Thermodynamics of the MJO in the suppressed phase

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Outline

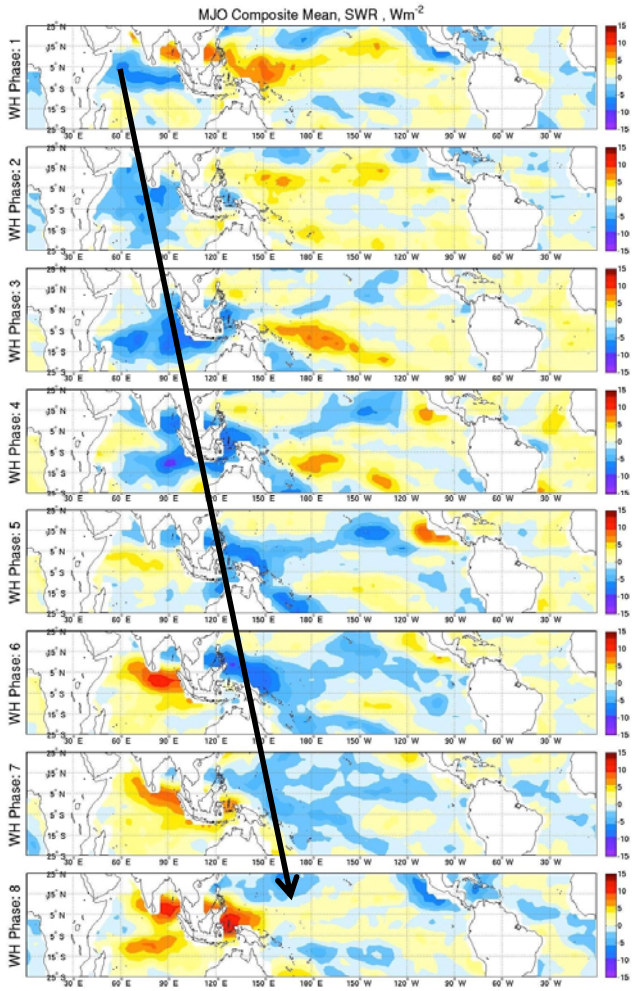
- Motivating questions
- Datasets & Domain
- Validation of satellites
- Identification of MJO Types
  - Matthews (2008) OLR Index
- Comparisons of different events
  - OLR and Clouds vs.
  - AIRS/AMSU Temperature and Humidity

MJO Initiation, Propagation, and Failures

- Observational perspective
  - MJOs initiate over the IO and the propagate eastward
  - Some MJOs are considered primary while others follow a previous MJO event.

- Focus here on:
  - What are the thermodynamic precursors for MJO initiation

  - What are the differences between primary, succeeding, and non-MJO convection



Datasets

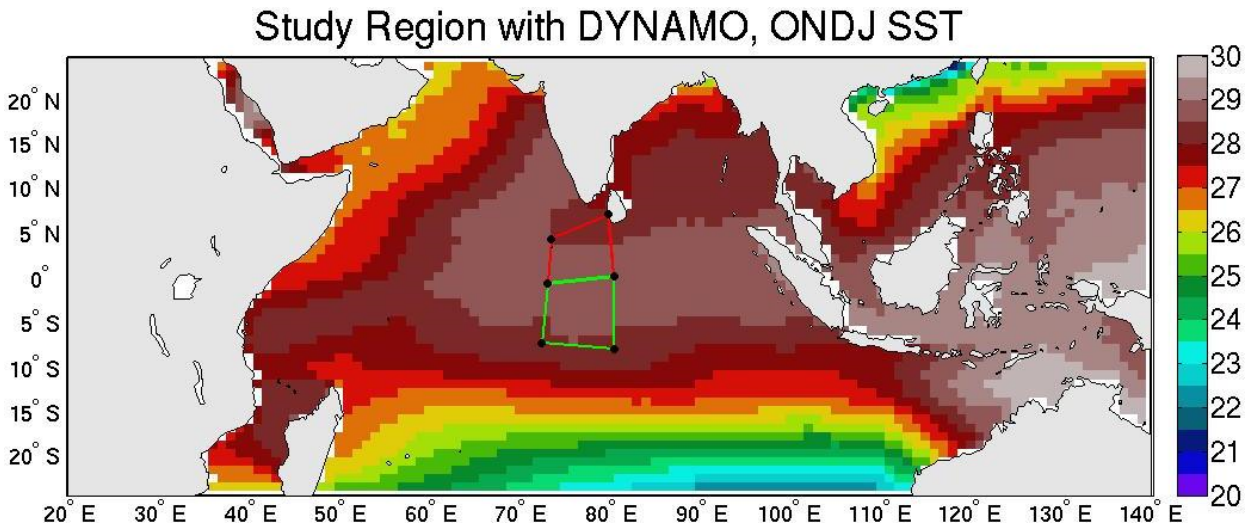
<u>Satellite (2002 – 2013)</u>

- MODIS
- AIRS/AMSU
- TMPA 3hr
- CERES SYN 3hr
- OAFLUX

<u>*In situ (2011)*</u>

- DYNAMO Ship & CSU Sounding Products 3b
  - Use to examine capture of signals in satellite products

