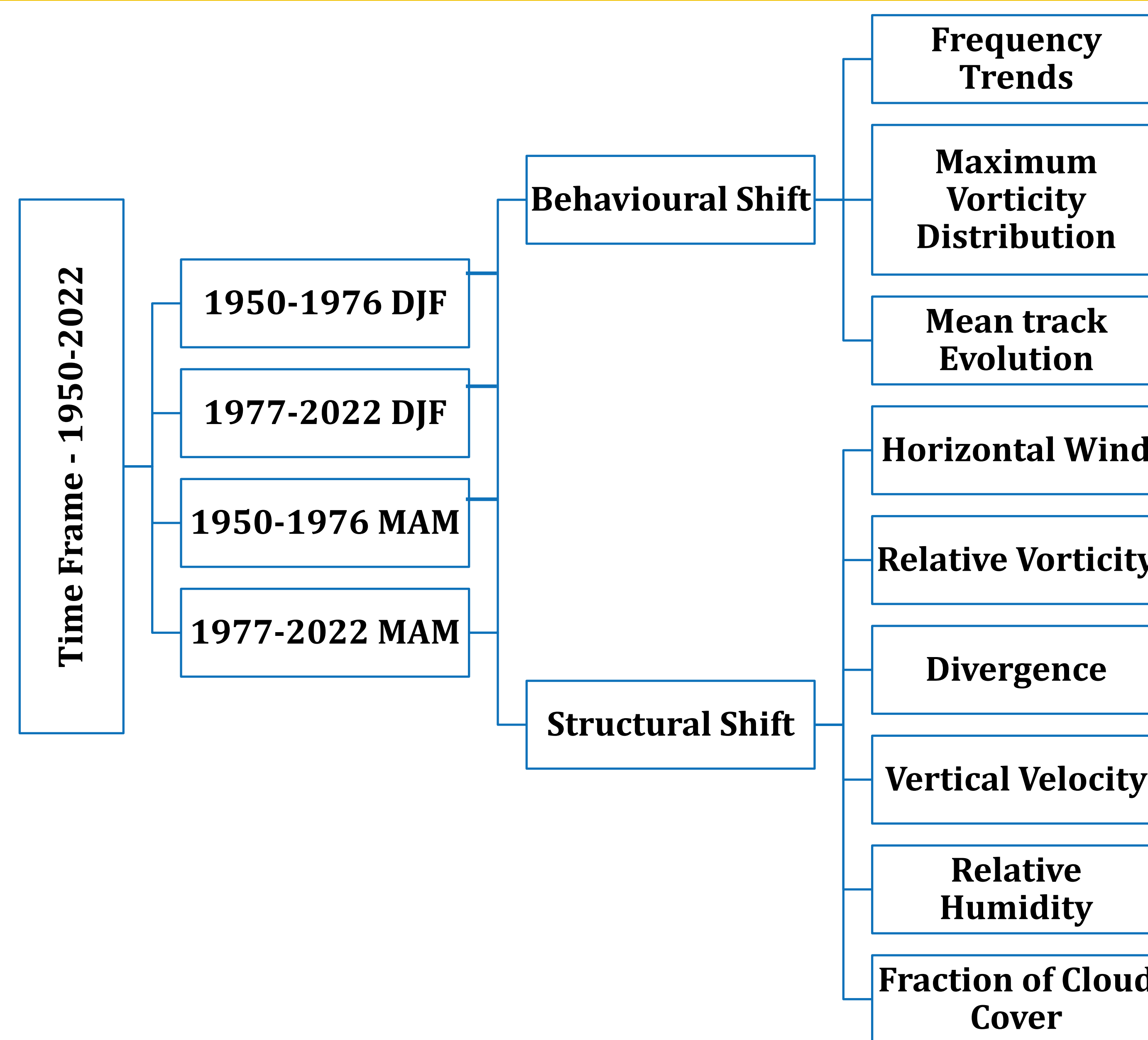


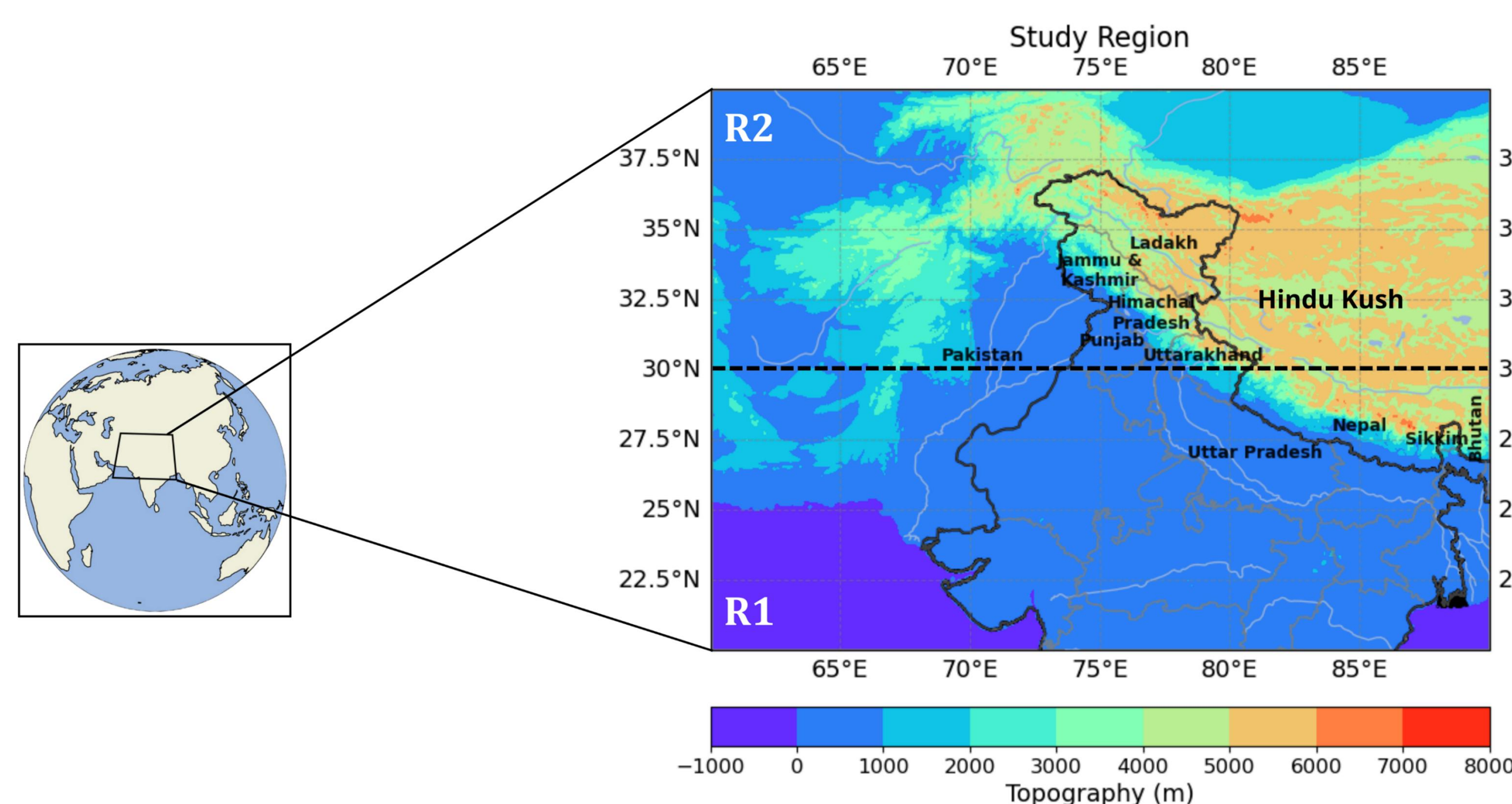
1. Motivation and Background

- Western Disturbances (WD) are extratropical low-pressure systems dominant in winter months.
- Recently, their activity has been increasingly observed during the pre-monsoon (March-May), yet systematic analyses of this shift remain sparse.
- The study evaluates behavioural and structural changes in WDs across two distinct periods (1950–1976 and 1977–2022). ERA5 postprocessed daily statistic dataset of different atmospheric variables and WD track data from Hunt et al. (2018) has been used in this study.

