Kelvin Wave Impacts on MJO* Convection and Cirrus

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*Madden-Julian Oscillation (1971, 1972)

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Dynamics of the MJO (DYNAMO; October 2011 – March 2012)

- **Moistening processes** during the initiation stage of the MJO
- Role of **convective cloud populations** in MJO initiation
- Role of **air-sea interaction** in the Indian Ocean in MJO initiation
OLR anomalies and MJO-filtered OLR (10N to 10S) for DYNAMO period

Kiladis et al. (2014)
Kiladis et al. (2001) argued that features were a gravity wave response to MJO convective envelope phases:

- Deep moist column
- UT (300-400 hPa) warm anomalies
- Tilted RH, T’ anomalies near tropopause
DYNAMO Sounding, ERA Interim Temperature Anomalies
ERA Interim 7-20 day bandpass T anomalies

T [K]: 31 Oct 2011

Gan

Manus

01-Oct-2011
100 hPa

CALIPSO cloud index (Virts and Wallace 2010)

ERAi

Pressure [hPa]

cool

warm

T' [K]: 31 Oct 2011

June 2006 – June 2009
T anomalies affect cloud-top heights

Gan Island RH, T'

(red dots are when CALIPSO detected cirrus)
Increasing UT relative humidity & cirrus, reduction in net radiative heating rate leading up to MJO active phases
Buildup of \(<\text{MSE}\)\) attributed equally to horizontal advection of MSE and cirrus-caused reduction in net radiative cooling (surface fluxes roughly constant during these periods)
Kelvin wave $T$ anomalies affect depth of convection within MJO $\rightarrow$ reduction in cloud-top height late in MJO active phase
Summary

- Two prominent MJOs during DYNAMO
- Cirrus preceding MJO active phase related to Kelvin wave cool anomalies: reduction in LW cooling, aids in buildup of MSE as MJO initiates over Indian Ocean
- Descending warm anomalies reduce depth of convection in latter stages of MJO active phase; impacts vertical motion (& heating) profiles
Del Genio et al. (2012)

- CALIPSO/CloudSat ten MJO composite
- Found descending cloud top with time
• Gottschalck et al. (2013, MWR) link Oct and Nov events to global circuits in 200-hPa velocity potential anomalies
• Haertel et al. (2014, QJRMS): circumnavigating equatorial Kelvin waves that transform between dry and moist, which initiate and dissipate MJO convection
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