

# A Monsoon Bridge Across Continents: Untangling the Strengthening Link Between Indian and Sahel Rainfall

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## Motivation

- Understanding the link between the Indian and Sahelian summer monsoons is important for the livelihoods of millions.
- This study addresses the evolving nature of the interaction between the Sahelian Summer Monsoon and the Indian Summer Monsoon

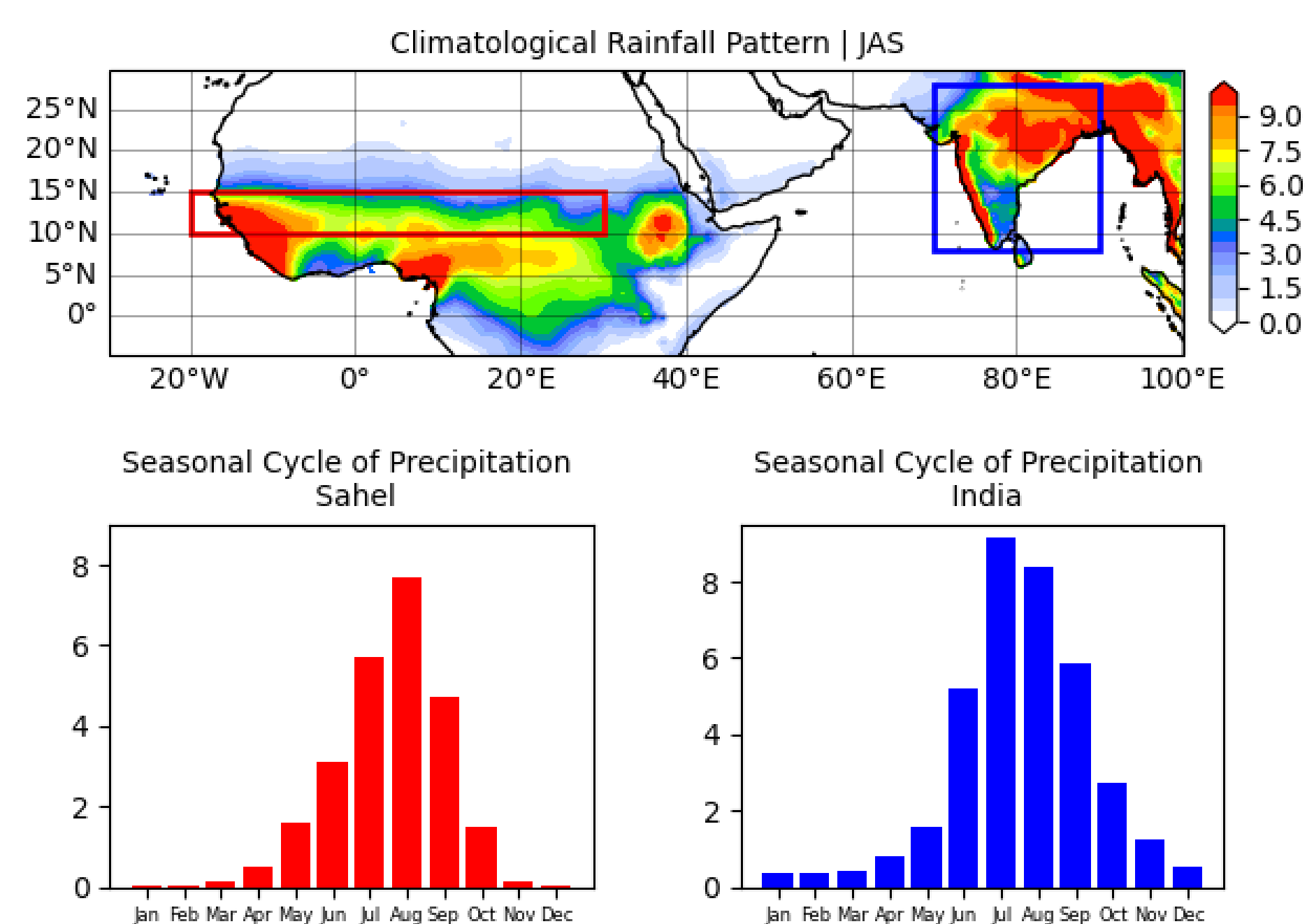
## Data & Methodology

### (a) Datasets

- Monthly Precipitation Dataset have been taken from Climate Research Unit (CRU) at a grid resolution of 0.5° x 0.5°.
- Other Atmospheric variables have been taken from ERA5 at a spatial resolution of 0.25° x 0.25°

