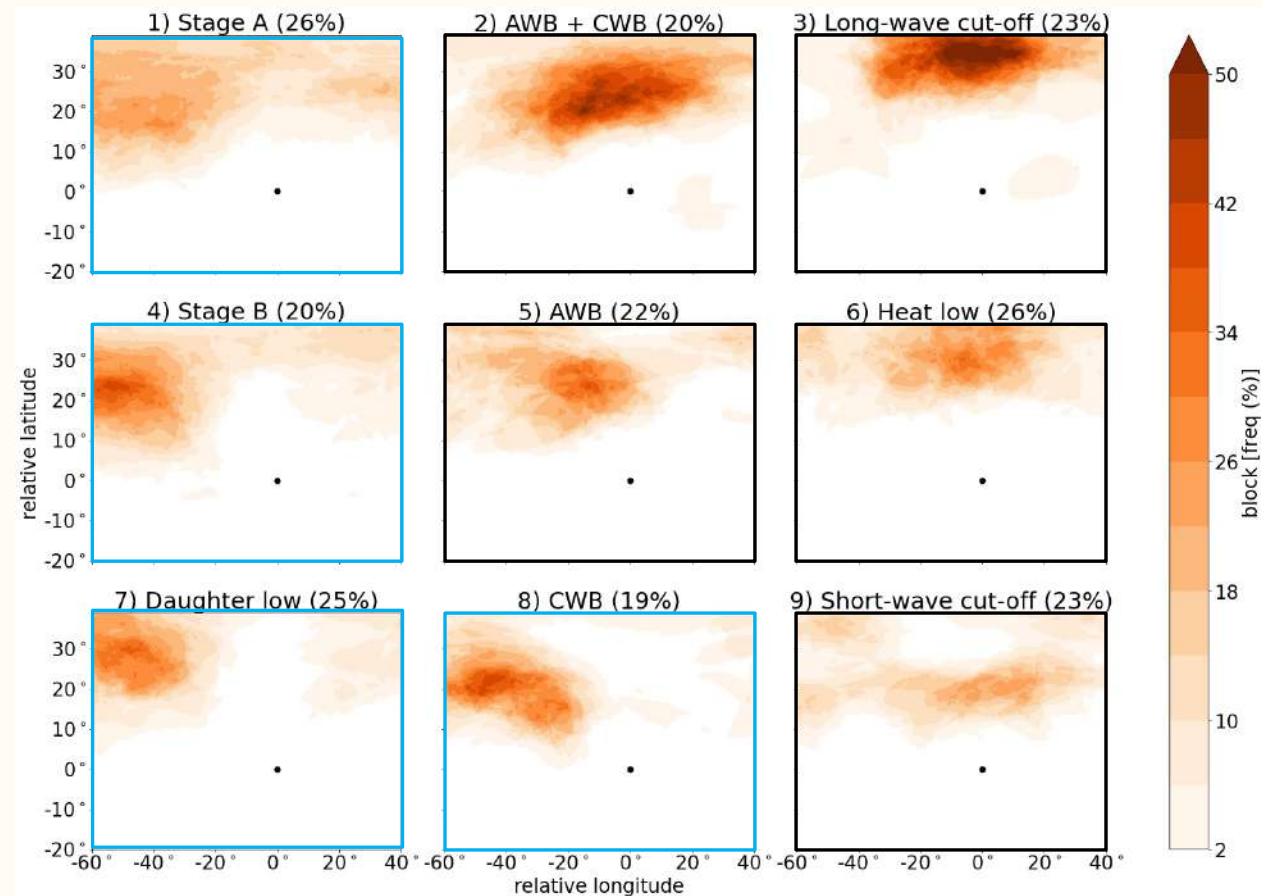
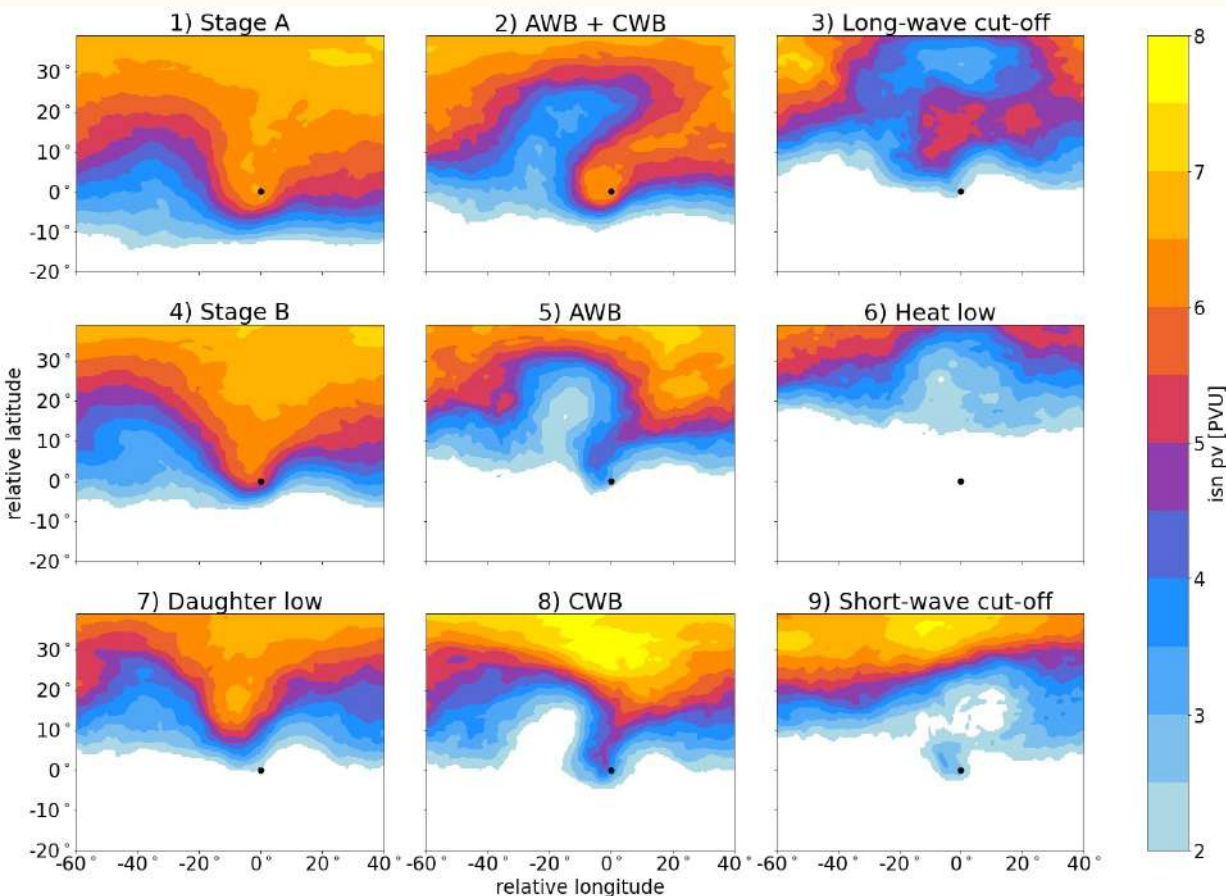