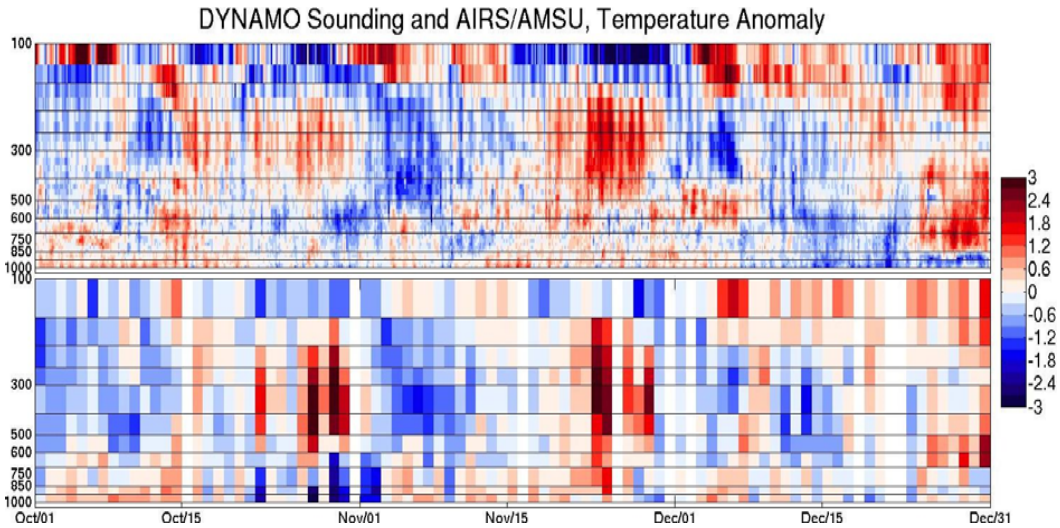
20N/S , 20E-140E



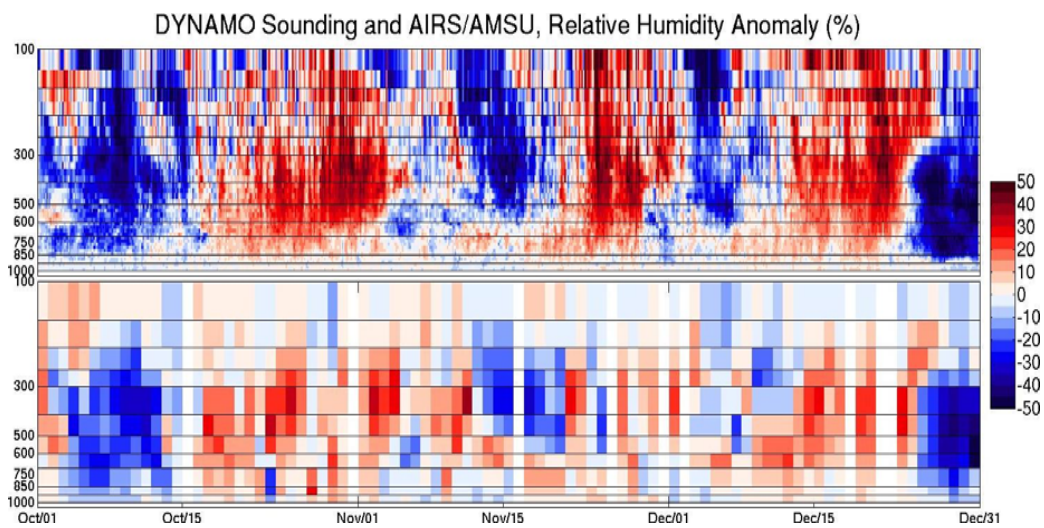
- The general area of focus is for MJO events that initiation over the central (60E-90E) Indian Ocean

AIRS-AMSU Temperature and Humidity Retirvals

Temperature Anomaly (w.r.t DYNAMO time-mean)