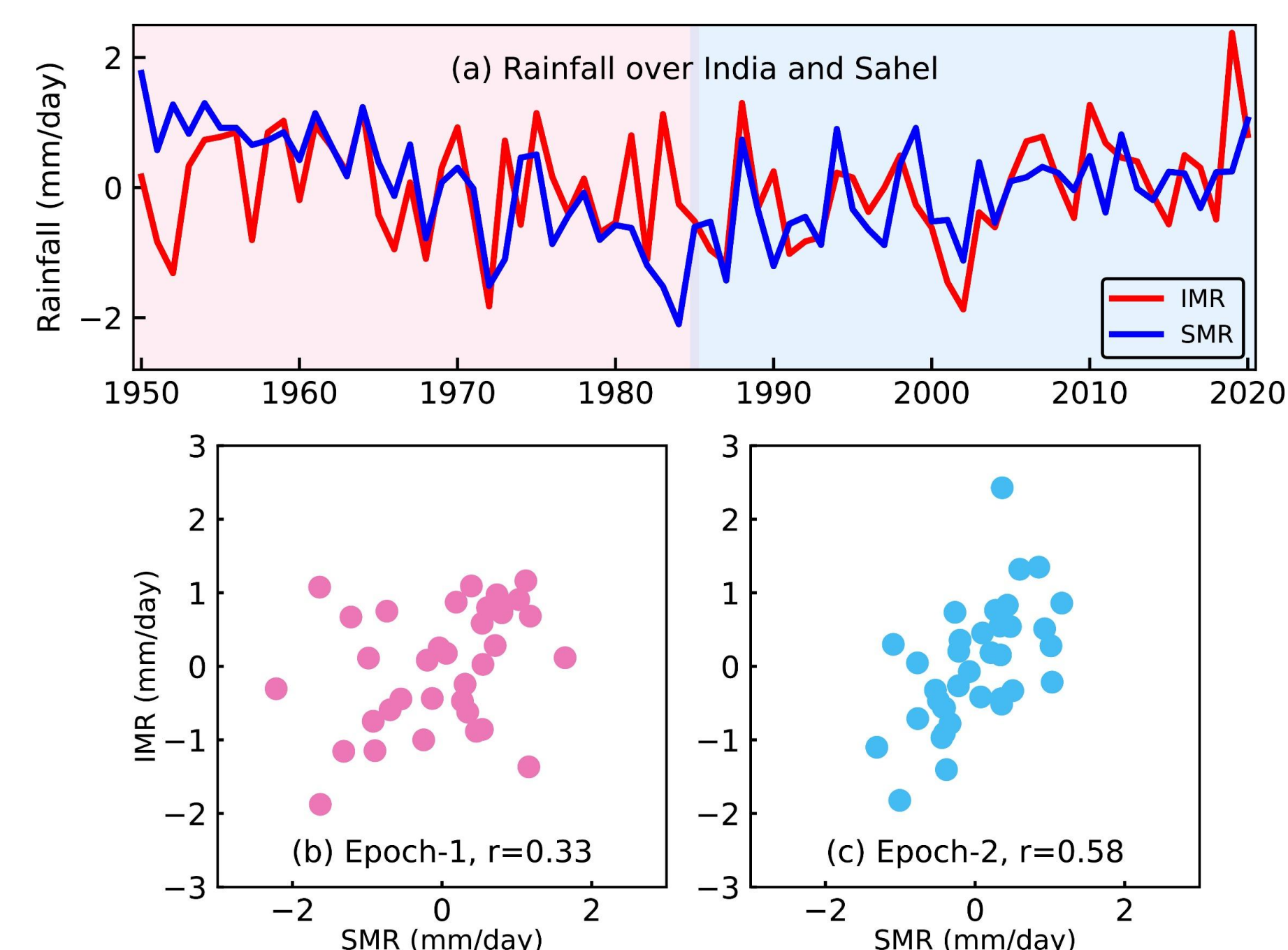
### (b) Methodology

- Season Definition (JAS):** Monsoon season characterized using **July–August–September (JAS)** averages.
- Indian Monsoon Rainfall (IMR):** Area averaged rainfall over 8°N–28°N, 70°E–90°E.
- Sahelian Monsoon Rainfall (SMR):** Area averaged rainfall over 10°N–15°N, 20°W–30°E.
- African Easterly Jet (AEJ):** Zonal winds between 500–700 hPa averaged over 10°N–20°N, 20°W–30°E
- Potential Vorticity (PV) =  $\frac{\bar{\omega}_a \cdot \bar{\nabla} \theta}{\rho}$

