

Mechanism on the epochal shift in translation speed of tropical cyclones formed over the Bay of Bengal region

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Introduction

Tropical Cyclones Translation Speed (TCTS), is the rate at which tropical cyclones move across a region and plays a critical role in determining the extent of TC-induced destructiveness to the densely populated coastal communities and economies.

- TCTS was recognized as important TCs characteristics other than their inherent characteristics such as size and intensity, as slow-moving storms can produce stronger local impacts with its effects in terms of catastrophic flooding caused by the stronger surge and rainfall accumulation, and vice-versa.



Long-term temporal behavior of TCTS over the BoB remained largely under-explored

Datasets & Methodology

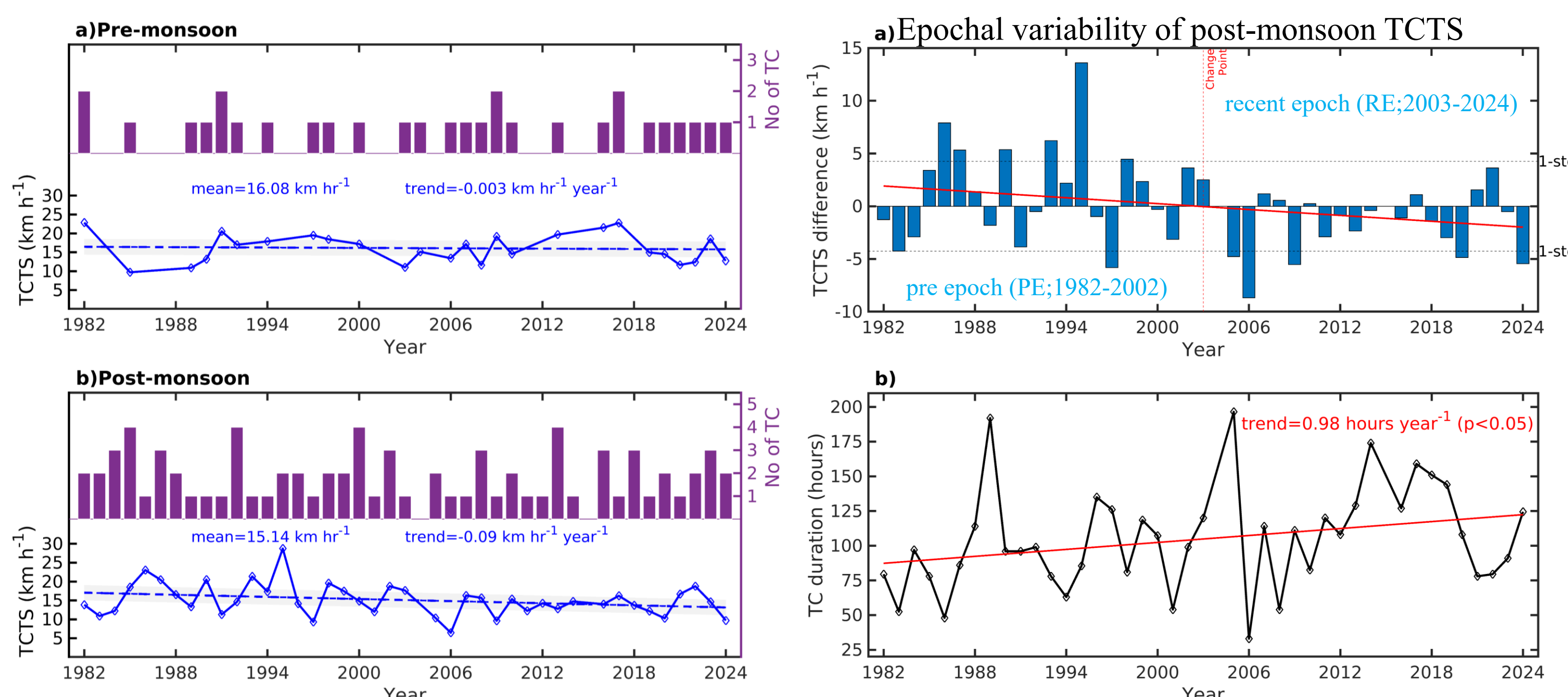
- BoB TCs: best-tracks data for the period spanning 1982 to 2024 provided by the Regional Specialized Meteorological Centre (RSMC), IMD, New Delhi (<http://www.rsmcnewdelhi.imd.gov/>).