# How many cyclones had a block persisting for 2 days prior to the peak?



Isentropic PV (320-340K)

Blocking Frequency



19-26% of cyclones in each cluster had a block persisting for 2 days prior to the peak

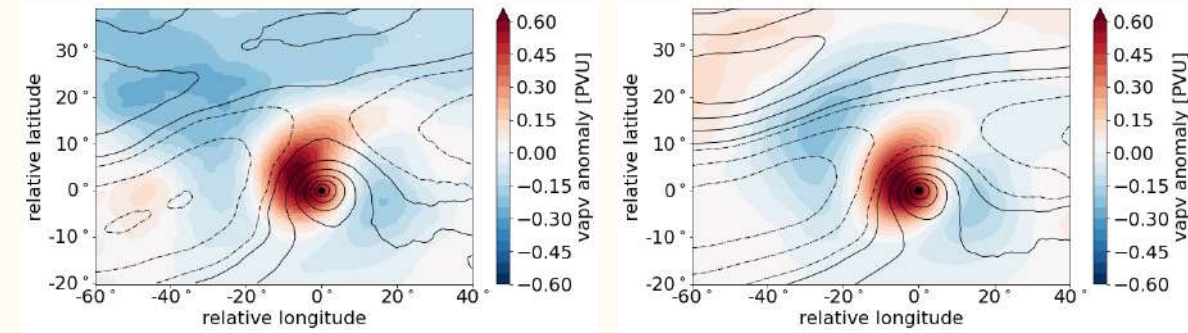