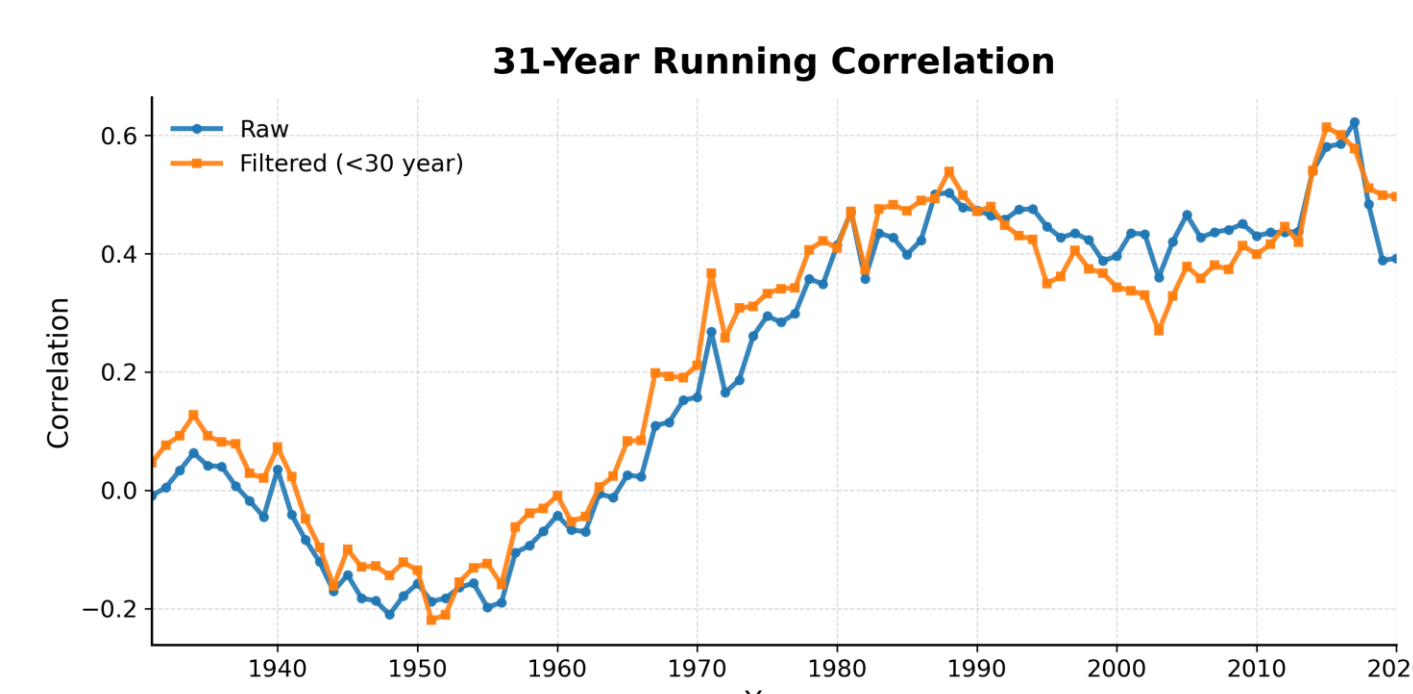


## Results

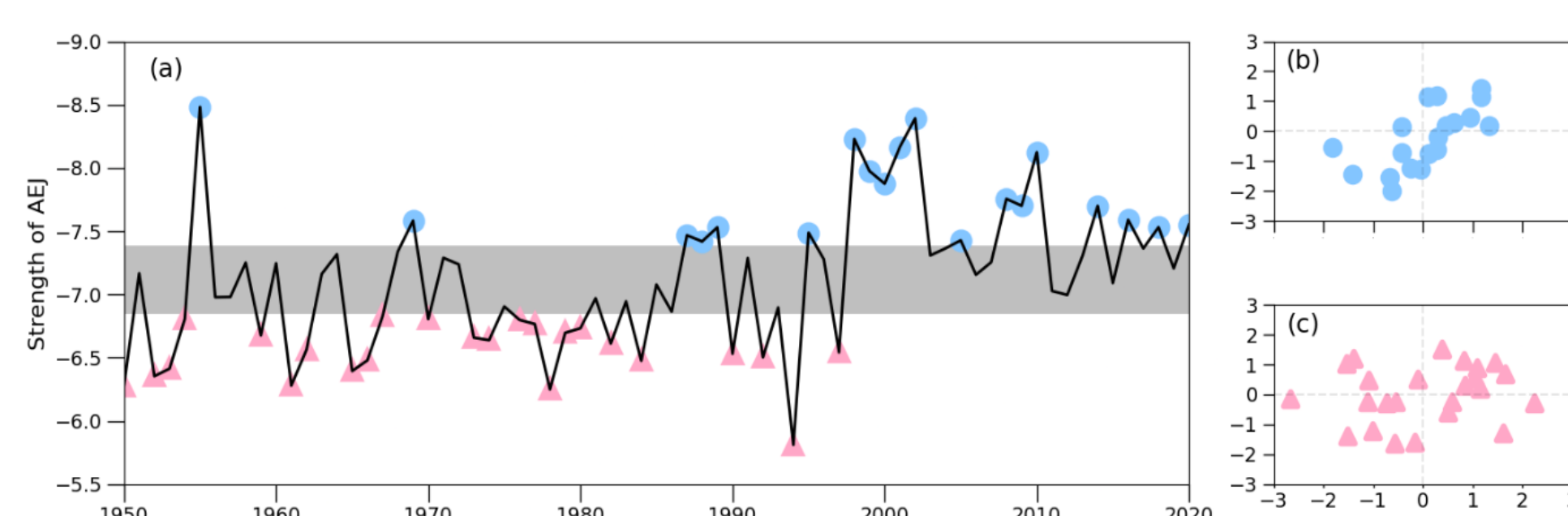
### (a) Evolution of Coupling Strength



- Strengthened IMR–SMR Link:** Correlation increases from **0.33 (1950–1984)** to **0.58 (1985–2020)**, indicating stronger coupling in recent decades.
- Robust Long-Term Trend:** Running correlation shows a **gradual increase** rather than a sharp decadal shift, and this strengthening persists even after removing the decadal cycle from each rainfall time series.

