

# Interdecadal variability of western North Pacific summer monsoon through the Pacific-Japan (PJ) pattern

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## Introduction

The Pacific-Japan (PJ) pattern is known as a basic pressure pattern during summer over the western North Pacific (Nitta 1987, Kosaka and Nakamura 2006). The PJ pattern is also known as a remote response from interannual variability of warm anomaly of summer Indian Ocean after the El Niño which suppresses the convection over Philippines and enhances Baiu/Meiyu activity (Xie et al. 2009). In this study we defined the new PJ pattern index using station data and reproduced the PJ pattern from 1897 to 2012, and investigated the interdecadal variability of summer monsoon activity over the western North Pacific.

## PJ pattern index

The PJ pattern index is defined as a seesaw of the sea level pressure (SLP) correlation pattern of the EOF PC1 (Fig. 1) and chose Yokohama of Japan and Hengchun of Taiwan.

- PJ pattern index - EOF PC1 (1979-2009) correlation **0.81**
- PJ pattern index -Wang and Fan (1999) Western North Pacific summer monsoon index (ERA40: 1958-2002) correlation **0.88**

## PJ pattern index : Yokohama—Hengchun (JJA mean SLP)

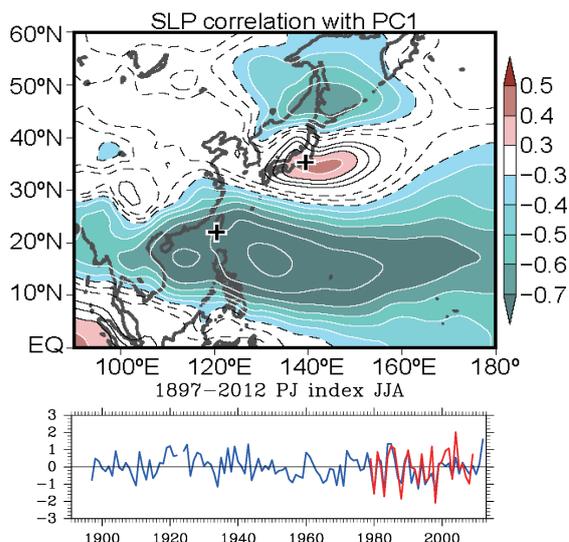


Fig. 1: The correlation between EOF PC1 of JJA 850hPa vorticity and SLP(1979-2009 JRA25)(top). + locates at Yokohama and Hengchun. Time series of PJ pattern index (1897-2012) (blue line), and EOF PC1 (1979-2009) (red line) (bottom).

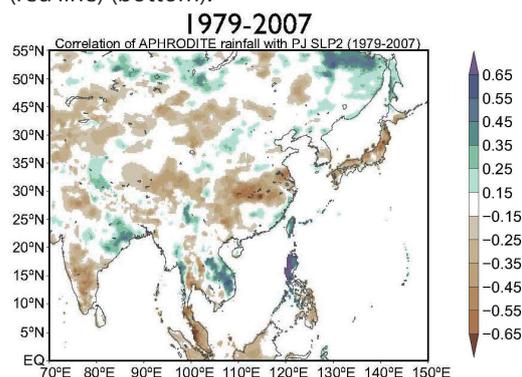


Fig. 2: Correlation map of APHRODITE rainfall (JJA) with PJ pattern index (1979-2007).

## Interdecadal variability of the PJ pattern

The PJ pattern index and preceding winter (DJF) Niño3.4 sea surface temperature(SST) have high negative correlation after 1970s (Fig. 3). However this correlation becomes unclear before 1970s. It is related to the ENSO (El Niño Southern Oscillation) regime shift (Nitta and Yamada 1989; Xie et al. 2010). On the other hand, the correlation between PJ pattern and ENSO is also high before 1910.

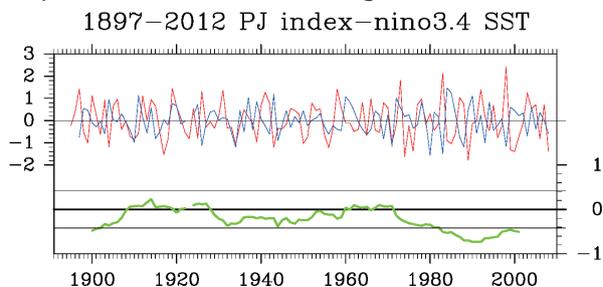


Fig. 3: The correlation (green line) between PJ pattern index (blue line) and preceding DJF Niño3.4 SST (red line). Nine years anomaly and 21 years running mean are performed in the correlation. Thin lines are 95% significance level.

## 1897–2012 PJ index and other indices

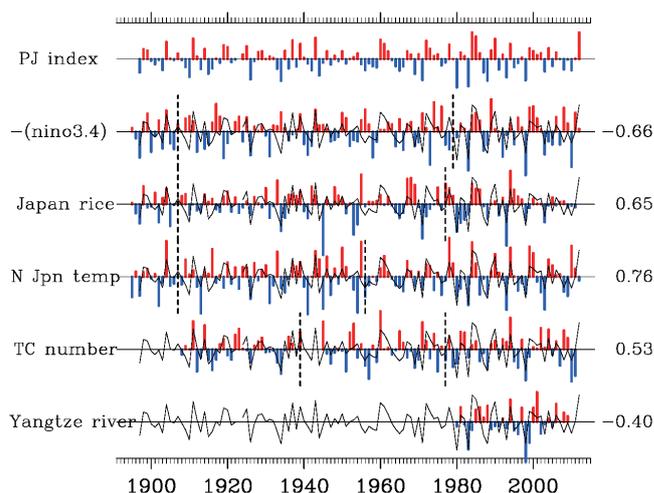
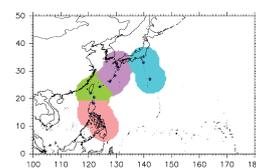


Fig. 4: Normalized time series from 1897 to 2012

- the PJ pattern index
- Niño3.4 SST (preceding DJF)
- northern Japan JJA temperature
- rice product in Japan
- tropical cyclone (TC) number (JJA)
- Yangtze river flow (Datong JJA)



Thin lines are PJ index. Dotted bars are the period of high correlation with the PJ index. Right side numbers are correlation coefficient between PJ index and other indices. Target area of TC number analysis is the colored area (bottom).

## Summary

The PJ pattern index was defined using station data and reproduced the western North summer monsoon activity from 1897 to 2012. The correlation to PJ pattern index is high in summer temperature in Japan and China, summer monsoon rainfall, summer TC numbers, preceding winter ENSO, rice product in Japan, and Yangtze river flow. The PJ pattern index is one of the major index for representing Asian summer monsoon for long-term period. Interdecadal modulation of ENSO influences the strength of the PJ pattern index correlation. The 115-year time series of PJ pattern index demonstrates that climate variability associated with ENSO regime is the dominant variability.