Kelvin Wave Impacts on MJO Convection and Cirrus*

Richard H. Johnson
Erin L. Dagg
Thomas Birner
Paul E. Ciesielski

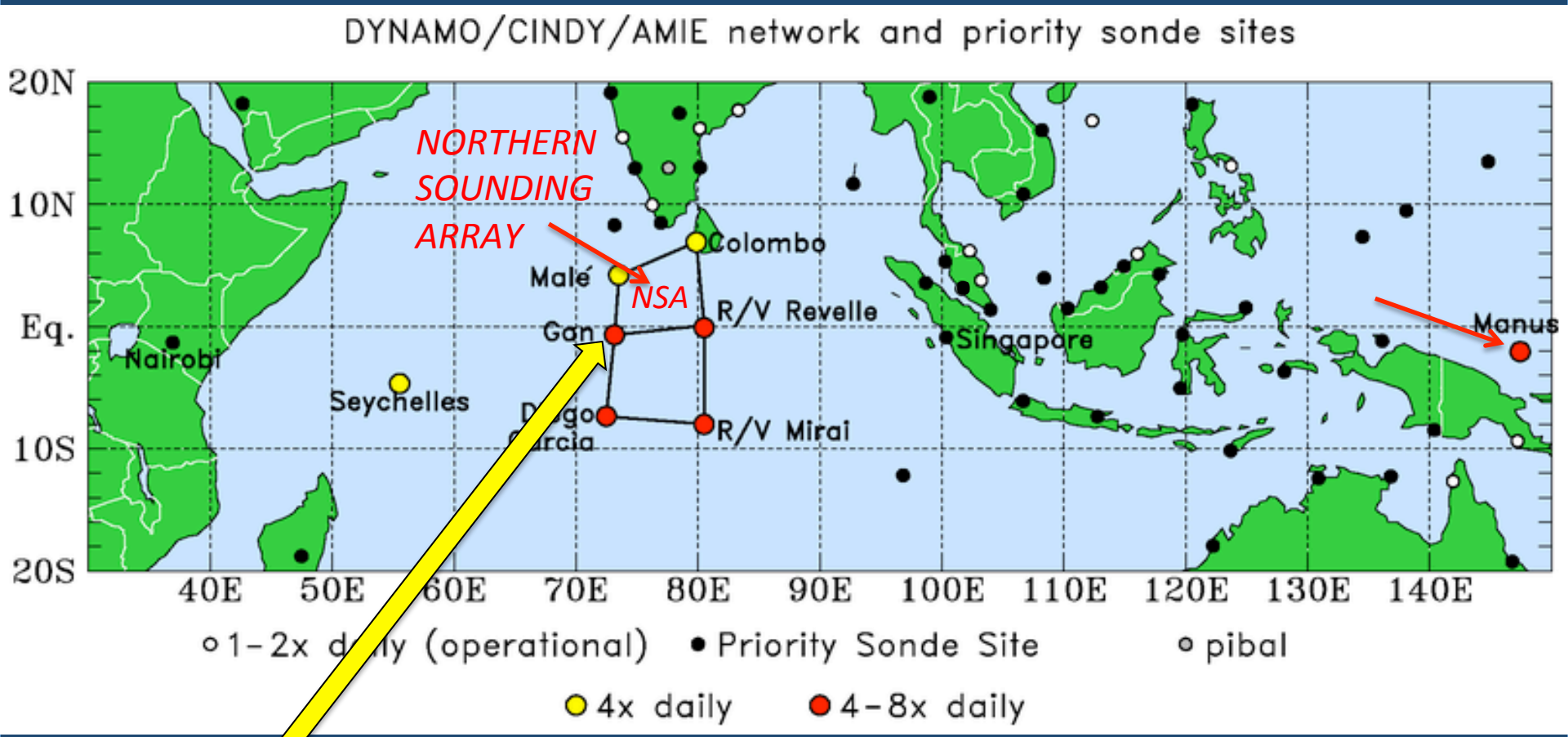
Colorado State University

**Madden-Julian Oscillation (1971, 1972)*

2016 SPARC Gravity Wave Symposium, 16-20 May, Penn State

Indian Ocean
24 October 2011

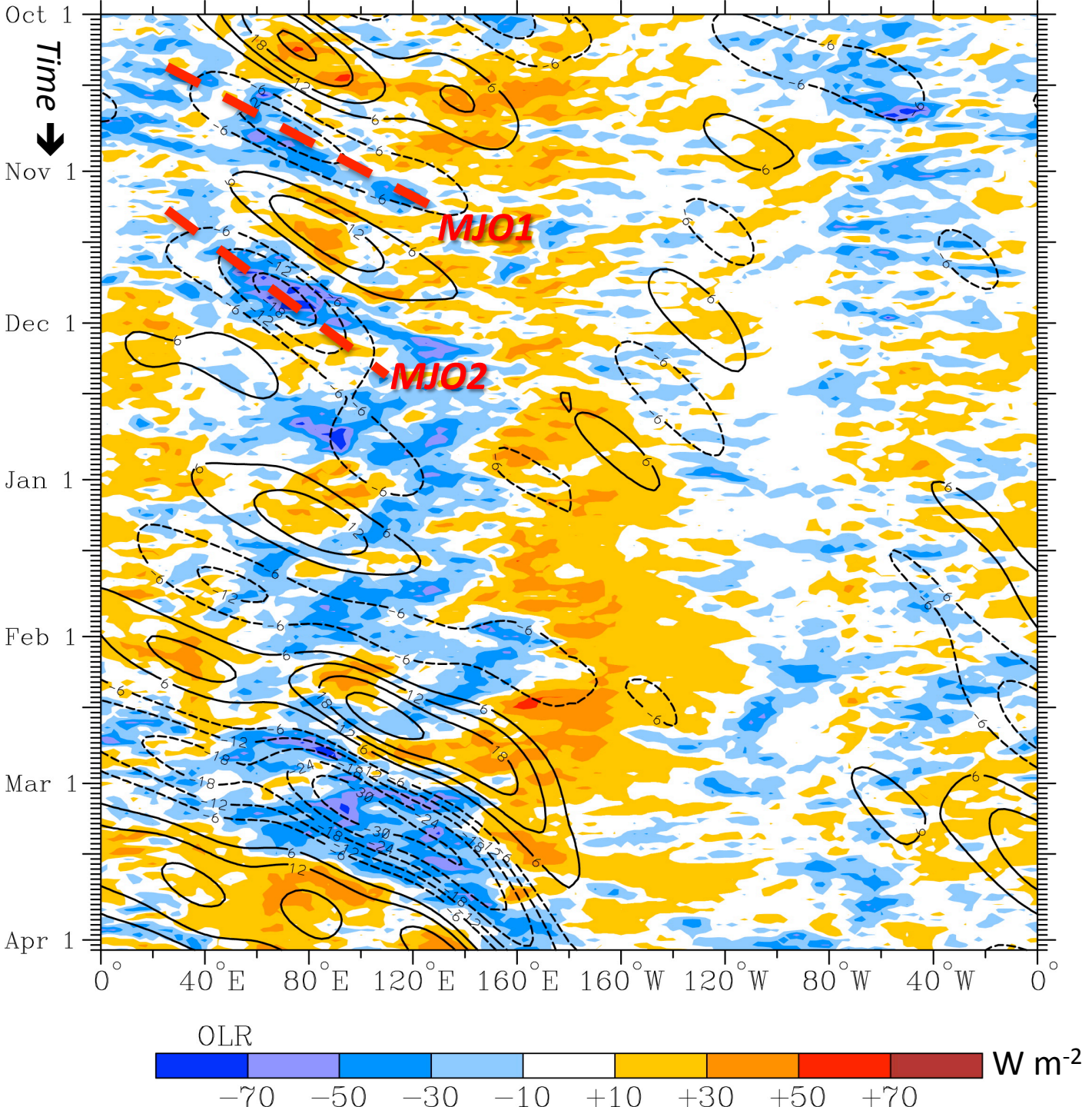
Dynamics of the MJO (DYNAMO; October 2011 – March 2012)