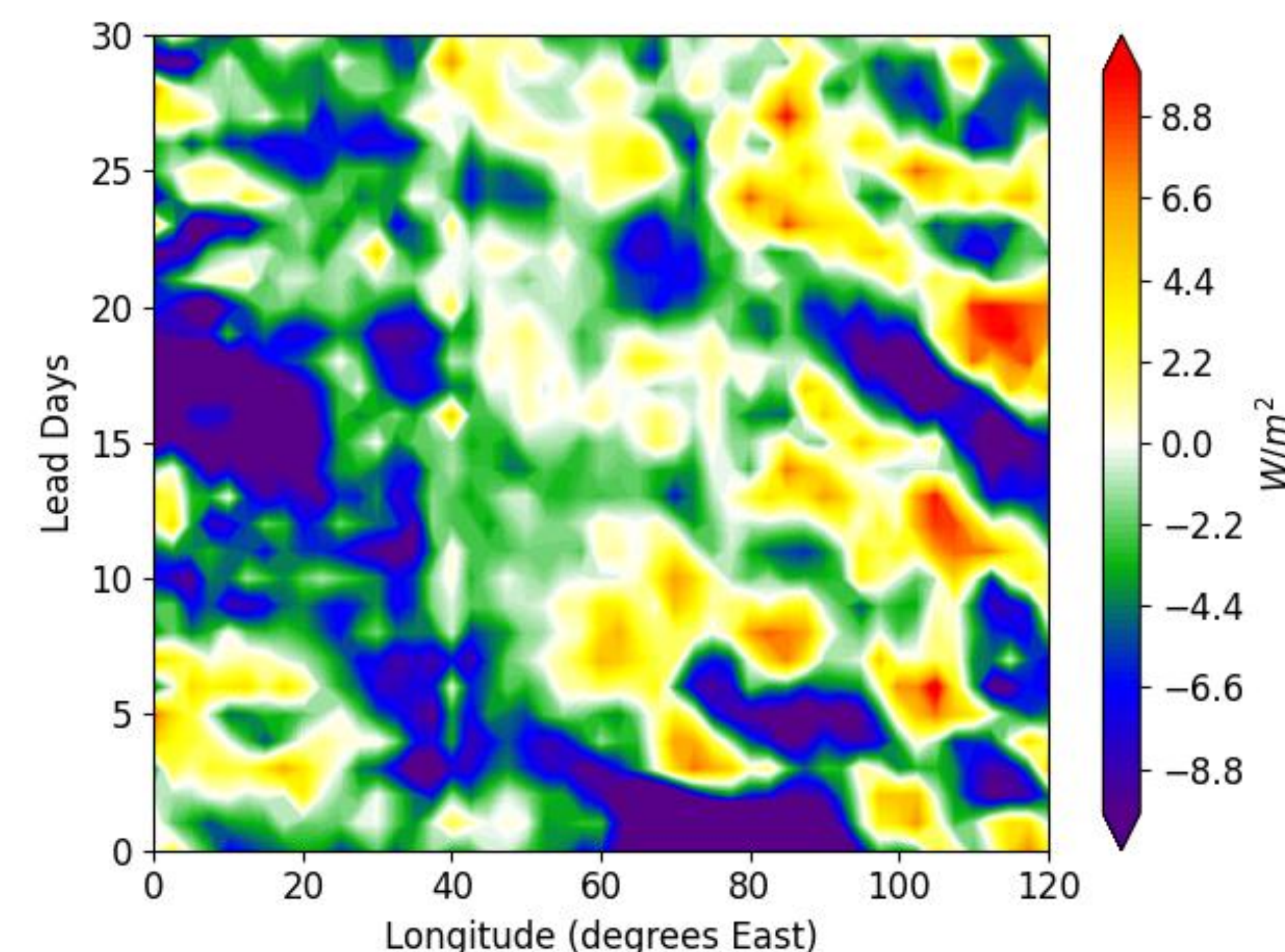


### (b) Role of African Easterly Jet



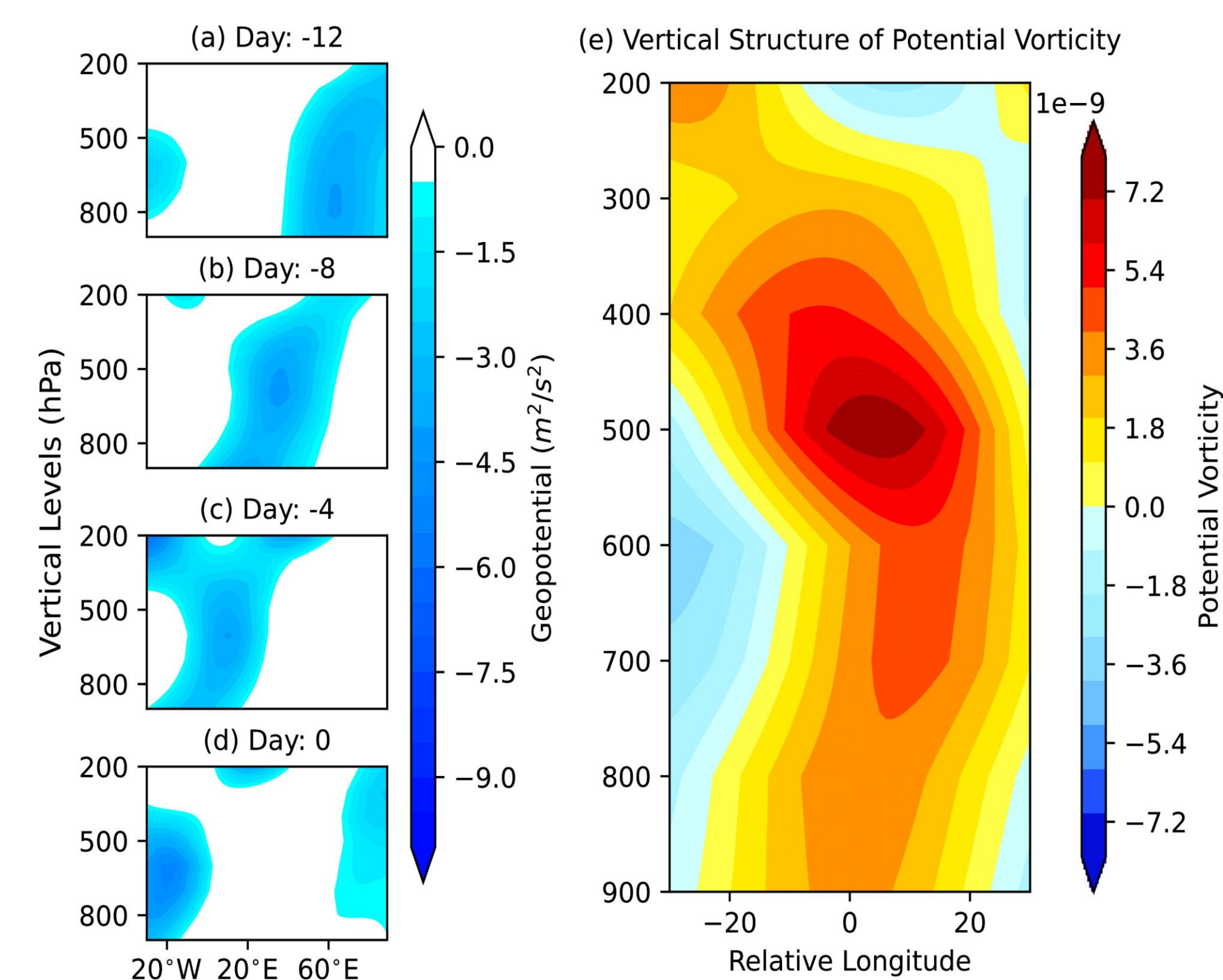
- AEJ-Modulated Coupling:** Compositing by AEJ strength reveals clear separation, **strong AEJ** years show high IMR–SMR correlation (**0.79**), while **weak AEJ** years show much lower correlation (**0.29**).
- Recent Strengthening of AEJ:** The frequency and intensity of **strong AEJ** years have increased in recent decades (**1985–2020**), consistent with the observed strengthening of IMR–SMR coupling.