- Atmospheric variables including horizontal winds (u , v), and geopotential (z) are retrieved from the 5th generation ECMWF reanalysis (ERA5).

- Translation speed of TCs (TCTS) is estimated based on changes in latitude and longitude between successive best-track positions.
- Mann-Kendall (MK) test, Pettitt test, and Students t-test
- TC removal method proposed by Carl Schreck's (Schreck et al. 2011; Aiyyer et al. 2012)
- Vertically integrated Steering flows, Rossby wave source (RWS), Wave Activity Flux (WAF), and Meridional Mass Stream Function (MSF) diagnostics

Key findings

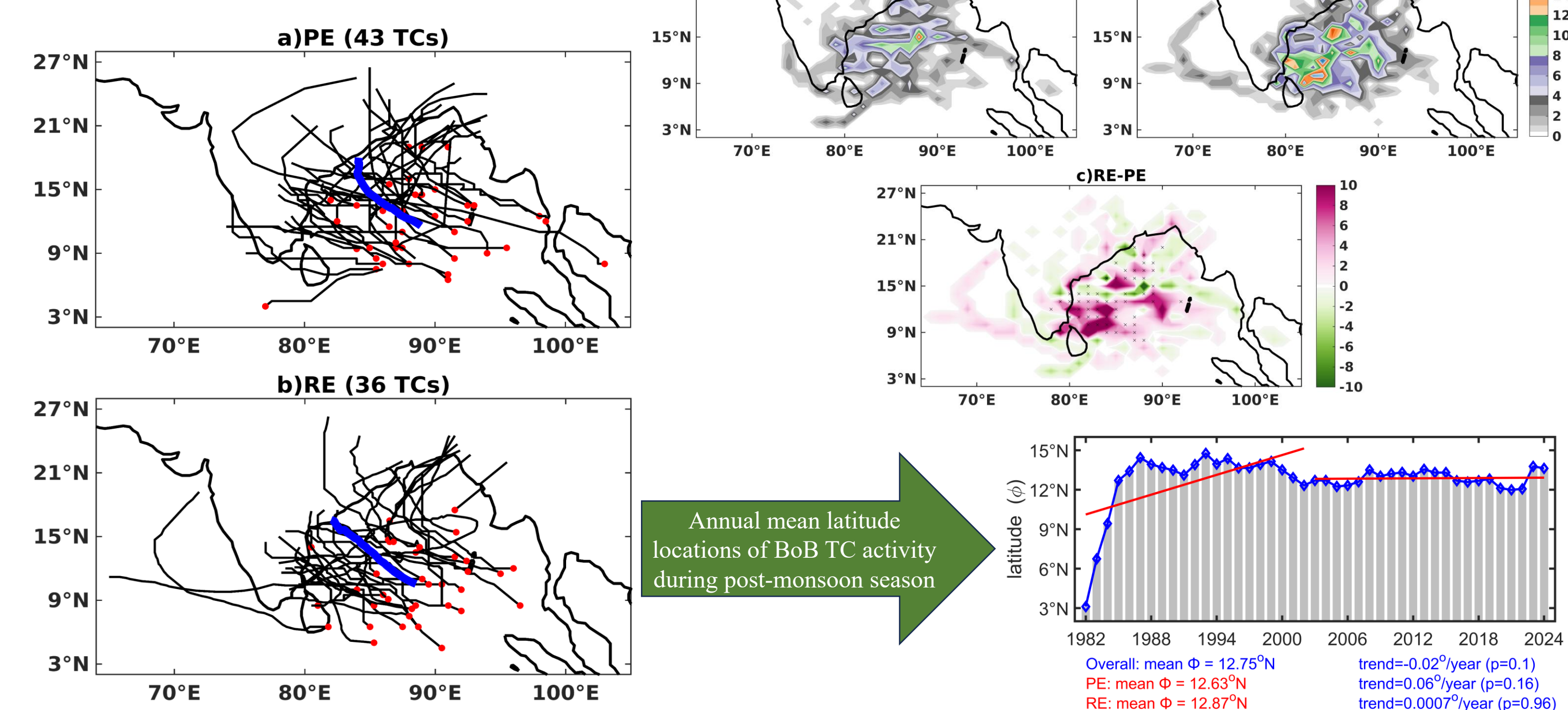
❖ Variability of TCTS over the BoB



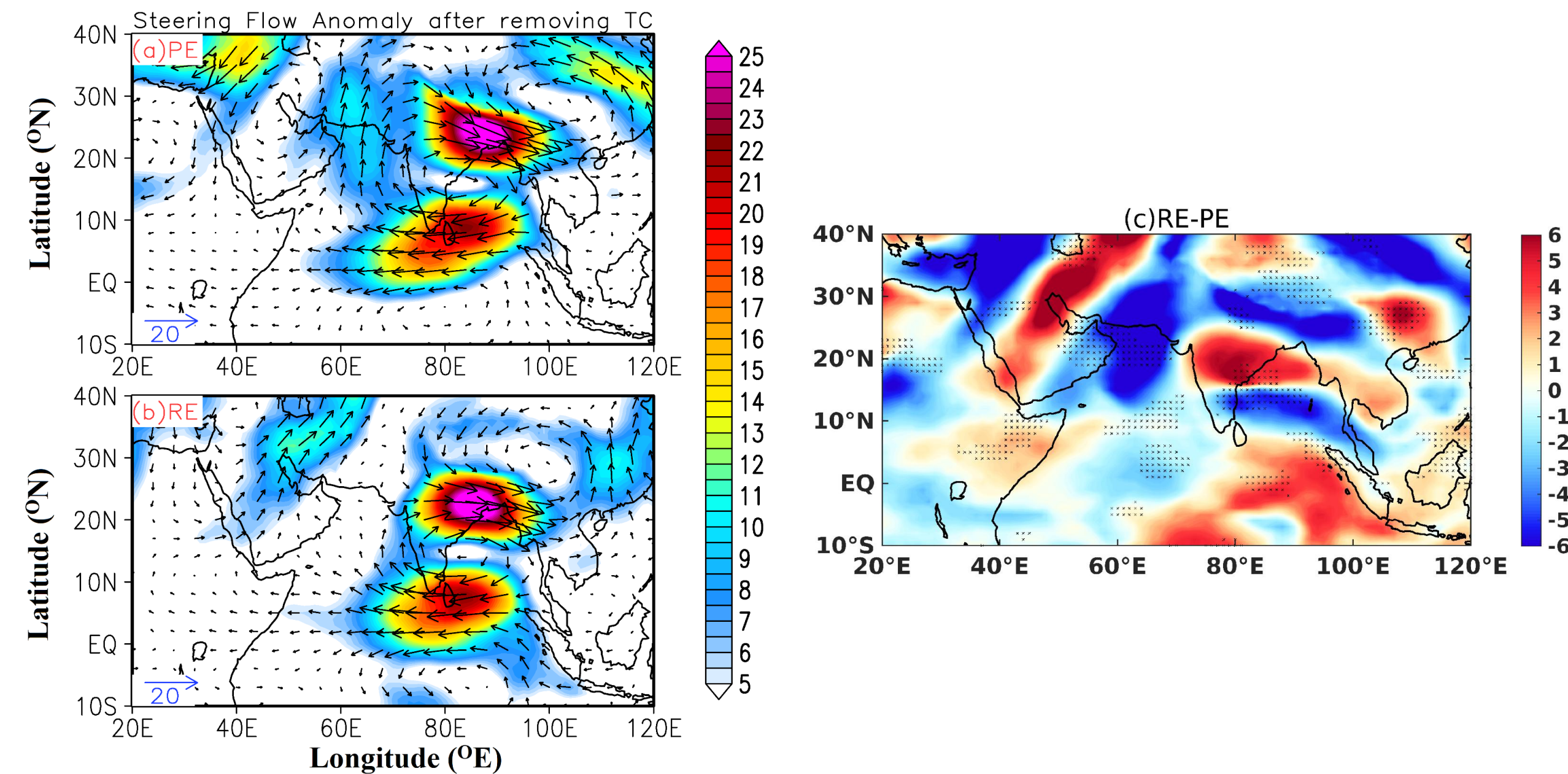
- Despite the difference in mean TCTS between the two seasons, the overall TCTS variability shows a gradual decreasing trend during both seasons.
- Trends in TCTS are significant at 15% ($p > 0.85$) and 90% ($p = 0.1$) confidence levels during pre- and post-monsoon seasons respectively.