- ***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*

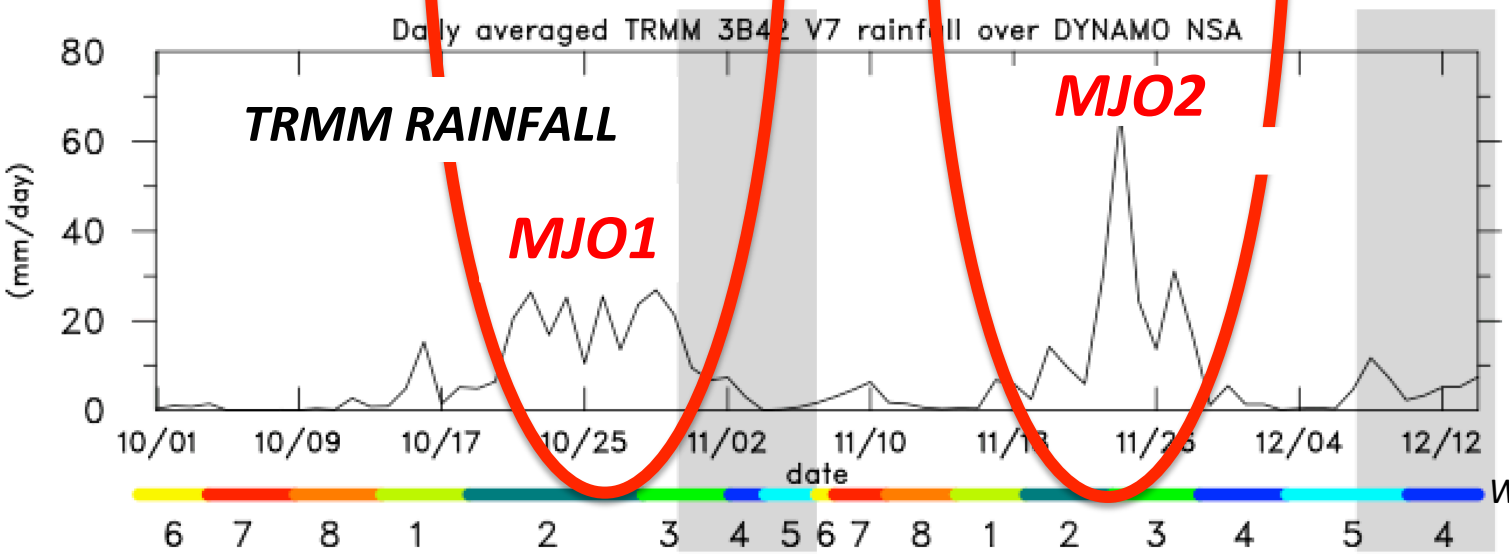
OLR anomalies and MJO-filtered OLR (10N to 10S) for DYNAMO period

Kiladis et al. (2014)



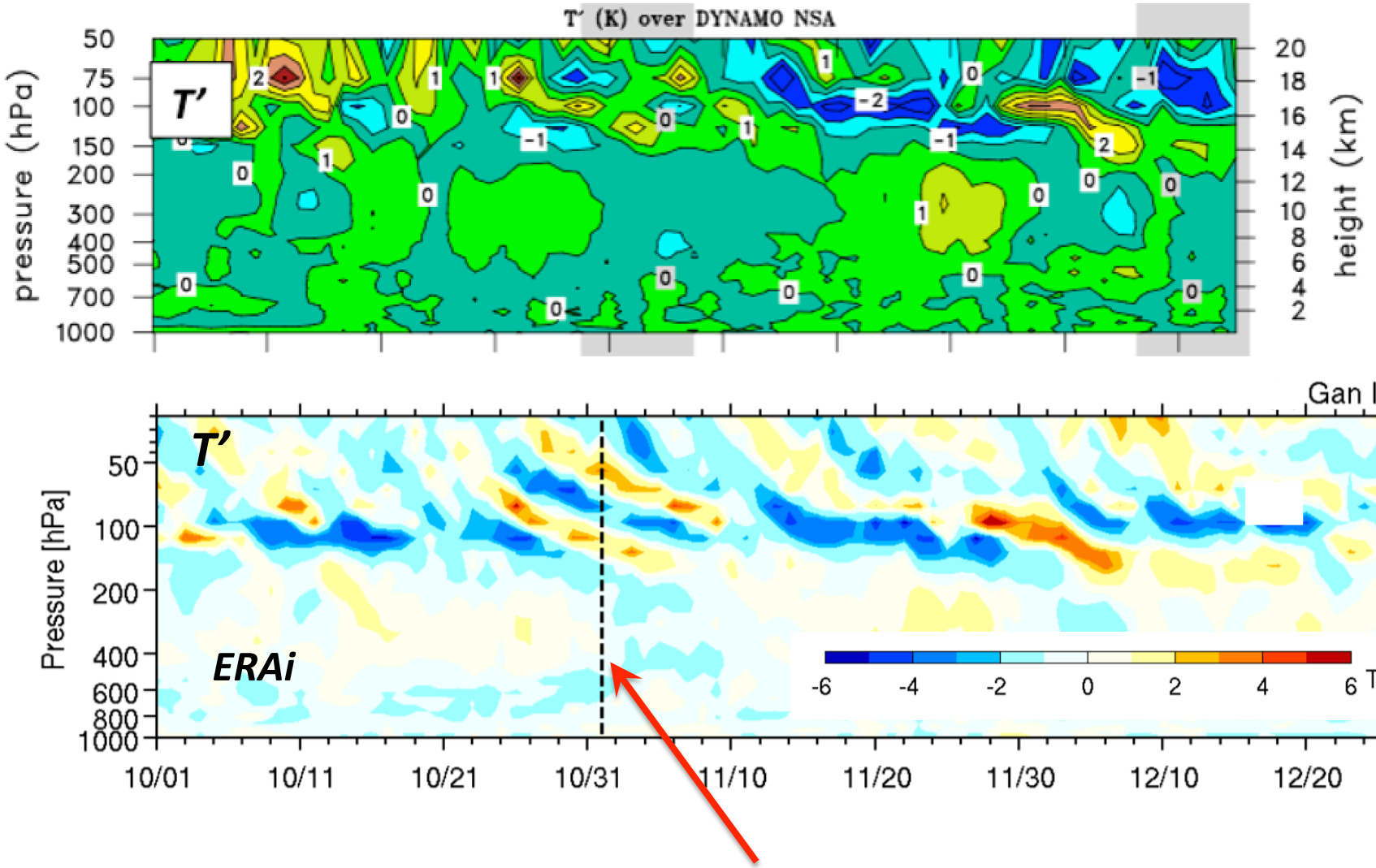
MJO active phases:

