Decadal to Bi-Decadal Rainfall Variation in the Western Pacific: A Footprint of South Pacific Decadal Variability?

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Abstract

*A new Pacific decadal SST pattern, the **South Pacific Decadal Oscillation (SPDO)**, is identified and found to have a significant impact on the **decadal to bi-decadal rainfall variation** in the Western Pacific during July-October in the second half of the 20th century.*

1. Identification of SPDO

*SPDO is the first EOF (explaining 27% of total variance) of the SST south of 20°S during July-October (JASO), with a significant spectral peak at **10-20 years**. The pattern exists in all months and is also the first orthogonally-rotated EOF in the whole Pacific.*

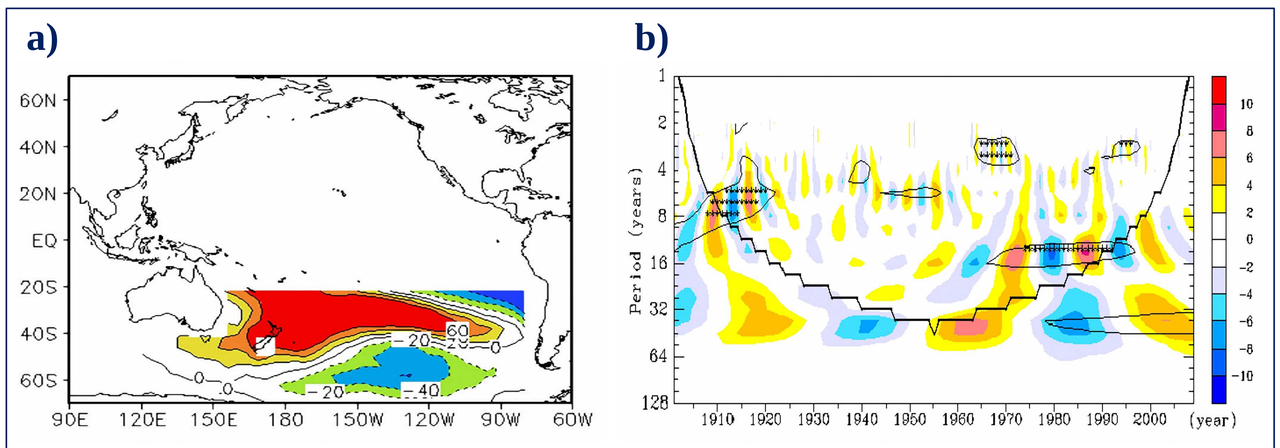


Figure 1. (a) The 1st SSTA EOF, SPDO, during JASO. (b) Corresponding wavelet transform. The asterisk and light black line mark the wavelet spectrum that is significant at the 5% and 10% level, respectively, based on a Monte Carlo approach.