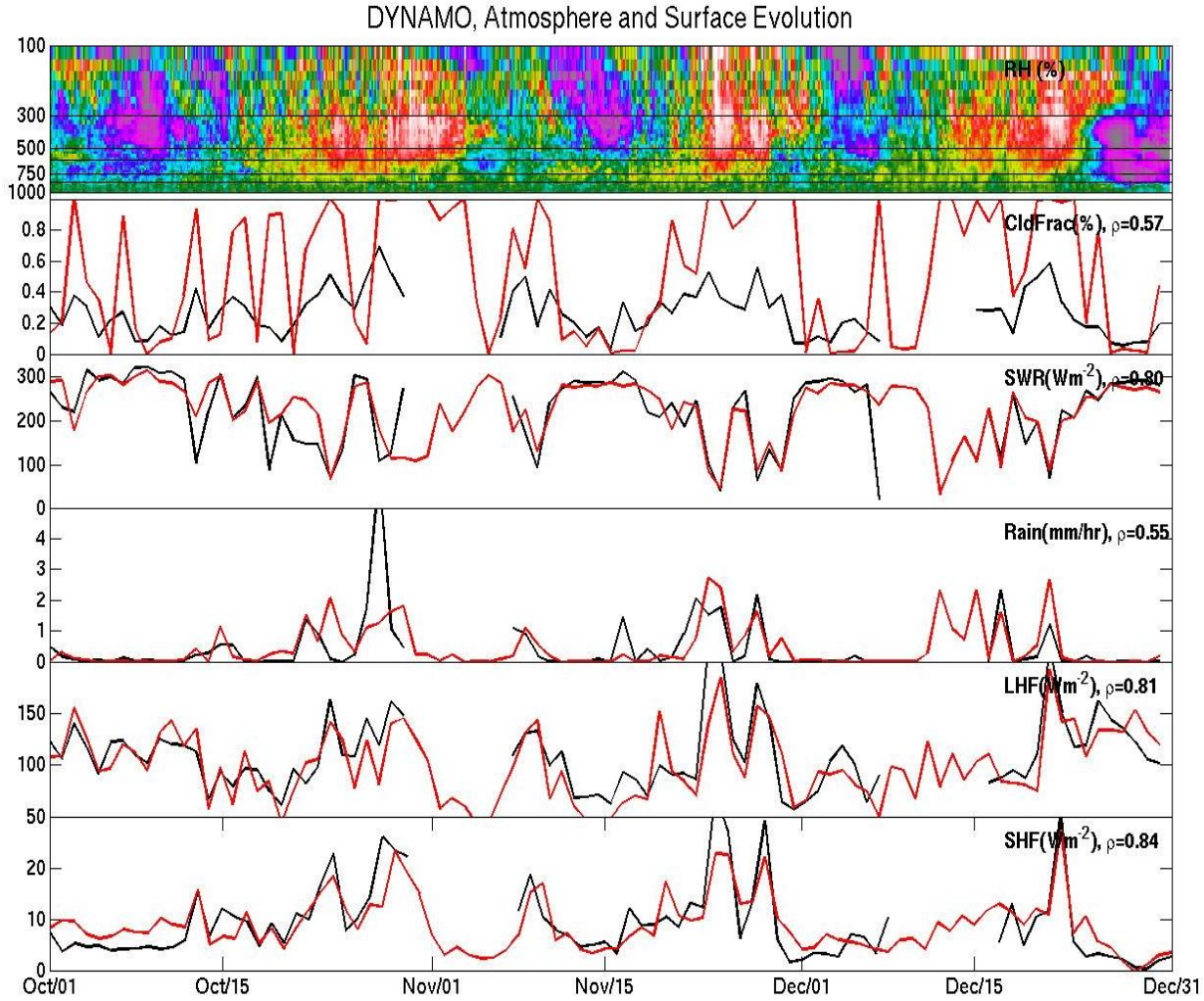


Relative Humidity Anomaly



- DYNAMO soundings and AIRS/AMSU both show 3 pulses of mid-level warming and moistening during Oct-Dec 2011 with about the same timing
- The amplitude of the RH anomalies are are about (10%) smaller than those from soundings.
- RH moistening anomalies persist a little longer while dry anomalies are somewhat shorter in duration for AIRS/AMSU

RV/Revelle vs. MODIS/CERES/TRMM/OAFLUX



- The cloud fraction from MODIS show "OK" agreement with DYNAMO ceilometer
  - At least 3 reasons:

    i) *Point vs. 1-degree spatial observations*

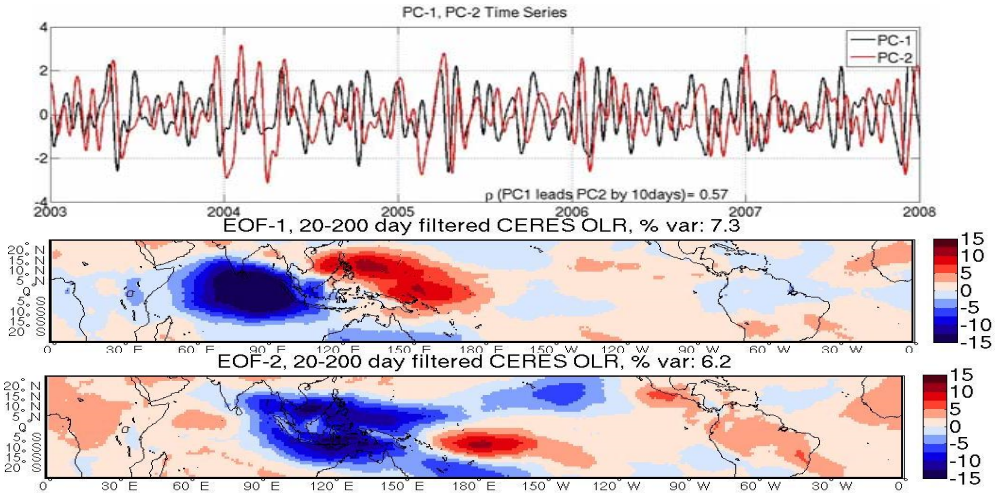
    ii) *MOIDS CTP-COT Fraction is based only on daytime, successful retrievals*

