

Sources of error for ocean feedbacks to the MJO

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A suite of air-sea interaction diagnostics tailored to intraseasonal timescales is applied to coupled and uncoupled simulations with three different climate models. Mean state differences between coupled and uncoupled simulations for each model are minimized by forcing the uncoupled simulation with 31-day smoothed SSTs from the coupled simulation. With this framework, differences in MJO behavior for each model pair arise from the removal of ocean feedbacks.

For each model, removal of interactive ocean feedbacks (i.e., the uncoupled simulation) enhances off-equatorial convection at the expense of equator-centric convection and opposes formation of the convectively-generated equatorial low-pressure anomaly. The resulting reduction in the east-to-west pressure gradient weakens downstream moistening by horizontal advection, and hinders MJO propagation in the uncoupled simulations.

The air-sea interaction diagnostics point to the importance of negative SST feedbacks to off-equatorial convection (associated with equatorial Rossby waves) as one mechanism to help focus MJO convection on the equator and maintain the critical moistening by advective processes. Our analysis points to several possible systematic biases that may negatively impact MJO propagation: 1) over-active equatorial Rossby wave modes, 2) a muted SST response to MJO forcing due to poor vertical resolution of the upper ocean, and 3) insufficient convective entrainment and detrainment. On the other hand, strong ocean feedbacks and robust MJO propagation in one coupled model were the result of an excessively dry tropical boundary layer that exaggerated the role of surface fluxes in the MJO moist static energy budget.