Why do atmosphere-ocean interactions improve predictions of the Madden-Julian oscillation?

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Many studies have shown that including atmosphere-ocean interactions improves the representation of the Madden-Julian oscillation (MJO) in climate models, as well as the prediction skill for the MJO in initialised medium-range and sub-seasonal weather forecasts. There is little consensus, however, on the physical mechanisms by which coupling advances the simulation of the MJO. The strength and nature of the effects of coupling vary from one model to the next: in some models air-sea coupling reduces propagation speed; in others, it accelerates it; in still others, coupling does not affect propagation speed, but adjusts the amplitude of the MJO instead.

We present reforecast simulations of the MJO within the framework of an atmospheric model coupled to a one-dimensional mixed-layer ocean model. This framework allows easily performing a wide range of sensitivity experiments to determine the mechanisms by which coupling affects MJO predictions. We perform reforecasts of several MJO events, chosen to sample a range of background states (e.g., phase of the El Nino-Southern Oscillation), MJO event type (e.g., propagating versus decaying) and MJO event strength (e.g., strong versus weak). Our sensitivity experiments target particular physical processes that affect atmosphere-ocean exchange: removing the diurnal cycle of atmosphere-ocean interactions, homogenising the sea-surface temperatures within the MJO region, and homogenising surface fluxes.

We present the results from these reforecast experiments, to advance our understanding of how tropical air-sea exchange influence the development of tropical convection on synoptic to sub-seasonal scales.