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A mechanism denial study on the Madden-Julian Oscillation

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A series of Madden-Julian oscillation (MJO) mechanism-denial experiments is performed using an atmospheric general circulation model (AGCM). Daily climatological seasonal cycles of i) surface latent heat flux, ii) net radiative heating rate, and iii) surface wind stress are obtained from a control simulation and prescribed in place of the normal interactive computations of these fields in order to turn off the i) wind-induced surface heat exchange (WISHE), ii) cloud-radiation interaction (CRI), and iii) frictional wave-CISK (FWC) mechanisms, respectively. Dual and triple mechanism denial experiments are also conducted by switching off multiple mechanisms together. The influence of each mechanism is assessed by comparing experiments with that mechanism turned off to those in which it is not. CRI and WISHE are both found to be important to the simulated MJO amplitude and propagation speed, while FWC has weaker and less systematic effects. The MJO is weakened when CRI is turned off, but strengthened when WISHE is turned off, indicating that CRI and WISHE amplify and weaken the MJO, respectively, in the control simulation. The negative influence of WISHE is shown to result from simulated phase relationships between surface winds, surface fluxes and convection which differ significantly from those found in observations. The positive influence of CRI is consistent with a strong simulated relationship between daily grid-point column-integrated radiative and convective heating; the mean ratio of the latter to the former exceeds 0.2 for rain rates less than 14 mm/day.