### (c) Westward Propagating Mode



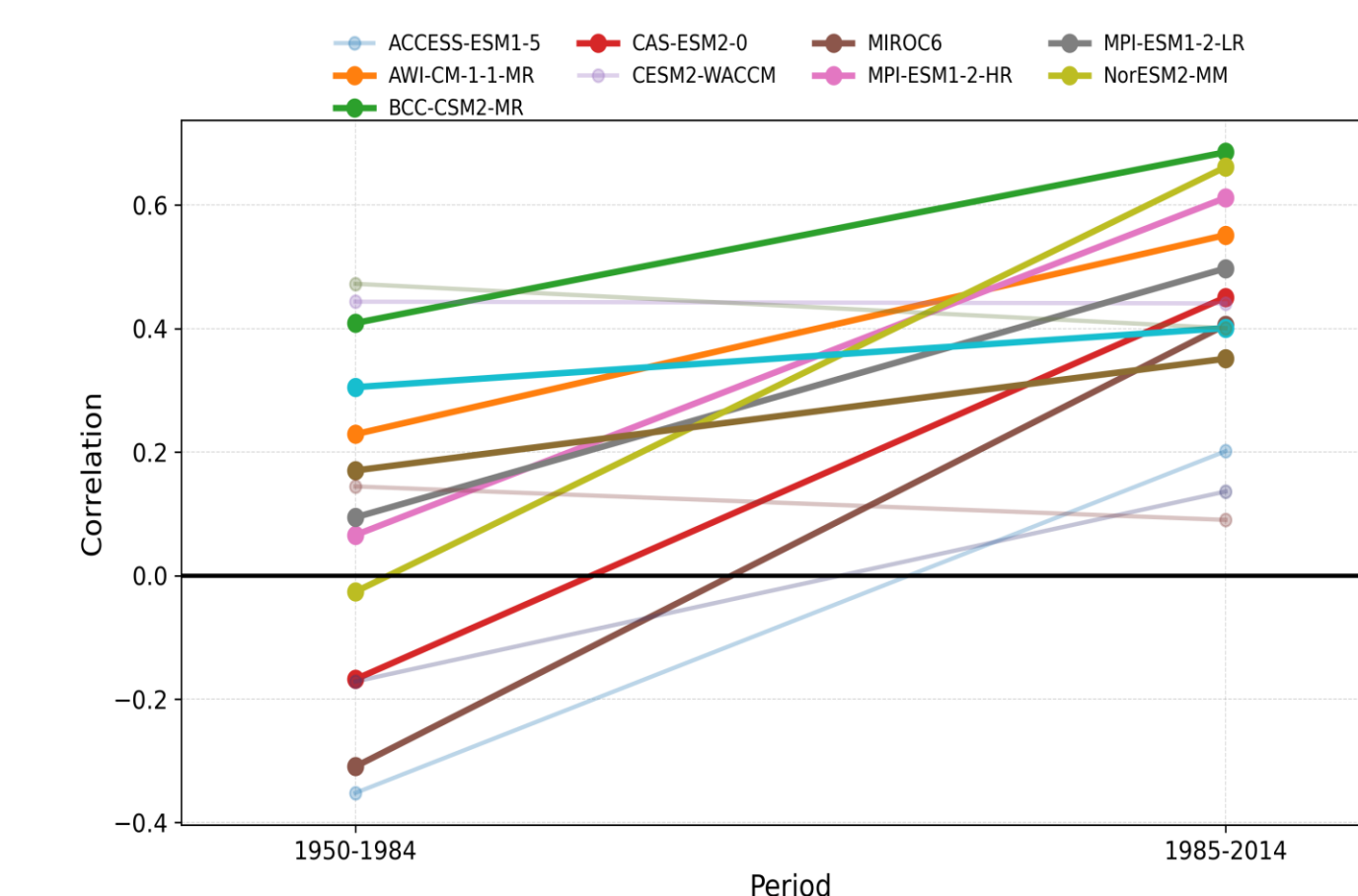
- The Hovmöller diagram of 10–20°N-averaged OLR anomalies shows a westward propagation of negative OLR anomalies.
- This signal extends from the Indian and Arabian Sea region all the way to West Africa