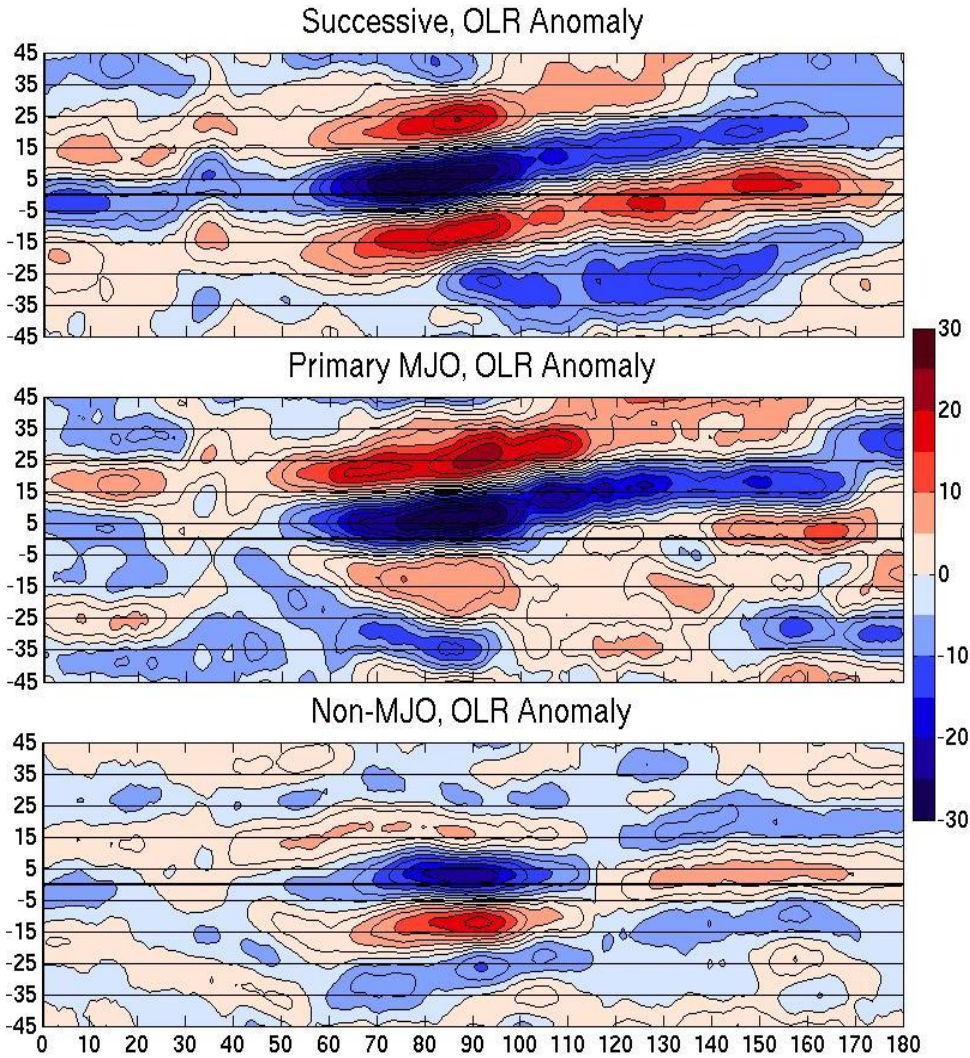
    iii) More sensitive to upper-level clouds

- Despite sampling differences, MOIDS cloud fraction do capture the times of enhanced cloudiness with MJO convection

- CERES SWR, OAFLUX turbulent, and TRMM rainfall all show very good agreement on of timing and amplitude of signals on synoptic and intraseasonal time scales.

