

Dynamics of the Asian Summer Monsoon Anticyclone

Insights from potential vorticity tendency diagnostics

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KEY FINDING

Three robust ASMA vortex modes emerge across reanalysis; advection steers their motion while diabatic heating modulates their strength.

STUDY QUESTION & DATA

The Asian Summer Monsoon Anticyclone (ASMA) dominates the boreal-summer UTLS. Its centers move, split and shed eddies, so a single-vortex view can miss key structure.

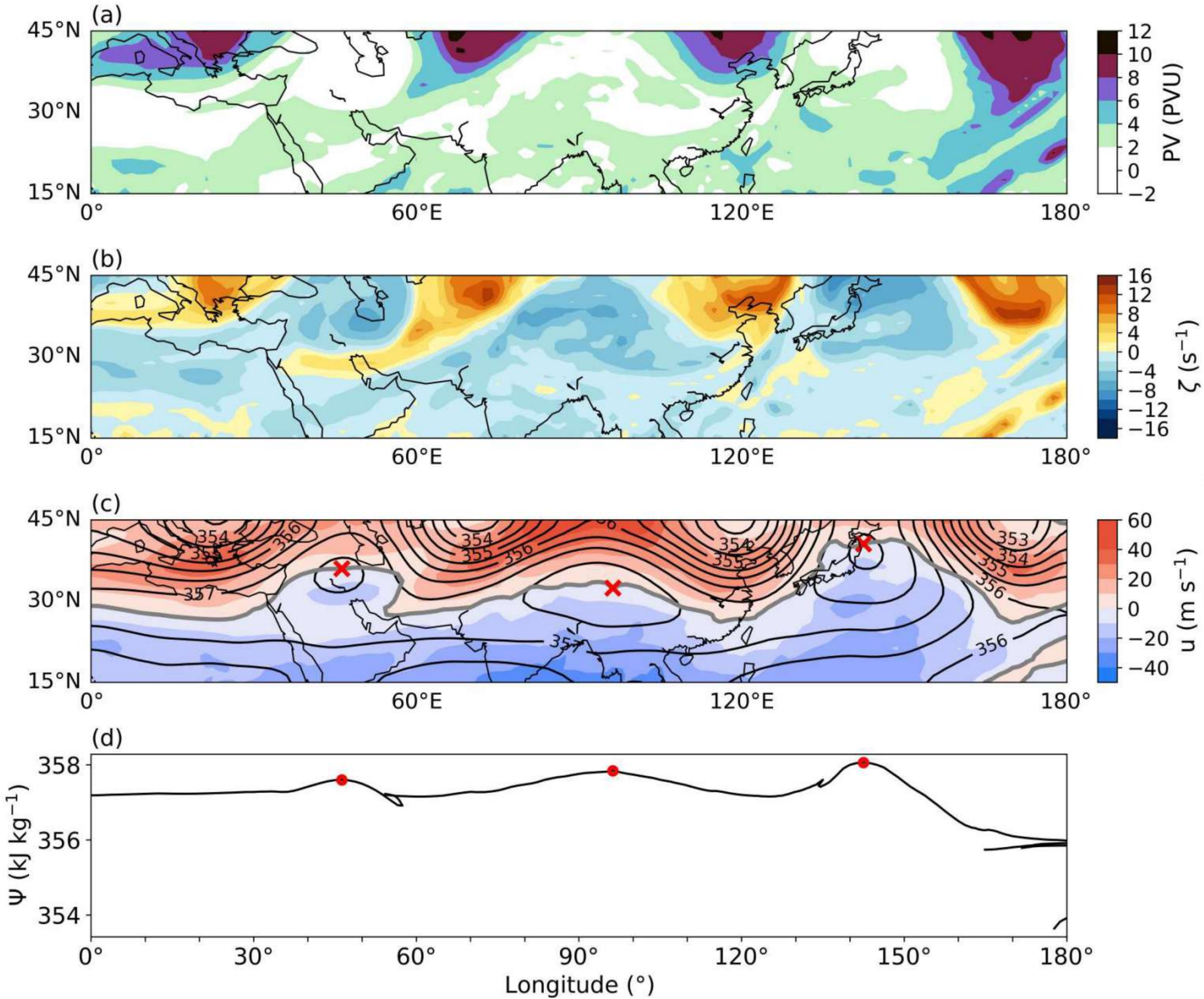
ERA5 · JRA-3Q · MERRA-2 | May–September 2000–2020 | 6-hourly | 1.25° grid | 100 hPa and 370 K level

MULTI-CENTER VORTEX TRACKING

- 1 Locate the $u = 0$ ridge within 15–45°N, 0–180°E.
- 2 Find local Montgomery stream-function maxima along the ridge.
- 3 Filter by anticyclonic vorticity, wind reversal and contour length; link centers through time.

