

Multiscale Interaction in the Western North Pacific: Do Tropical Cyclones Contribute to Climate Variability?

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Abstract

The weather and climate in the tropical and subtropical Western North Pacific (WNP) in the boreal summer are affected by the mutual interaction between the perturbations of different time scales ranging from ENSO to intraseasonal oscillation, and to tropical cyclone (TC). Downscale modulation effect of lower-frequency circulation on higher-frequency perturbation and **significant feedback of TCs to the large-scale flow** are reported.

1. Modulation of ENSO on monsoon trough, ISO, and TCs

During the El Niño, the monsoon trough shifts southeastward. As a result, ISO and TCs are more active in the region to the southeast of its normal location. The reversed situation occurs during the La Niña events: the monsoon trough, ISO and TCs shift northwestward.

3. TC Feedback

3.1 Enhancement of climate variability

While being clustered by the large-scale circulation, TCs in turn enhance intra-seasonal and interannual climate variability by more than 50 percent. The existence of TCs also enhances the circulation contrast difference in the WNP between El Niño and La Niña.

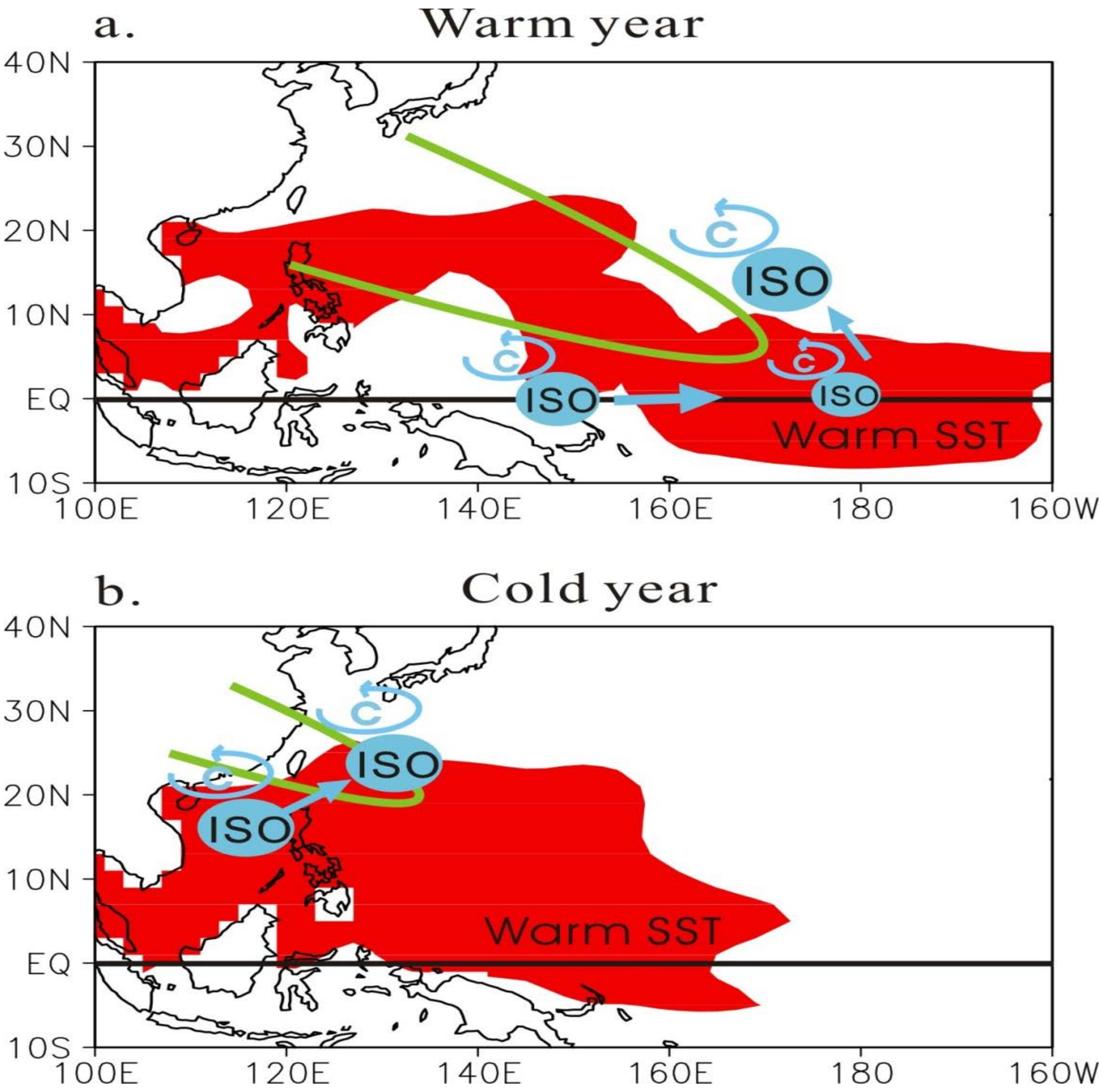


Figure 1. Schematic diagram showing the spatial relationship between El Niño/La Niña, intraseasonal oscillation, and tropical cyclones. (From Tsou et al.)

