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Interactions between the Pacific-Japan teleconnection pattern and the Indian Ocean

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A meridional teleconnection pattern called the Pacific-Japan (PJ) pattern is an important mode of variability that influences summer climate over the western North Pacific (WNP). The pattern features meridional dipoles of precipitation and lower-tropospheric circulation, whose lobes are located over the subtropical and midlatitude WNP. While El Nino-Southern Oscillation (ENSO) is effective in triggering the PJ pattern, it has become known that the pattern is an atmospheric internal mode. The present study examines a possibility that the PJ pattern interacts with oceanic anomalies other than ENSO.

We have conducted a coupled general circulation model experiment with GFDL CM2.1, where sea surface temperature (SST) is restored toward its climatology over the eastern equatorial Pacific to suppress ENSO (denoted as NoENSO experiment). Our empirical orthogonal function analysis reveals that the PJ pattern is a dominant mode over the summer WNP in the absence of ENSO. The PJ pattern in NoENSO is significantly stronger that that observed in an experiment with the atmospheric component of CM2.1 forced with climatological SST (CLIMO experiment), indicating an amplification of the pattern by coupling. The PJ pattern in NoENSO experiment is accompanied by SST anomalies over the northern Indian Ocean (IO) and an atmospheric equatorial Kelvin wave. This study proposes an IO-PJ coupled mode. In this mode, a reduction in precipitation over the subtropical WNP forces an atmospheric cold Rossby wave response that extends westward to the northern IO. The associated easterly anomaly weakens the surface monsoon westerlies and warms the northern IO. The warmer IO induces atmospheric warm Kelvin wave that penetrates into the equatorial western Pacific. Ekman convergence associated with this warm Kelvin wave causes anomalous surface divergence over the subtropical WNP, which suppresses the atmospheric convection locally and thereby closes a feedback loop.

Keywords: Asian summer monsoon, air-sea interactions, a coupled mode, GCM