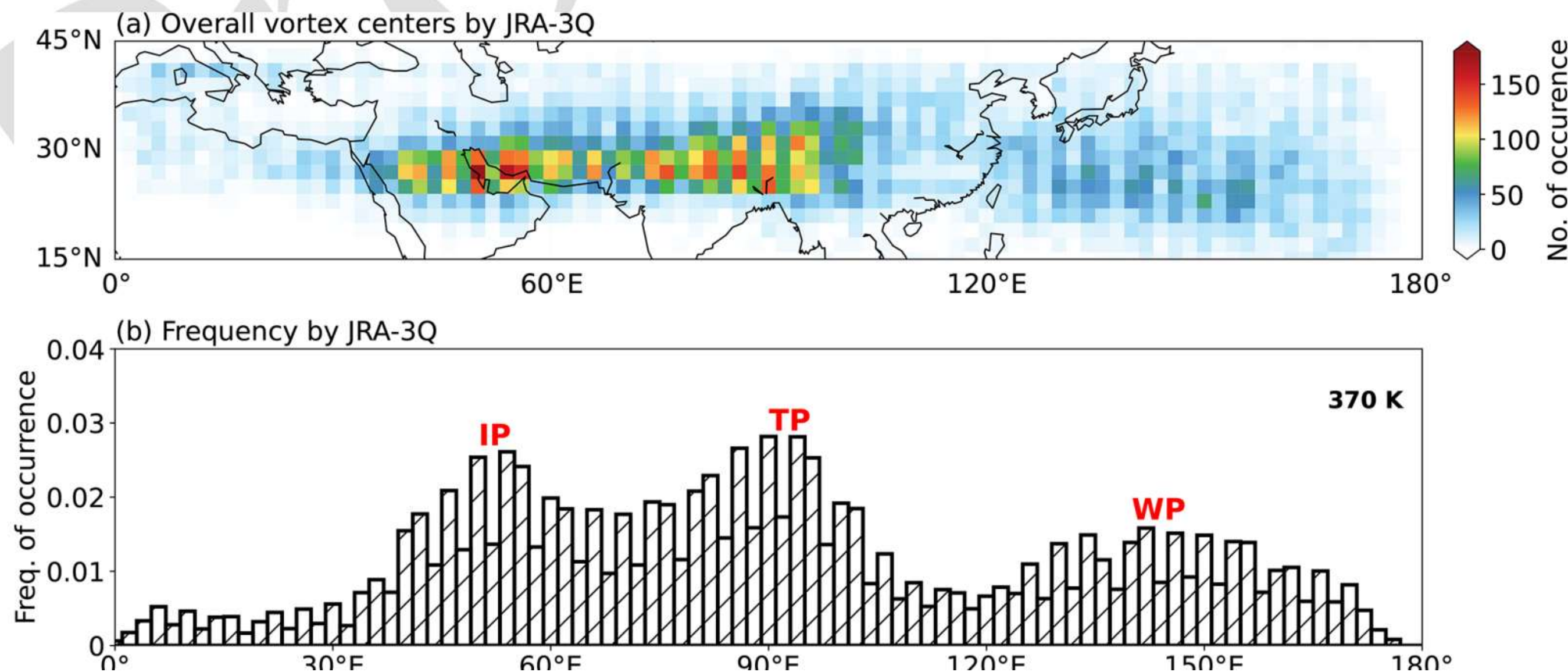
Persistent centers: $\leq 10^\circ$ displacement per step and detected for ≥ 4 consecutive 6-hourly times (> 18 h). $> 65\%$ of detections are persistent in ERA5 and JRA-3Q.

FIGURE 1 · IDENTIFYING VORTEX CENTERS



JRA-3Q snapshot at 370 K, 17 Aug 2019. Red crosses mark centers identified as local MSF maxima along the $u = 0$ ridge.

FIGURE 2 · WHERE CENTERS OCCUR



JRA-3Q, May–September 2000–2020. Multiple centers can coexist; occurrence peaks mark IP, TP and western Pacific modes.

