Interannual–Decadal Potential Temperature Variability in the Tropical–North Pacific Ocean and Deep South China Sea

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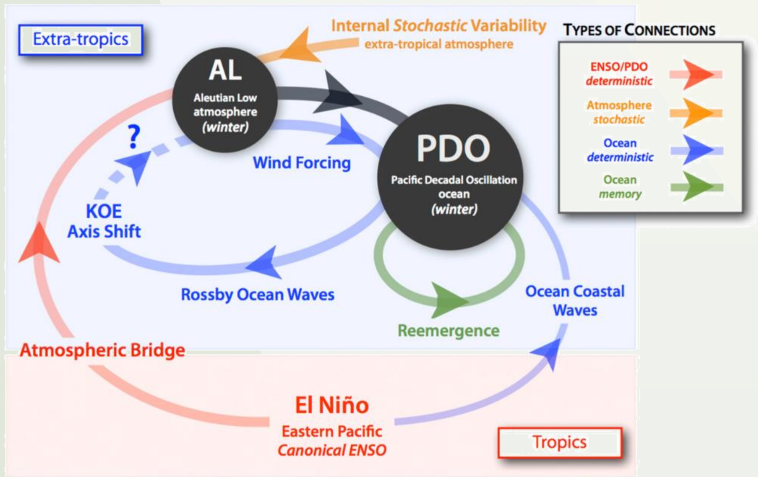
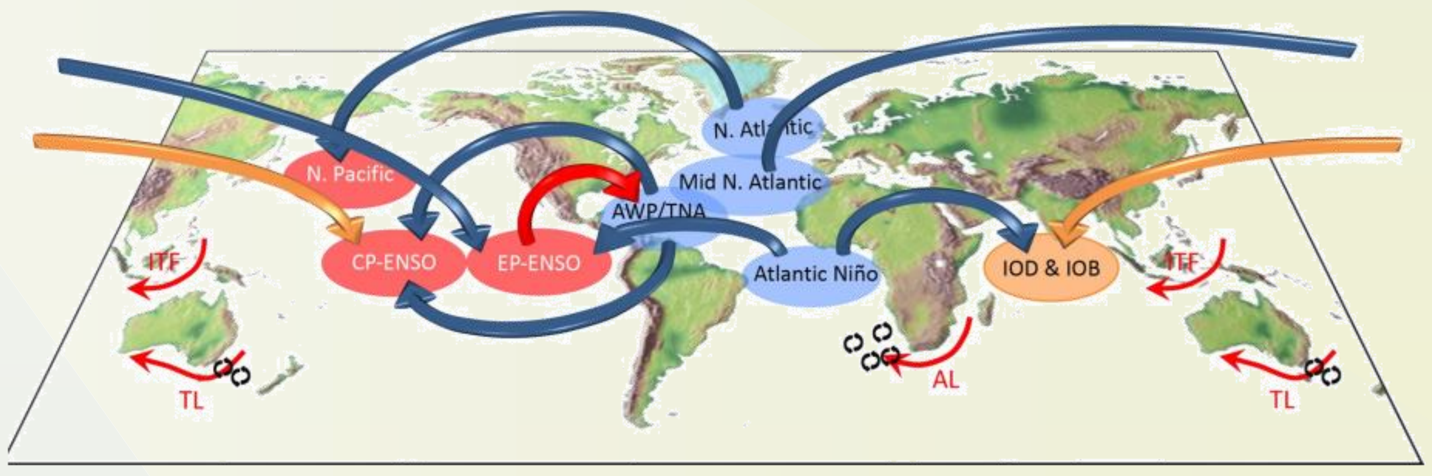
The climatic variabilities in the NPO and TPO



Newman, M., et al. (2016)



Wang CZ (2019)

