Understanding the Indo-Pacific warm pool expansion: Seasonal changes

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The Indo-Pacific warm pool (IPWP), enclosed ocean near equator with 28°C isotherms, plays a critical role for global atmospheric circulation and hydrological cycle through supporting the Walker circulation's rising branch and changing rainfall distribution throughout the tropics to extra-tropics. A recent study found that the observed expansion of the IPWP since 1950s is primarily caused by human-induced greenhouse gas increase (Weller et al. 2016). The IPWP has large seasonal fluctuations due to its meridional shifts following solar radiations and also asymmetric variations between the Indian and Pacific basins. Understanding changes in seasonal IPWP is important for its impacts on global and regional precipitations. Here we conduct an attribution analysis of seasonal IPWP changes by comparing observations and CMIP5 multi-model simulations. Observations exhibit the IPWP expansion across all seasons. Larger seasonality is seen in the observed expansion of the Indian Ocean warm pool while relatively uniform warm pool expansion appears over the Pacific Ocean. Also, stronger expansion occurs in boreal winter and autumn seasons such that the Indian Ocean warm pool exhibits the largest expansion during boreal winter. For better comparison with the observations we have selected CMIP5 models which can reproduce the observed climatological IPWP area. It is found that simulations with those selected CMIP5 models under natural and anthropogenic (ALL) forcings can capture the observed IPWP expansion, with some overestimation in the Pacific and some underestimation in the Indian Ocean. To identify causes of the observed seasonal IPWP changes, we apply an optimal fingerprint technique, where the observed changes are regressed onto the model response patterns to ALL, natural (NAT), and anthropogenic (ANT = ALL - NAT) forcings. The resulting regression coefficients are then evaluated to determine which external forcing significantly contributes to the observed changes. Results show that ANT signals are detected robustly in the IPWP area changes in all seasons for the whole Indo-Pacific Ocean. Anthropogenic signal amplitudes are found to be consistent with the observed trends in the Indian Ocean while models' underestimation exists. External forcings signal is not clear in Pacific through whole season, excepting boreal winter. Our results provide the first evidence for human influence on the observed seasonal warm pool changes. Influence of the seasonal IPWP changes on precipitation and teleconnection patterns will be discussed.

Key words: Indo-Pacific warm pool, detection and attribution, convection

References

Weller et al., 2016: *Sci. Adv*,.**2**, e1501719