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Relationship between the western North Pacific Ocean and the East Asian summer monsoon and its non-stationarity

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In this study, the relationship between the western North Pacific Ocean (WNPO; 0–55°N, 100–165°E) and the East Asian summer monsoon (EASM) and its non-stationarity are investigated. It is found that the WNPO-EASM connection experiences a well-defined interdecadal change in the late 1980s and early 1990s. The EASM-related WNPO sea surface temperature anomaly (SSTA) pattern changes from the dipole pattern [WNPO dipole (WNPOD)] that develops over the period between 1968 and 1987 (P1) to a tripole pattern [WNPO tripole (WNPOT)] between 1991 and 2010 (P2). The positive (negative) phase of the WNPOD is characterized by warm (cold) SSTAs in the Japan Sea and Kuroshio–Oyashio Extension region, and cold (warm) SSTAs in the subtropical WNPO, whereas the positive (negative) phase of the WNPOT shows warming (cooling) in the Kuroshio Extension region (KER), and cooling (warming) in the south of Kamchatka Peninsula (SKP) and Philippine Sea (PS). During P1 (P2), the WNPOD (WNPOT) can be regarded as the first (second) leading mode of summer WNPO SST variability, and its positive phase is associated with a weakened WNPO subtropical high and thereby the deficient summer rainfall in the Yangtze River valley, together with a strong EASM, and vice versa. The change in the WNPO–EASM relationship may be caused by interdecadal changes in the relationship of the equatorial central Pacific (ECP) with the WNPO and EASM, and an increase in summer KER SST variability associated with an enhanced PDO. During P2, because the ECP warming-induced cyclonic anomalies move northwestwards and intensify, summertime ECP warming is able to generate a strong EASM and significant cooling over the two poles of the WNPOT (SKP and PS). These strengthened impacts of the ECP on the WNPOT and EASM contribute to the strengthened WNPOT–EASM relationship during P2. In addition, the increased KER SST variability associated with an enhanced PDO in summer between 1991 and 2010 changes the KER-related atmospheric circulation over East Asia and thus the KER–EASM relationship during P2. These two factors probably cause the EASM-related WNPO SSTA pattern to change from the WNPOD in P1 to the WNPOT in P2.