# Vertically averaged PV (VAPV) Anomalies

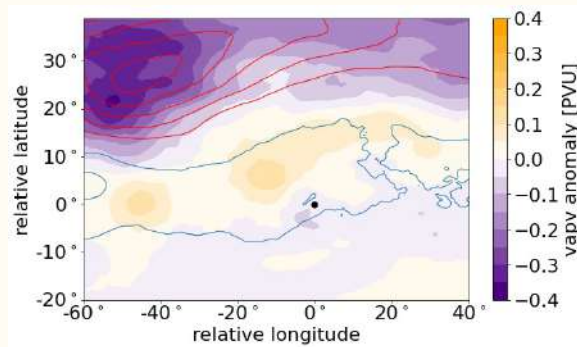
Difference per cluster

With Blocks

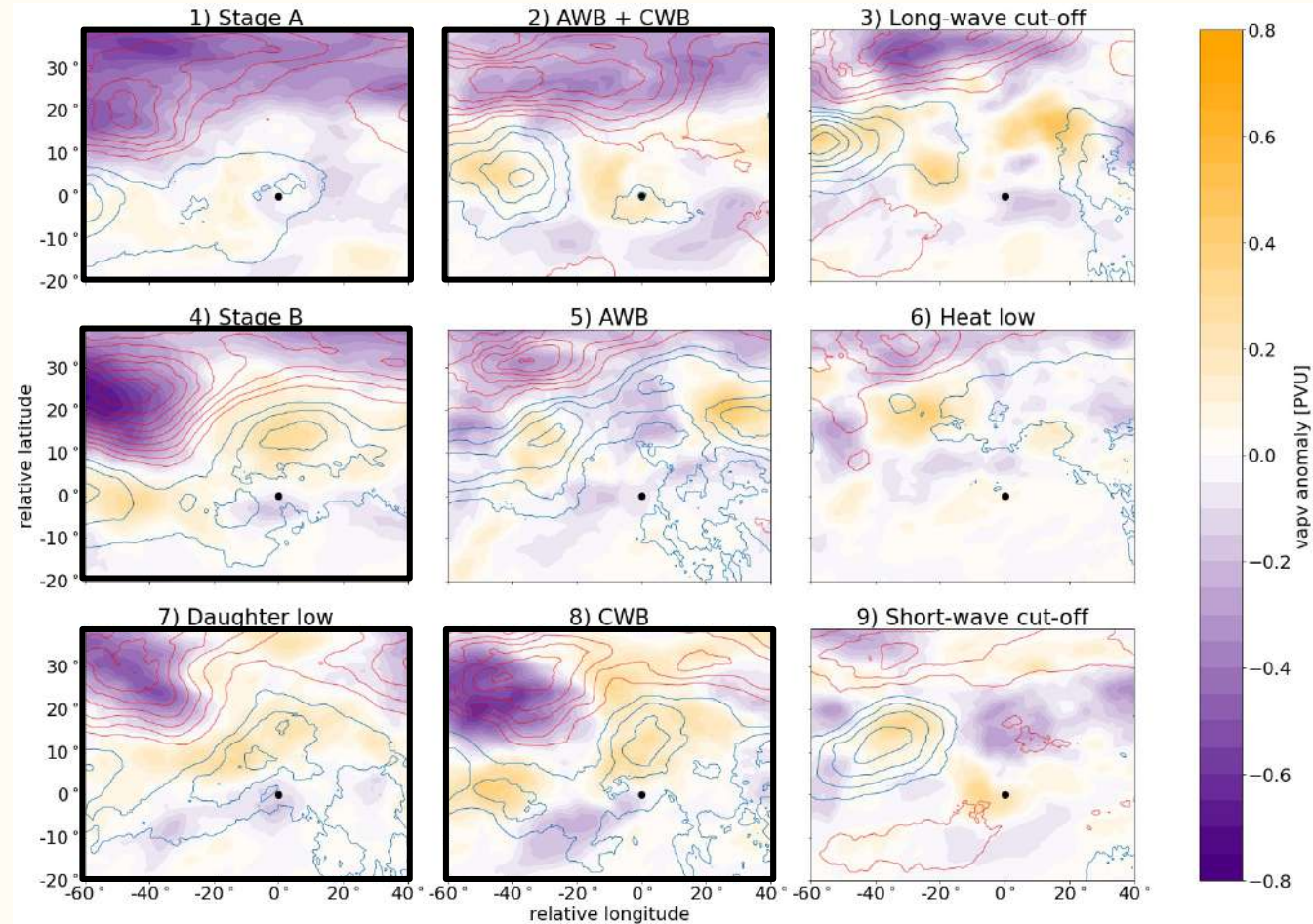
Without blocks



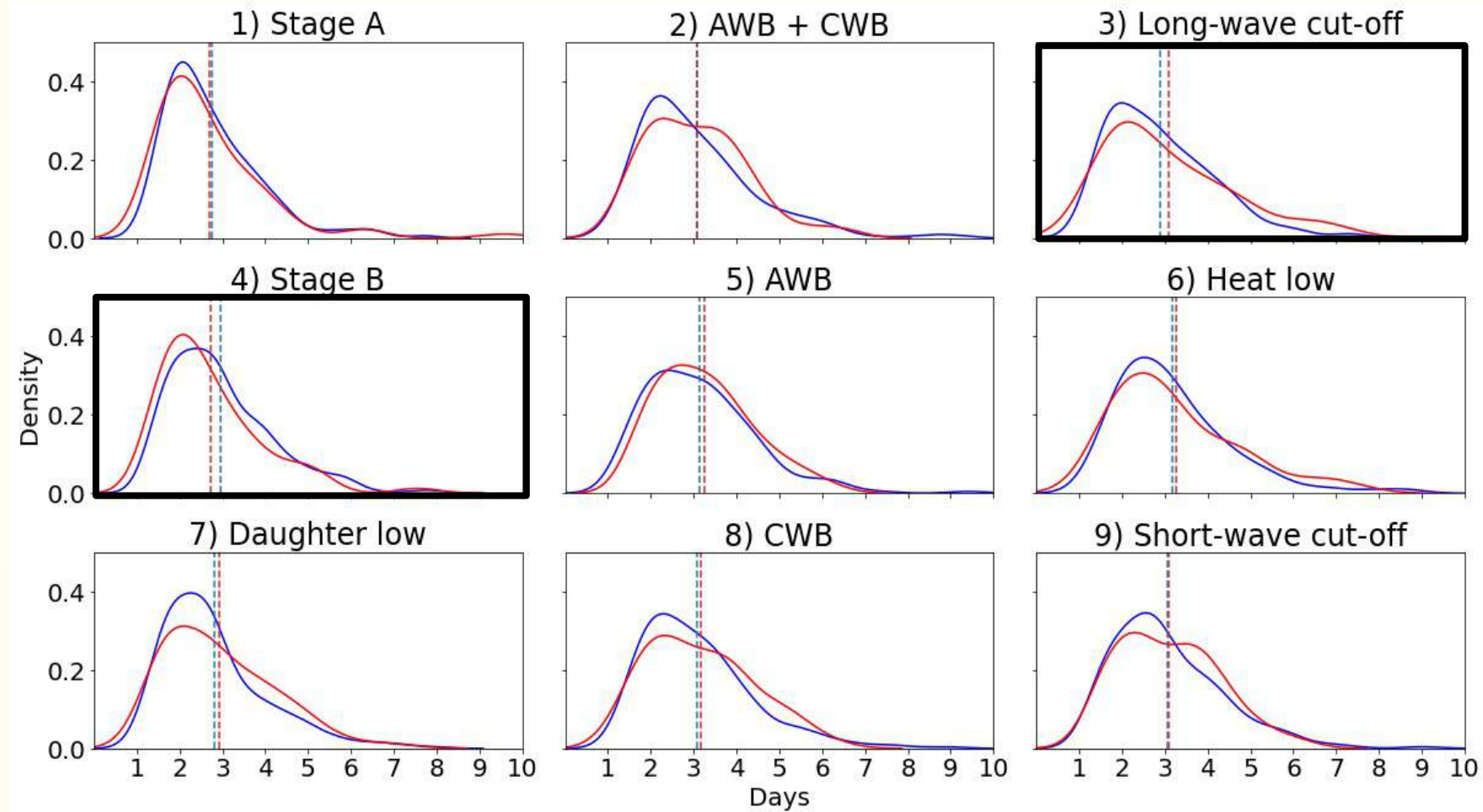
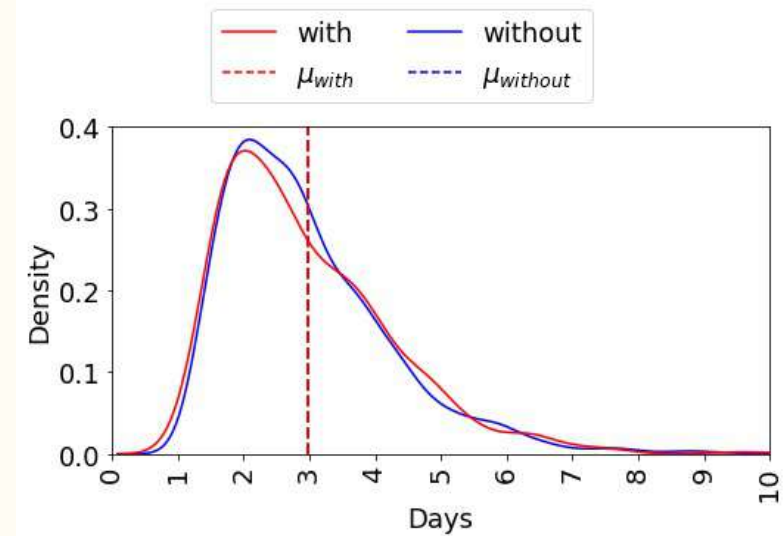
Difference in means:  
blocks – without blocks