2. ISO Modulation effect on TC/sub-monthly wave pattern

A sub-monthly (8-30 days) wave pattern is found to propagate northwestward from the tropical Philippine Sea to the East China Sea. The wave pattern is often accompanied by tropical cyclone, which is embedded in its cyclonic circulation. Both the sub-monthly wave and tropical cyclone are found to be more active and better organized during the westerly phase of ISO, when the monsoon trough is strong and extends eastward into the Philippine Sea. On the contrary, both are weak and poorly organized in the easterly phase of ISO, when the monsoon trough is weak and retreats westward and retreats westward to the South China Sea.

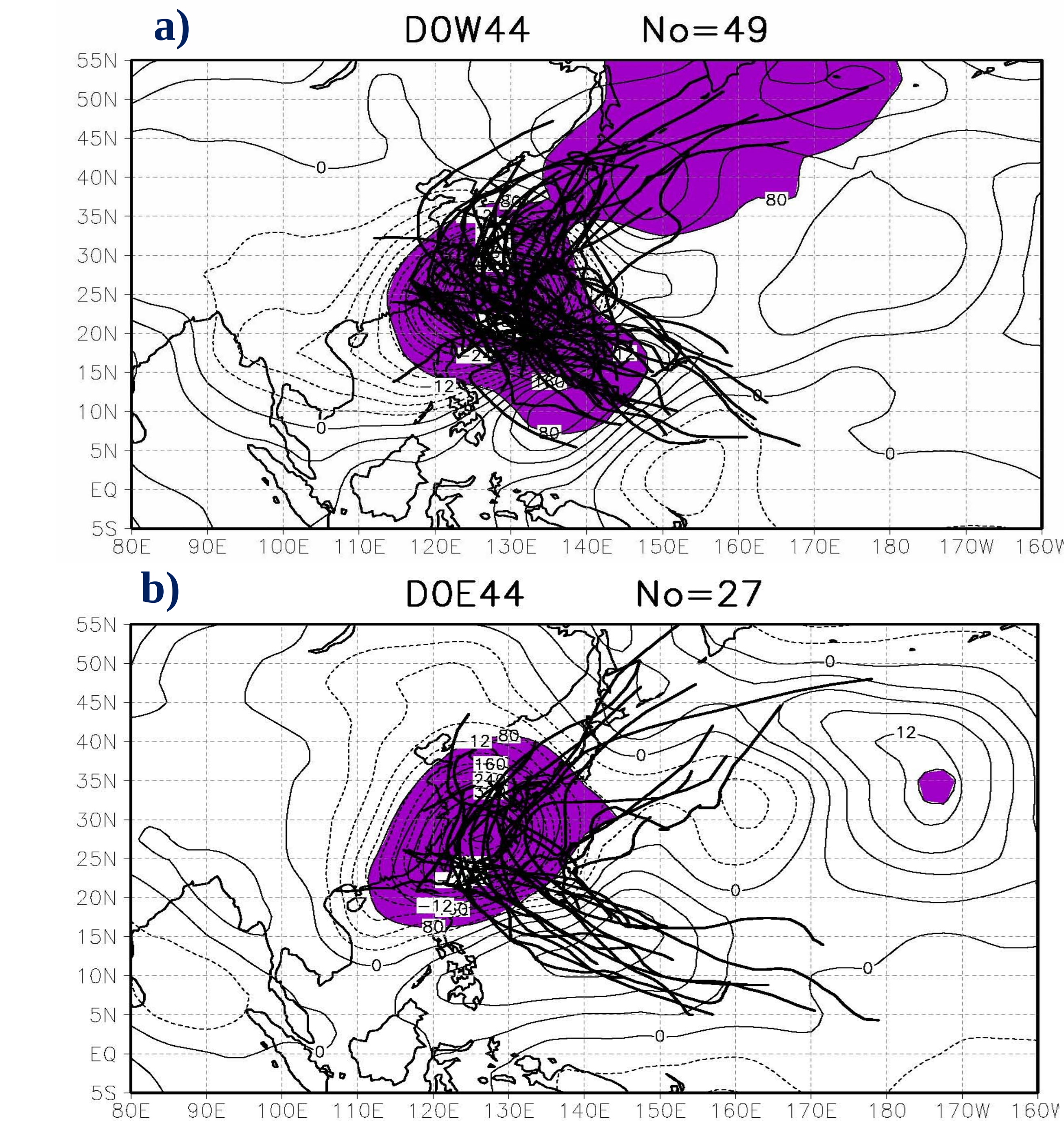
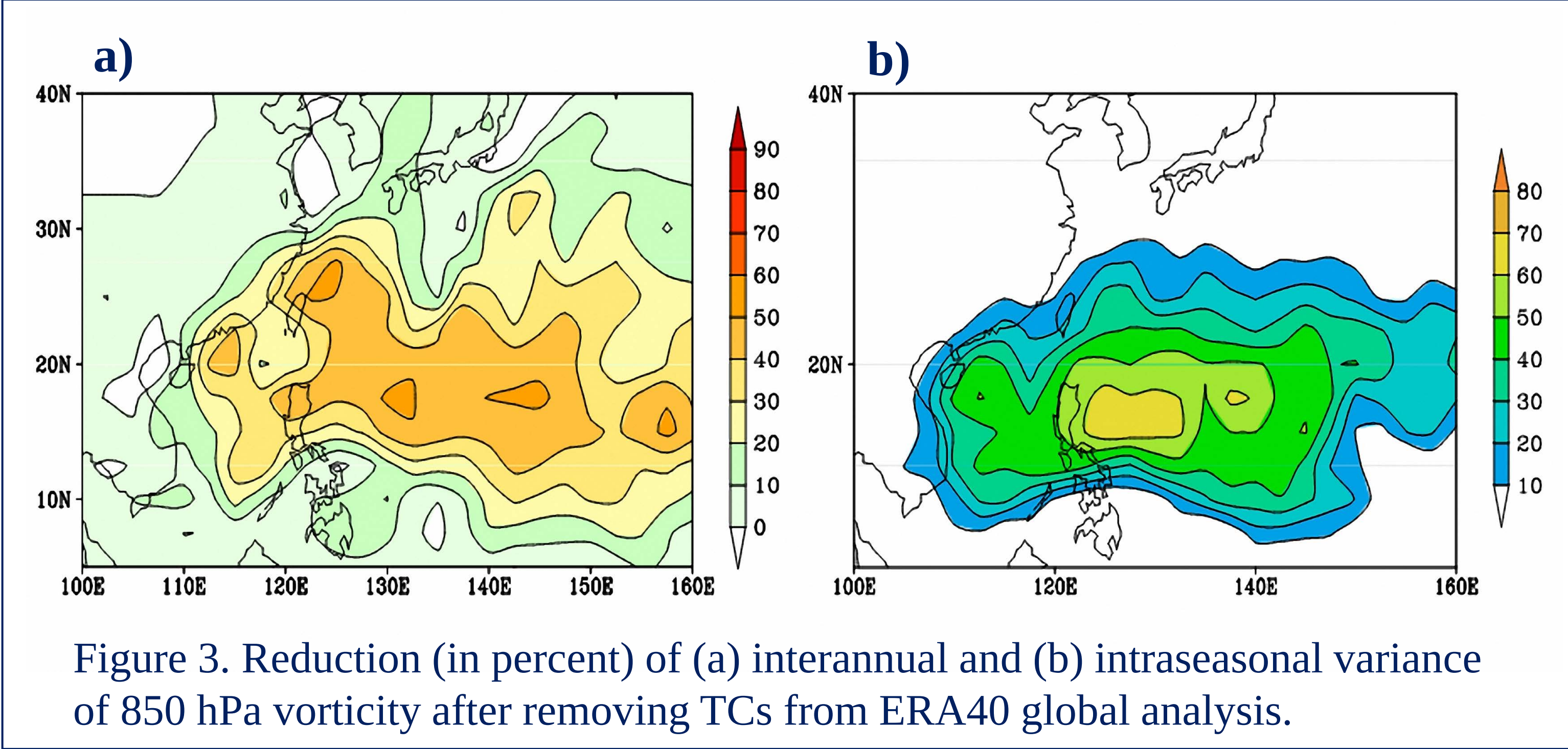


Figure 2. TC/submonthly wave pattern in the intraseasonal (a) westerly and (b) easterly phase.



3.2 Enhancement of eddy-mean flow interaction in the WNP

The embedding TCs in the sub-monthly wave pattern enhance kinetic energy of the wave pattern and kinetic energy conversion from mean flow to eddy, and help sustain the sub-monthly wave pattern. This enhancement is more significant in the ISO westerly phase when the monsoon trough is stronger.

