The Impacts of Wintertime North Atlantic Storm Track Regimes on Cyclonic Activity Downstream

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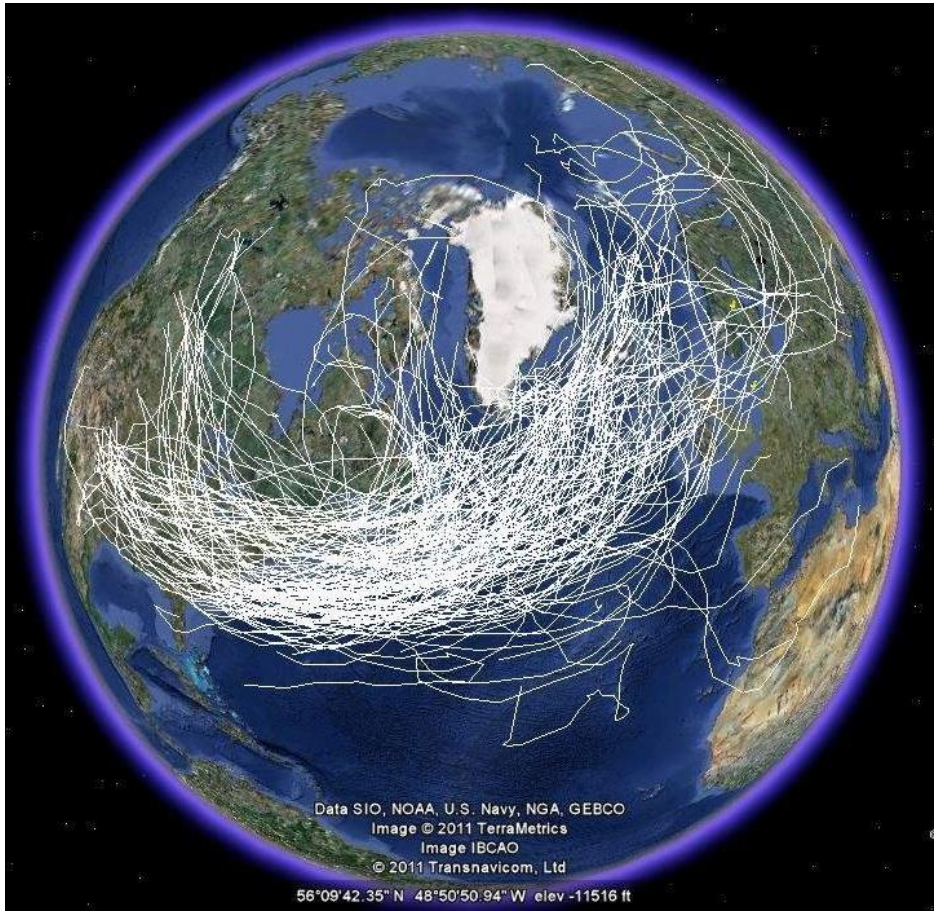
(1) Perturbation (2) Propagation (3) Interaction

The North Atlantic Storm Track as a Point of Reference

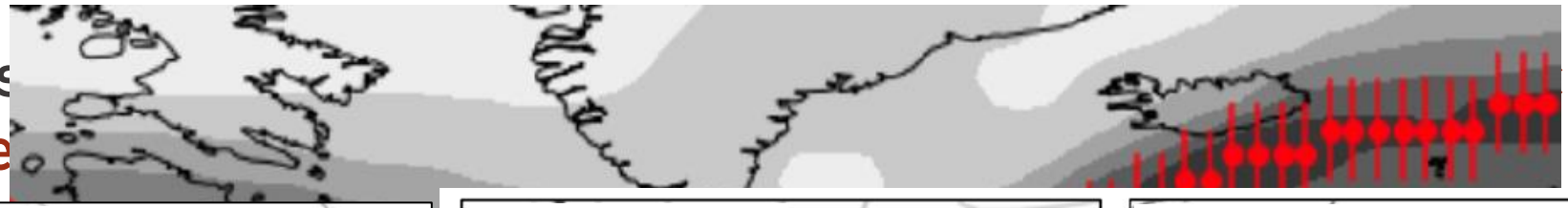
- Analysis on multiple time scales.
- Interacts with various elements along the chain:
  - Perturbs upper-level flow via warm conveyor belts (Raveh Rubin & Flaounas, 2017).
  - Tied to high frequency jet stream variability (Novak et al., 2015).
  - Can directly cause Mediterranean cyclogenesis “clusters” (Ziv et al., 2015).