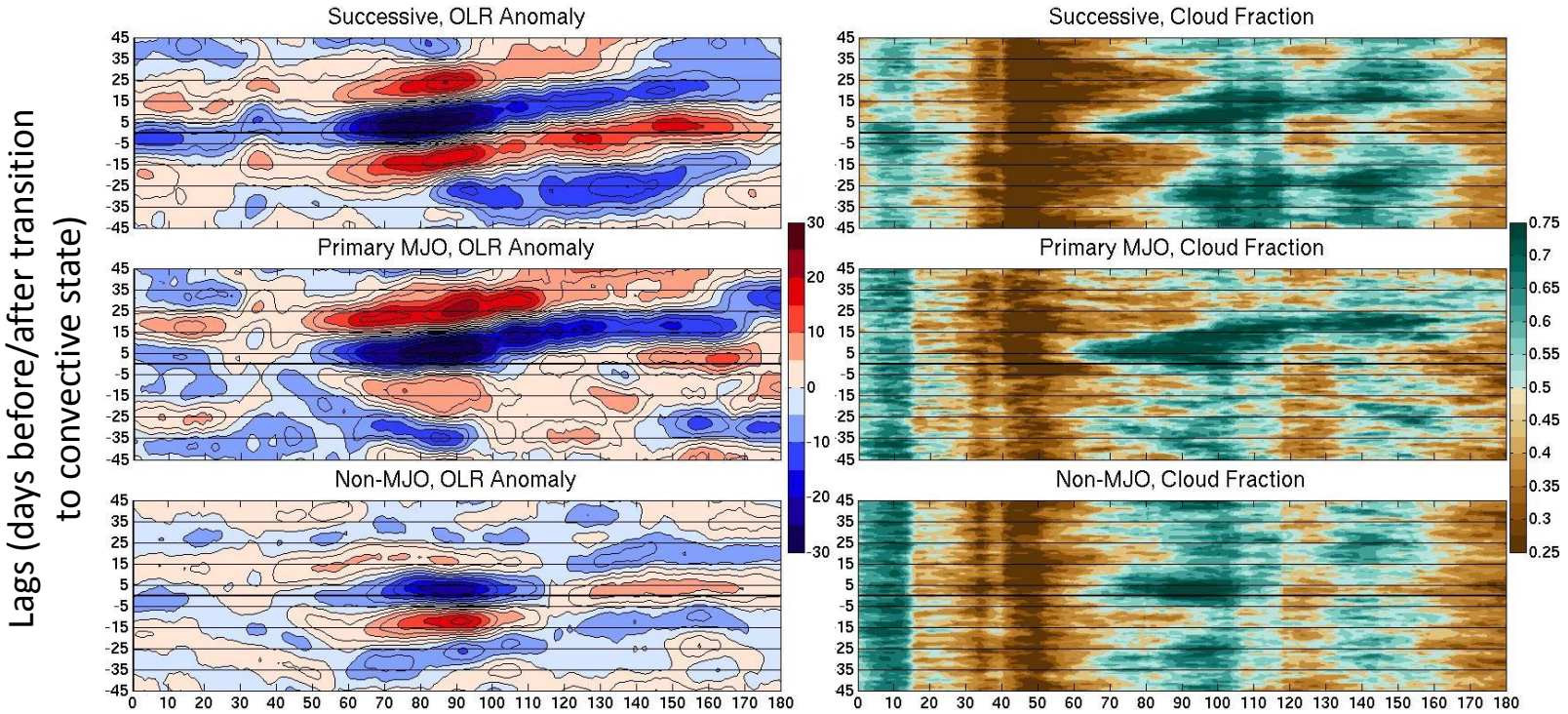
MJO – What's in a name ?





- Follow Matthews (2008) to define an index based only on the 1st two EOF/PC of 20-200 day filtered OLR
  - *Form an (almost) quadrature pair of indices keyed only on the convective signal*
- Using phase space progression, we can identify at least 3 types of events
  - *Successive – A new MJO transitions from a preceding MJO*
  - *Primary – An MJO starts from a non-MJO state*
  - *Non-MJO – An organized convective pulse develops but does NOT propagate*

A bird's-eye view ….