❖ Factors influencing TCTS trends over the BoB region

➤ Latitudinal dependency of TCTS

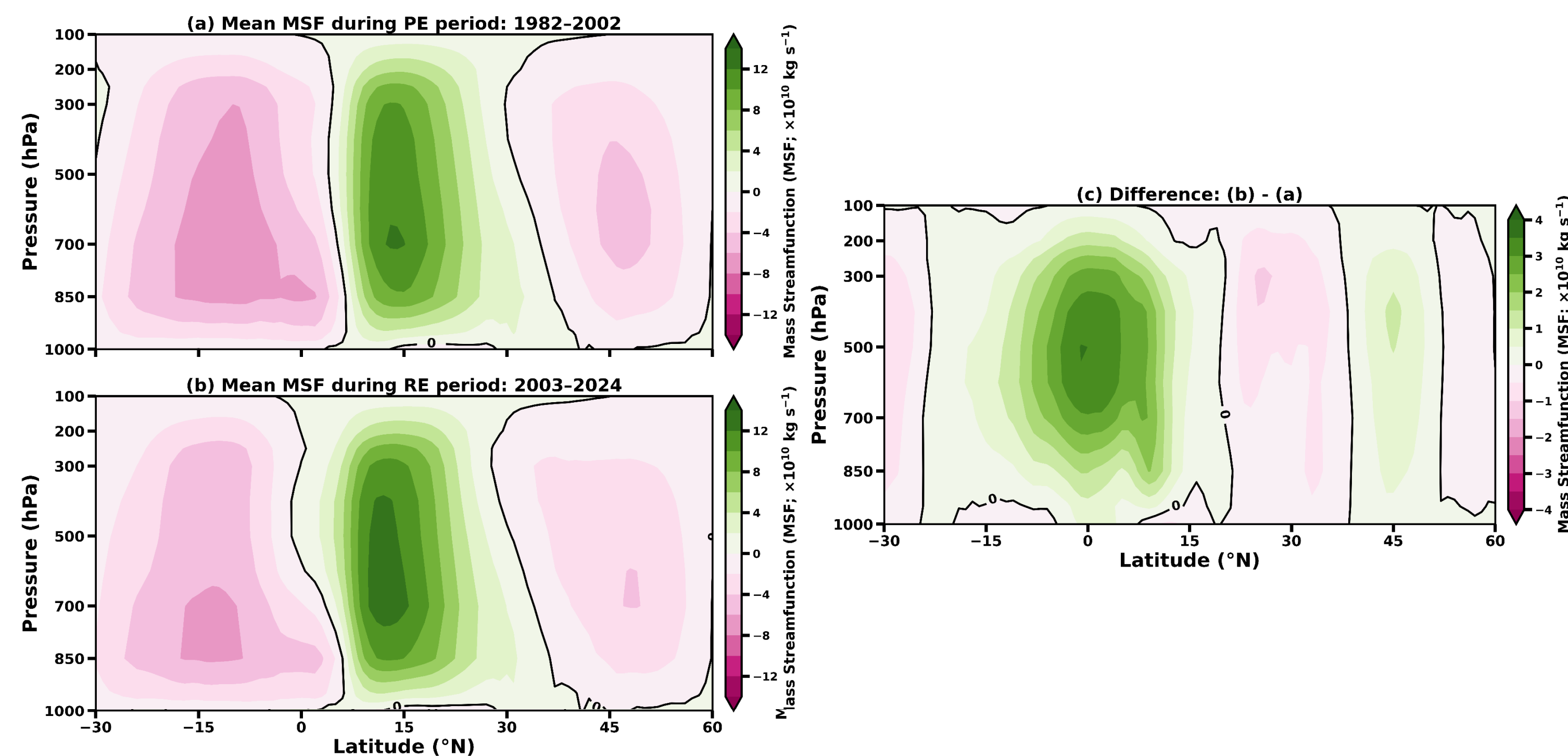


➤ Background wind speed changes & large-scale environment



- During RE period: A significant reduction in wind speeds are observed below 15° N of the BoB region where a relatively greater track density is concentrated.

