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Sea surface temperature impact on Madden-Julian Oscillation convection in the Met Office coupled and atmosphere-only forecast models

Eliza Karlowska[1,2], Adrian Matthews[1], Benjamin Webber[1], Tim Graham[2], and Prince Xavier[2]
[1]University of East Anglia, Environmental Sciences, Norwich, United Kingdom
[2]Met Office, Exeter, United Kingdom

Forecasting the Madden-Julian Oscillation (MJO) is challenging for many numerical weather prediction (NWP) systems and climate models. Models tend to simulate slower MJO propagation than in observations, impacting other weather and climate patterns across the world through its teleconnections. Observations show that sea surface temperatures (SST), and subsequently sea surface fluxes influence MJO convection in the tropics. Coupled ocean-atmosphere models, which dynamically predict SST, tend to perform better in forecasting the MJO than atmosphere-only models that use persisted SST. Lower resolution coupled climate models are routinely used by forecasting centres, however, there are only a few operational weather forecasts utilising high resolution coupled NWP systems. The Met Office has developed a coupled NWP system running in near real-time since May 2016, alongside their operational, atmosphere-only NWP system. Comparison between the models using the Real-time Multivariate MJO index reveals that both are similarly skillful within 7 and 10 forecast days for operational and coupled models, respectively. The coupled model produces faster MJO propagation than the operational model. Consistent with this faster propagation, coupled model forecasts initiated during active MJO convection over the Indian Ocean (RMM phase 1), show enhanced convection by lead day 7 in the Sulawesi-Banda Sea region located ahead (to the east) of the convective envelope. Warm SST anomalies of order 0.1°C in that region are simulated in the coupled model composites from lead day 1, consistent with observations. When the coupled model is initialised with active MJO convection over the Maritime Continent (RMM phase 4), the model suppresses convection faster in the equatorial Indian Ocean region, which is behind (to the west) of the MJO convection. Cold SST anomalies are created in the coupled model from lead day 1 in that region, stronger than observations suggest and leading to excessive suppression of convection in the coupled model here. We explain the differences between the coupled and atmosphere-only simulations through a combination of upwelling diagnostics, analysis of moisture budget terms and targeted numerical experiments for SST-convection feedback.