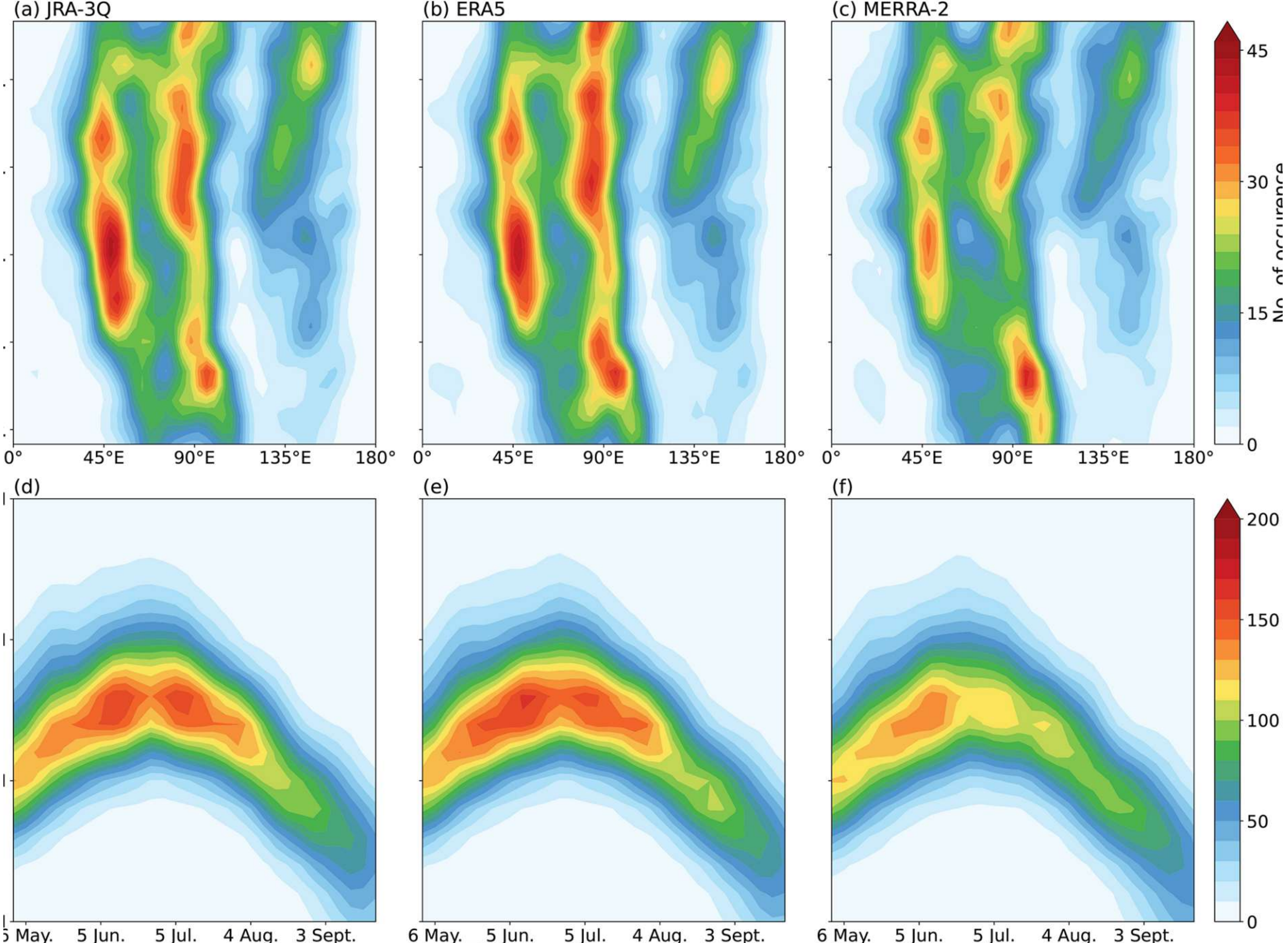
THREE MODES ACROSS THREE REANALYSES

Vortex occurrence shows three longitudinal modes in JRA-3Q, ERA5 and MERRA-2.

Iranian Plateau: $\sim 45\text{--}65^\circ\text{E}$; Tibetan Plateau $\sim 85\text{--}100^\circ\text{E}$

Bonin High/western Pacific: $\sim 135\text{--}150^\circ\text{E}$

FIGURE 3 · SEASONAL EVOLUTION



Vortex occurrence at 370 K, May–September 2000–2020. Columns: JRA-3Q, ERA5, MERRA-2; rows: longitude and latitude phases.