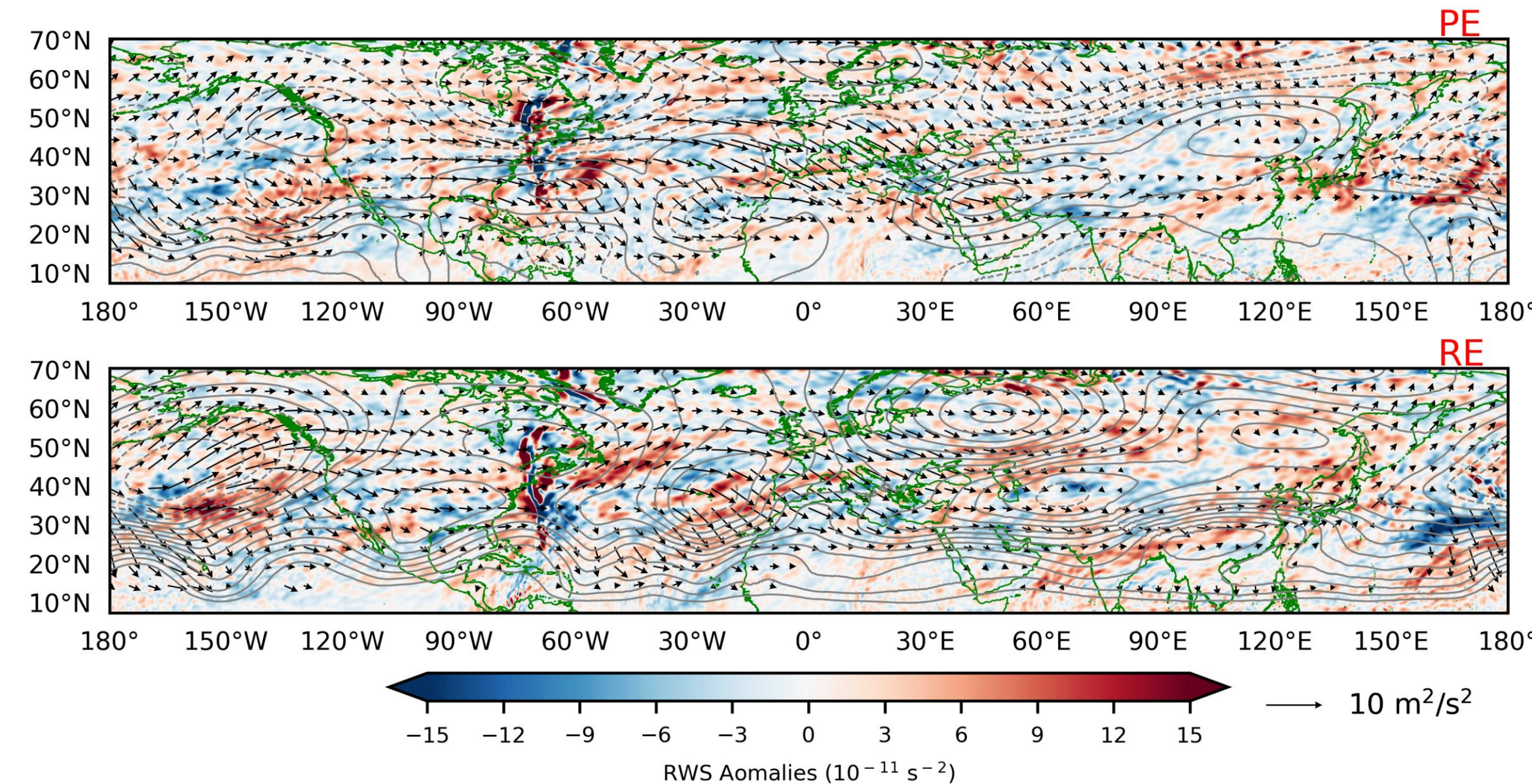
➤ Dynamical mechanism linked to WAF and Hadley cell circulation changes



TCs activity in the near equatorial latitudes with lower TCTS and westward/north-westward movement during RE period is promoted by

Stronger but equatorward-confinement of tropical HC circulation

Southward WAF guided by northerly/northeasterly steering flows



Concluding summary

- Translation speed of the BoB TCs is significantly reduced by ~10% in the recent epoch (RE; 2003-2024) compared to prior period (PE; 1982-2002), therefore leading to an increase in their residence time at a rate of 0.98 hours/year and greater region's exposure.
- The slowdown is mainly explained by a shift in TC tracks toward lower latitudes combined with the observed changes in large-scale steering flows in association with the manifestation of mid-latitude Rossby wave activity and the tropical Hadley cell circulations.
- As observed changes in the tropical-extratropical circulations can also be confounded with broader climate modes (e.g., ENSO, IOD, NAO etc.), the future studies performed by the isolation of these modes will have greater potential for a better understanding on the role of tropical and sub-tropical dynamics towards influencing BoB TCTS and their motion.

Reference

Gorja, M. M. K., Vissa, N. K., Viswanadhappalli, Y., Konda, G., & Gulakaram, V. S. (2026). Mechanism on the epochal shift in translation speed of tropical cyclones formed over the Bay of Bengal region. *Meteorology and Atmospheric Physics*, 138(3), 32. <https://doi.org/10.1007/s00703-026-01137-8>