- The Tropical and North Pacific Ocean (TPO and NPO, respectively) host significant climate variability modes, namely the El Niño–Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO)
- the climate variabilities in the TPO and NPO are integrated. Consequently, separating the variability of SSTAs over the TPO and NPO into interannual and decadal components is a rather complex process, as these signals are integrated.
- These climate variabilities over the TPO and NPO have global impacts through both oceanic pathways and atmospheric bridges

Data

- Temperature: Synoptic monthly gridded World Ocean Database (1945-2014, 1°x1°x 28 level, 0-3000m)
- Source: **World Ocean Database (WOD)** (Boyer et al., 2013)

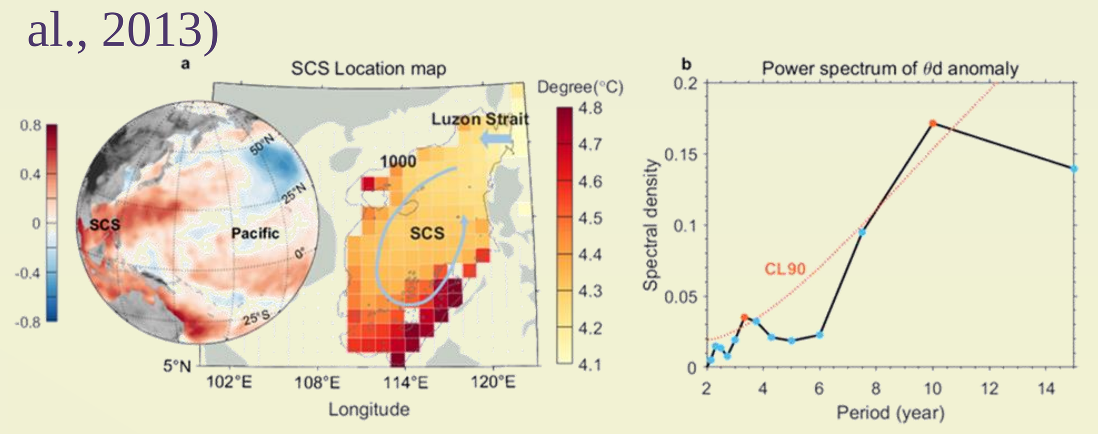


Fig.2 (a) Shaded areas in the Pacific Ocean represent the correlation coefficients between Pacific SSTAs (north of 25ºS) and domain-averaged South China Sea (SCS) SSTAs (5.5ºN–23.5ºN, 100.5ºE–122.5ºE). Shaded areas in the SCS represent the depth-averaged climatological potential temperature in the deep (1,000–2,500 m depth) SCS. Arrows indicate the deep-layer LST and the cyclonic circulation (Gan et al., 2016) in the deep SCS. (b) Power spectrum (orange dashed line indicates the 90% confidence levels) of the depth-averaged (1,000–2,500 m depth) observed θd anomaly in the SCS (5.5ºN–23.5ºN, 100.5ºE–122.5ºE) from the SMG-WOD data set.

- Annually averaged θ_d is applied to better highlight the **interannual** and **decadal** variabilities.

The interactive SST variability in the TPO and NPO

MVEOF Mode1	MVEOF Mode2	MVEOF Mode3
EP-El Nino	CP-El Nino	CP-El Nino
Warm PDO	NPMM	Victoria Mode