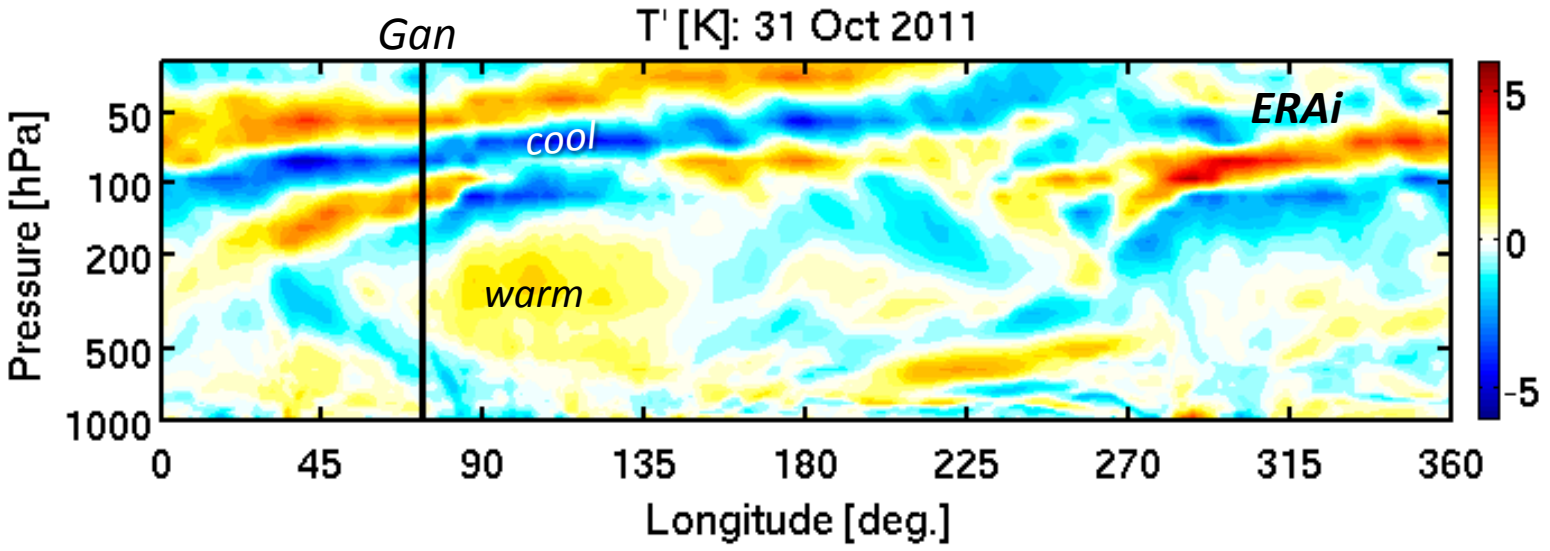
- *Deep moist column*
- *UT (300-400 hPa) warm anomalies*
- *Tilted RH, T' anomalies near tropopause*



