Properties of MJO Convection Diagnosed from DYNAMO/CINDY/AMIE Sounding Arrays

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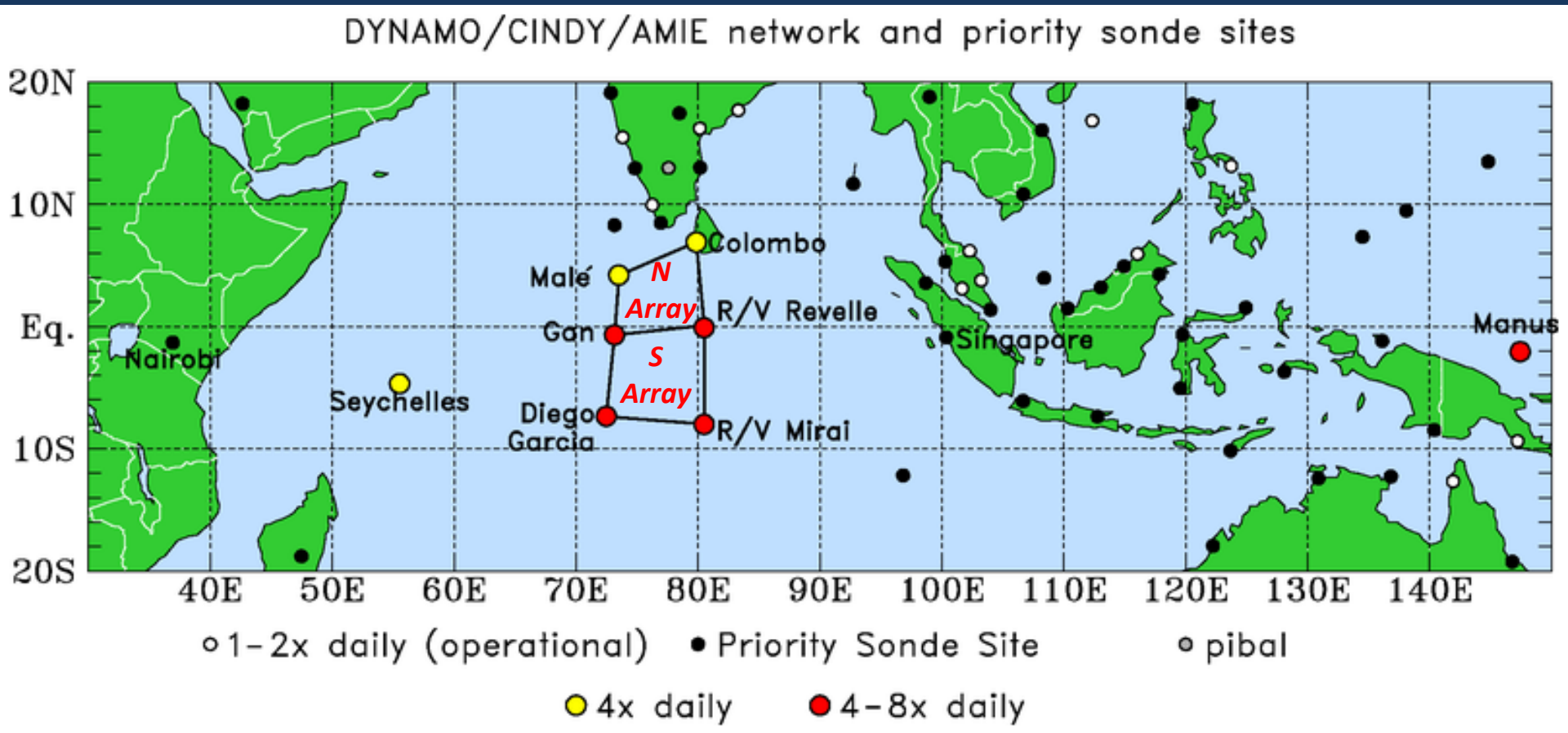
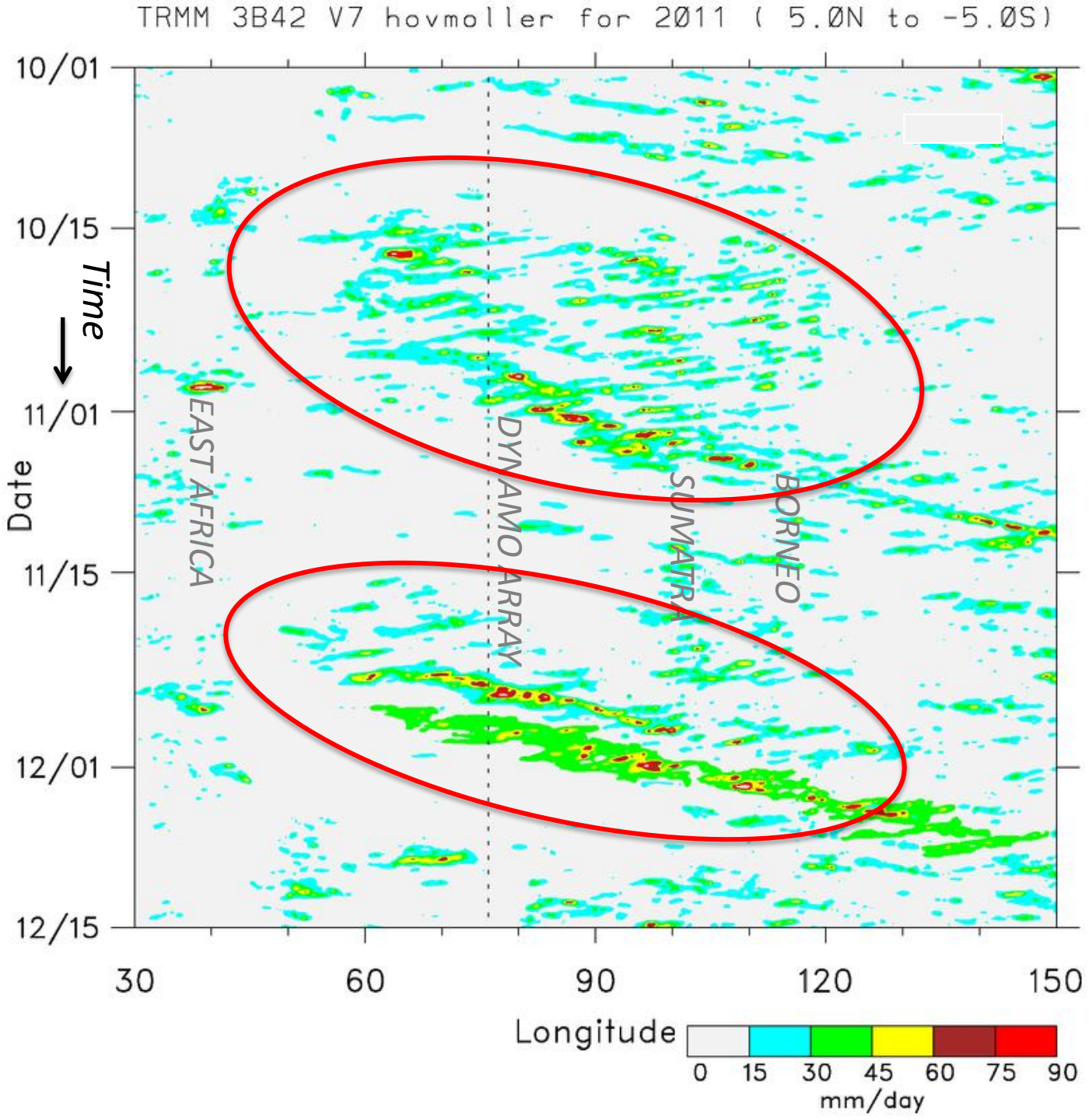
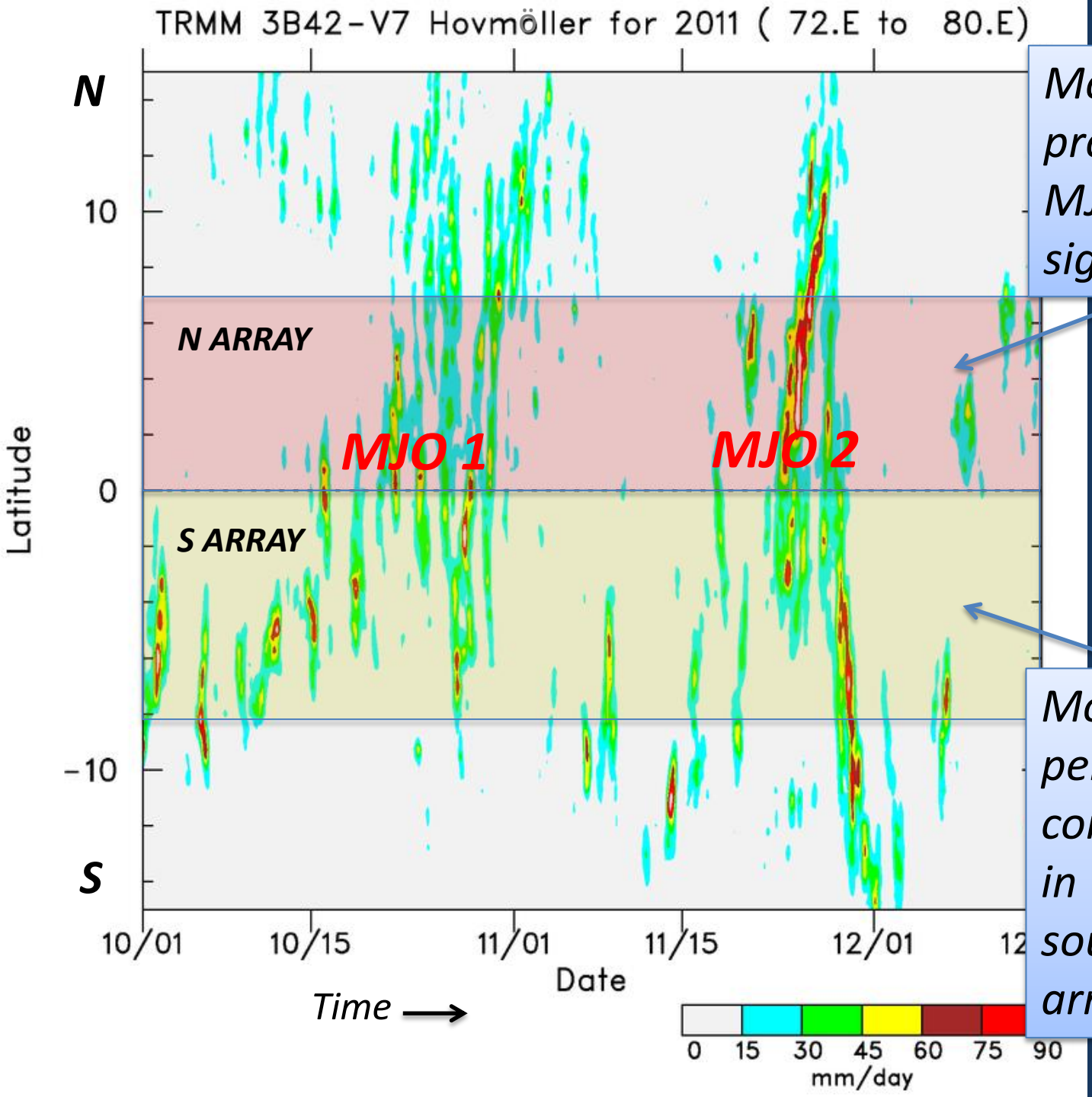