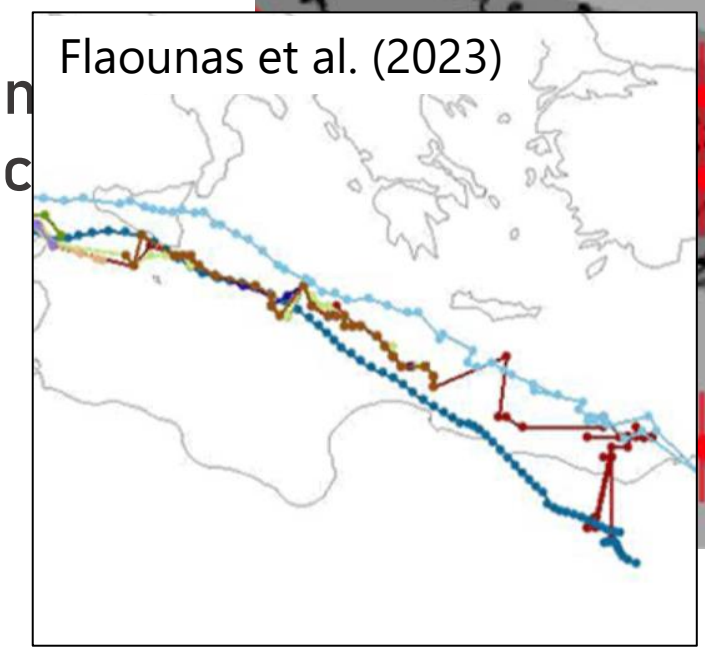
https://wis-wander.weizmann.ac.il/earth-sciences/track-how-storms-will-veer-warmer-world

Data & Methods

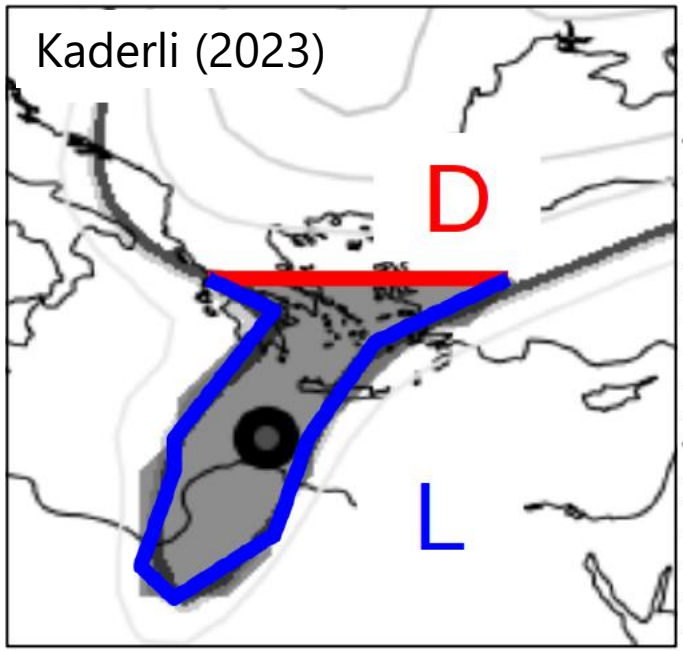
- Daily and monthly ERA5 data for 1979-2019 winters (DEC-FEB); Rain station data from 21 locations in Israel.
- K-means clustering on 300 hPa Eddy Kinetic Energy maxima.
- Three datas lone tracks, PV streame
- Con ated to c



