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Assessment of MJO detouring in the CMIP6 models

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The Madden-Julian oscillation (MJO) is the most pronounced tropical intraseasonal oscillation affecting the local and global weather climate systems. The MJO propagates eastward passing through the Maritime Continent (MC) where its propagation tends to be weakened or ceased, so-called “barrier effect”. This weakening and dissipation over the MC are even more exaggerated in the climate model. Another obstacle for simulating realistic MJO propagation is related to the MJO seasonality. The eastward propagation of MJO tends to detour southward over the MC during boreal winter. This is partly attributed to the higher sensitivity of MJO precipitation to the MJO moisture over the southern MC in boreal winter when the background moisture and wind are favorable to the moisture-precipitation coupling and wind-evaporation feedback associated with the Australian monsoon. We thus established the MJO detouring metric to quantitatively evaluate the performance of MJO’s southward detour in the 35 Coupled Model Intercomparison Project Phase 6 (CMIP6) models. We first calculated the lead-lag regression coefficient of 20-100 days bandpass-filtered OLR anomalies onto the area-averaged OLR over the Indian Ocean [5° S-5° N, 85-95° E], where the equatorial MJO convective envelops begin to propagate to the MC. The MJO-related convection is defined as the normalized regression coefficient by the observed maximum larger than 0.5. The propagation is detected by accumulating the occurrence of the MJO convection between the preceding 9 days and the following 27 days from the peak in the Indian Ocean base point. Finally, the detour metric is defined by the meridional difference of area-averaged accumulation over the regions between the southern MC [15-5° S, 110-150° E] and equatorial MC [5° S-5° N, 110-150° E]. Based on the MJO propagation and detour metrics, we selected three CMIP6 model groups consisting of ‘propagating and detouring’, ‘propagating and non-detouring’, and ‘non-propagating and non-detouring’. The comparison among the groups reveals that the background moisture field over Australia is the key component in improving the simulation of MJO propagation and detouring over the MC in the climate model.

Key words: Madden-Julian oscillation (MJO) propagation, MJO detouring, CMIP6, Maritime Continent Barrier effect