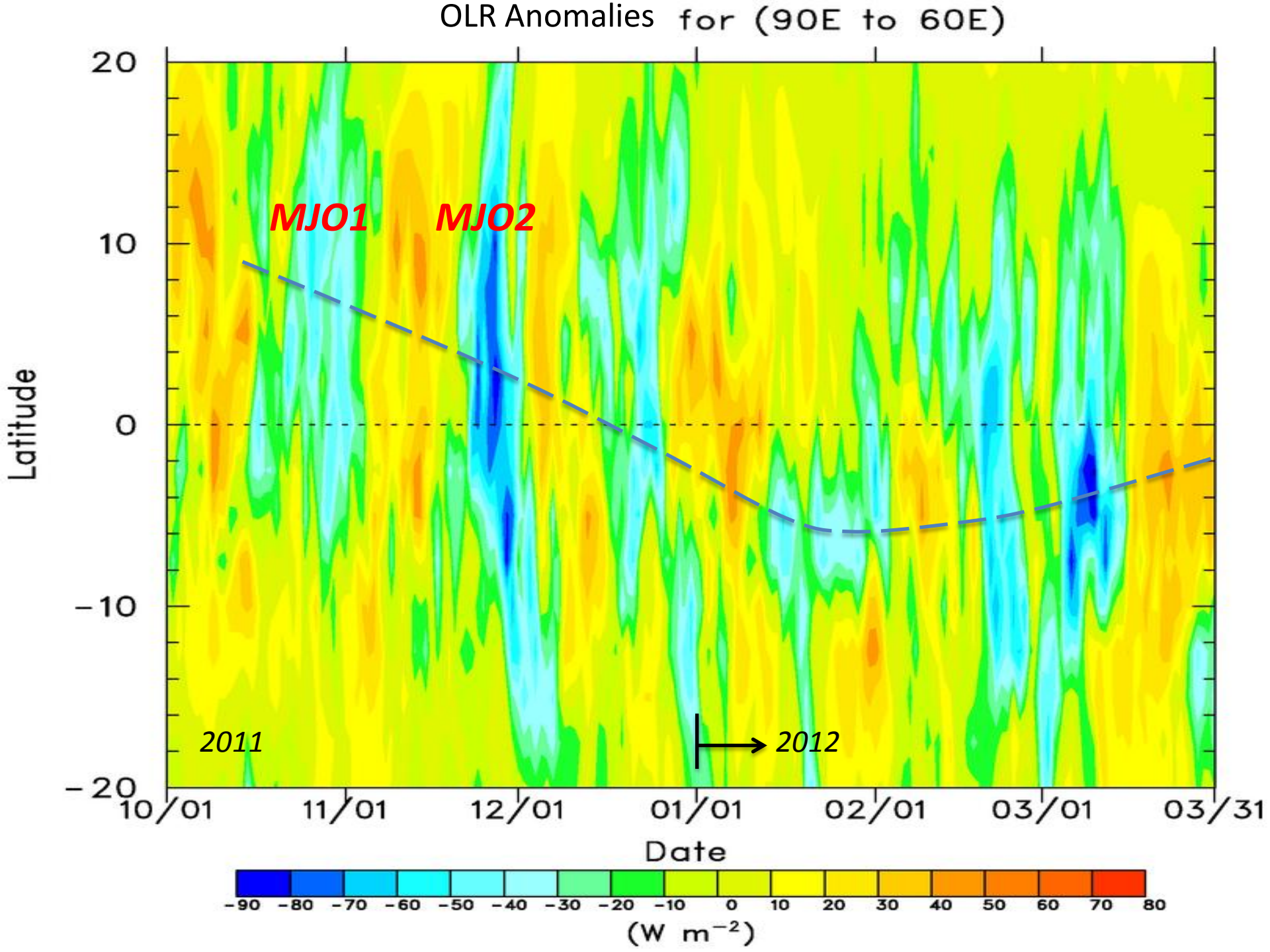
- *Northern Array: October-early December, 4/day soundings*
- *Southern Array: October-November, 8/day soundings*
- *Gridded analysis 1 deg, 4/day, mix of high-res and GTS-res data, no model data*

- *Two prominent MJO events: October and November*

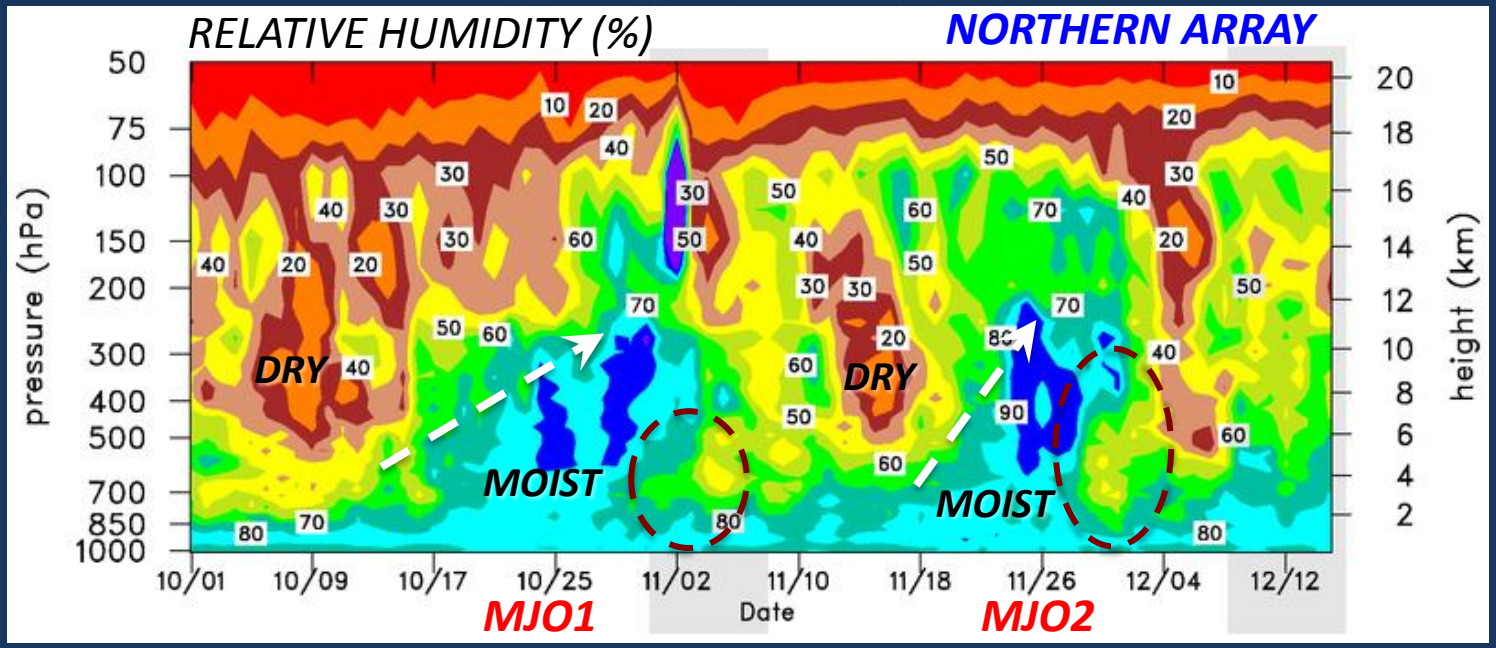
- *MJO envelopes consists of westward- and eastward-moving disturbances*

