Heat and Moisture Budgets of Simulated MJO in the NCAR CAM3

Guang Zhang

Scripps Institution of Oceanography
Background

• Simulated MJO in CAM3 was weak.
• When the deep convection scheme was modified with a new closure, the simulated MJO was realistic.
• When the shallow convection scheme was turned off below 700 mb in the topics, MJO simulation deteriorated again.
• What is the role of shallow convection, and how does it interact with deep convection to affect MJO simulation?
Approach

• Use CAM3 as a modeling tool:
  – **CTL**: Run CAM3 with Revised Zhang-McFarlane scheme for deep convection and Hack scheme for shallow convection for 10 years (1980-1989)
  – **NSC**: Use the same model configuration but with Hack scheme turned off below 700 mb within 25 deg from the Equator

• Analyze the heat and moisture budgets for simulated MJOs and compare with ERA40 reanalysis data
Observed MJO magnitude and eastward propagation were simulated well with revised deep convection scheme, but not in the standard CAM3.
Improvement disappears once shallow convection is turned off
November-April mean state of OLR (shaded) and U,V850 (vector).

Not much difference in mean low-level circulation.
Dry static energy anomalies in phases 1-8 of MJO from ERA40

CAM3
Height-phase cross section of composite moist static energy and its difference between the layer 500-100 hPa and 900-500 hPa

MSE(500-100hPa)-MSE(900-500hPa)
Vertical profiles of specific humidity averaged over the longitudes where the mature phase of MJO is located.
Moisture budget for ERA40 reanalyses
Deep convection shallow convection

Moisture budget for CTL
Moisture budget for NSC
Combined effect of vertical advection and convective drying on \( q \)
Precipitation Anomalies in different phases of MJO (mm day$^{-1}$)
Summary

• MJO simulation is very sensitive to both deep and shallow convection.
• Heat and moisture budgets are analyzed to understand the role of shallow convection in MJO simulation.
• The major difference between the two simulations with and without shallow convection is the lower troposphere moistening from initiation to developing stage of MJO.
• With shallow convection, the lower troposphere has positive moisture anomalies and more clouds before deep convection.
• Large-scale precipitation does not appear to be an important factor in this case.