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Title: The role of air-sea coupling in MJO propagation in the Hadley Centre model
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Abstract:
The Madden-Julian oscillation (MJO) is the dominant mode of sub-seasonal (30-60 day) variability in tropical convection. Through its modulation of monsoon systems and teleconnections to modes of extra-tropical circulation (e.g., the North Atlantic Oscillation), the MJO provides a critical source of monthly predictability globally. Most general circulation models (GCMs) used for sub-seasonal to seasonal prediction, however, fail to simulate the amplitude, period, propagation or teleconnections of the MJO.

In its default configuration, the U.K. Met Office atmospheric model (GA3.0) has no detectable MJO; sub-seasonal variability in convection is weak and dominated by westward propagation. We recently improved the MJO in GA3.0 by increasing a parameter F, which controls the rates of entrainment and mixing detrainment for deep and mid-level convection. This produces stronger variability in convection, but propagation remains deficient, particularly through the Maritime Continent.

We conduct experiments with GA3.0 coupled to many columns of the K Profile Parameterisation boundary-layer ocean model (GA3.0-KPP), at default and high F, to understand how the amplitude of the MJO in GA3.0 affects the response to air-sea coupling. Coupling is applied in the tropical Warm Pool region (30S-30N, 40-200E) At default F, coupling increases MJO amplitude by a similar amount to increasing F, but propagation is still weak. At higher F, coupling does not significantly affect MJO amplitude, but improves eastward propagation considerably. Propagation through the Maritime Continent is particularly enhanced.

To understand these results, we perform a sensitivity test with high F in which coupling is applied in only the Indian Ocean (30N-30S, 40-100E). Propagation terminates sharply at the edge of the Maritime Continent (near the coupling boundary) in this simulation. We conclude that well-resolved air-sea coupling in both the Indian and West Pacific Oceans is required for the MJO to propagate through the Maritime Continent in this model.
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