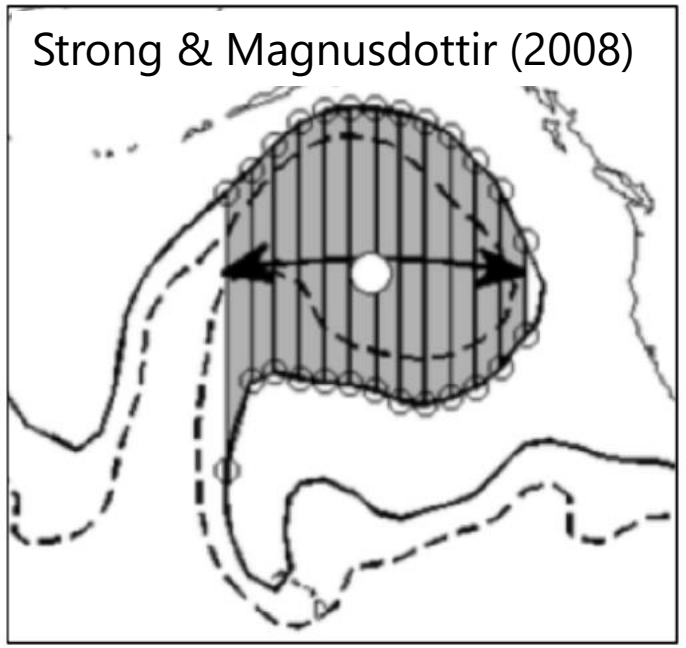
Flaounas et al. (2023)



Kaderli (2023)

