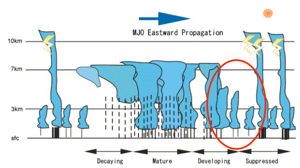
Low-level Heating and the MJO

Courtney Schumacher, Cara-Lyn Lappen, and Fiaz Ahmed

Department of Atmospheric Sciences, Texas A&M University

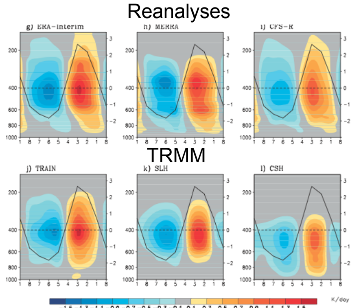
1. Introduction

It is hypothesized that specific cloud populations at different stages are essential to the initiation of the Madden-Julian Oscillation (MJO). In particular, the occurrence of shallow convection that then transitions to congestus before the active phase of the MJO (e.g., Morita et al. 2006) is thought to provide low-level heating that then promotes large-scale moisture convergence necessary for the MJO to form. This poster will present results from model runs of a modified version of CAM4 to show the relative importance of low-level heating in the initiation and maintenance of the MJO.



2. Heating retrievals

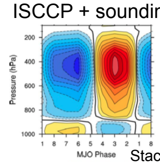
Reanalyses



Jiang et al. (2011)

- In the Indian Ocean, reanalyses see low-level heating tilt with anomalies of 0.1-0.5 K/day, while TRMM retrievals see no tilt

ISCCP + soundings



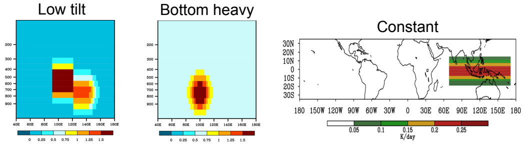
Stachnik et al. (2013)

- An ISCCP retrieval using a look-up table from sounding arrays across the globe sees low-level heating ahead of MJO center

3. CAM4 simulations

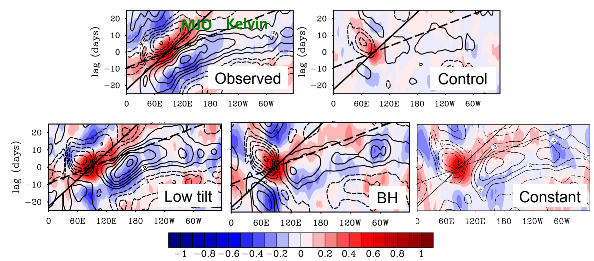
Idealized heating distributions are inserted in CAM4 and the full physics of the model is allowed to respond.

Input heating



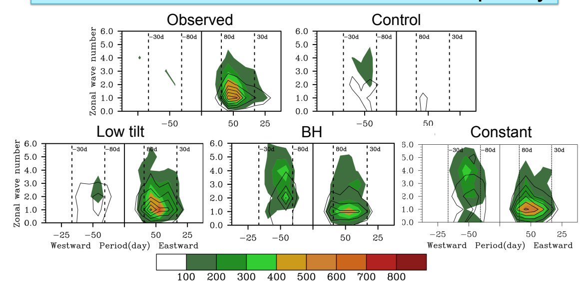
- The first two heating profiles are moved eastward at a typical MJO speed while the third is like the bottom-heavy (BH) profile, but much weaker and continually present

OLR+850 hPa u-wind lag correlations



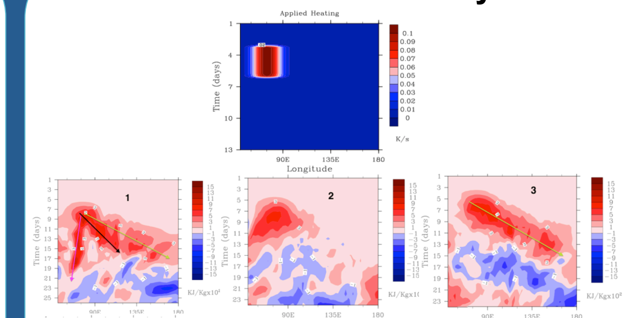
- The propagation speed of OLR and u850 anomalies from the Indian Ocean reference point show significantly improved MJO and Kelvin wave signals for all added heating

OLR+850 hPa u-wind wave number-frequency

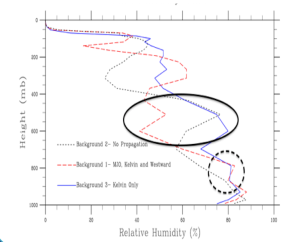


- Added low-level heating has significant power in MJO band compared to control run, although only tilted case does not add significant westward propagation at high wave numbers

4. Moisture sensitivity



- A stationary bottom heavy heating blob is inserted in the Indian Ocean for 3 days and produces different propagation in vertically integrated moist static energy anomalies depending on initial conditions



- Atmosphere 1 has the highest mid-tropospheric saturation deficit and is the only run to create an MJO-like signal
- Atmosphere 3 is the most humid and only produces a Kelvin wave feature

5. Conclusions

- Eastward propagating tilted heating associated with a cloud population that evolves from shallow convection to congestus forces the most realistic MJO signal in OLR and winds in CAM4
- Eastward propagating low-level heating with *no tilt* and weak low-level heating over the active MJO region that *does not propagate eastward* also force a reasonable MJO response
- Thus, it appears that the MJO is most sensitive to the existence of low-level heating ahead of the MJO center and not necessarily its vertical tilt or propagation, at least in CAM4
- Additional runs suggest that the environment's ability to organize convection on MJO scales in the model is not dependent on a moist mid troposphere