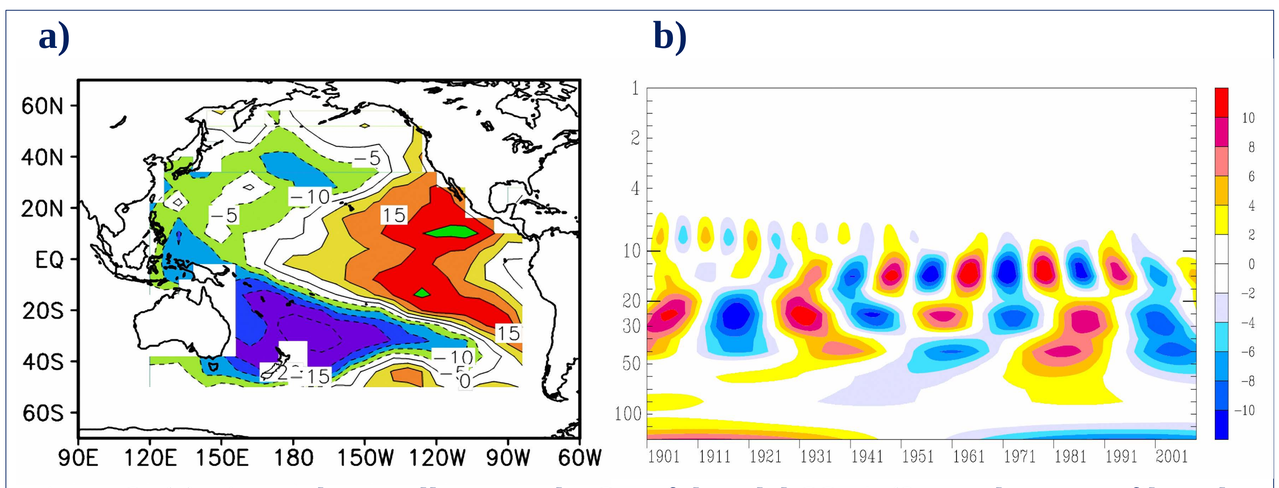


Figure 2. (a) First orthogonally-rotated EOF of decadal SSTA (8-year low-pass filtered, 15.3% variance) in the Pacific and (b) corresponding wavelet transform coefficient.

2. Relationship with decadal-bidecadal rainfall variation in the Western Pacific

SPDO is significantly correlated with the 10-20-year JASO rainfall variation in the Western Pacific, e.g., Korea, Taiwan, the Maritime Continent, and East Australia, where rainfalls are also characterized by a 10-20-year spectral peak. When the SSTA in the Western South Pacific is positive, the rainfall anomaly in the above areas is also positive.