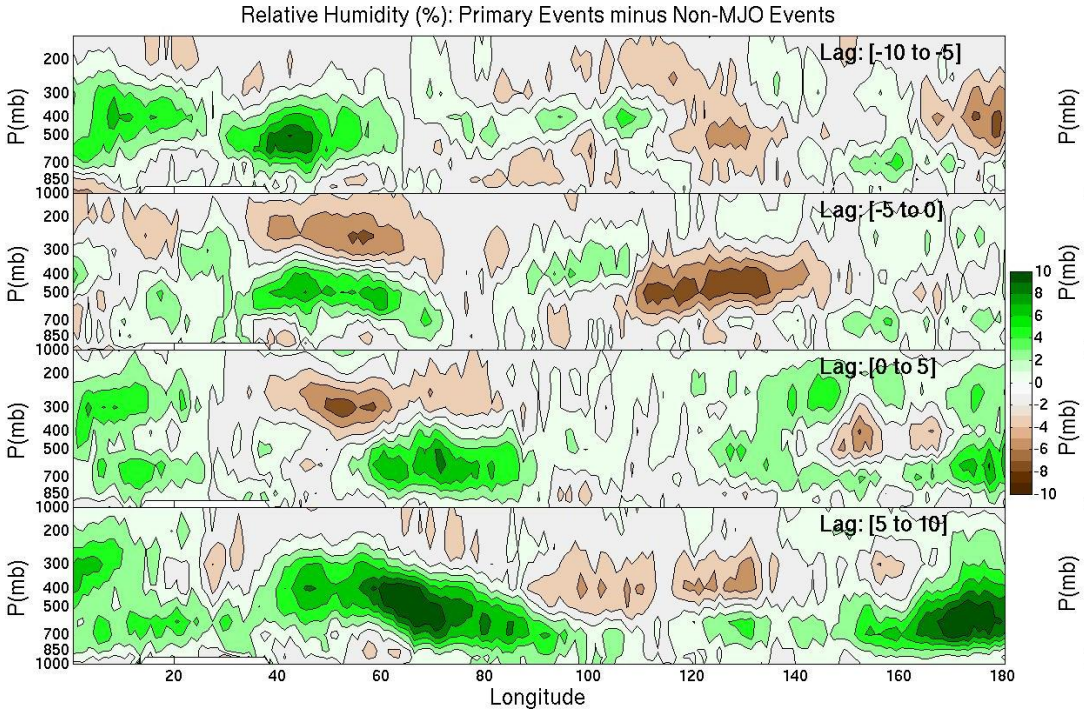


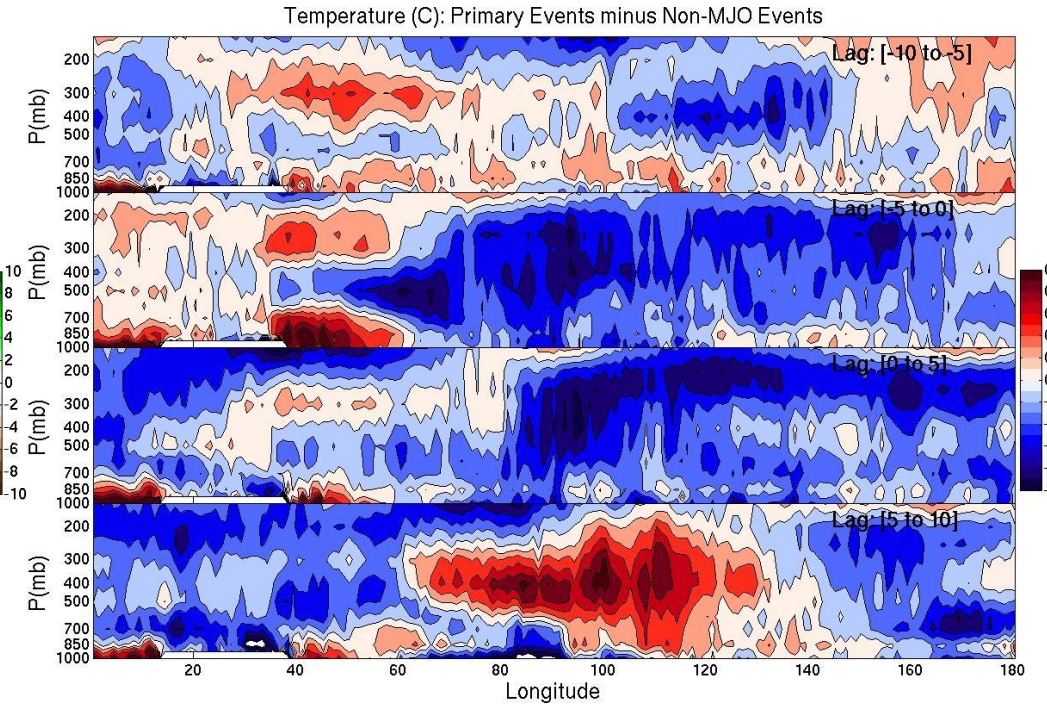
- You can clearly see the convective pulses in the OLR and Cloud Fraction (and Rainfall) product as you would expect
- However, looking at differences between MJO types results in some ambiguities
  - For example, from 120E-160E you might expect reduced cloud fraction for primary events than Non-MJO events;
  - Instead, the cloud fractions are fairly similar

  Why? i) Cloud fraction is only one measure of a cloud ; ii) Clouds are only one influence on OLR

VS. Atmospheric Sounder's View

Composite Difference = (PRIMARY – NonMJO)

