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Underestimated ENSO Asymmetry and Zonal Currents over the Equatorial Western Pacific in OMIP2 experiments

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The El Niño-Southern Oscillation (ENSO) is one of the most significant integrated interannual oscillations with coupled atmosphere-ocean processes in the tropical Pacific. Most coupled climate models are weak in depicting ENSO asymmetry over equatorial Pacific subsurface. And it is still unclear how the stand-alone ocean model contributes to this bias. In this study, we found that most ocean models from the Ocean Model Intercomparison Project (OMIP), driven by JRA55, underestimate the asymmetry of ENSO in the equatorial western Pacific subsurface. We investigated the primary factors contributing to this bias using composite analysis and diagnostics, and found that the weaker responses in upwelling and stronger responses in downwelling to westerly and easterly wind stress anomalies in the models are mainly responsible for the bias. Furthermore, the underestimation of zonal current variability over western Pacific subsurface, influenced by the gradient of mean state of sea surface height along the equatorial Pacific, leads to an opposite relationship between asymmetry and the zonal component of nonlinear dynamic heating in the western Pacific subsurface comparing to that in the eastern Pacific subsurface. Our study emphasizes the importance of accurately modeling ocean currents to capture the characteristics of ENSO nonlinearity and highlights the significance of nonlinear dynamic responses to external forcing.