Anthropogenically Forced Multidecadal Sea Surface Temperature Variability in the Indo-Pacific Warm Pool

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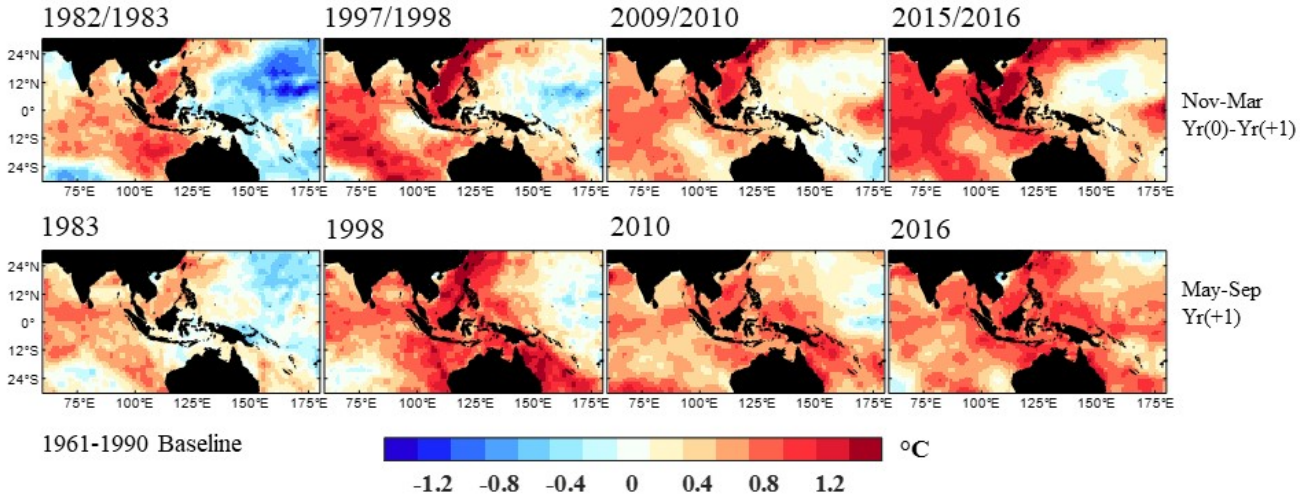
A solid understanding of sea surface temperature (SST) dynamics will benefit the society considering its apparent influence on various aspects, including marine ecosystem and weather/climate sciences. Such understanding becomes even more important for the Indo-Pacific Warm Pool (IPWP) where the Coral Triangle region and the Intertropical Convergence Zone (ITCZ) reside. In this study, we examined long-term SST variabilities in the IPWP over the last 120 years based on global SST reconstruction datasets. We focused on decadal-interdecadal timescale which is usually overlooked in previous researches. There was a tendency of strong persisting warming following Eastern Pacific-El Niño (EP-El Niño) events in the early 21st century (1997/1998, 2009/2010, 2015/2016) compared during the late 20 th century (e.g., 1982/1983). Removing linear trend of the SST Anomalies (SSTA; 1961-1990 mean seasonal cycle removed) in IPWP however, did not yield significant changes in the tendency. This tendency from the early 21st century resulted in an opposite decadal pattern between the IPWP and the adjacent Pacific Ocean which showed a decadal cooling trend tied to the recent global warming hiatus. Empirical Orthogonal Function analysis applied on SSTA revealed the first two leading modes that associated with the Global Surface Temperature (GST) increase and EP-El Niño, respectively. Interaction between the first two leading modes of IPWP SSTA indicates the overall region response to the El Niñ o-Southern Oscillation (ENSO) from zero-lagged to seasonal-time-scale lagged response. Coupled ocean-atmosphere processes associated with the lagged response to the ENSO suggest anomalous features in IPWP that can extend more than six months from the triggering ENSO. The extended anomalous features, including intensification (weakening) of southeast monsoon circulation, reduced (increased) precipitation and latent heat flux were associated with El Niño (La Niña) which led to change in the incoming solar radiation. Over the study period (1900-2019), this lagged IPWP response to ENSO showed strong shifts from 1970s toward El Niño-warming favorable condition which explains the previously mentioned warming tendency. The southeast monsoon circulation enhancement from 1970s associated with the emergence of interhemispheric warming gradient was presumed as one of determining factors to these shifts. Models with realistic ENSO and IPWP SST variabilities features from the Coupled Model Intercomparison Project Phase 6 (CMIP6) further confirm the possible influence from anthropogenic influence on the lagged IPWP response to the ENSO. Sensitivity analysis from historical and pre-industrial control experiment showed notable difference in the lead-lag correlation structure between IPWP SSTA and Central-Eastern Pacific SSTA (NINO3.4), implying the possible extent of anthropogenic forcing in altering region response to the ENSO. Results provided in this study highlights the importance of incorporating anthropogenic forcing influence in assessing ENSO impact on the IPWP.

Keywords: Indo-Pacific Warm Pool, Sea Surface Temperature, Low-frequency Variabilities



Seasonal SSTA Composite in the Indo-Pacific Warm Pool during the Eastern Pacific-El Niño events over the 1980-2020

