A trans-season out-of-phase relationship of tropical cyclogenesis between the western North Pacific and South China Sea

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1. Introduction

The western North Pacific (WNP) and South China Sea (SCS) are two adjacent ocean basins where summer monsoon and tropical cyclone (TC) activities are rather active. Although the interannual variations of TCs over the WNP and SCS have been extensively studied, only a few studies explored the linkage of TC variations in the two regions. Ling et al. (2015) found a see-saw relation in the interannual variability between local TCs over the SCS and non-local TCs that form over the WNP and enter the SCS in summer. We examine whether there is a link of TC genesis between the WNP and the SCS. It's found that simultaneous relationship between the SCS and WNP TC geneses in JJASON is insignificant. Furthermore, our analysis identified a trans-season connection between the SCS and WNP TC genesis. The purpose of the present study is to display evidence for the trans-season association between the WNP and SCS TC genesis on the interannual time scale and explore the reason for this trans-season linkage.

2. Methods

a. Genesis potential index (GPI)

$$GPI = |10^5\eta|^{3/2} \times (1 + 0.1V_{shear})^{-2} \times (\frac{H}{50})^3 \times (\frac{V_{pot}}{70})^3 \times (1 - \frac{\omega}{0.1}),$$

where η is the absolute vorticity at 850 hPa, V_{shear} is the magnitude of the vertical wind vector difference between 200 hPa and 850 hPa, H is the relative humidity at 700 hPa, V_{pot} is the maximum potential intensity (MPI) modified by Bister and Emanuel (1998), and ω is the vertical pressure velocity at 500 hPa.

b. Model

A linear baroclinic model (LBM) is used to illustrate the role of SST anomalies around the Maritime Continent on lower-level circulation over the SCS. To confirm the impacts of SST anomalies in MAM and JJASON on the lower-level circulation changes over the WNP and SCS, respectively, we perform numerical experiments using the Community Atmospheric Model of version 5.0, the atmospheric component of Community Earth System Model (CESM).

3. Results

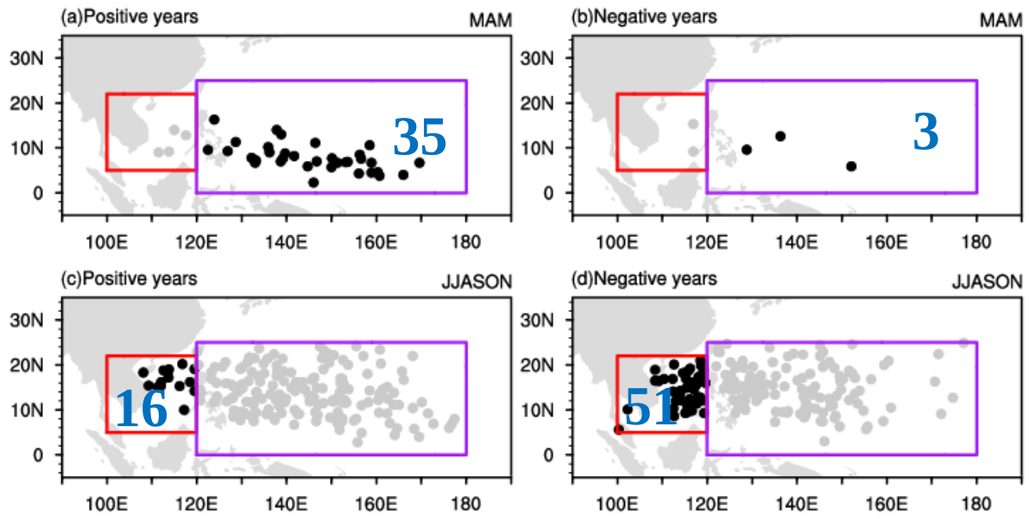

Fig. 1 The composite TC genesis number over the WNP in MAM and over the SCS in JJASON in black dots during positive index years and during negative index years.