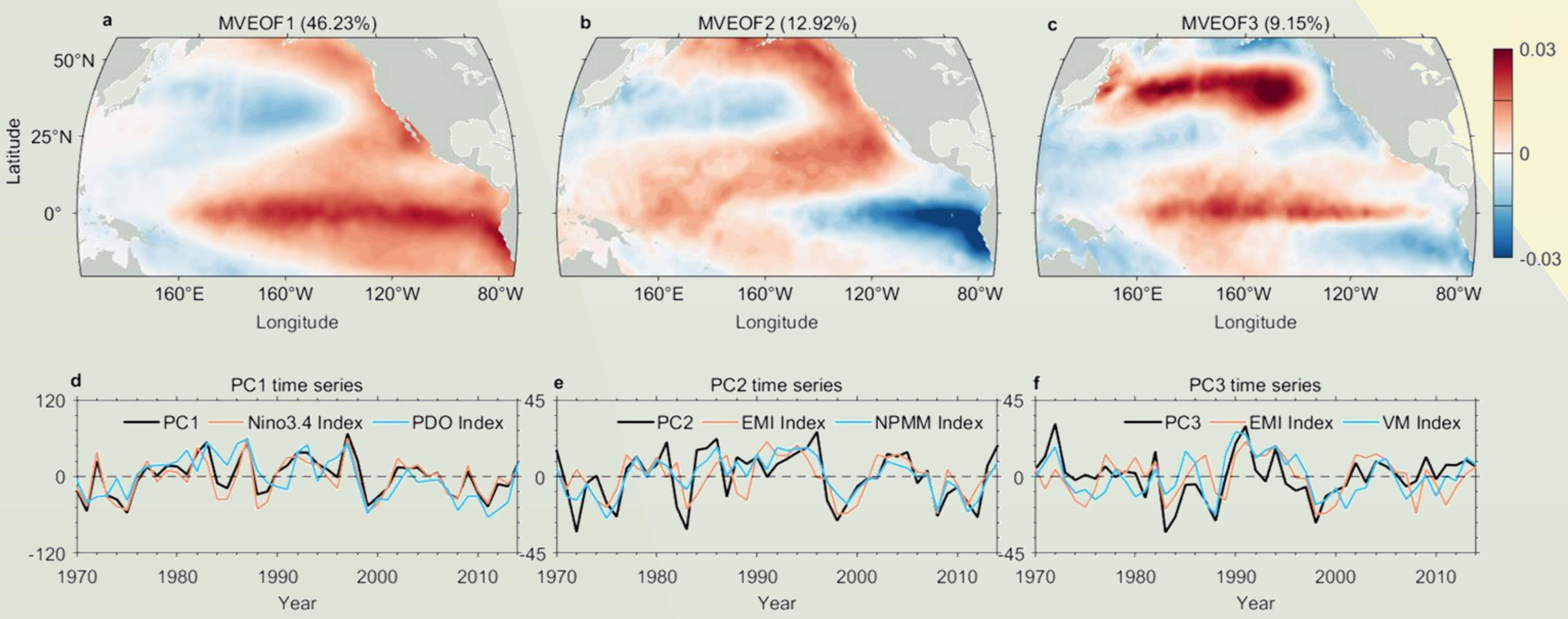


Figure 1. Coherent variations between sea surface temperature anomalies (SSTAs) in the Tropical Pacific Ocean (TPO; 20.5° S–20.5° N) and SSTAs in the North Pacific Ocean (NPO; 20.5° S–62.5° N). (a, d) First, (b, e) second, and (c, f) third multivariate empirical orthogonal function (MVEOF) modes and principal components (PC, black solid line) of the NPO and TPO SSTAs during the 1970–2014 period. The orange and blue lines in panel (d) represent the Nino3.4 and Pacific Decadal Oscillation (PDO) indices, respectively. (e) Similar to panel (d), but for the El Niño Modoki (EMI) and North Pacific Meridional Mode (NPMM) indices. (f) Similar to panel (d), but for the EMI and Victoria Mode (VM) indices.