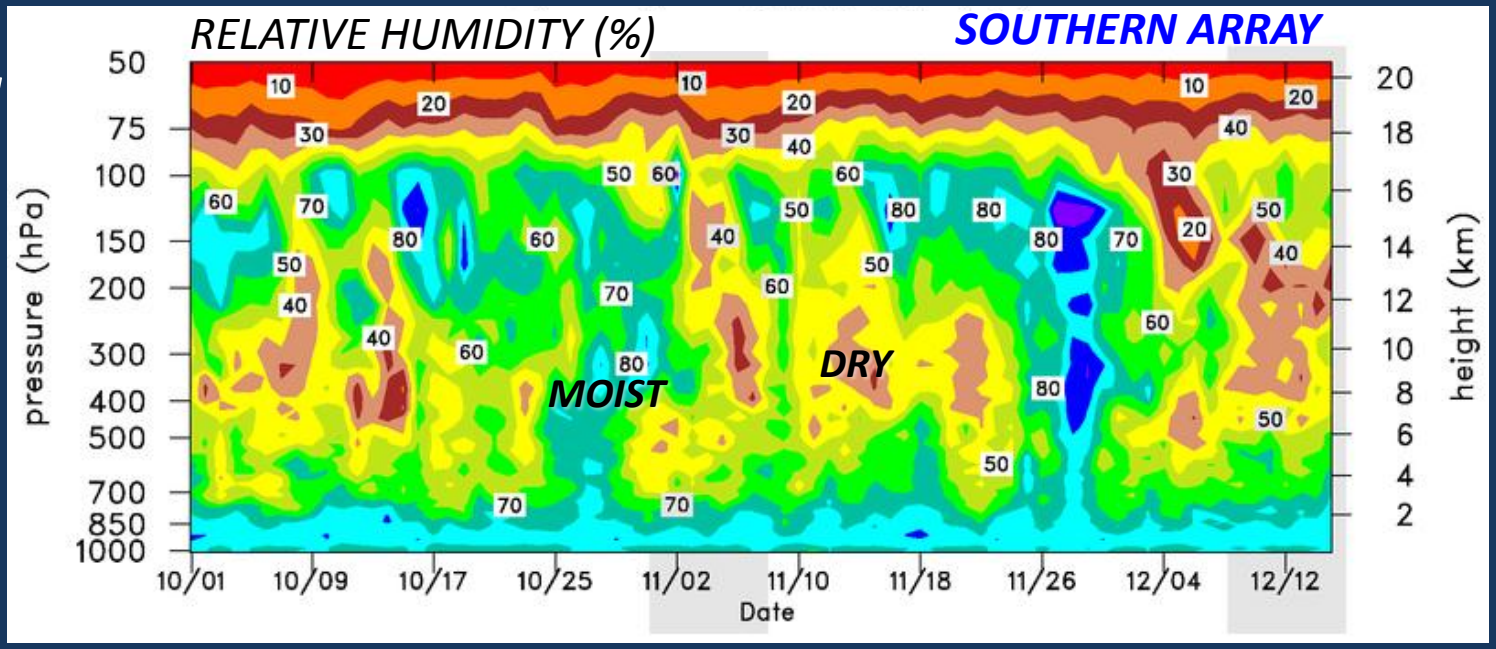



TRMM 3B42-V7 Hovmöller for 2011 (72.E to 80.E)
N
10
0
-10
S
Latitude
N ARRAY
S ARRAY
MJO 1
MJO 2
10/01
10/15
11/01
11/15
12/01
Date
Time
0
15
30
45
60
75
90
mm/day
More prominent MJO signal
More persistent convection in southern array