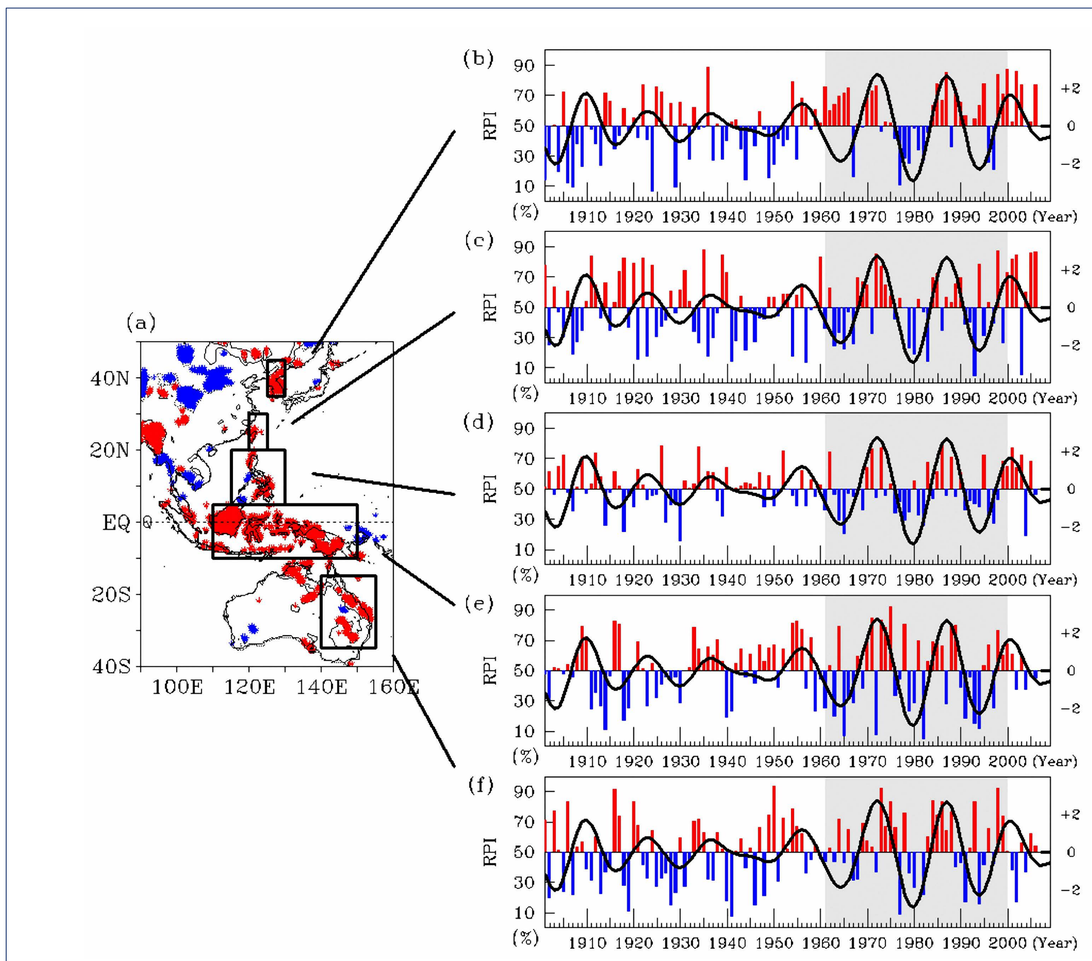


Figure 3. (a) Correlation coefficients between the 10–20-year filtered CRU rainfall in the Western Pacific and 10–20-year SPDO index during JASO for the 1961–2000 period. Correlation coefficients between 0.6 and −0.6 were not plotted and are stippled when statistically significant. (b–f) The year-to-year JASO rainfall index in Korea, Taiwan, the Philippines, the Maritime Continent and Eastern Australia. Also shown in Figures 3b–3f is the 10–20-year SPDO index.

3. Corresponding Circulation

The anomalous circulation associated with SPDO is characterized by anticyclonic circulation in the lower troposphere and cyclonic circulation in the upper troposphere of the tropical-subtropical Pacific. This circulation is associated with anomalous convergence (divergence) in the Western Pacific and anomalous divergence (convergence) in the Eastern Pacific in the lower (upper) troposphere.