### (d) Vertical Structure

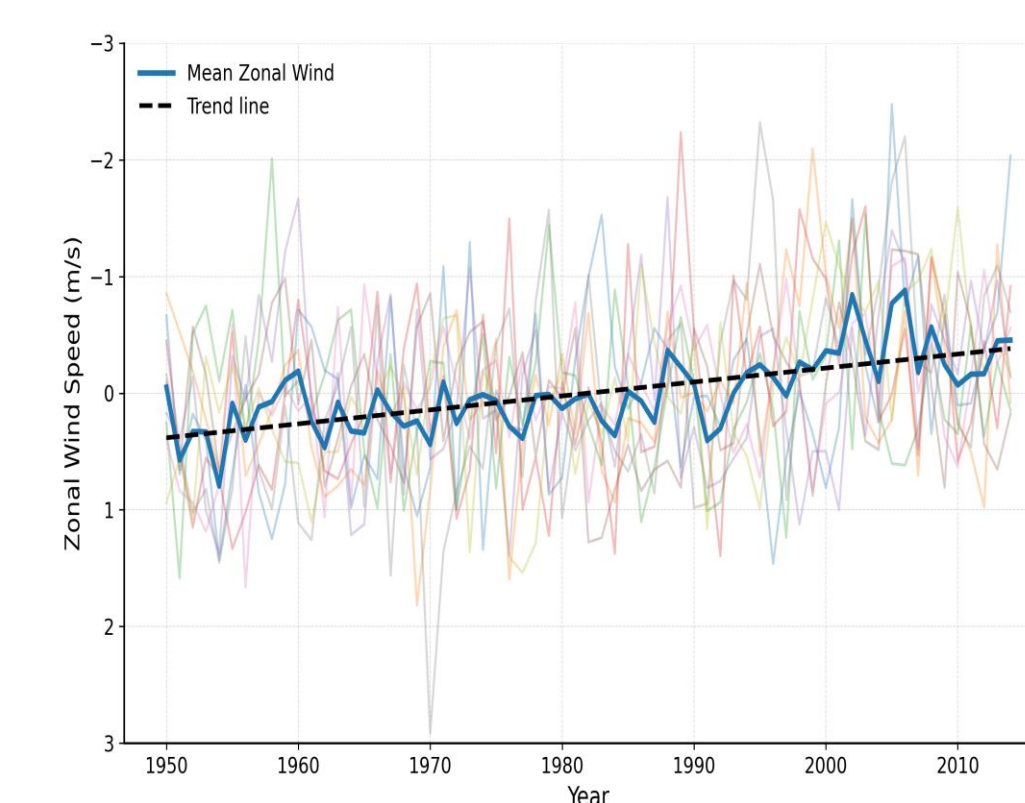


- Filtering and propagation:** Data filtered for 10–20-day variability and zonal wavenumbers  $\leq 6$  in geopotential and PV reveals a distinct westward-propagating system which originates at the Indian longitudes.
- These waves have a **mid-tropospheric PV** core near the AEJ; a stronger AEJ enhances their westward advection, strengthening IMR–SMR coupling.

