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# The Direct Response in the Equatorial Pacific to the 11 year Solar Cycle Forcing and its mechanisms

Wenjuan Huo (1,2) and Ziniu Xiao (1)

(1) State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China (E-mail: huo@lasg.iap.ac.cn), (2) University of Chinese Academy of Sciences, Beijing 100049, China

The equatorial Pacific response to 11-year solar cycle is assessed in observation and ensemble historical–Nat simulations from the Coupled Model Intercomparison Project, Phase 5 (CMIP5). We find the central equatorial Pacific is sensitive to the solar forcing. A significant positive correlation is found between observed sea surface temperature (SST) anomaly and sunspot number (SSN) index with a lag of 2 years in the central Pacific. The 11-year solar signal particularly exits in the SST and zonal wind anomalies from spectrum analysis. Based on composite analysis, a warming response appears in the central Pacific with lagging the solar cycle by 1–2 years in observation, and 2–3 years in simulation results. Associated with the ocean temperature anomaly, an anomalous twin Walker circulation cells arise in the equatorial Pacific with their updraft branch centered over the central equatorial Pacific, which is significantly both in observation and simulation.
Mixed layer heat budget analysis shows that the atmosphere radiation fluxes modulated by the amounts of cloud cover are responsible for the warming response pattern in the central Pacific. There is a significant positive correlation between the meridional gradient of cloud cover ($\Delta\alpha$, Subtropics−Tropic) and zonal SST gradient ($\Delta$T, east−west) in the equatorial Pacific. The warming response in the central equatorial Pacific is amplified by the coupled atmosphere and ocean processes. On the one hand, owing to the zonal SST gradient decreasing in the western and central Pacific but increasing in the eastern and central Pacific, anomalous zonal wind convergence appears in the central Pacific in the three years following the solar peak. The ocean heat transport effect is negative in the central equatorial Pacific, more warm water accumulates locally. On the other hand, anomalous ascending motion over the central Pacific increases the high cloud amount and lets more shortwave radiation come into surface, which combined with the longwave radiation trapping, also amplifies the warming response in the central Pacific.