MSLP\_diff >= 0  
MSLP\_diff < 0

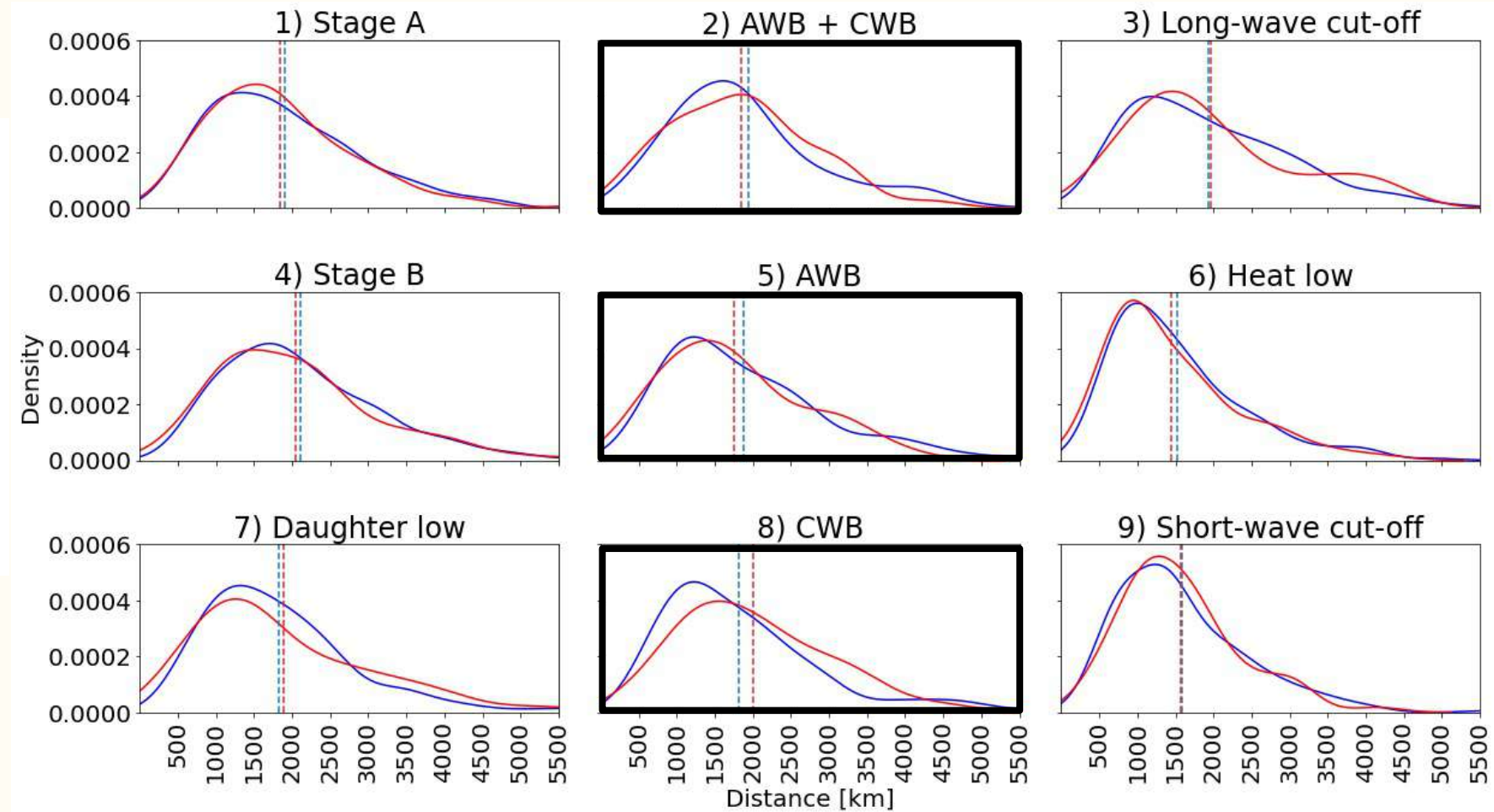
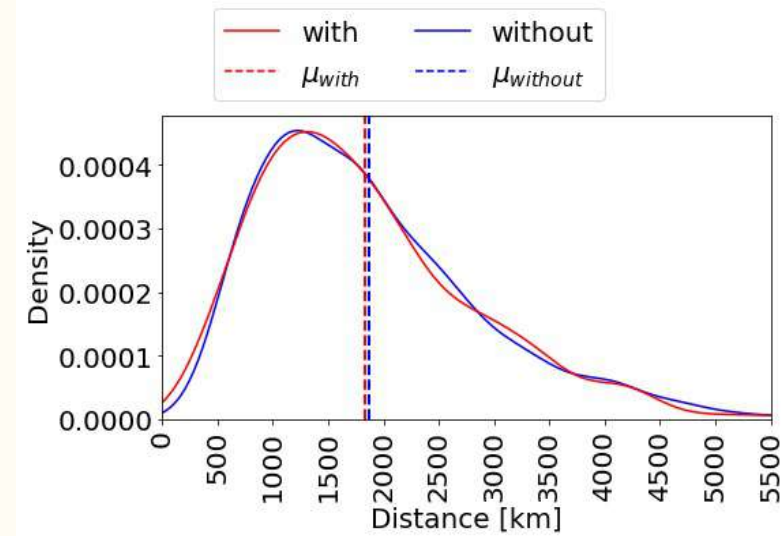


