The Madden-Julian Oscillation simulated by the Beijing Climate Center's AGCM

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Using Beijing Climate Center's (BCC) AGCM the Madden Julian Oscillation (MJO) has been simulated. The BCC AGCM is developed based on the NCAR CAM3. The model is modified in the following aspects: An reference atmosphere is added to the model; A new Zhang's convection scheme (Zhang and Mu, 2005) is modified and incorporated into the model to replace the old one (Zhang and McFarlane, 1995); The moisture flux calculation in open ocean is also modified to represent the effect of ocean wave on the latent heat flux; A new calculation method of snow cover fraction is also added to the model.

The model was run from 1949 for 50 years under the observed monthly SST as the lower boundary condition.

The tropical MJO in the model output is analyzed and compared with the observation and also with the result given by the original NCAR CAM3. The results are as followings:

1. The time-space spectral analysis showed that there are obvious spectral energy peak in the wave one and wave period of 20-90 days for both the zonal wind (U) at 850 hPa and precipitation in the BCC model output. Also the energy of the eastward propagating wave is much larger than that of the westward propagating waves. These features are very close to those from NCEP reanalysis.
2. The BCC AGCM simulated MJO has much realistic space distribution. In winter, the MJO mainly active in the southern hemisphere and its maximum energy center is along 10°S, while in summer the MJO active region move northwestward to the southeast Asia region, its center located along 10°N. In addition to the Indian and western Pacific region, there is another MJO active region in summer in the area of eastern Pacific north to the equator.
3. The BCC AGCM simulated MJO has obvious annual cycle. It is characterized by the seasonal migration of the MJO active center between the two hemispheres and/or by the strength variation of the MJO activity. In the Indian – western Pacific region, the MJO is the strongest in winter with its maximum center at 130°-150°E, 10°S. This maximum becomes weaker in spring and moved northwestward towards equator and in summer the MJO active region moves northwestward further to southeast Asia and becomes strong again. From summer to winter the MJO active region moves back in the reverse direction and its strength become weaker in autumn and stronger again in winter. The other MJO active region in the Eastern Pacific north to equator also has annual variation, it appears stronger in summer and weaker in winter but with no movement across equator.
4. The BCC AGCM reproduced a realistic eastward propagating speed of MJO about 5-10 m/s which is close to or little bit faster than the observation.
5. In overall, the BCC AGCM has better ability than the original CAM3 in simulating the MJO.