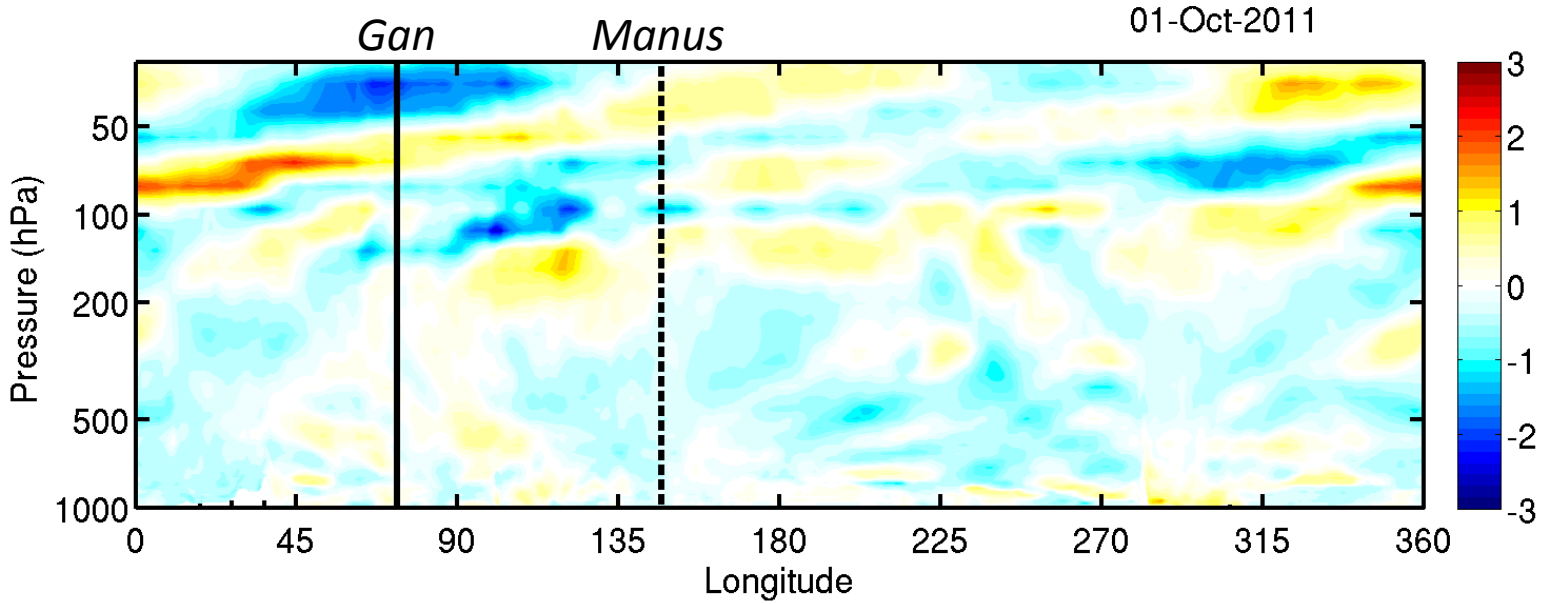
Wheeler-Hendon Index

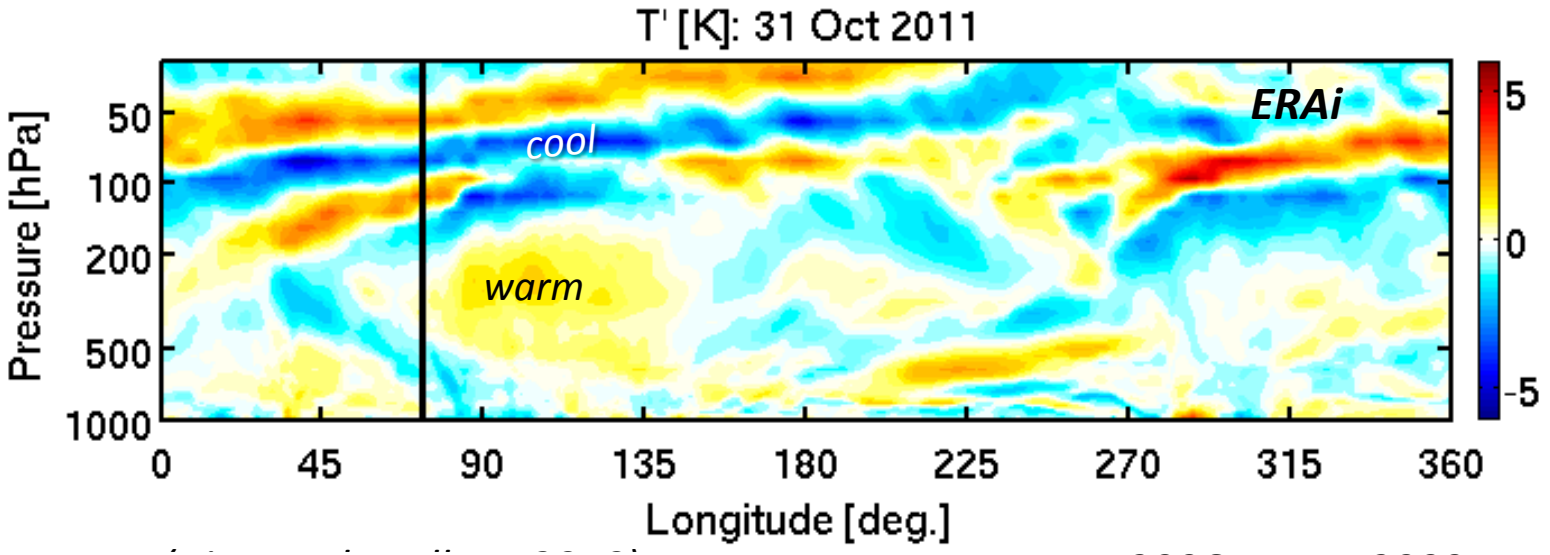
DYNAMO Sounding, ERA Interim Temperature Anomalies