# Lifetime of cyclones [days]



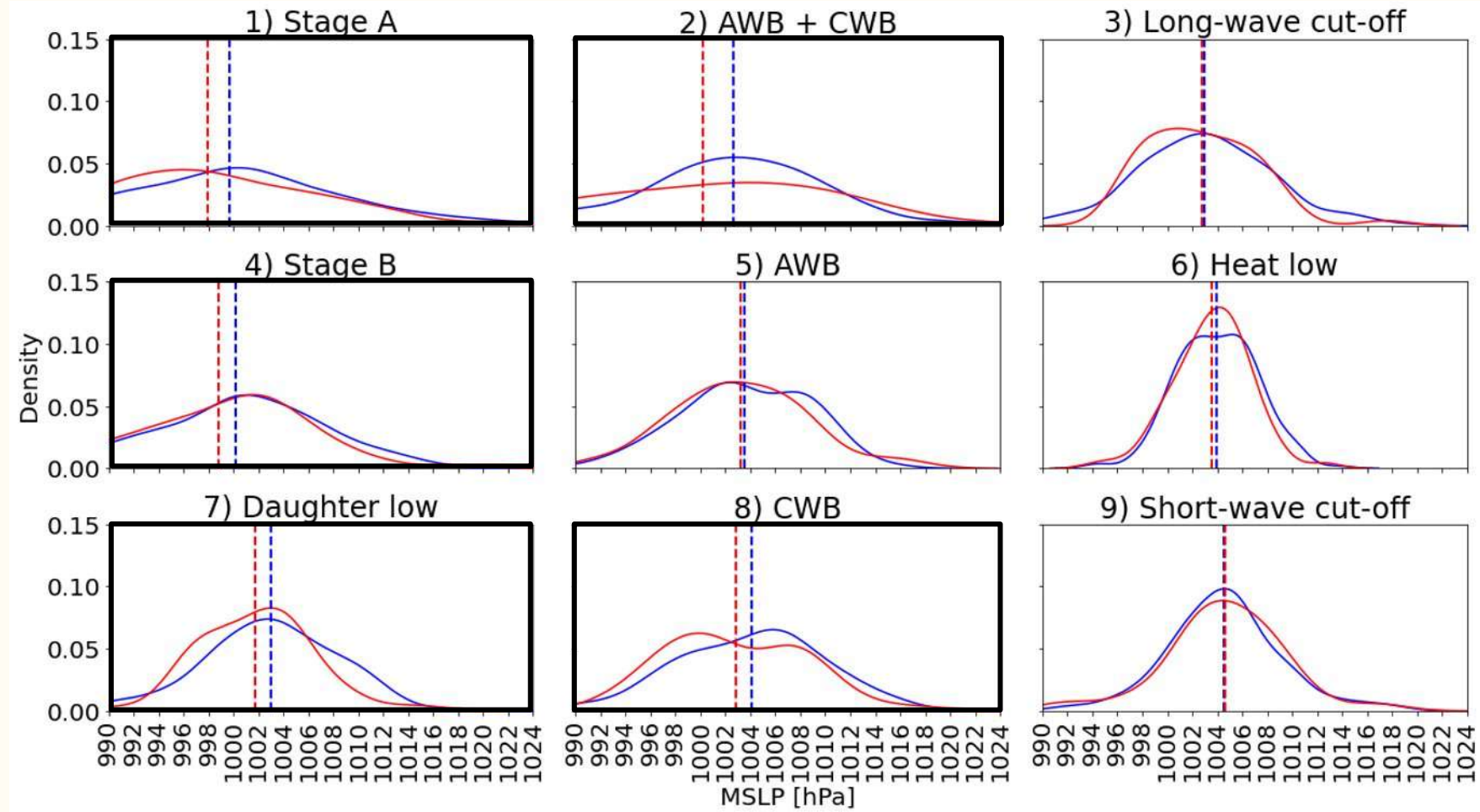
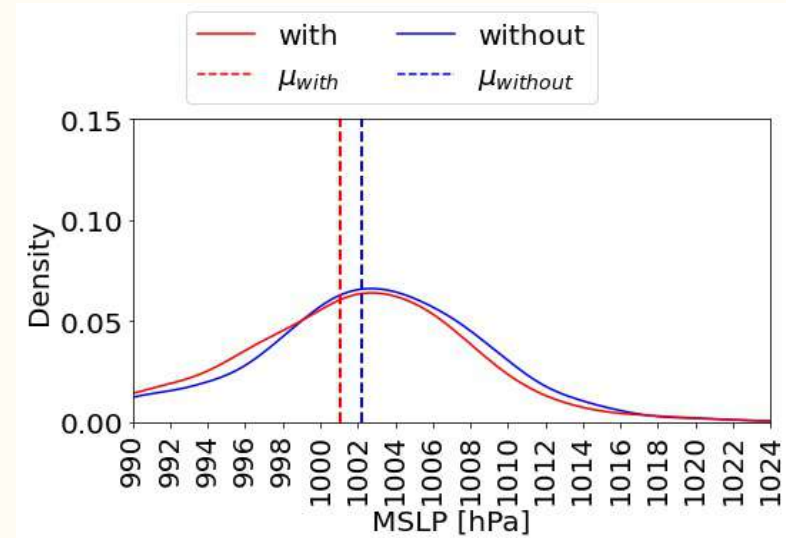
No major impact on lifetime