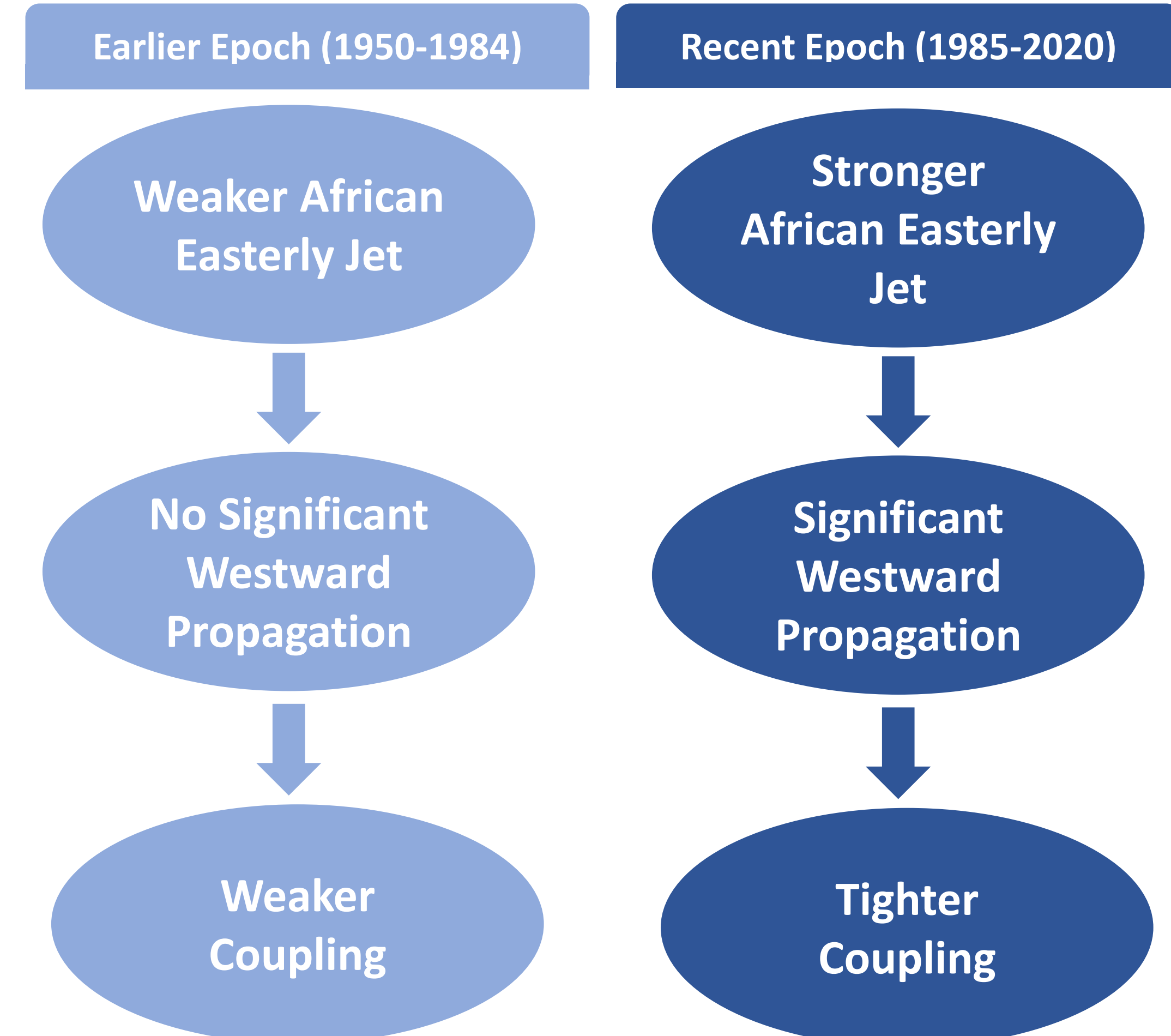
### (e) Validation through CMIP6 Data



- CMIP6 Validation:** Analysis of 14 historical simulations shows 9 models reproduce the increasing IMR–SMR correlation.
- All **9 models** that capture this trend also show a **strengthening of the AEJ**, supporting its role in enhanced coupling.



## Conclusions



## References:

Bordoloi, A., Chakraborty, A., & Nanjundiah, R. S. (2025). Enhanced covariability of Indian and Sahelian summer monsoons in recent decades. *Environmental Research Communications*, 7(12), 121006.