ERA Interim 7-20 day bandpass T anomalies

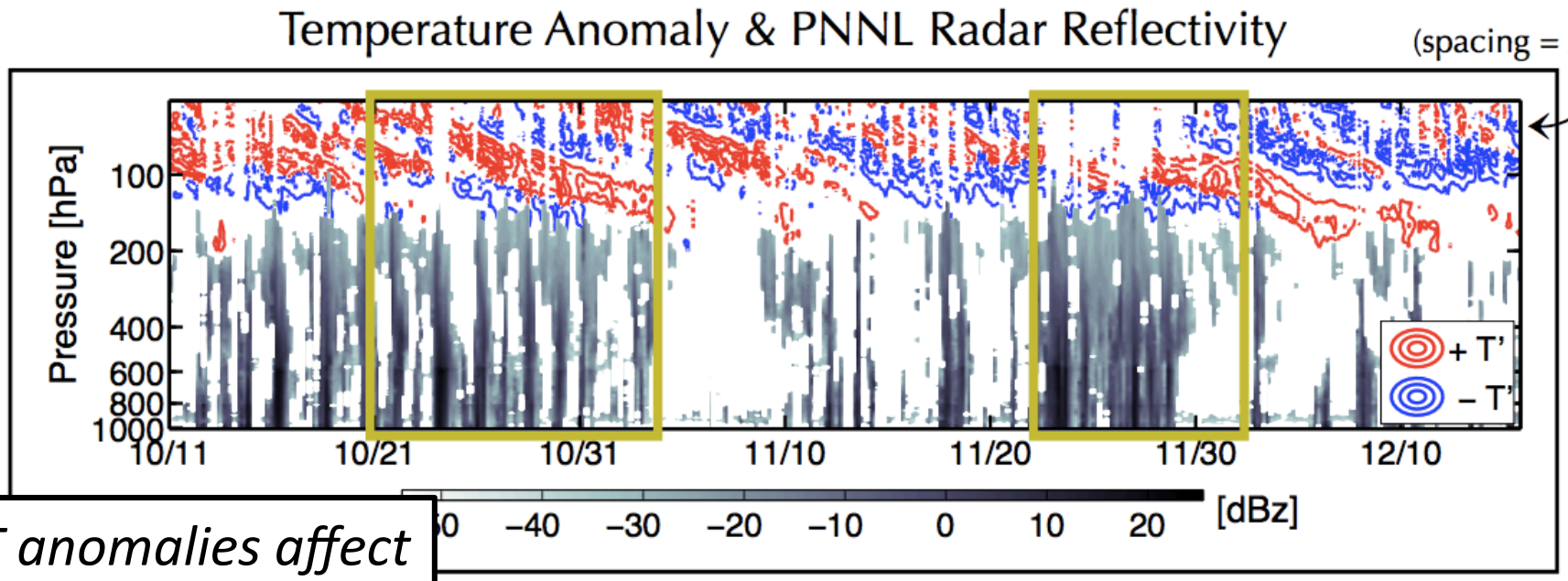




June 2006 – June 2009

0

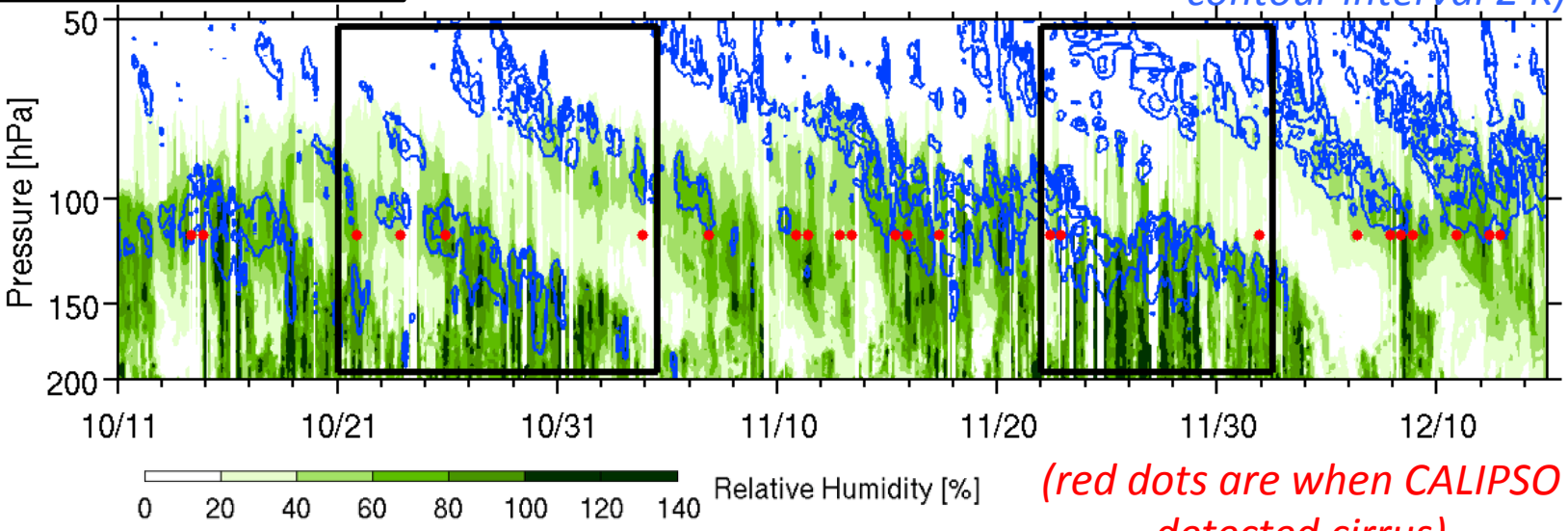
360



T anomalies affect cloud-top heights

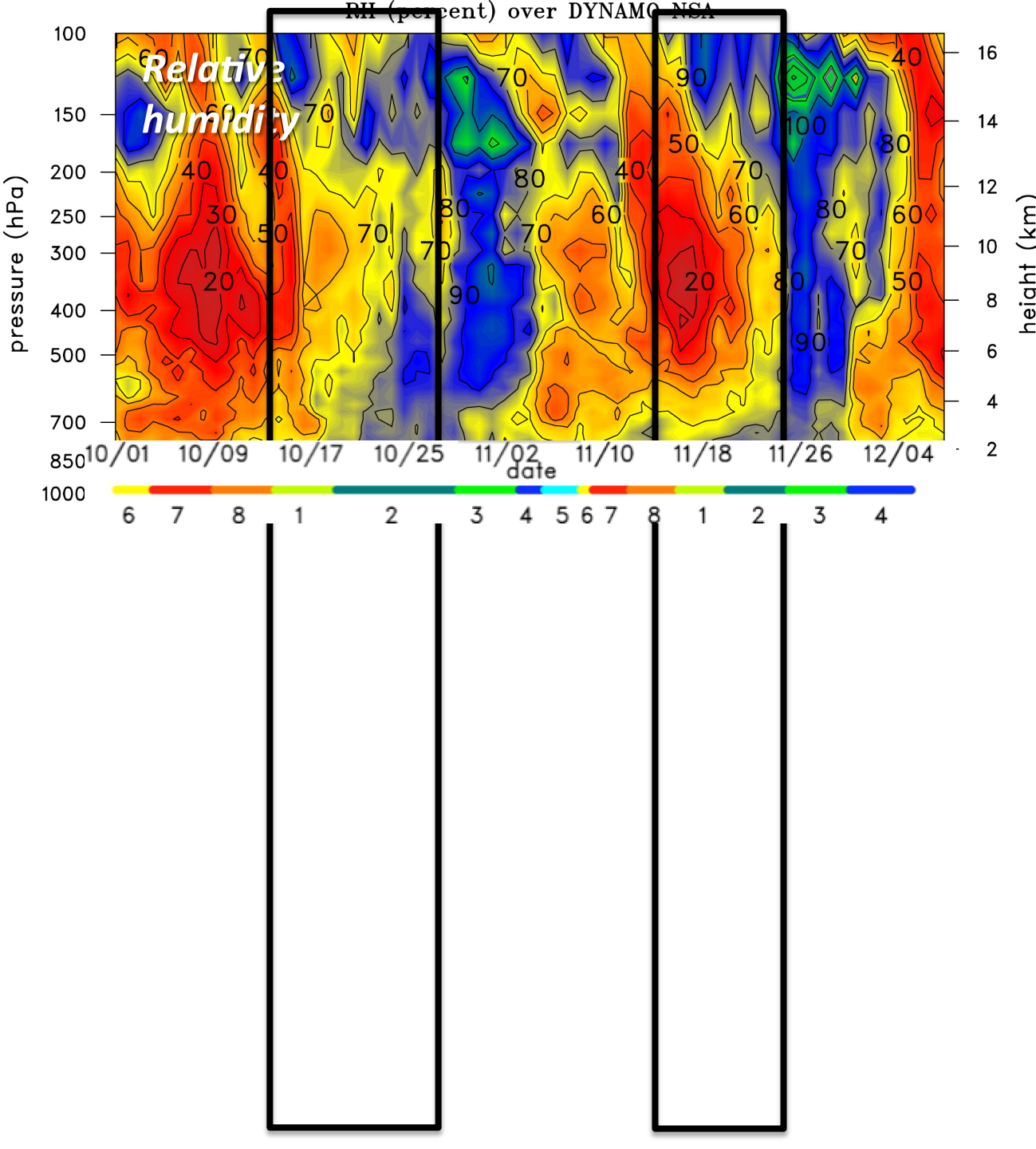
Gan Island RH, T'

(only negative T' shown, contour interval 2 K)



(red dots are when CALIPSO detected cirrus)

Increasing UT relative humidity & cirrus, reduction in net radiative heating rate leading up to MJO active phases