# Distance travelled [km]





# MSLP at peak [hPa]

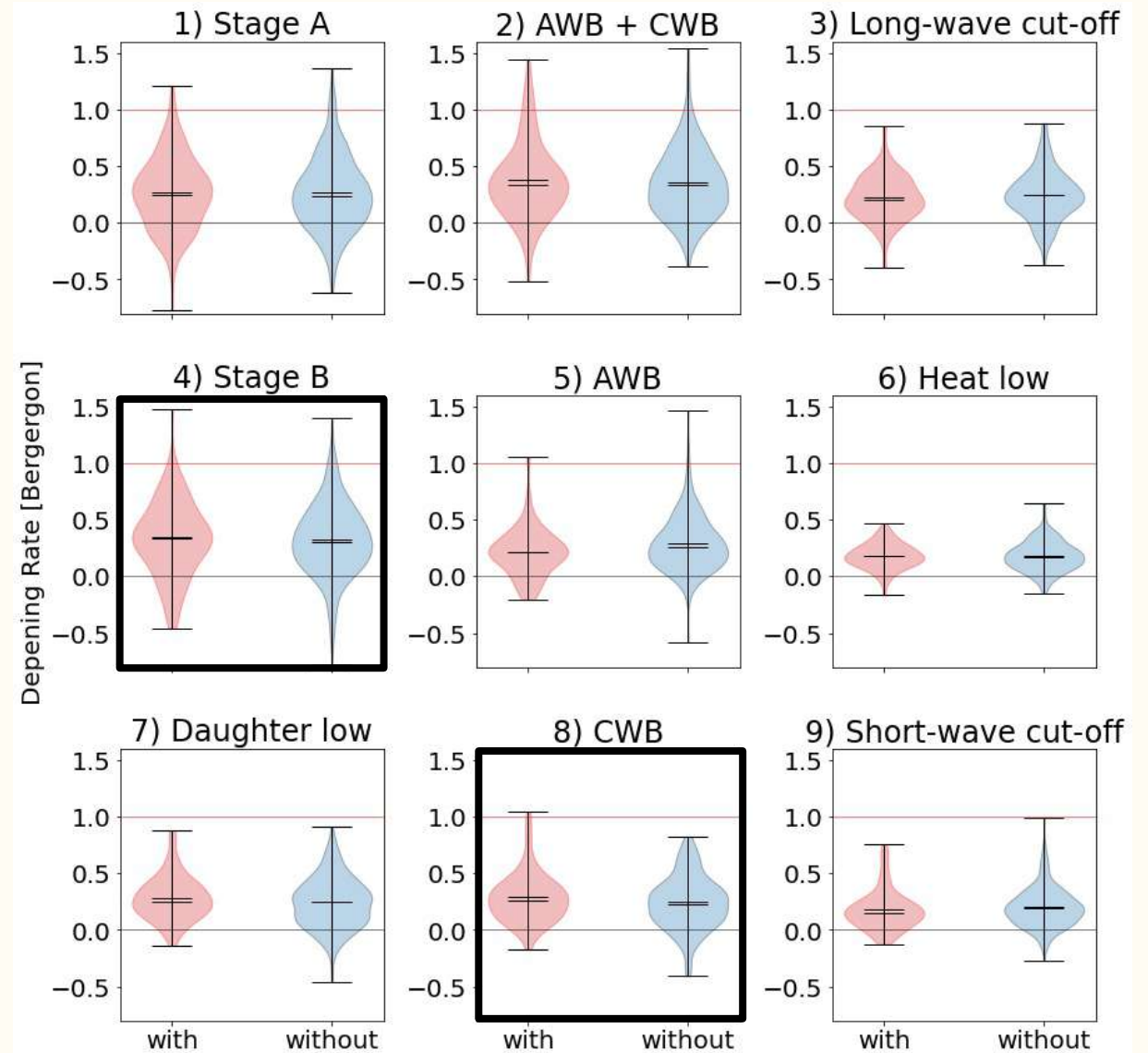
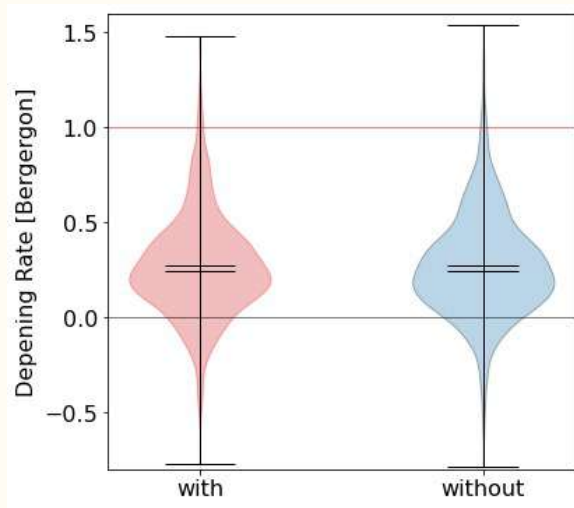


Persistent blocking for 2 days prior peak → deeper cyclone

# Cyclone Explosiveness

$$Bergeron = \frac{\sin 60 SLP_{t-12} - SLP_{t+12}}{\sin \varphi_t} \cdot \frac{1}{24}$$