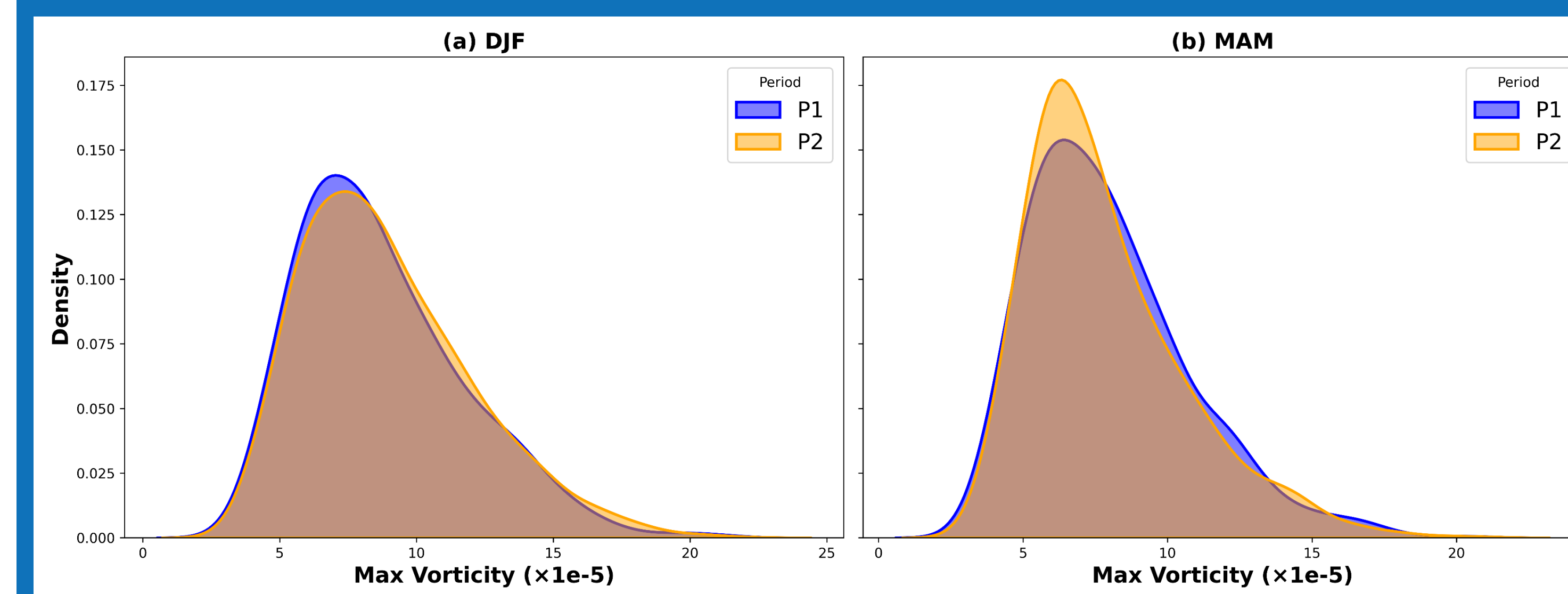
2. Methodological Overview