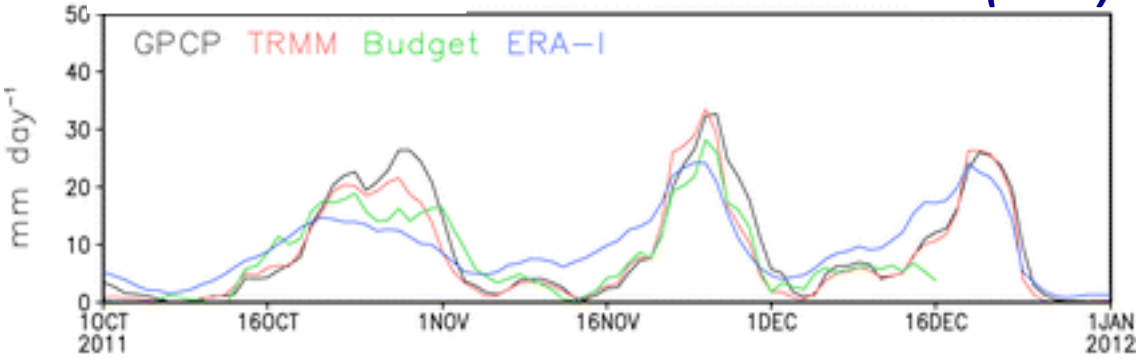


Northern Sounding Array

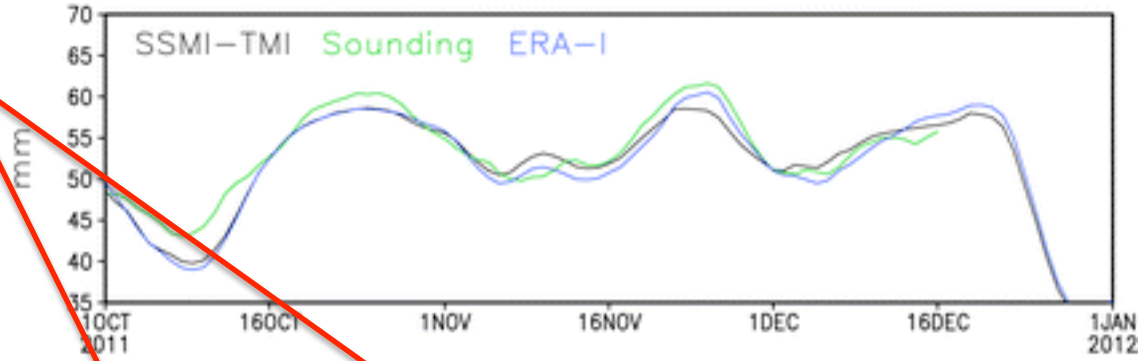
- *Buildup of <MSE> attributed equally to horizontal advection of MSE and cirrus-caused reduction in net radiative cooling (surface fluxes roughly constant during these periods)*

RAINFALL

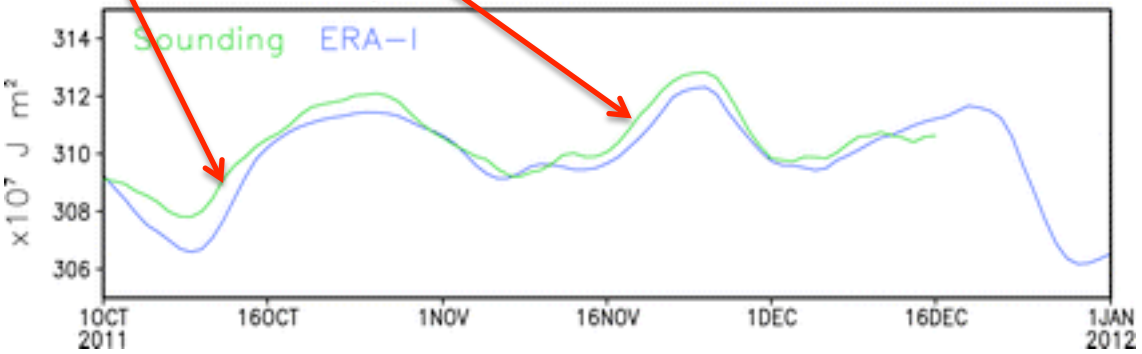
Sobel et al. (2014)