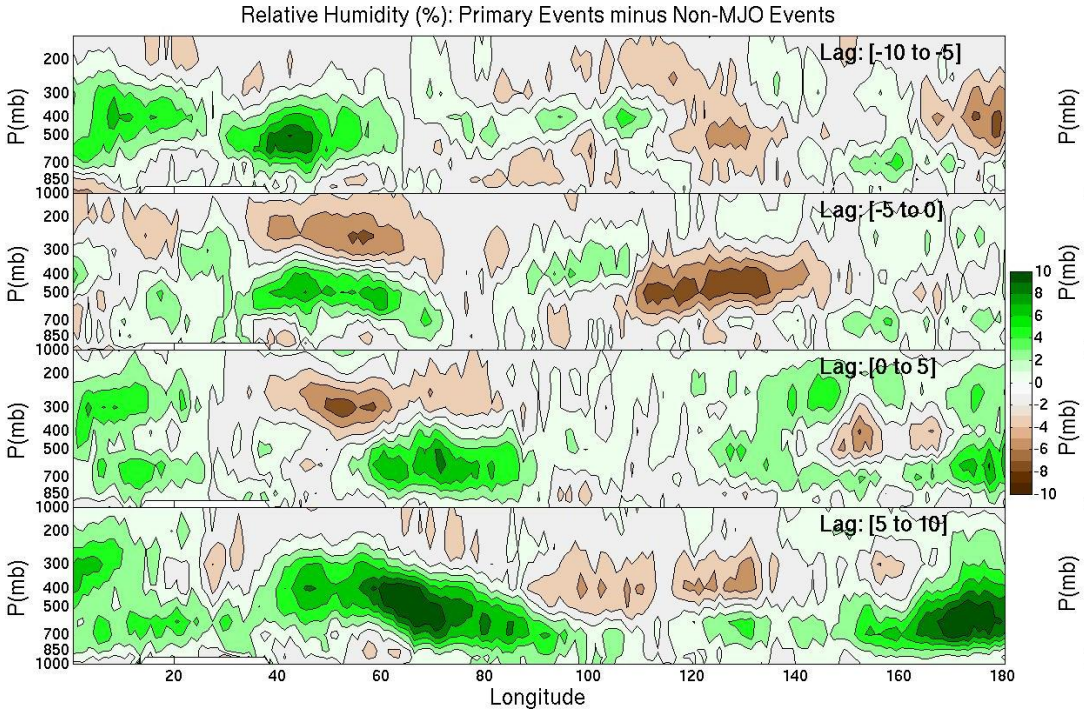


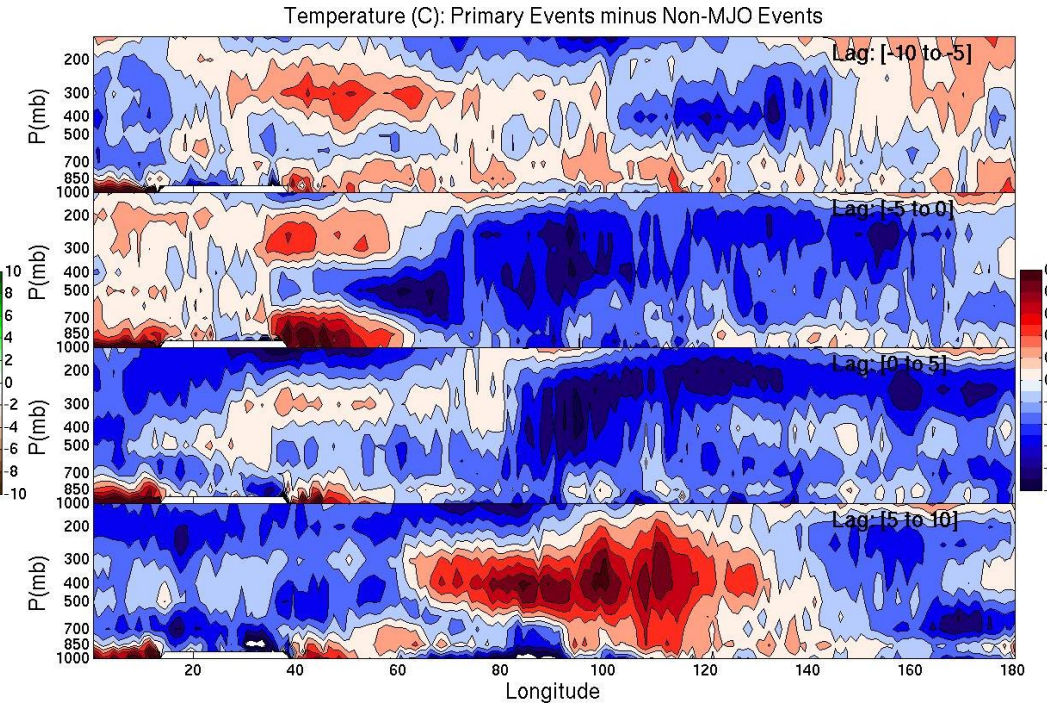


- Prior to a Primary MJO event, a moist mid-level (400-700mb) is present that propagates eastward towards the 60E-90E region where the convection becomes organized and amplified post- 0-day.
- For a Primary MJO event, there is a more moist mid-layer just east of 60E-90E, and significantly drier mid layer from 110E-140E.