3. Study Region



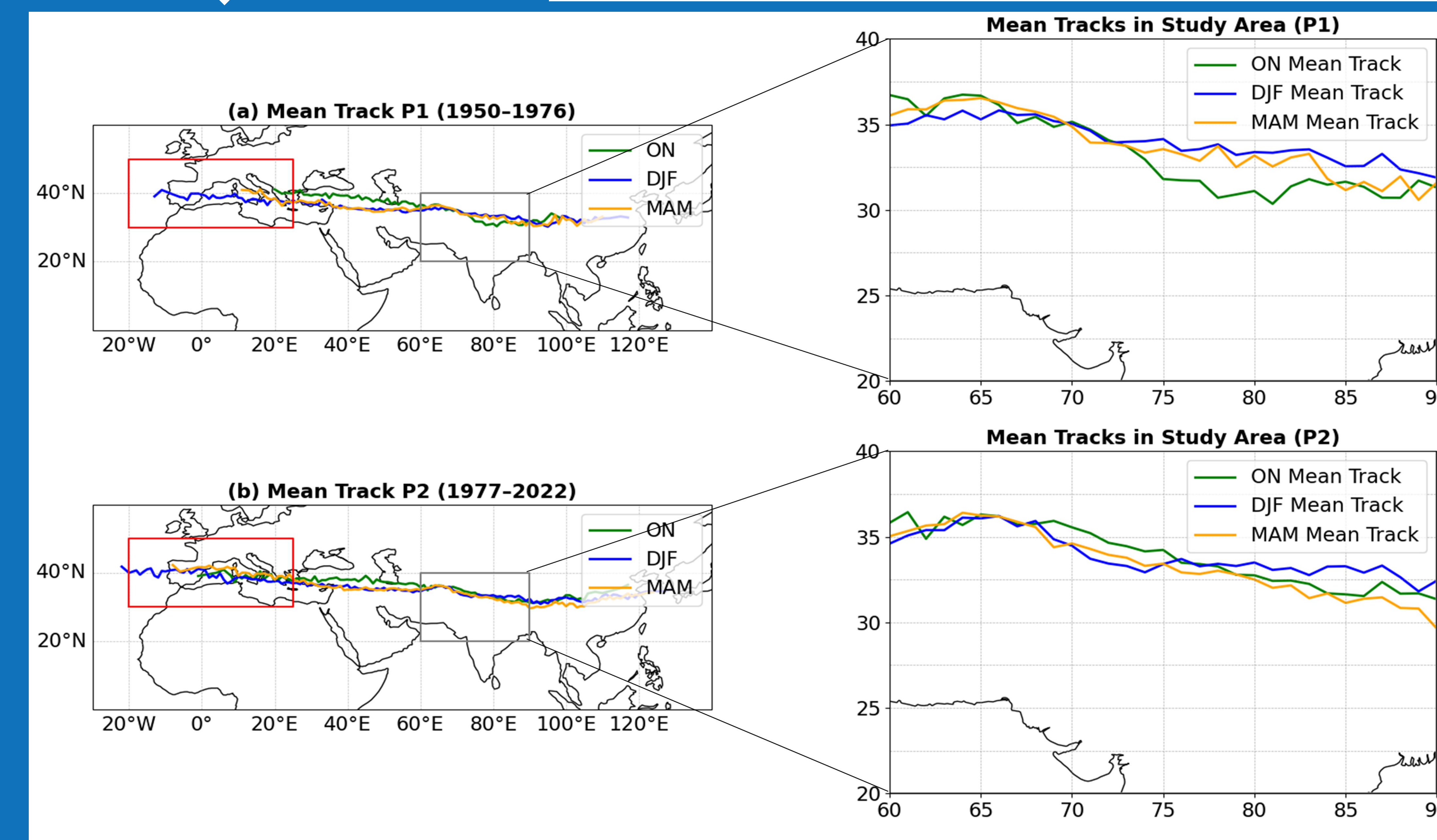