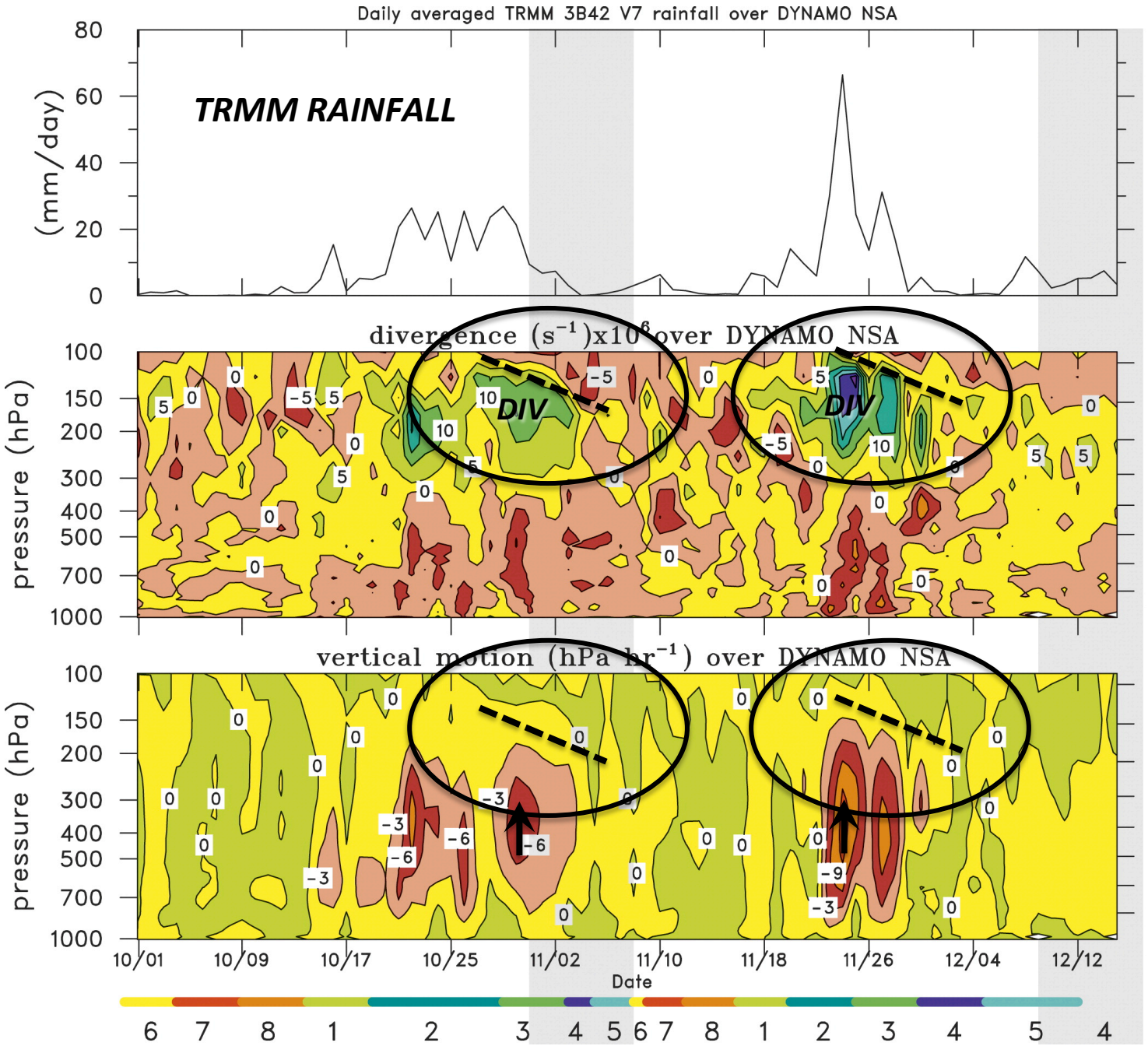
PRECIPITABLE WATER



COLUMN-INTEGRATED MOIST STATIC ENERGY <MSE>



Kelvin wave T anomalies affect depth of convection within MJO ➔ reduction in cloud-top height late in MJO active phase