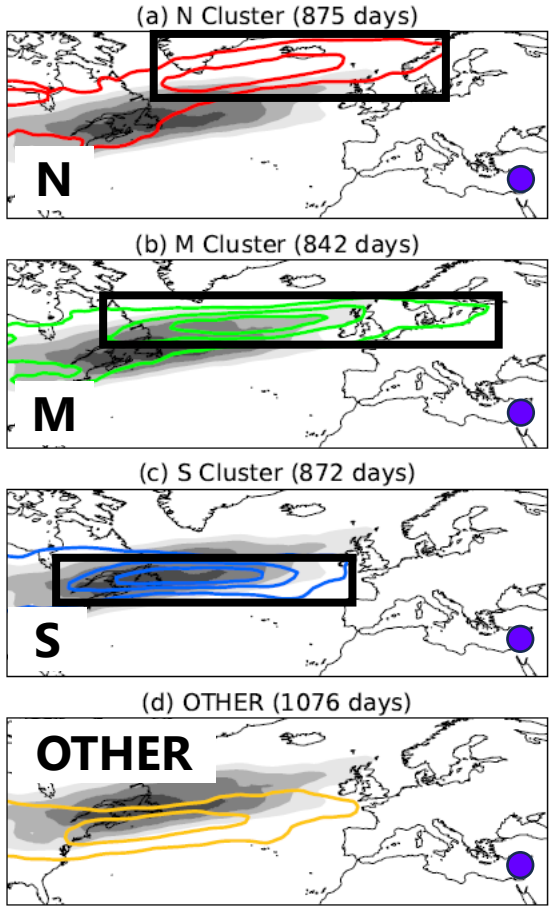


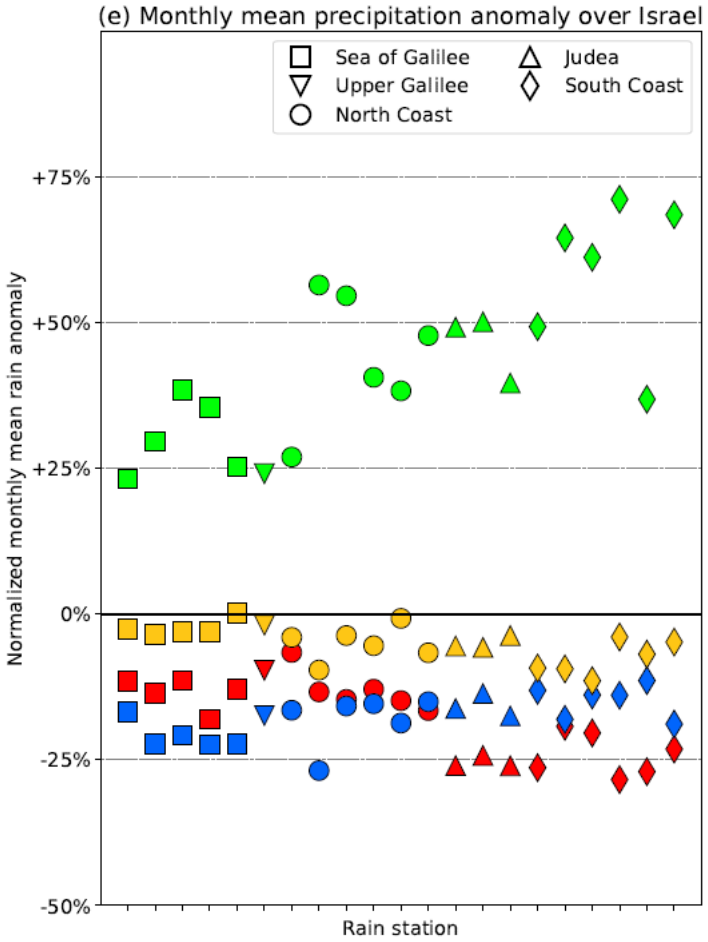
Strong & Magnusdottir (2008)



Storm Track Regimes and Mediterranean Precipitation

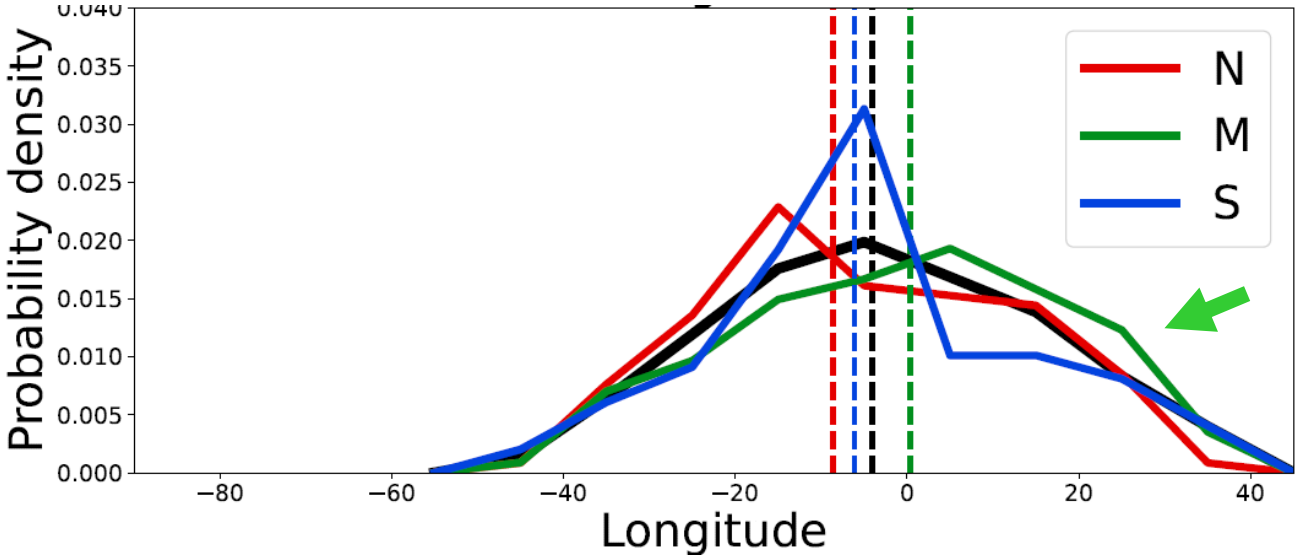
- Clusters vary in latitude position and zonal extent.
- The M cluster reaches further into Scandinavia and increases monthly precipitation by 25-75%.
- Goldilocks behavior: when the storm track is shifted too northward (N) or southward (S), rain decreases by ~20%.