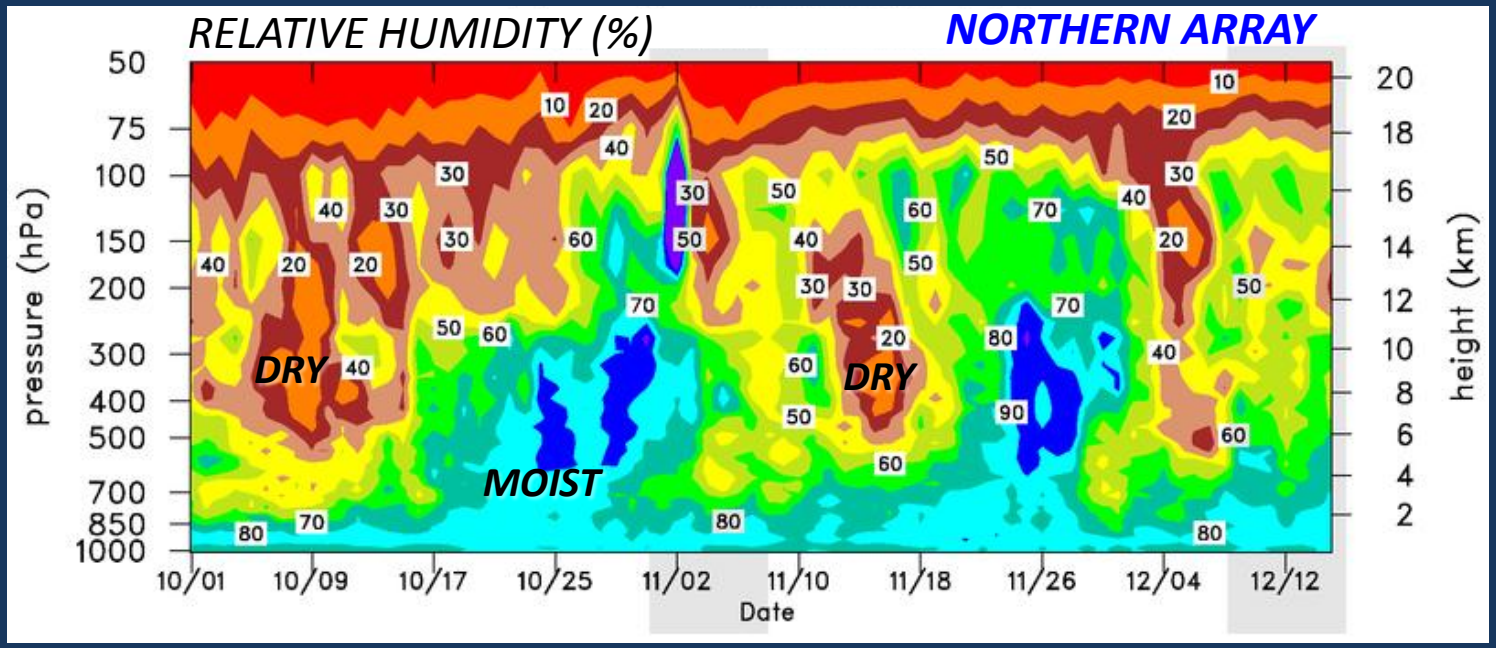

OLR Anomalies for (90E to 60E)
MJO1
MJO2
2011
2012
Latitude
20
10
0
−10
−20
10/01
11/01
12/01
01/01
02/01
03/01
03/31
Date
−90 −80 −70 −60 −50 −40 −30 −20 −10 0 10 20 30 40 50 60 70 80
(W m^{-2})

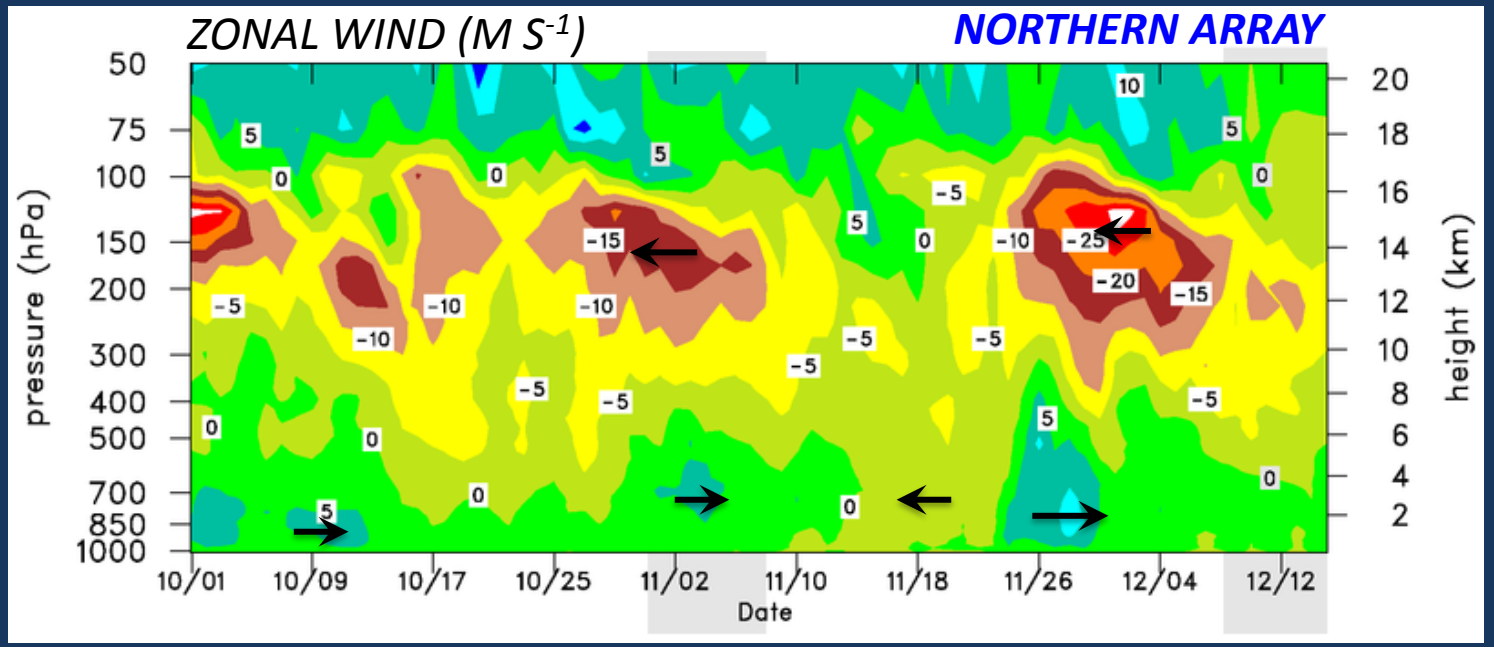
- *Gradual build-up of moisture over ~2-week periods, followed by rapid drying*
- *MJO moistening still evident, but weaker signal*
- *Deeper, more persistent lower-trop moisture*