Bergeron > 1 ⇒ explosive cyclone

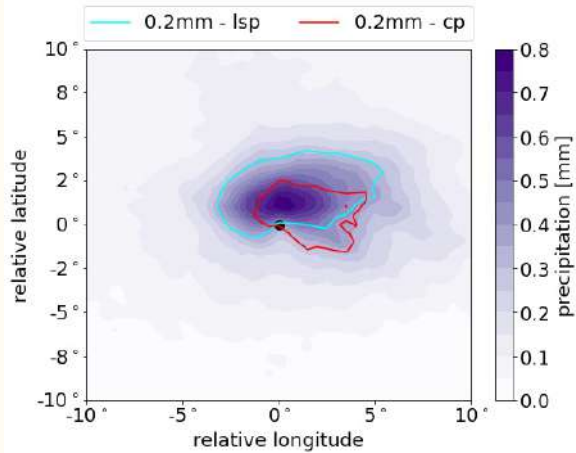


# Precipitation

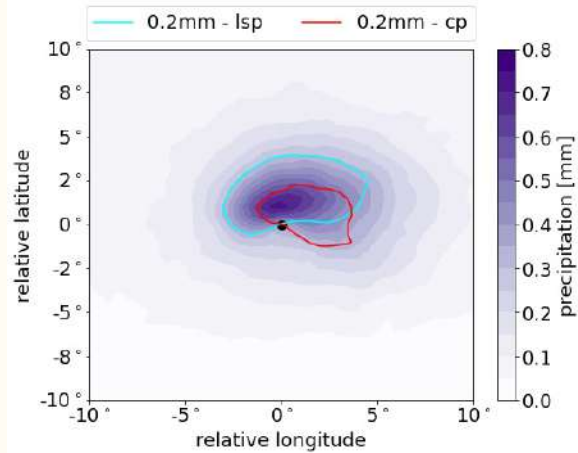
lsp: large-scale precipitation  
 cp: convective precipitation  
 total precipitation = lsp + cp

Difference per cluster

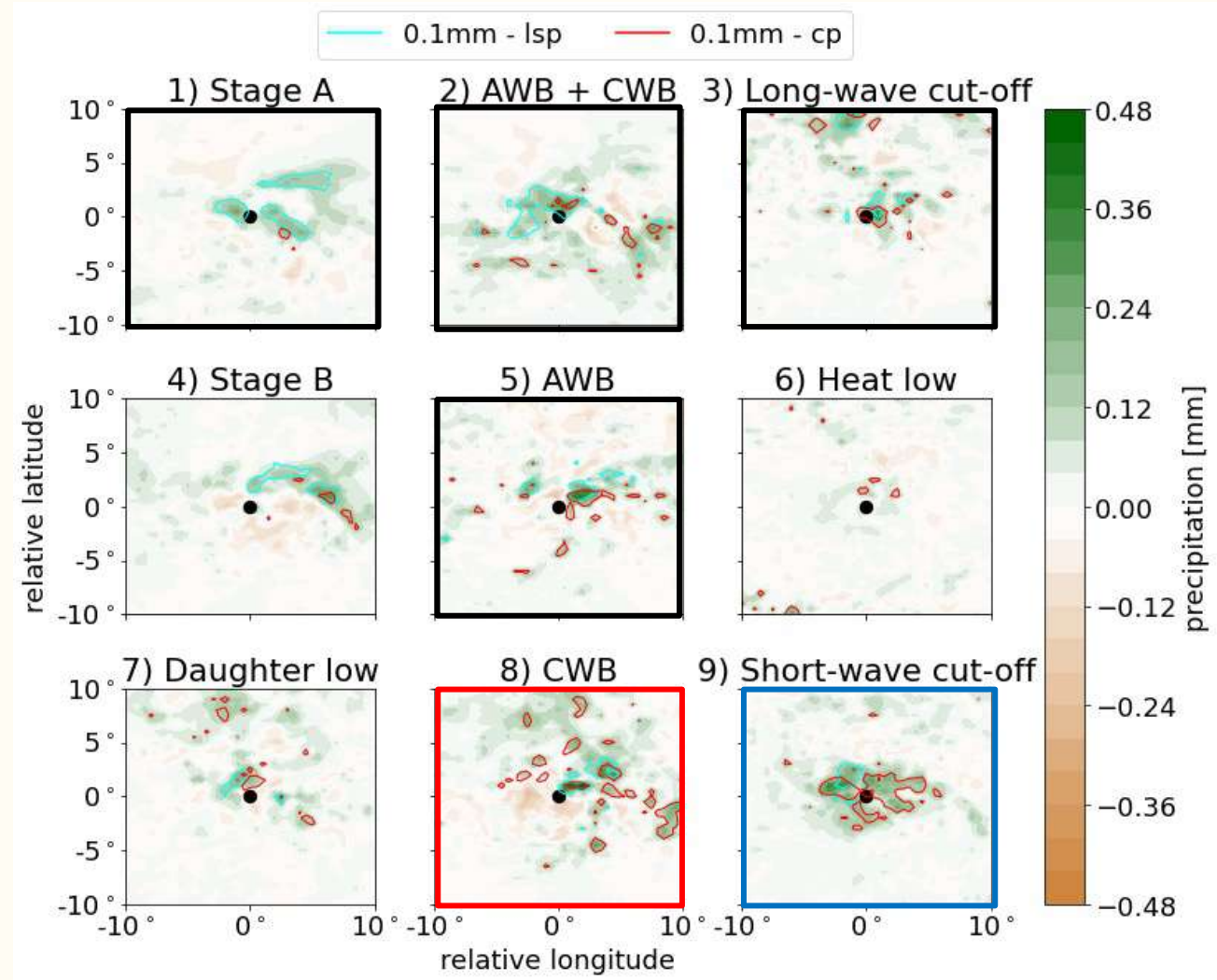
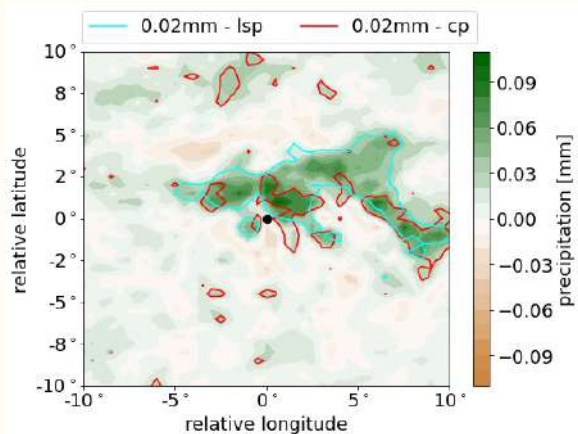
With Blocks