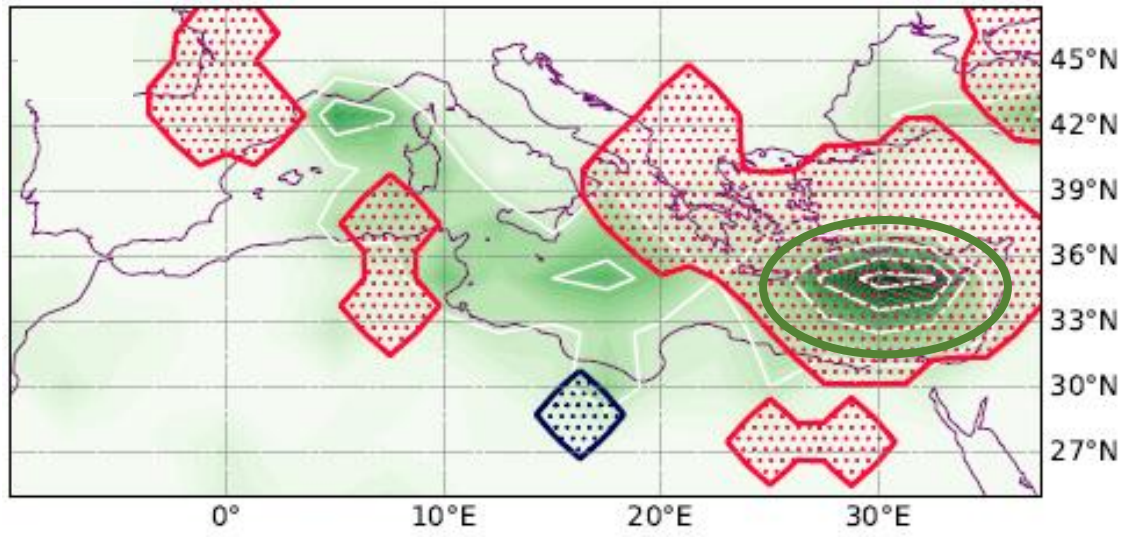
Changes Along the Dynamical Chain

Rossby wave breaking by longitude



During M cluster months, RWBs tend to form further east…

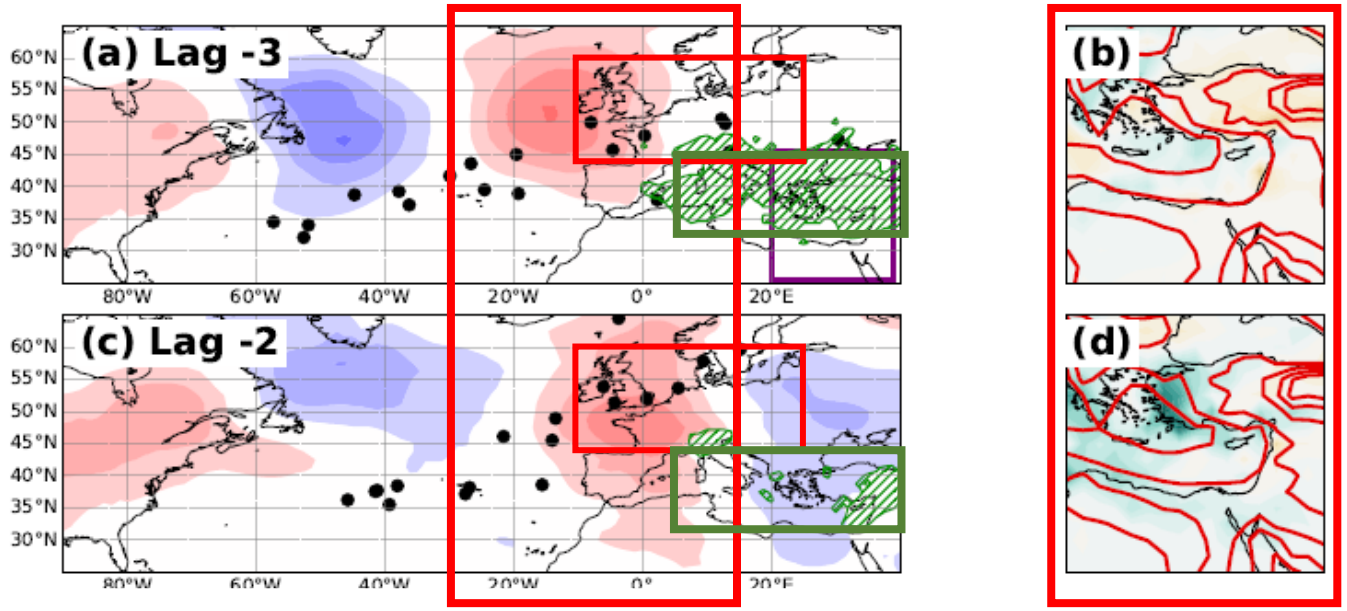