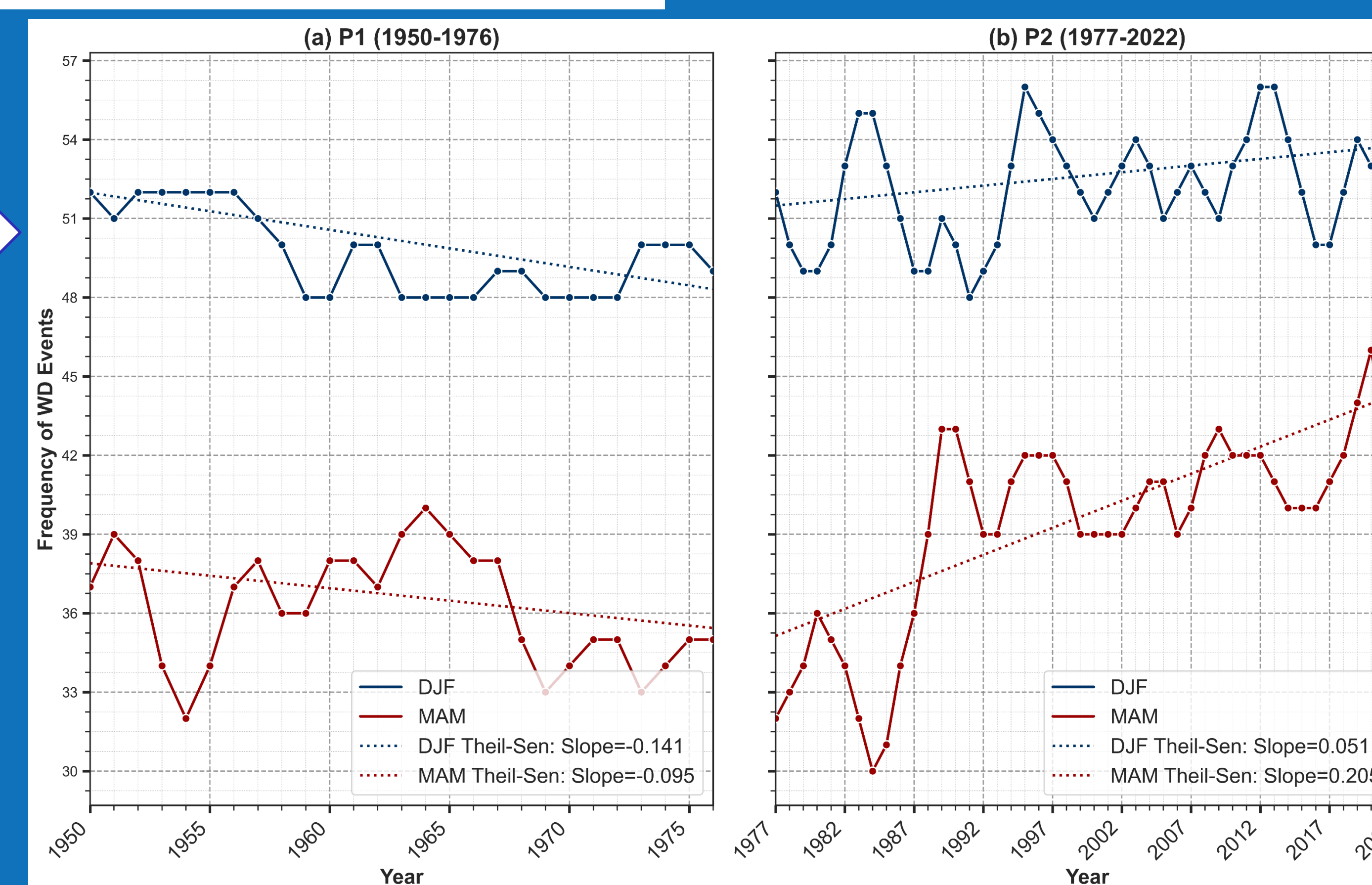
4. Behavioural Shift in WDs