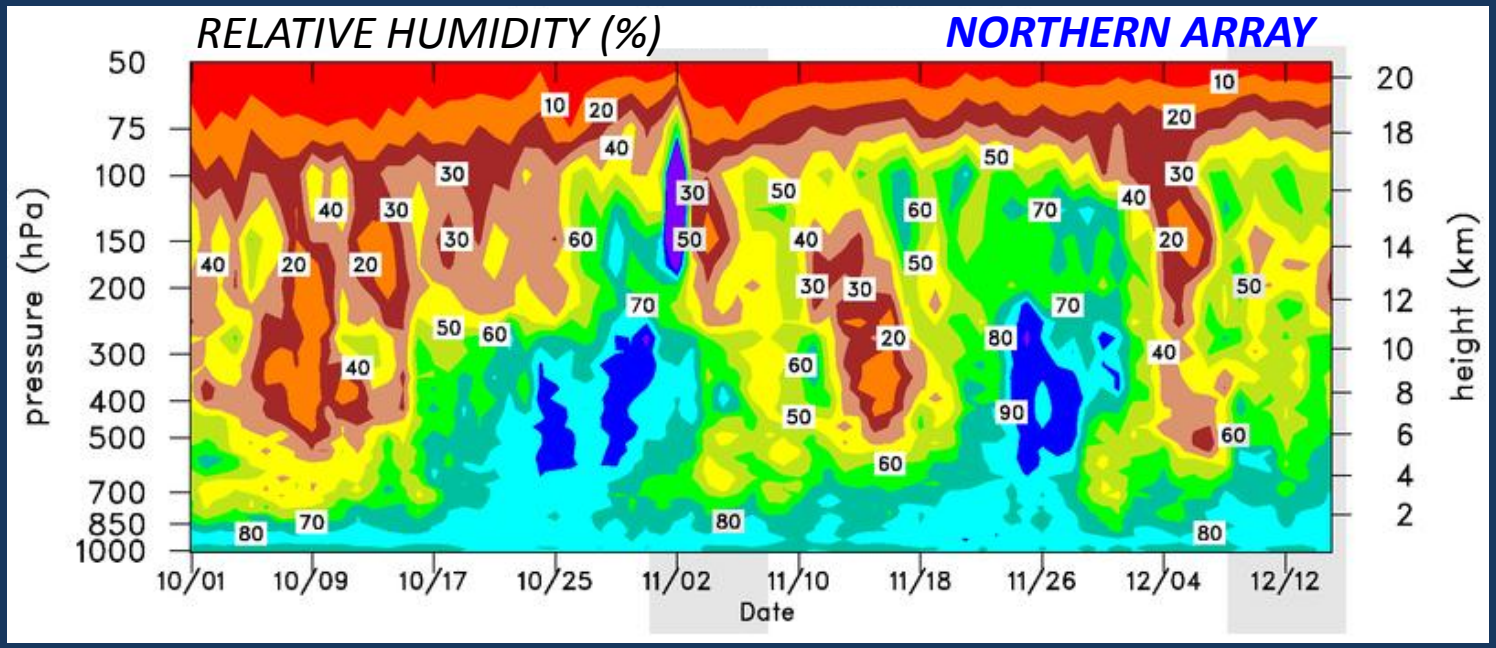


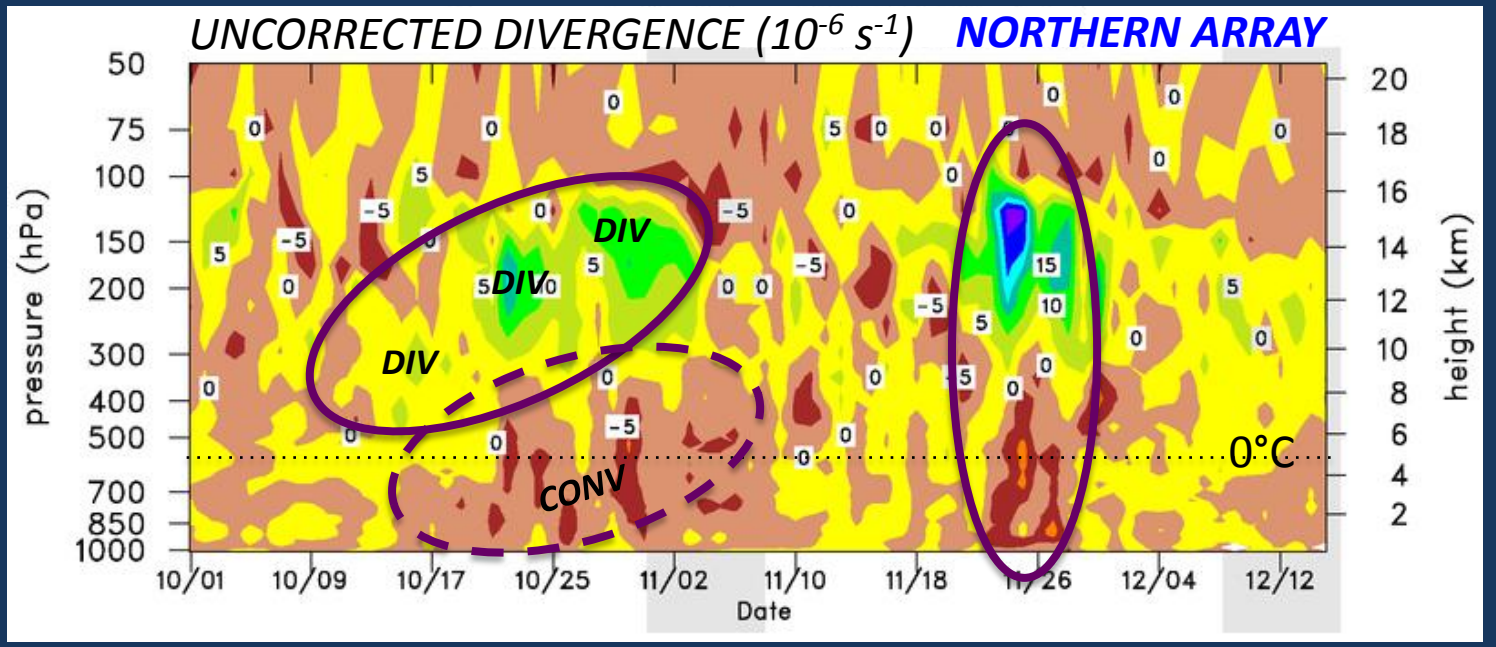
- *Gradual build-up of moisture over ~2-week period, followed by rapid drying*
- *MJOs accompanied by enhanced low-level Wly, upper-level Ely*
- *Ely flow at low levels only with 2nd MJO*