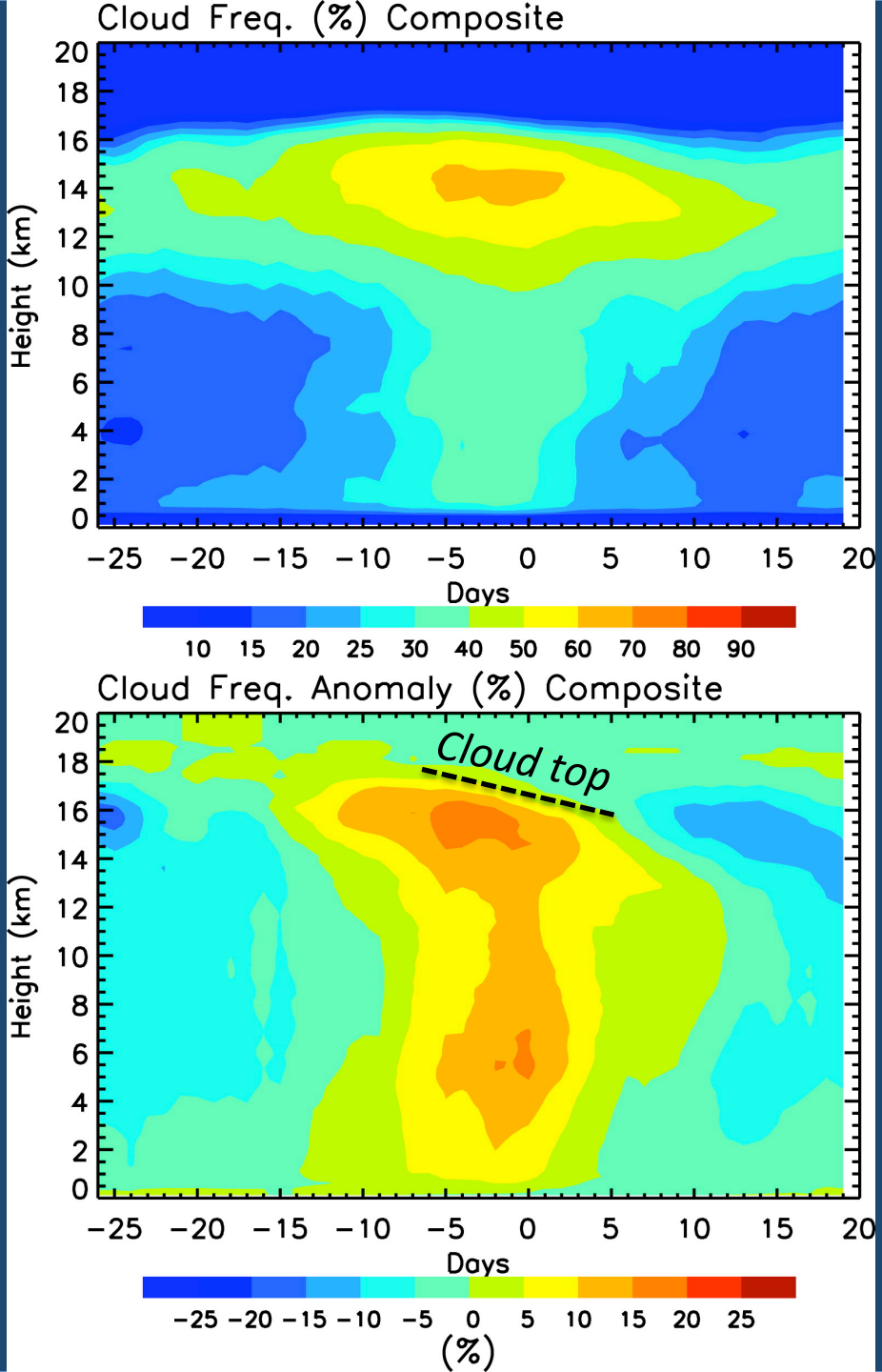


Summary

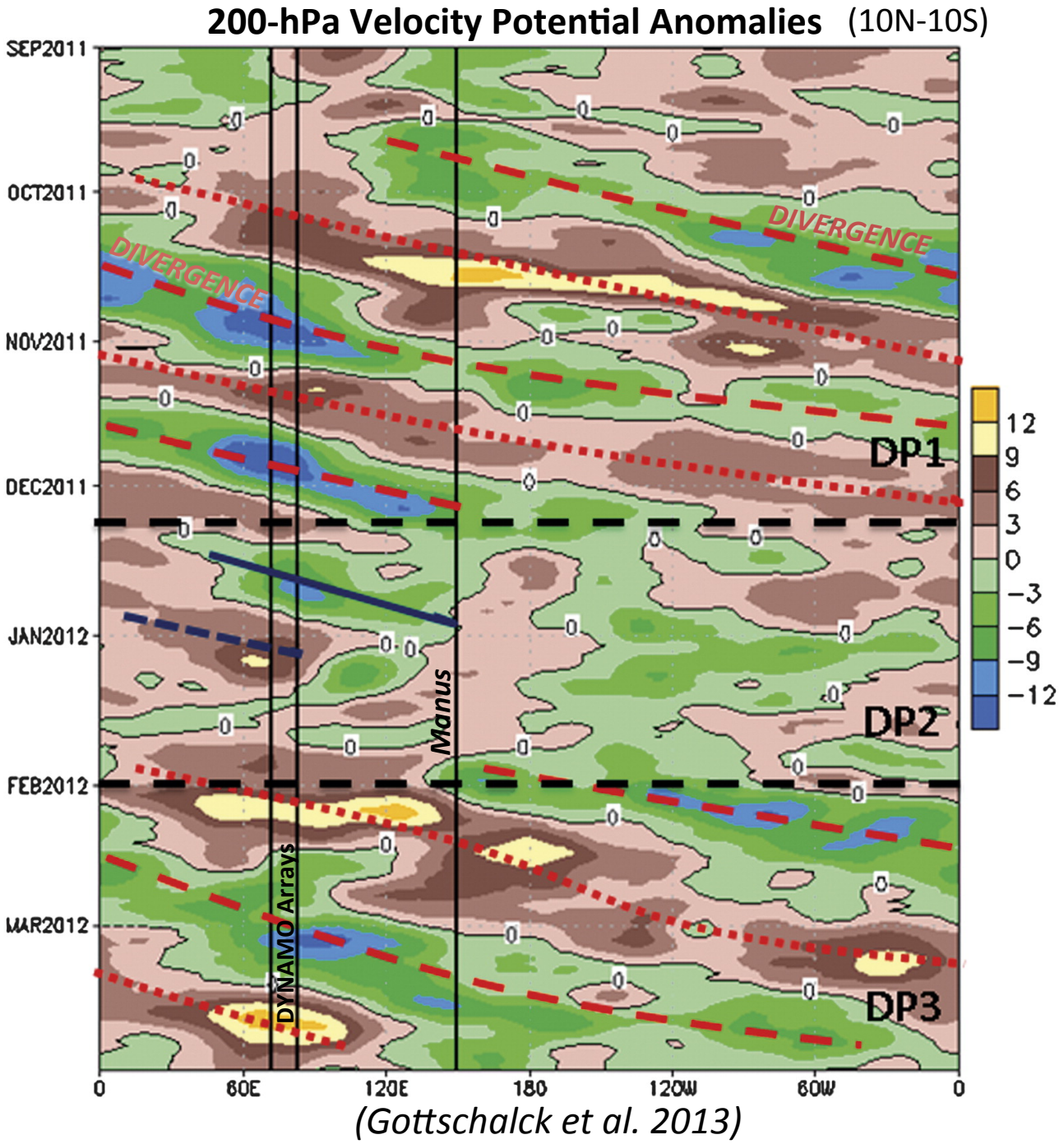
- *Two prominent MJOs during DYNAMO*
- *Cirrus preceding MJO active phase related to Kelvin wave cool anomalies: reduction in LW cooling, aids in buildup of MSE as MJO initiates over Indian Ocean*
- *Descending warm anomalies reduce depth of convection in latter stages of MJO active phase; impacts vertical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

Del Genio et al. (2012)

- *CALIPSO/ CloudSat ten MJO composite*
- *Found descending cloud top with time*

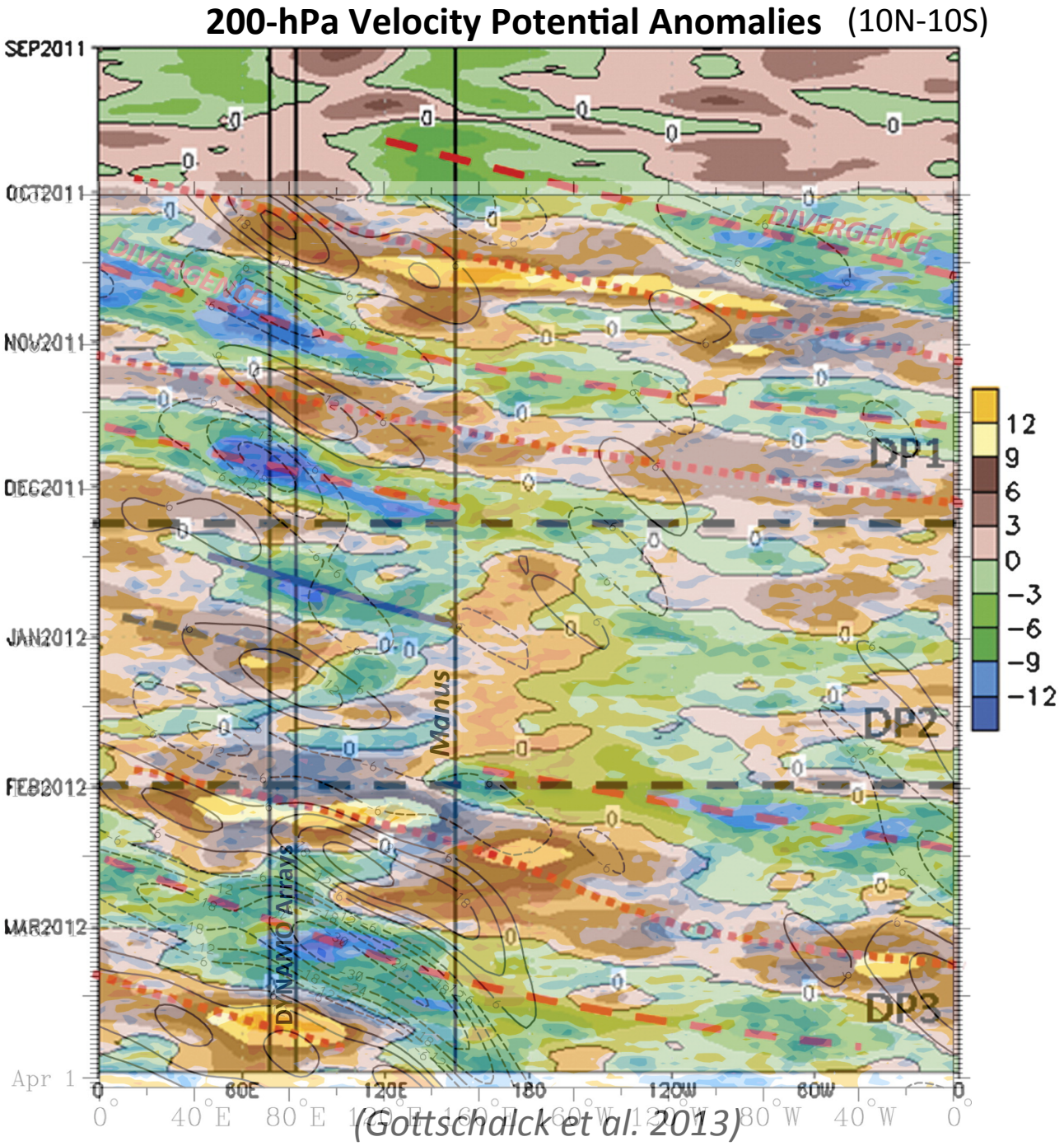


- *Gottschalck et al. (2013, MWR) link Oct and Nov events to global circuits in 200-hPa velocity potential anomalies*
- *Haertel et al. (2014, QJRMS): circumnavigating equatorial Kelvin waves that transform between dry and moist, which initiate and dissipate MJO convection*



(Gottschalck et al. 2013)

- *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*



(Gottschalck et al. 2013)