# Future changes of the cross-equatorial SST gradient over the Eastern Pacific

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Tropical climate will provide substantial impacts on the regional climate patterns over the globe. Regarding the future changes in the zonal atmospheric and ocean circulation over the tropical Pacific, most of the future projections and careful observational analyses showed a future slowdown of the Walker Circulation and relaxed zonal gradients in the thermocline depth and sea surface temperature (SST) by the Bjerknes feedback. In the future changes in the meridional circulation over the tropics, the inter-hemispheric asymmetry in increase rates of surface air temperature (SAT) tends to induce a meridional displacement of the Inter-tropical Convergence Zone. Although individual roles of the atmospheric and ocean dynamics are still in debate, the meridional interaction between the extratropics and tropics are well investigated. In these studies, the inter-hemispheric asymmetry was treated as an external remote forcing to the tropical ocean-atmosphere. However, the wind-evaporation-SST (WES) feedback can work as an internal dynamics in the future changes of the tropical ocean-atmosphere. The present study attempts to examine the future changes of the tropical climate with a special interest in the meridional direction in association with the WES feedback, on the basis of the Coupled Model Intercomparison Project Phase 3 (CMIP3) and Phase 5 (CMIP5). Assuming the hydrostatic adjustment to the warmed lower atmosphere in the future climate, the inter-hemispheric SAT asymmetry can lead to southerly surface winds over the equator as a trigger of the equatorial WES feedback and eventually form the enhanced cross-equatorial SST gradient. Indeed, among various intensities in the SAT asymmetry based on many future projections under different $CO_2$ emission scenarios, a linear relation is displayed between the inter-hemispheric asymmetry and meridonal SST gradient. In the multi-model ensemble, the enhanced meridional SST gradient with positive (negative) changes in the northern (southern) tropics is already found in the first half 50-year climatologies during 21st. century over the eastern tropical Pacific. These spatial features are much pronounced in the second half of the century. In association with the enhanced SST gradient, cross-equator southerlies with enhanced southeasterly trade and associated SLP patterns are found in the first and second halves, respectively. In the meridional interaction between the extratropics and tropics, the equator-ward divergent surface winds from the relatively increased SLP in the mid-latitude toward the decreased SLP over the equator tend to be stronger over the South Pacific than over the North Pacific. This inter-hemispheric asymmetry in the subtropical SLPs acts to form anomalous convergence zone near the equator. While most of the simulations exhibited the enhanced meridional SST gradient and cross-equatorial southerlies, a few simulations displayed the opposite response. The exact reason why the opposing response was simulated is not a simple question. But our analyses indicate that the successful reproducing of the current meridional circulation is very important to discuss the future change in the meridional gradient. Finally, the meridional gradient is all enhanced in the CMIP5 simulations.

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