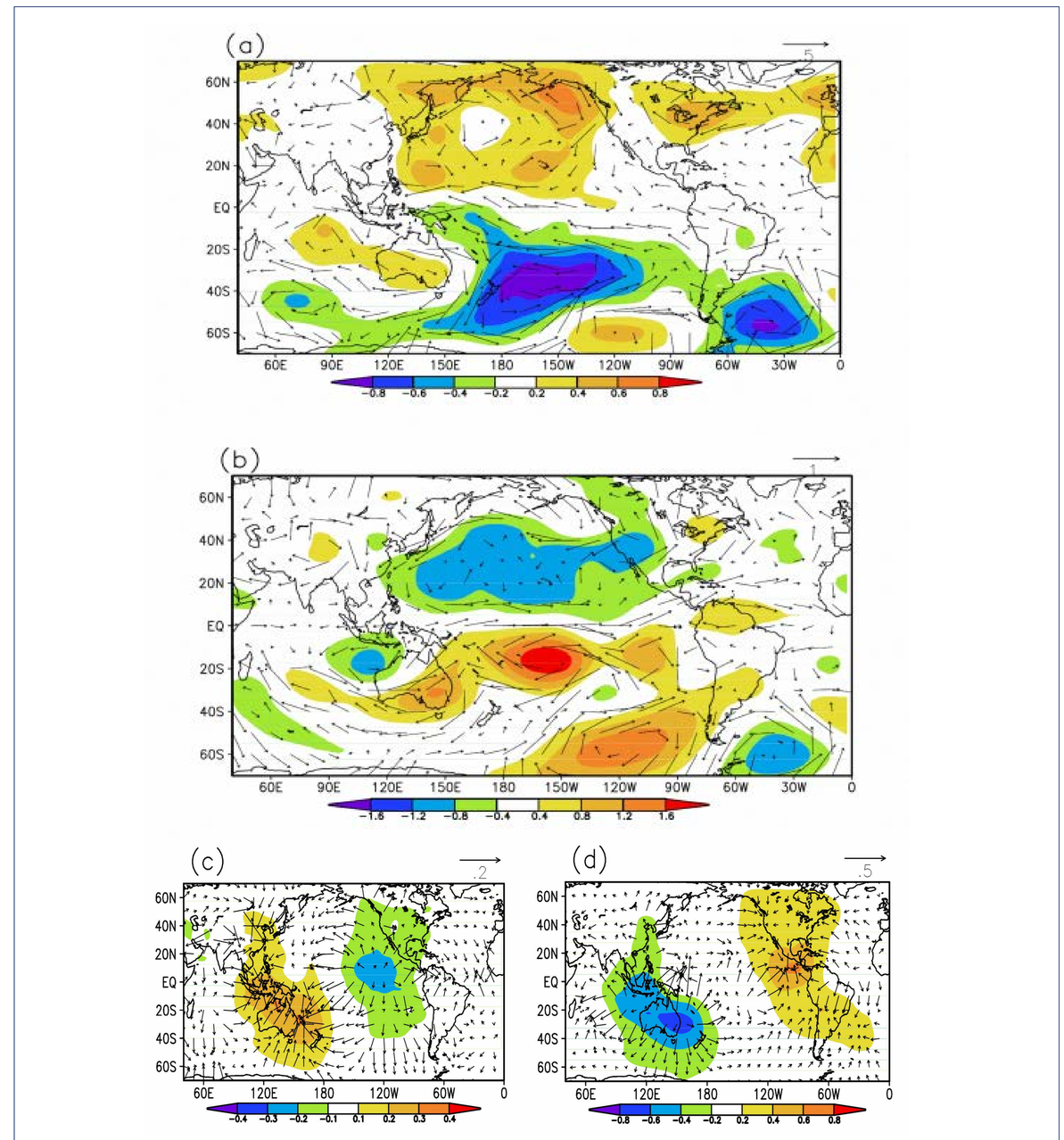
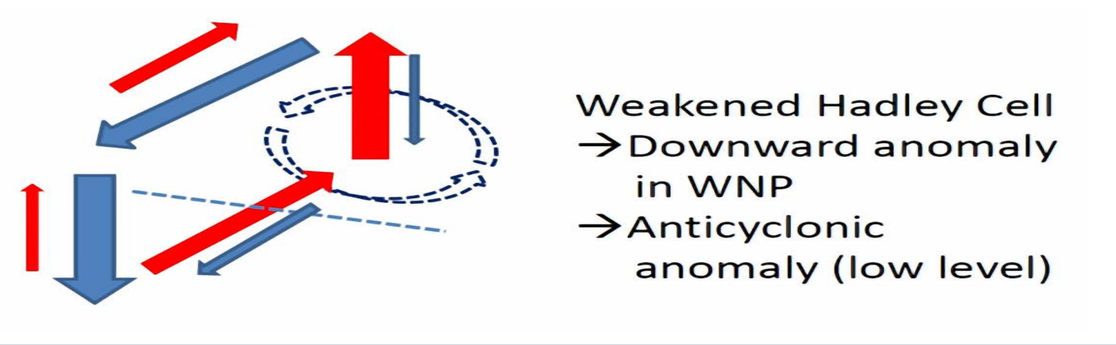


Figure 4. Regression coefficients between the 10–20-year SPDO index and 10–20-year filtered (a) 850 hPa and (b) 200 hPa stream function and (c, d) velocity potential (106 m^2 s^{-1}, colored) and divergent winds (vectors) during JASO for the 1961–2000 period.

4. Physical interpretation

The anomalous divergent circulations were likely driven by the SSTA and resulted in the anomalous rainfall in Eastern Australia and the Maritime Continent. It is conjectured that the SSTA in the Western South Pacific led to an anomalous Hadley-like circulation in the Western Pacific and indirectly affected the convection activity in the Philippine Sea and the Pacific anticyclone and moisture convergent zone located to the west of the anticyclone, which in turn impacted the rainfall in the Philippines, Taiwan and Korea. This indirect mechanism is explained as follows.

Warm SSTA in SW Pacific
- ***→ Smaller N-S SST Gradient.***
- ***→ Weaker Hadley Cell***
- ***→ Downward anomaly in WNP***
- ***→ Low-level anticyclonic anomaly in WNP***
- ***→ Anticyclone and confluent zone shifted westward***
- ***→ Enhanced low-level convergence in East Asian coast***
- ***→ More rainfall along the East Asian coast***



5. Reference

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