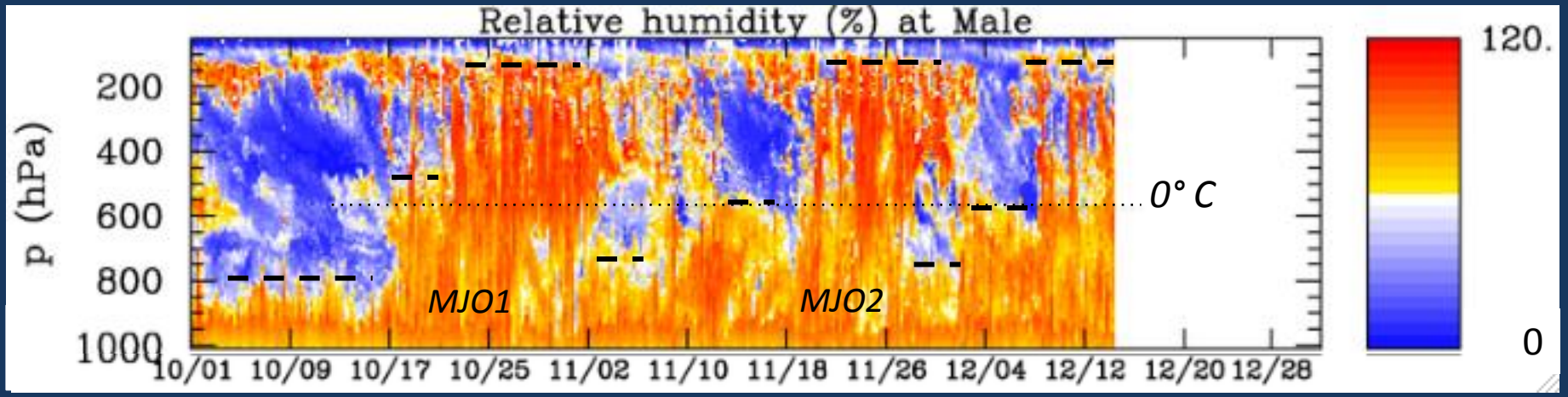


- *Gradual build-up of moisture over ~2-week periods, followed by rapid drying*
- *Ascending divergence, convergence maxima during first MJO*
- *More rapid development, second MJO*