Possible Driving processes over the Atmospheric Bridge

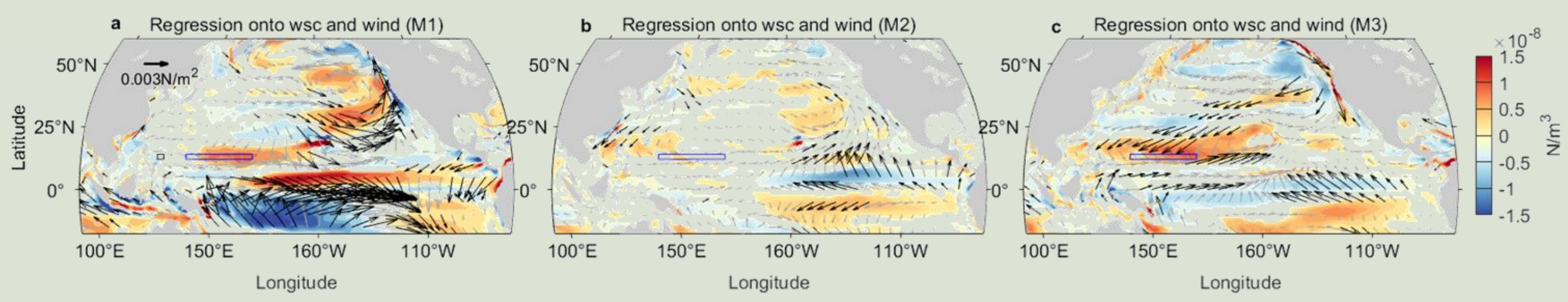


Figure 3. Composites of regression maps of wind stress anomaly (arrows) and wind stress curl anomaly (shading) over the Pacific Ocean onto the PC1, PC2, and PC3 time series during their respective positive phases are shown in panels (a)–(c). The colored (white) shading areas and black (gray) arrows are significant (insignificant) at the 90% confidence interval. The small black box (12° N–14° N, 127° E–130° E) in panel (a) indicates the area serving as an index of the North Equatorial Current Bifurcation (NECB) latitude to the east coast of the Philippines (Qiu & Chen, 2010). The blue box (12° N–14° N, 140° E–170° E) indicates the region where the wind stress curl is important for NECB migration.

Mode 1	Mode 2	Mode 3
AL ↑, warm PDO SSTAs, Hadley circulation ↑, Walker circulation ↓ cooling SSTAs → Rossby wave → AAC	winds ↓ evaporative heat loss ↓ WES feedback AC over SCS	Walker circulation ↑ AC over SCS

