Diagnostics of Oceanic Kelvin Wave Responses to Westerly Wind Events in the equatorial Pacific in CMIP6 models

Jingxuan Cui[1], Emily Riley Dellaripa[1], Charlotte DeMott[1], and Eric Maloney[1]

1. Department of Atmospheric Science, Colorado State University

Westerly wind events (WWEs) are anomalously, strong, long-lasting westerlies that typically occur over the tropical warm-pool region, associated with intraseasonal variations such as the Madden-Julian oscillation (MJO). Through imparting stresses on the ocean surface, strong WWEs can excite intraseasonal oceanic Kelvin waves (KWs) that can trigger El Niño events, which in turn modulate background conditions that affect MJO characteristics and subsequent WWEs and KWs. Thus, faithful representation of WWEs and KWs in models is important to simulating intraseasonal to interannual air-sea feedbacks in the tropics.

We have developed a set of diagnostics to evaluate WWEs and KWs in the equatorial Pacific in CMIP6 historical simulations. By examining the frequency, duration, amplitude, and zonal distribution of the WWEs, we find that WWEs are weaker and less frequent than observed. Biased WWE distributions lead to zonally-shifted KW variance in models. Models also fail to simulate realistic KW propagation and show a significant slow bias with a second baroclinic mode KW feature, rather than the dominant first baroclinic mode feature in observations. Through diagnosing the upper ocean vertical wavenumber, we identified that the slow bias largely results from model KWs having unrealistic influence from higher baroclinic modes, rather than the biased ocean stratification, which is supported by the vertical mode decomposition of the ocean density. These diagnostics can be applied in the coupled NOAA Unified Forecast System (UFS) subseasonal to seasonal prototypes to understand bias sources for WWEs and KWs and further improve the forecasts of El Niño onset and subsequent weather extremes.