Without blocks



Difference in means

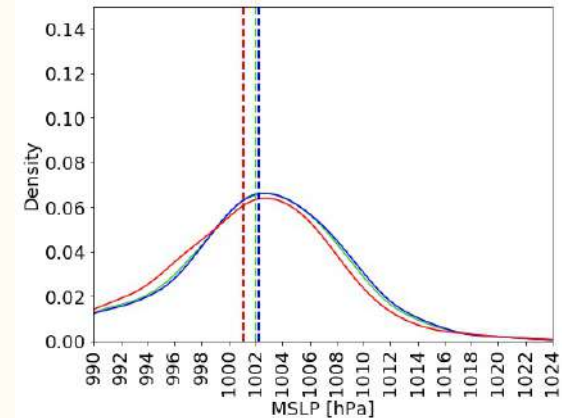
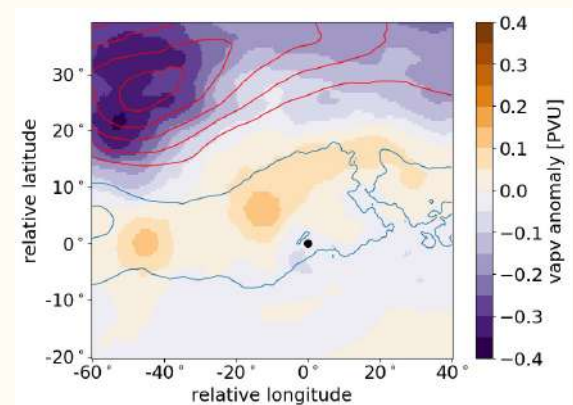
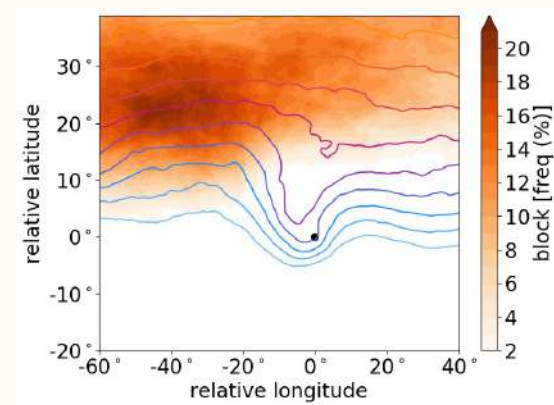


Persistent blocking for 2 days prior peak → more precipitation

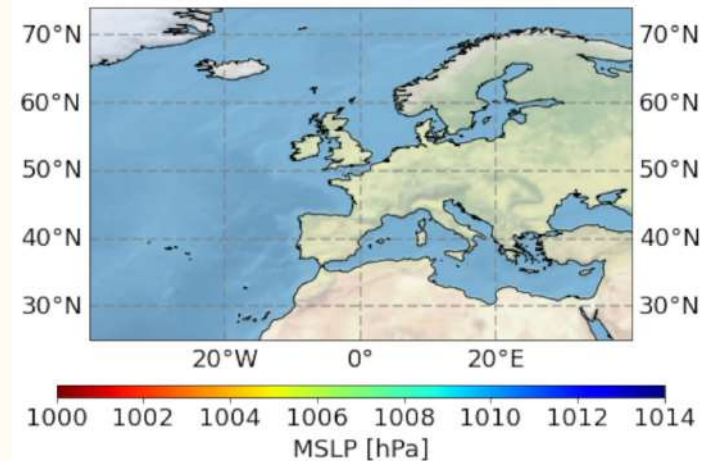
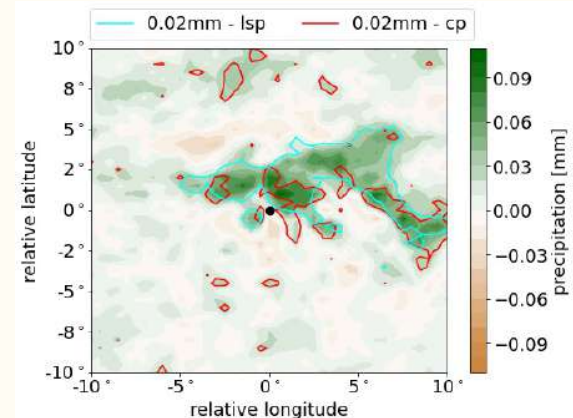


# Summary

- Systematic investigation of frequency of MC development downstream of atmospheric blocks over the Euro-Atlantic region
- Results are cluster specific
- Persistent blocking for 2 days prior to peak leads to:
  - deeper cyclone, not necessarily more explosive
  - increased precipitation on the northern part of the cyclone



time = 2020-09-12T06:00:00





# References

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- Flaounas, E., Aragão, L., Bernini, L., Dafis, S., Doiteau, B., Flocas, H., L. Gray, S., Karwat, A., Kouroutzoglou, J., Lionello, P., Pantillon, F., Pasquero, C., Patlakas, P., Picornell, M. A., Porcù, F., D. K. Priestley, M., Reale, M., Roberts, M., Saaroni, H., Sandler, D., Scoccimarro, E., Sprenger, M., and Ziv, B.: A composite approach to produce reference datasets for extratropical cyclone tracks: Application to Mediterranean cyclones, *Weather Clim. Dynam. Discuss.* [preprint], <https://doi.org/10.5194/wcd-2022-63>, in review, 2023.
- Givon, Y., Hess, O., Flaounas, E., Catto, J. L., Sprenger, M., and Raveh-Rubin, S.: Process-based classification of Mediterranean cyclones using potential vorticity, *EGUsphere* [preprint], <https://doi.org/10.5194/egusphere-2023-1247>, 2023.
- Schwierz, C., Croci-Maspoli, M., and Davies, H. C. (2004), Perspicacious indicators of atmospheric blocking, *Geophys. Res. Lett.*, 31, L06125, doi:[10.1029/2003GL019341](https://doi.org/10.1029/2003GL019341).
- Steinfeld, D., 2020: ConTrack - Contour Tracking. GitHub