

## Two dominant modes over the summertime western North Pacific and their interdecadal modulations

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Structures and dynamics of two dominant meridional teleconnection patterns over the summertime western North Pacific (WNP) in intraseasonal to interannual time scales are examined. One of them features a positive correlation between convective activity around the northern Philippines and lower-tropospheric circulation centered near Japan, and called the Pacific-Japan (PJ) teleconnection pattern. Preceding studies argued that this pattern could be regarded as a dynamical mode, which efficiently gain energy from background state. The PJ pattern is significantly correlated with El Niño-Southern Oscillation (ENSO) peaked in preceding winter. Through an empirical orthogonal function (EOF) analysis for over half a century of Japanese 55-year reanalysis (JRA-55), the PJ pattern outstands as the leading mode of lower-tropospheric vorticity. The second EOF mode features a positive correlation between convective activity centered at Guam of the Mariana Islands and lower-tropospheric circulation around the Bonin Islands. We therefore call it the Mariana-Bonin (MB) pattern. This pattern also gains energy from background state through barotropic and baroclinic energy conversion as efficiently as energy generation due to anomalous diabatic heating, and thus bears dynamical mode features. The efficiency, however, is less than in the PJ pattern, consistent with the dominance of the PJ over MB patterns. In addition, the MB pattern is highly correlated with ENSO in developing stage.

The two patterns have undergone significant interdecadal modulations. The PJ pattern amplified from the 1950s to 1980s, and then weakened until the 2000s. It is suggested that interdecadal changes of ENSO forcing of the PJ pattern via Indian Ocean and tropical WNP sea surface temperature anomalies are responsible for these modulations. The MB variance also shows interdecadal modulations but the changes are weaker than in the PJ pattern. As a result, the PJ pattern has degraded to the second EOF mode since the late 1990s, while the MB pattern has been promoted to the leading EOF mode instead.

Keywords: ENSO, Teleconnections