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Simulations of Madden–Julian Oscillation in High Resolution Atmospheric General Circulation Model

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The simulation of tropical signals, especially the Madden–Julian Oscillation (MJO), is one of the major deficiencies in current numerical models. The unrealistic features in the MJO simulations include the weak amplitude, more power at higher frequencies, displacement of the temporal and spatial distributions, eastward propagation speed being too fast, and a lack of coherent structure for the eastward propagation from the Indian Ocean to the Pacific (e.g., Slingo et al. 1996). While some improvement in simulating MJO variance and coherent eastward propagation has been attributed to model physics, model mean background state and air–sea interaction, studies have shown that the model resolution, especially for higher horizontal resolution, may play an important role in producing a more realistic simulation of MJO (e.g., Sperber et al. 2005). In this study, we employ unique high-resolution (25-km) simulations conducted using the Geophysical Fluid Dynamics Laboratory global High Resolution Atmospheric Model (HIRAM) to evaluate the MJO simulation against the European Center for Medium-range Weather Forecasts (ECMWF) Interim re-analysis (ERAI) dataset. We specifically focus on the ability of the model to represent the MJO related amplitude, spatial distribution, eastward propagation, and horizontal and vertical structures. Additionally, as the HIRAM output covers not only an historic period (1979-2012) but also future period (2012-2050), the impact of future climate change related to the MJO is illustrated. The possible changes in intensity and frequency of extreme weather and climate events (e.g., strong wind and heavy rainfall) in the western Pacific, the Indian Ocean and the Middle East North Africa (MENA) region are highlighted.