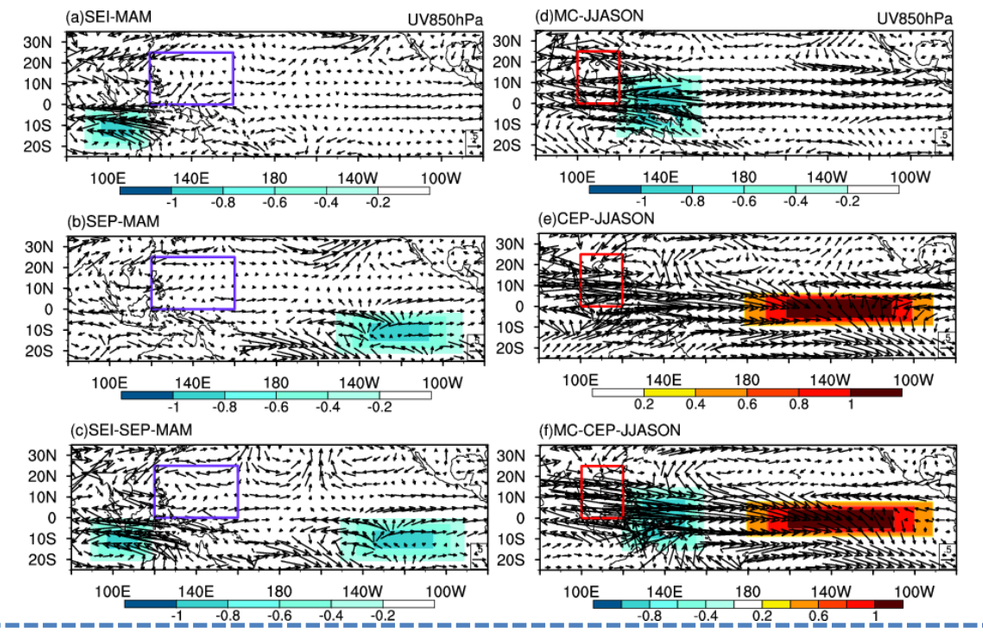

Fig. 2 The numerical results of 850-hPa circulation simulated by (a) SEI-MAM, (b) SEP-MAM, (c) SEI-SEP-MAM, (d) MC-JJASON, (e) CEP-JJASON, and (f) MC-CEP-JJASON experiments in relation to the CTL experiment.

Table 1. Description of numerical experiments with CESM.

Expt	Type of SST forcing	Domain of SST forcing
CTL	Climatology	Global oceans
SEI-MAM	Negative anomaly	SEI (20°S–0°, 90°E–120°E)
SEP-MAM	Negative anomaly	SEP (20°S–0°, 150°E–90°W)
SEI-SEP-MAM	Negative anomaly	SEI+SEP
MC-JJASON	Negative anomaly	MC (15°S–15°N, 120°E–160°E)
CEP-JJASON	Positive anomaly	CEP (-5S°–5°N, 180°–90°W)
MC-CEP-JJASON	Negative and Positive anomaly	MC+CEP

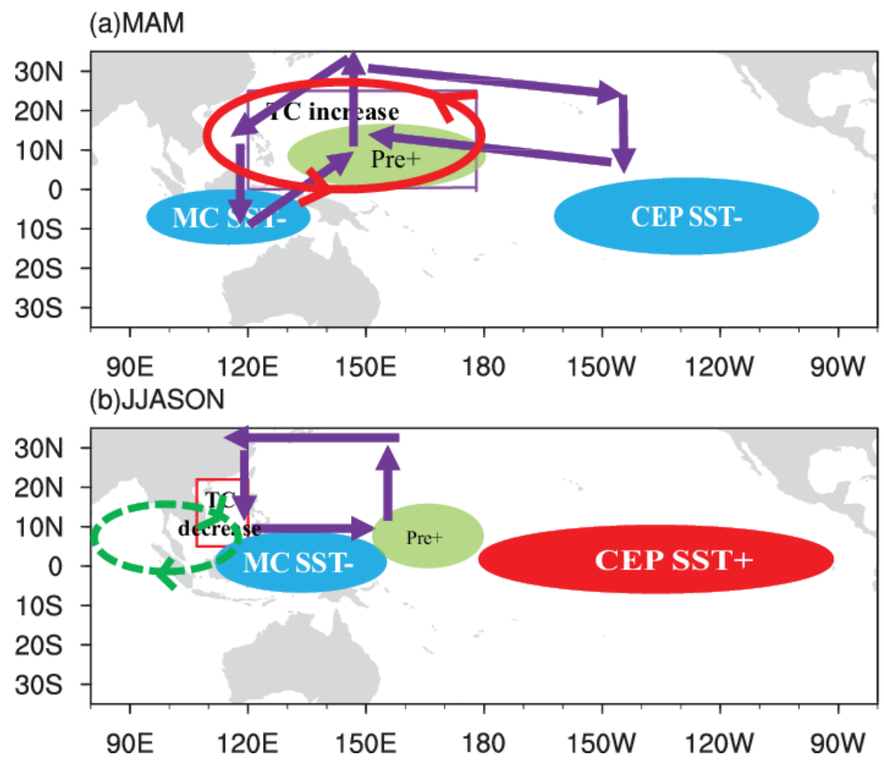

Fig. 3 Schematic diagrams showing the configuration of SST and precipitation anomalies and overturning circulation which lead to increase of TC genesis over the WNP in (a) MAM and decrease of TC genesis over the SCS in (b) following JJASON.

4. Conclusions

- A significantly out-of-phase variation is found between spring TC genesis over the WNP and the following summer–fall TC genesis over the SCS.
- Composite analysis and numerical model experiments show that negative SST anomalies during MAM in the tropical CEP and southeastern Indian Ocean work together to induce the positive GPI anomalies over the WNP, with the latter more important. In following JJASON, the reversed SST in the tropical CEP and the persistent negative SST anomalies around the MC lead to negative GPI anomalies and thus inhibit the TC genesis over the SCS.
- This out-of-phase relationship of TC genesis between the WNP and SCS also exists when the ENSO years are removed.

Reference: Cao, X.***,** R. G. Wu, L. T. Xu, Z. B. Wang, Y. Sun, Y. F. Dai and S. Chen, 2023: A trans-season out-of-phase relationship of tropical cyclogenesis between the western North Pacific and South China Sea, *J. Climate*, 36, 3697–3716, 10.1175/JCLI-D-22-0753.1