Cyclone track and PV streamer density



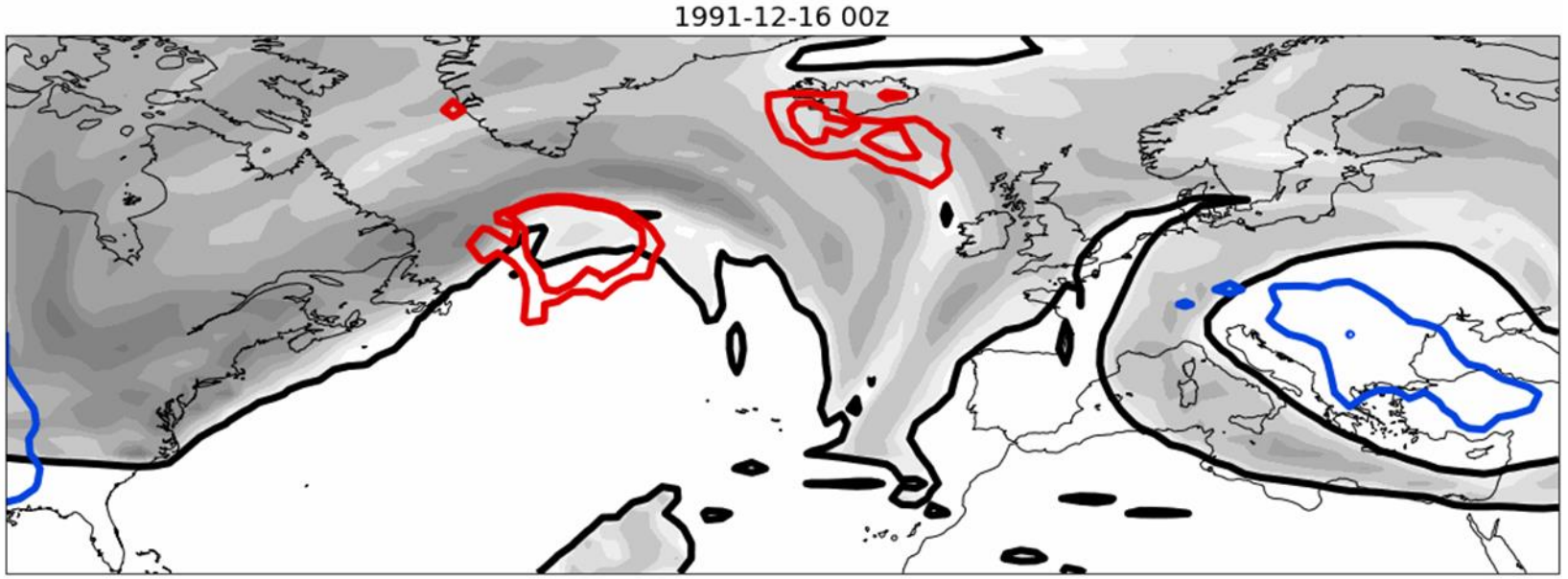
…which leads to more PV streamers (red hatches) and cyclones (green shading) over the E. Mediterranean