VS. Atmospheric Sounder's View

Composite Difference = (PRIMARY – NonMJO)



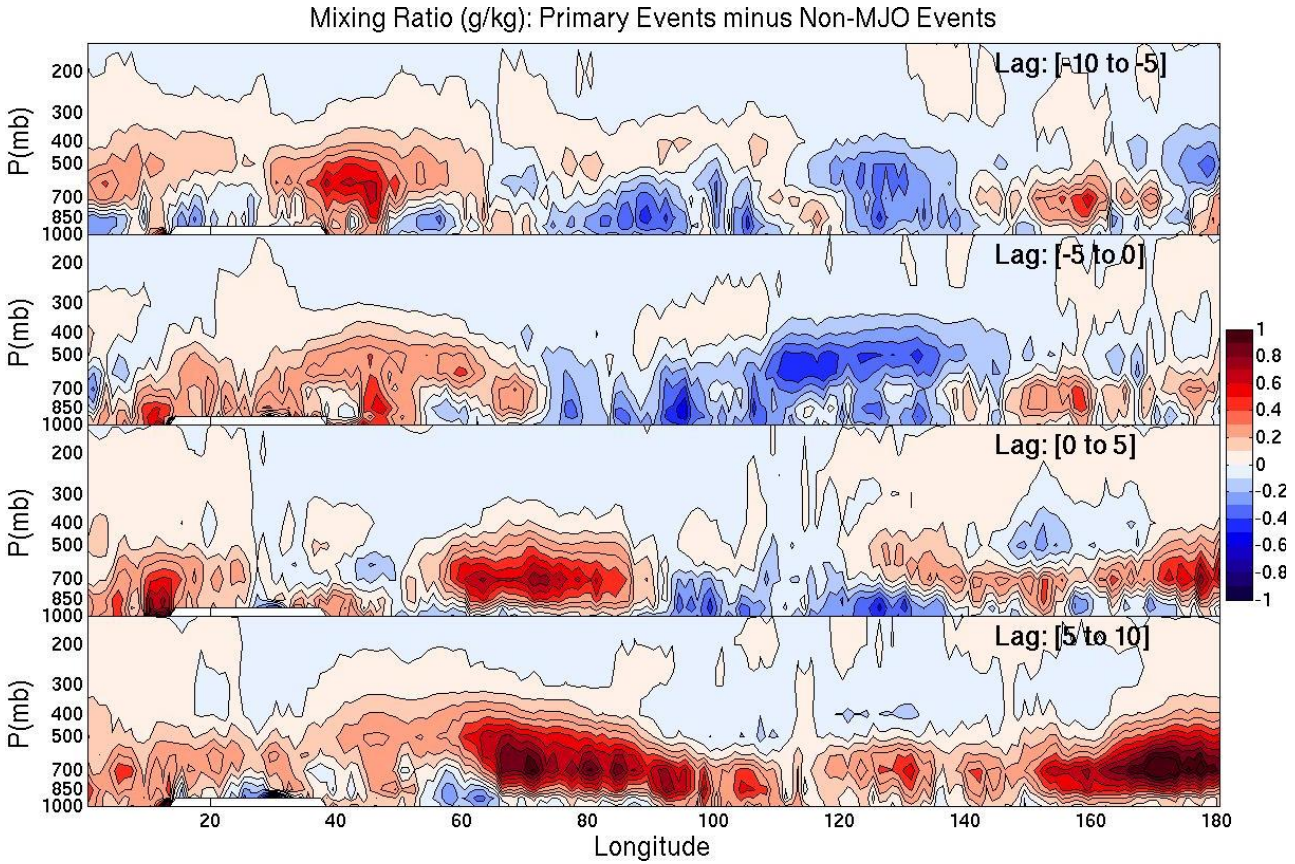


- Primary MJO boundary layer temperatures are warmer just west of of 60E-90E prior to deep convection
- Mid- to upper-level temperature are generally cooler (~20% of anomalous values) east of 60E prior to and just after transition to convective state
- The temperature response to diabatic heating is likewise much stronger for Primary MJO events

Summary

- AIRS/AMSU temperature and humidity retrievals are able to capture the atmospheric response to MJO events, albeit with somewhat reduced amplitude
- Together with other A-Train observations (e.g. CERES, MODIS), organized convective events were stratified into successive, primary, and, non-MJO events
- Those convective events that do not transition into a full-fledged propagating MJO have distinct large-scale environmental differences
  - *Primary MJO events occur under relatively cooler, wetter conditions over 60E-90E with a large mid-level dry anomaly over 110E-140E.*
- These differences, while marginally observable from cloud fraction and OLR, are readily apparent as differences in vertical sounder fields.

Extras


Mixing Ratio (g/kg): Primary Events minus Non-MJO Events
Lag: [-10 to -5]
Lag: [-5 to 0]
Lag: [0 to 5]
Lag: [5 to 10]
P(mb)
200
300
400
500
700
850
1000
20
40
60
80
100
120
140
160
180
Longitude
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1