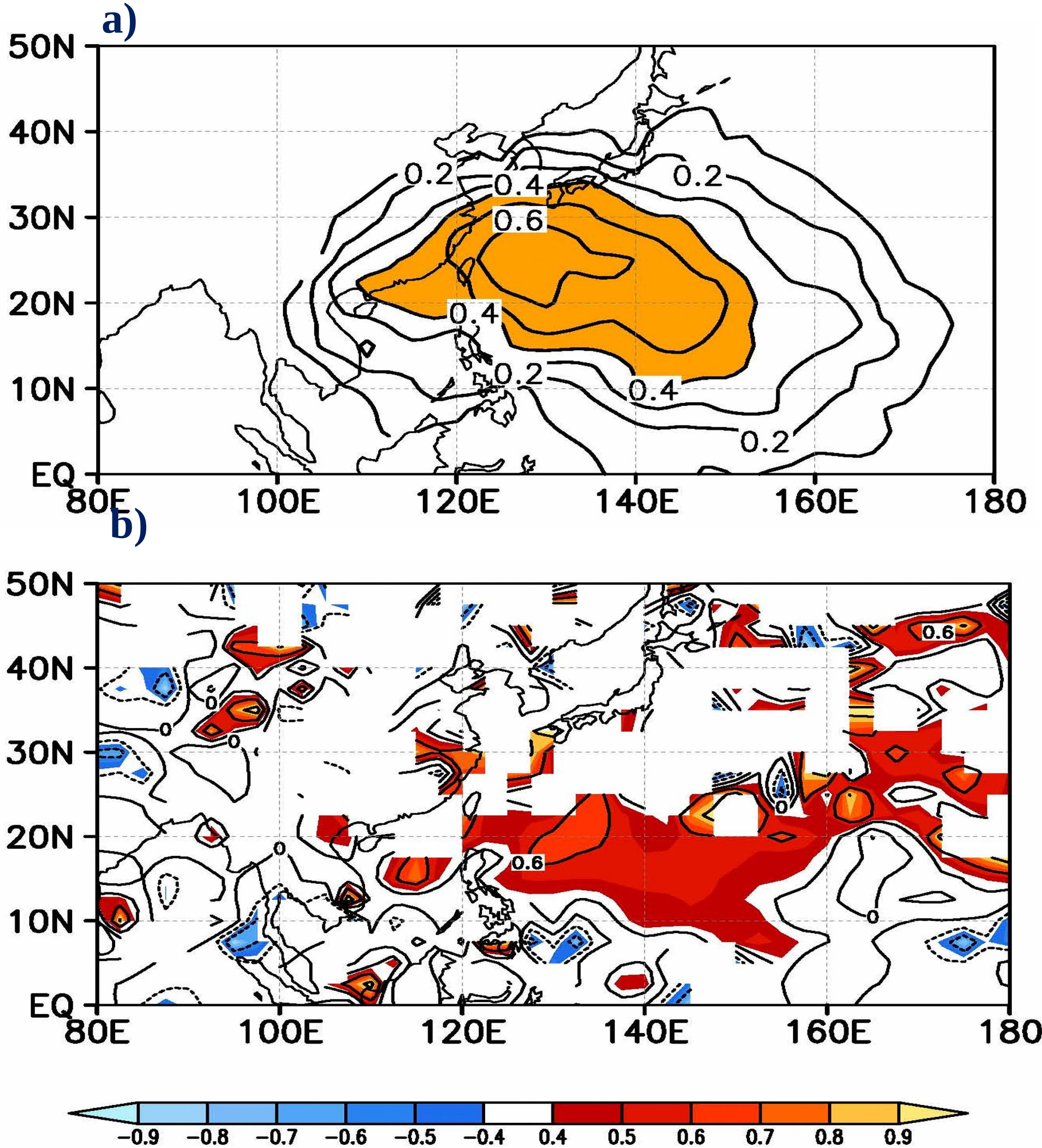


Figure 4. Contribution fraction of TCs to 850 hPa (a) kinetic energy and (b) barotropic energy conversion from mean flow to eddy.

4. Conclusion

The findings reveal the nature of active multiscale interaction in the WNP. **TCs leave significant footprint in climate variability by enhancing variability.** TCs and large-scale circulation in the Western North Pacific are mutually intertwined through rigorous eddy-mean flow interaction and therefore should be treated as an integrated multiscale system. **It is essential to well understand and simulate the multiscale interaction for a skillful prediction and projection of climate variability and change in the WNP.**

5. Reference

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