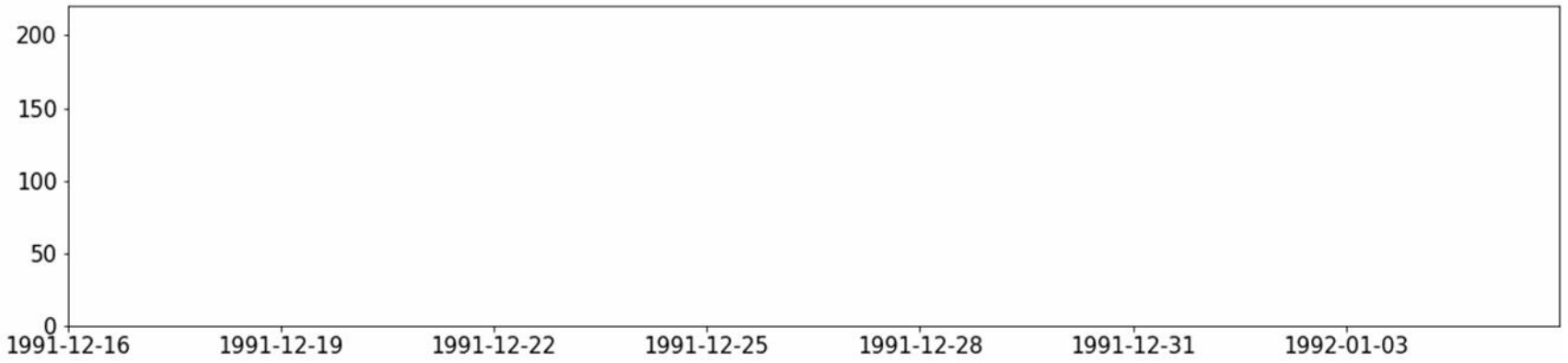
Time Evolution of a Rain Enhancing Event

- Time lagged composite of 60 M cluster events (6+ days), centered around maximum precipitation.
- A zonal SLP wave (shading) precedes the event, creating a high over the W. Mediterranean.
- RWBs (black markers) form north of the Mediterranean, creating more PV streamers downstream.
- A composite low (red contours) crosses the E. Mediterranean, producing strong rainfall.



A Test Case of an Extreme Winter (1991-1992)





850 hPa v'T'

SLP high

200 hPa PV

Anticyclonic RWB

Accumulated precipitation over Israel

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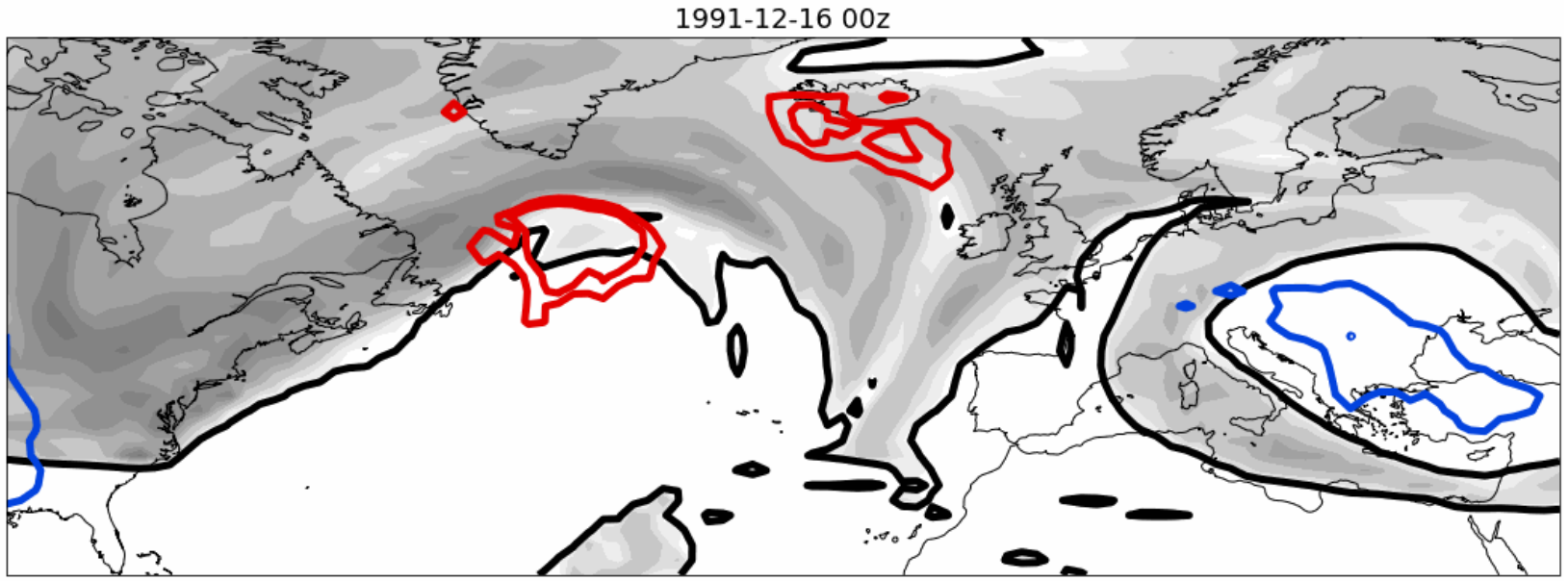