Possible Driving processes over the Oceanic Pathway

- **Upper-layered LST:**

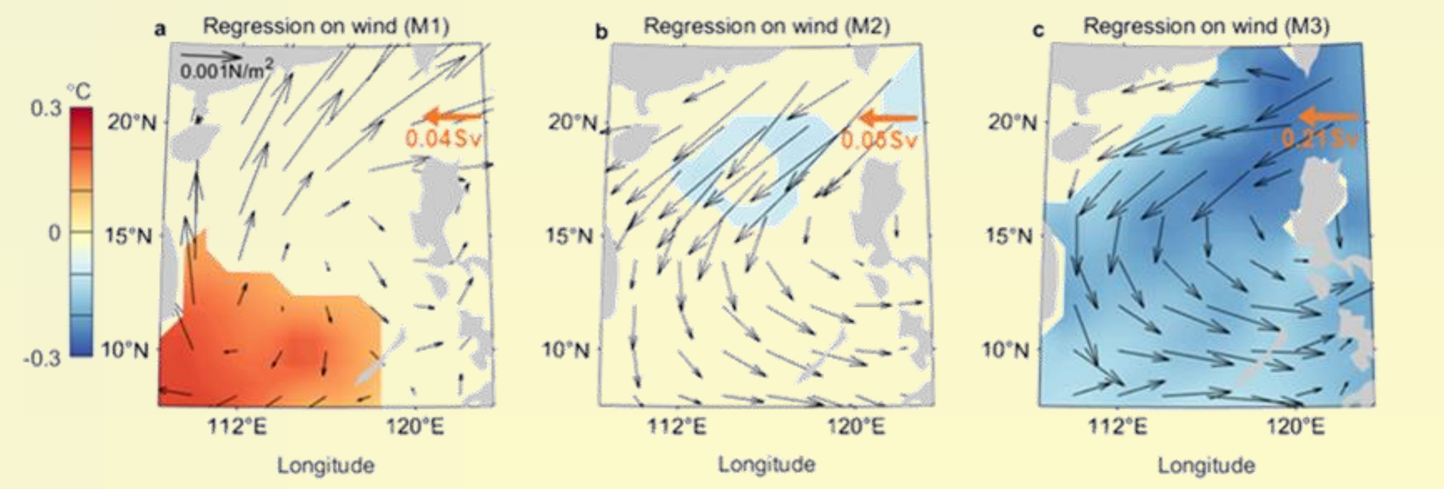


Figure 4. Composites of regression maps of wind stress anomaly (arrows) and SSTA (shading) over the SCS onto the PC1, PC2, and PC3 time series during their respective positive phases are shown in panels (a)–(c). The colored (white) shading areas are significant (insignificant) at the 90% confidence interval. Orange arrows indicate the direction of the upper-layer LST anomaly; numbers beside the arrows indicate the anomaly intensity.

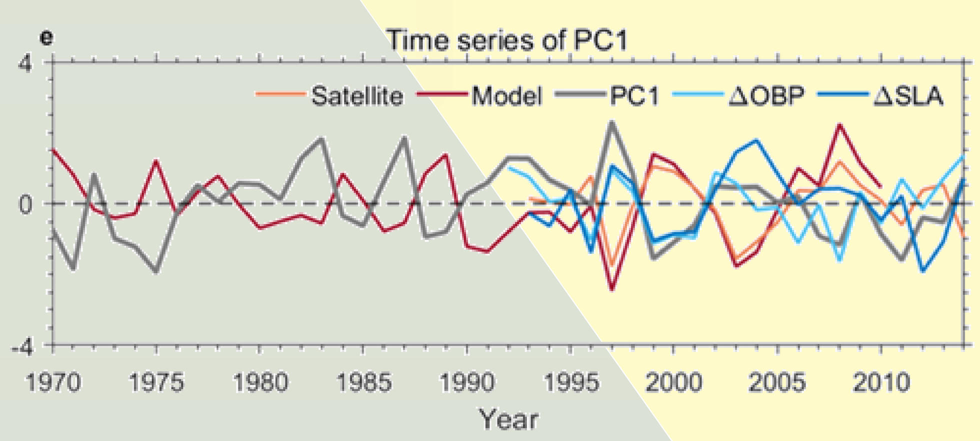
Local:

Mode 1	Mode 2	Mode 3
westward Ekman transport ↓	Ekman transport ↑	Ekman transport ↑

Remote:

Mode 1	Mode 2	Mode 3
WSC to the east of the Philippines ↑ → westward Rossby waves → SSH ↓ → northerly NECB →Upper-layered LST ↑	Insignificant NECB migration→ Upper-layered LST ↑	northerly NECB → Upper-layered LST ↑

- **Deep-layered LST:**



(e) Time series of the normalized PC1 (black line) and sea level anomaly (black box in Figure 3a) from satellite product (orange line, CMEMS) and from model product (red line, SODA2.2.4). Light (dark) blue line shows the normalized ΔOBP (ΔSLA) between eastern (21° N–23° N, 122° E–123° E) and western (19° N 21° N, 120° E–121° E) sides of the Luzon Strait.

- The detrending ΔSLA between the two sides of the Luzon Strait moderately correlates (r = 0.48) with the ΔOBP, implying remote modulation from upper-layer processes.
- During the warm PDO and EP El Niño-like phase , ΔSLA increases due to the influence of southwesterly wind stress anomaly, and its time series moderately correlates with that of PC1

Conclusion

- Our study reconstructed the SSTAs variability of TPO and NPO into three coherent modes, and indicate that the teleconnection of the TPO and NPO greatly contribute to the formation of different climate variabilities
- we highlighted evidence of how these variabilities are impacting the potential temperature variability of the deep SCS
- These results have important implications for depicting the variability of marginal seas in response to global climate variability.
- There is still a very long way to go in unraveling the dynamic processes

Reference:
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