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Embedding a one-column ocean model in CAM5 for improving low-resolution MJO simulations

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The impact of air–sea interaction on Madden–Julian oscillation (MJO) was investigated with the Community Atmosphere Model (CAM5) coupled to a one-column SIT (Snow/Ice/Thermocline) ocean model. The SIT embedding in CAM5 (CAM5-SIT) is developed to simulate high–resolution vertical mixing u-current, v-current, water temperature and salinity within 10-m depth and mid-resolution from 10-m depth down to the abyss. A more elaborate parameterization of vertical-mixing processes by the turbulent kinetic energy (TKE) equation provides realistic simulations of the turbulent mixing with a reasonable computational efficiency. Weak winds and large insolation resulted in SCAM a shallow mixed layer and large SST diurnal cycles at TOGA COARE during the IOP periods. By contrast, the strong wind (> 10 m/s) erroneously enhances mixed layer deepening and surface temperature cooling. Diurnal SST variation will strengthen the diurnal moistening in atmosphere and both are potential sources of MJO predictability. Time–evolving SST with a diurnal cycle strongly influences the onset and intensity of MJO convection. CAM5-SIT with half-hour coupling frequency significantly improves the MJO simulation over CAM5 with prescribed SST, fully coupled with Slab Ocean Model and with pop2 in wavenumber–frequency spectra of equatorial 850 hPa zonal wind (U850). The mean state SST and eastward propagating U850 and precipitation of CAM5-SIT results are similar to the observations. Using CAM5-SIT, the Rossby number of outgoing longwave radiation in wavenumber–frequency cross-spectra is weaker than observation, which is due to large–scale perturbation. The model distribution at high frequency and small–scale perturbation scheme in Kelvin wave are wider than observation. The coupled model experiments clearly demonstrate the importance of the diurnal SST in MJO eastward propagation.

Keywords: Madden–Julian oscillation; CAM5-SIT; turbulent kinetic energy; SST; TOGA COARE