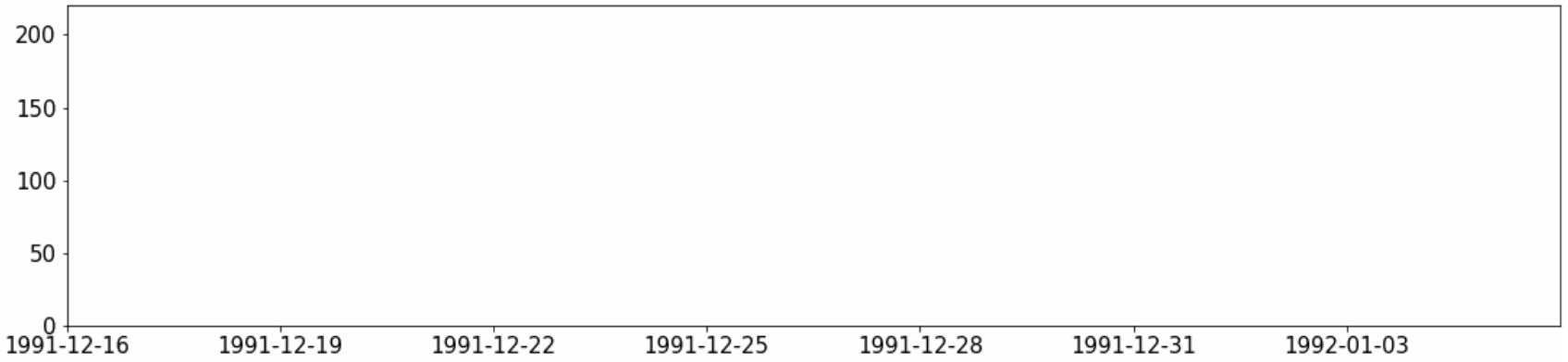

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Conclusions

- North Atlantic storm track regimes influence cyclonic activity downstream.
- The Atlantic-Mediterranean dynamical chain links the two regions. The perturbation-propagation-interaction sequence is frequent under the M cluster (composites and test cases).
- When extratropical storms reach further east, more PV is propagated to the Eastern Mediterranean. This increases instability and baroclinicity, enhancing rainfall.
- For other regimes (track shifted too northward or too southward), cyclogenesis is reduced in the Eastern Mediterranean and drier conditions emerge.

FOR MORE DETAILES:

Sandler, D., Saaroni, H., Ziv, B., Tamarin-Brodsky, T., & Harnik, N. (2024). The Connection Between North Atlantic Storm Track Regimes and Eastern Mediterranean Cyclonic Activity. *EGUsphere*, *2024*, 1-22