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Decadal variability of the Indo-Pacific Warm Pool and its association with atmospheric and oceanic water cycle variability

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Decadal variability of the Indo-Pacific Warm Pool (IPWP) sea-surface temperature (SST) and its association with atmospheric and oceanic water cycle are investigated with observed data sets. Two leading empirical modes (EMs) well represent the IPWP SST decadal variations. EM1 is an El Niño–Southern Oscillation (ENSO)-like pattern with out-of-phase SST anomalies in the western Pacific and the Indian Ocean, whereas EM2 displays an in-phase relationship between SST anomalies in the two regions. Consequently, spatial evolution of EM1 is dominated by opposing changes in zonal and meridional dimensions and thus a strong deformation of the warm pool on decadal time scales. EM2 is dominated by changes in size and intensity of the warm pool. Analyses of ocean thermodynamic fields associated with the two SST EMs indicate that decadal changes in the IPWP can extend down to 300 m depth. Oceanic processes may thus be involved in the IPWP decadal variability, including advections of mean temperature by both mean and anomalous ocean currents and effects of shallow tropical circulations (STCs) on the IPWP SST, which is consistent with some previous studies on tropical decadal variability. Both December–January–February (DJF) and June–July–August (JJA) atmospheric circulations exhibit thermally-direct responses to the two decadal IPWP SST EMs by altering the Hadley and Walker circulations. In addition, significant upper-level rotational flow anomalies in the extratropics are found to be associated with the decadal IPWP SST variability. Consistent with the upper-level flow anomalies and 850 hPa convergence-divergence patterns associated with the two SST EMs are rainfall anomalies over the United States. Since these rainfall anomalies are a significant fraction of seasonal-average rainfall and since these anomalies persist for many years, they potentially make a significant impact on U.S. water resources and agriculture.