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Effect of convection scheme on the boreal winter MJO

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The detailed characteristics of the boreal winter Madden-Julian Oscillation (MJO) is examined using the MRI AGCM that uses new mass-flux type cumulus scheme developed by Yoshimura (Yukimoto et al., 2010; hereafter, referred to as YM cumulus scheme) instead of AS-type cumulus scheme. In the YM cumulus scheme, convective updrafts with the minimum and maximum entrainment/detrainment rates are calculated as detailed entraining and detraining plumes as in a Tiedtke-type scheme, and multiple convective updrafts with different heights as in an AS-type scheme are represented by considering continuous convective updrafts between the minimum and maximum turbulent entrainment/detrainment rates. To evaluate the simulated MJO in MRI AGCM, the mean states, power spectra, propagation features, leading EOF modes, horizontal and vertical structure, and seasonality associated with the intraseasonal variability over the tropics are analyzed using a standard software package developed by the U. S. Climate Variability and Predictability (CLIBAR) MJO Working Group.
The simulated MJOs in the control model with the AS scheme are less realistic, although mean states in winds and convection is comparable to that of the observation. It shows low amplitudes in convection and low-level winds in the 20-100 day band and has standing structures in filtered anomalies. Comparison with a variant of the Arakawa-Schubert cumulus scheme (hereafter, referred to as AS) shows that, the intraseasonal (20-100 day) variability in precipitation, zonal wind, and outgoing longwave radiation (OLR) is enhanced substantially in YM scheme compared to the AS scheme. The amplitudes of the MJOs in zonal wind, precipitation, and OLR are enhanced, and MJO shows clearly eastward propagation from the Indian Ocean to the Pacific. The zonal winds shows a well organized baroclinic structure and can lead convection, suggesting the coupling among convection and zonal winds. Especially, in the composited mature phase of the simulated MJO, the low level convergence leads convection clearly so that the moisture anomalies tilt westward in the vertical, indicating that the low-level convection favors the eastward propagation.