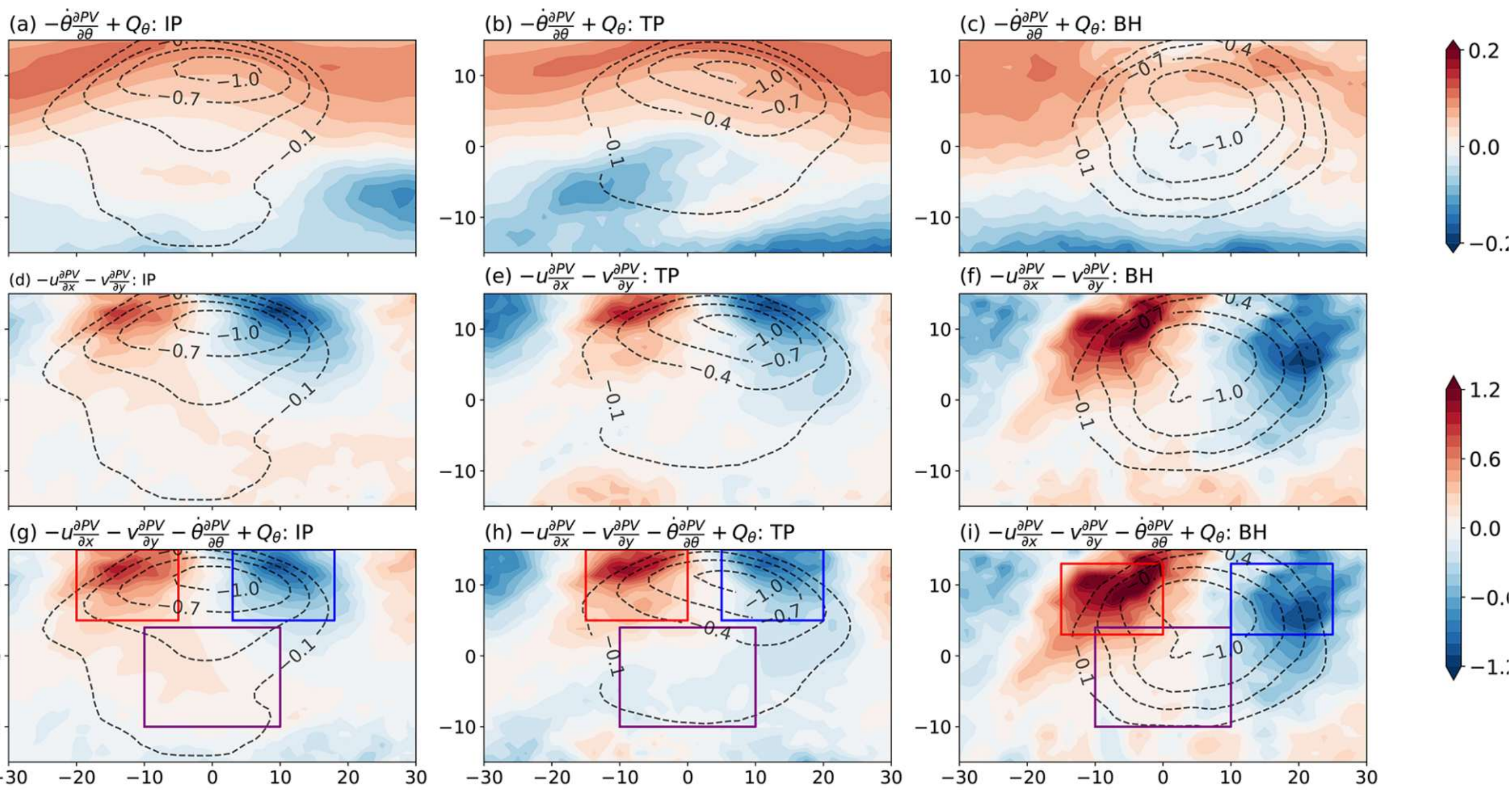
SEASONALITY

TP dominates in May; IP is most prevalent from mid-June to mid-July; TP returns as BH emerges in August–September. Centers migrate north early, reach $\sim 40^\circ\text{N}$ in mid-July to mid-August, then shift south.

PV BUDGET

An advective dipole steers vortex propagation; a mainly diabatic central tendency modulates its intensity.

FIGURE 4 · PV TENDENCY TRIPOLE



At 370 K (JRA-3Q). Rows: diabatic, horizontal advection, combined tendencies; columns: IP, TP, BH.

TAKE-HOME

Advection dominates vortex propagation. A central, mainly diabatic tendency modulates intensity. Latent heating is especially important for TP and BH modes; quantitative attribution differs among reanalysis.

INTERPRET WITH CARE

ERA5 non-radiative heating is a residual, unlike explicit moist-physics terms in JRA-3Q and MERRA-2. Mode intensity is less consistent than the three-mode structure.