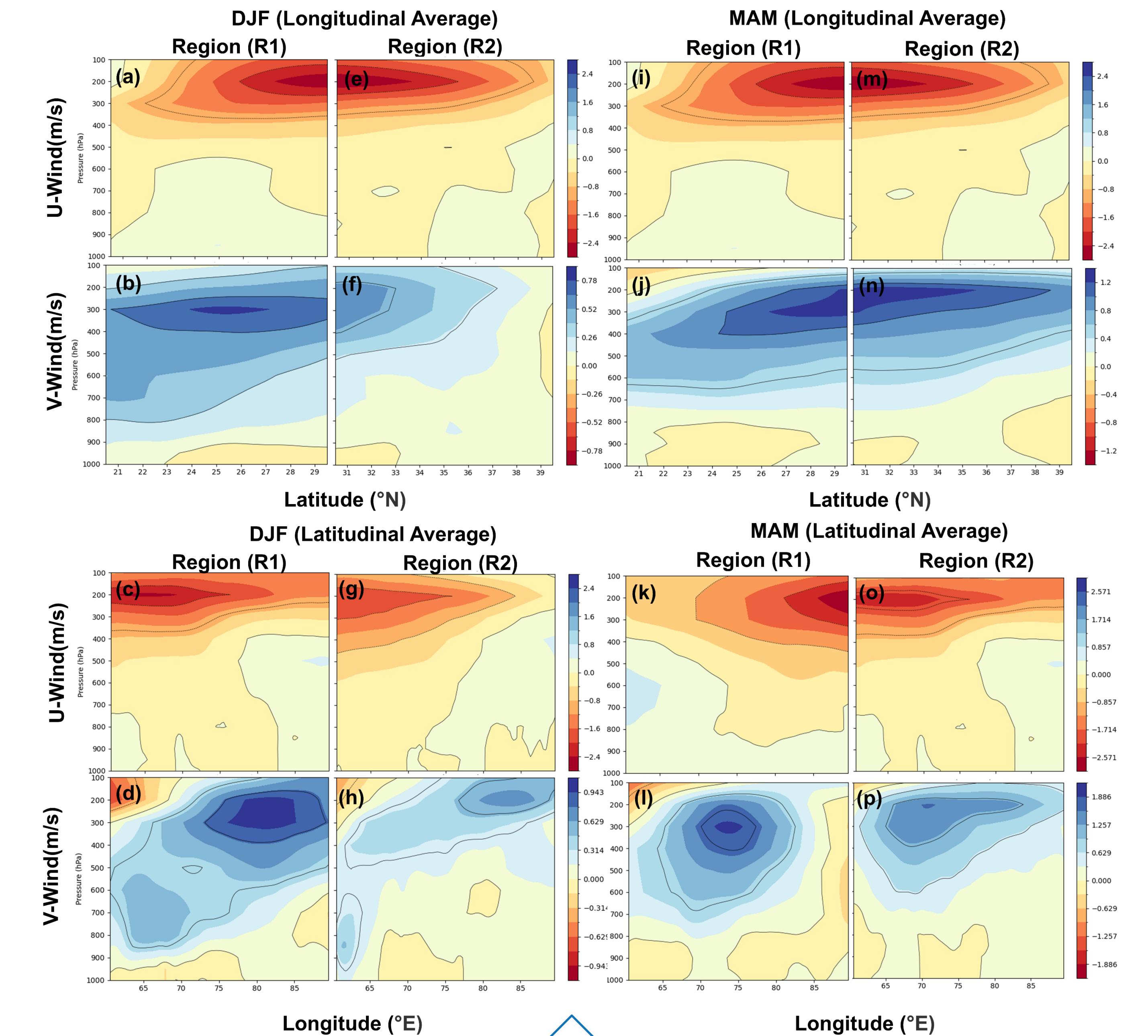
DJF and pre-monsoon KDEs indicate shift toward more frequent high-vorticity WD events in recent decades, despite sharper peak.

While WD frequency in DJF maintains stability in the long term, a significant uptick in pre-monsoon WD frequency can be observed.

The tracks in DJF and MAM shows westward displacement of origin, indicating development of longer tracks in recent decades.



5. Structural Evolution of WDs



The contour figures depict the difference (P1-P2) in composite vertical anomalies during the DJF and MAM seasons along the passage of WDs across two latitudinal zones: R1 and R2. The key physics depict the strengthening of upper-level U-winds, weakened poleward flow (V-winds), enhanced yet shallower convective activity in recent decades, especially during MAM.

6. Key Findings

- WD Frequency Stable during DJF but significant rise during MAM- shifting of dominant season from DJF to DJF and MAM.
- Westward shift in origin and longer mean tracks - more persistent systems with enhanced moisture transport potential.
- Structurally, intensified zonal winds and weakened poleward flow - strengthened subtropical jet.
- Overall, WDs becoming more dynamic and hydro meteorologically impactful in recent decades.

References and Publication Link:

- Hunt et al. (2025)
- Ahmed et al. (2022)
- Hunt et al. (2018)
- Roxy et al. (2017)
- Madhura et al. (2015)