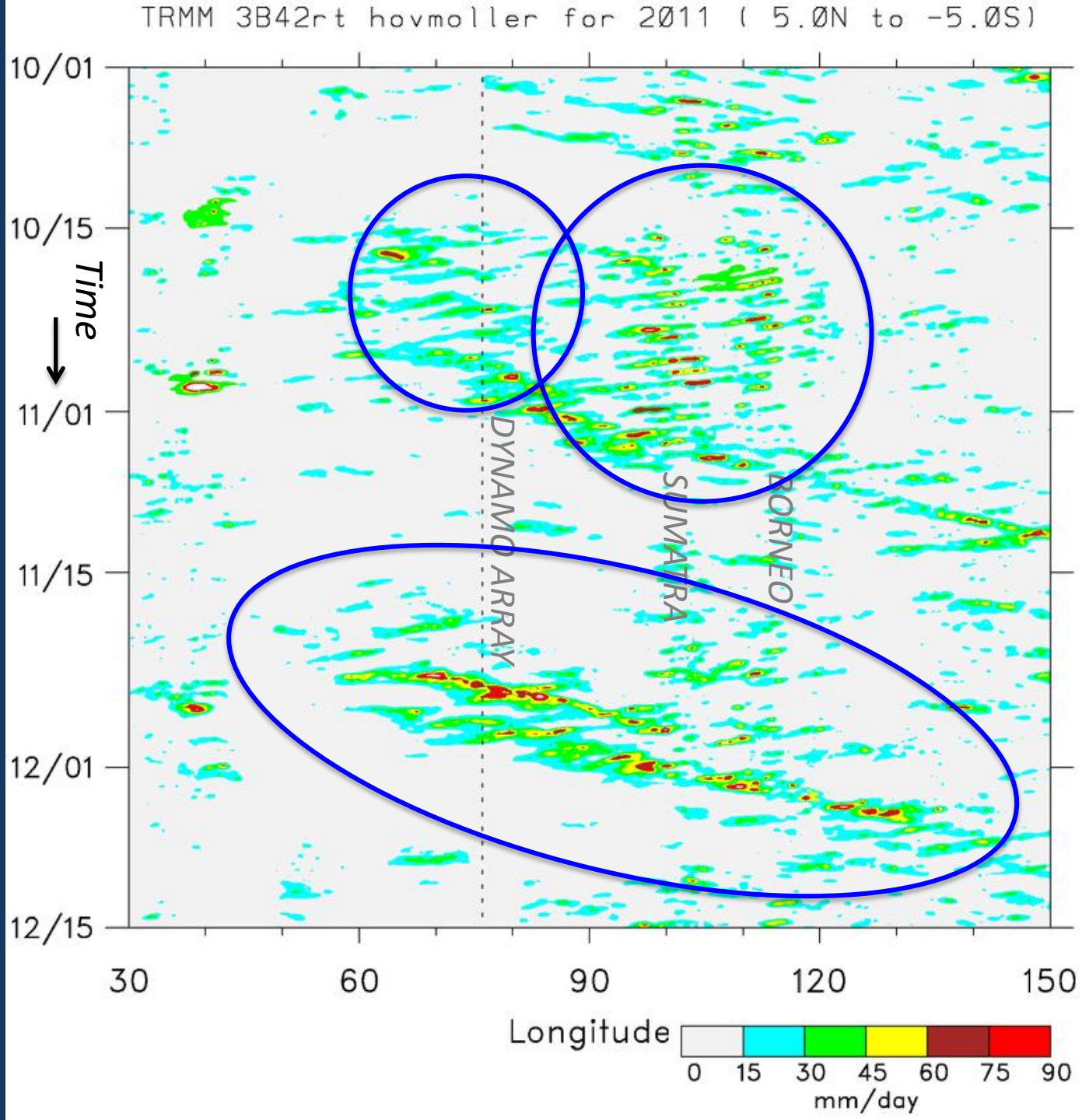


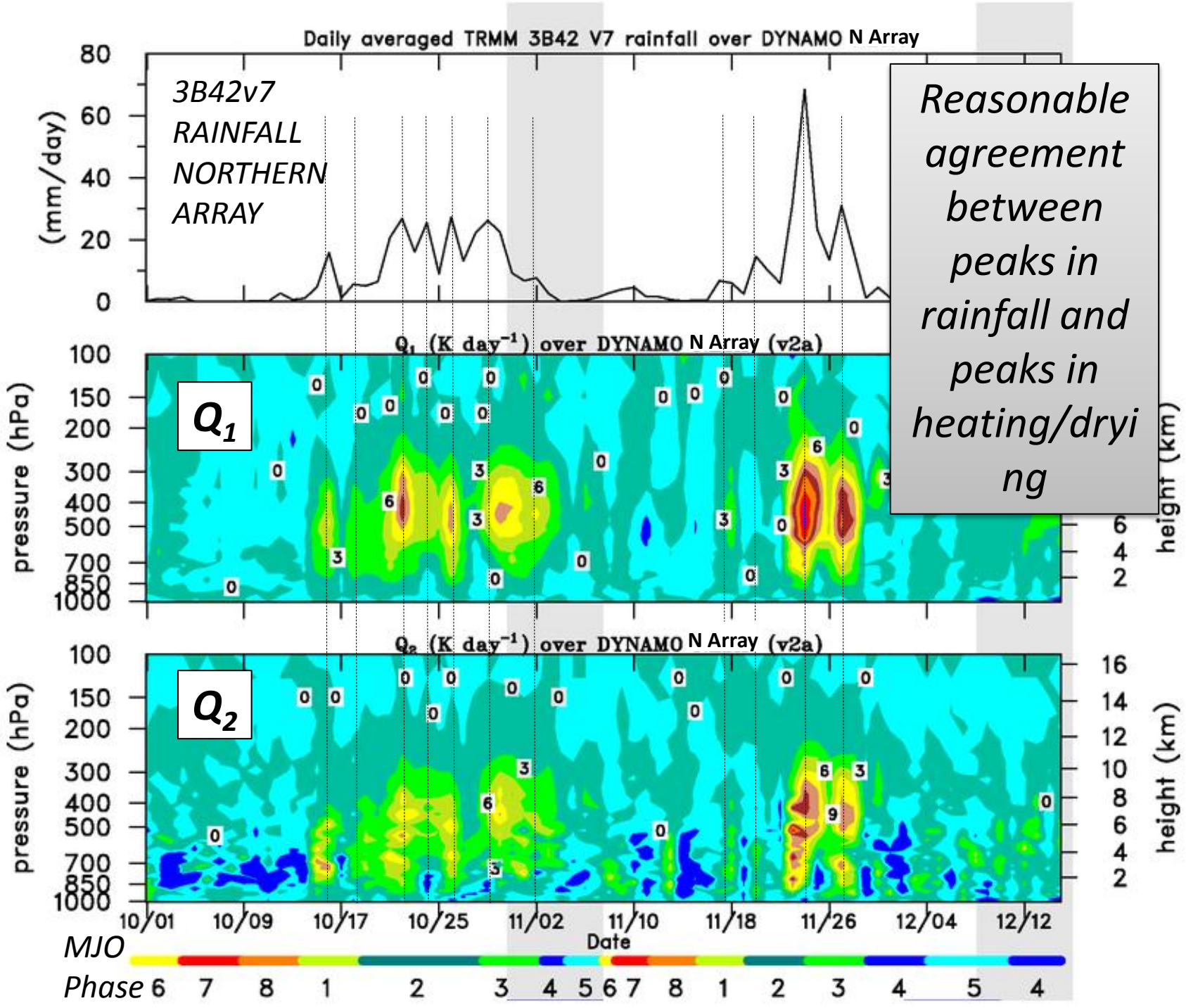
Time Series of Relative Humidity at Malé (4.2N)



- *Apparent stepwise moistening in developing phase of MJO (e.g., Kikuchi and Takayabu 2004; 2006 MISMO: Katsumata et al. 2009); consistent with recent CloudSat/CALIPSO analyses (Del Genio et al. 2012)*
- *Relationship to cloud populations yet to be determined*

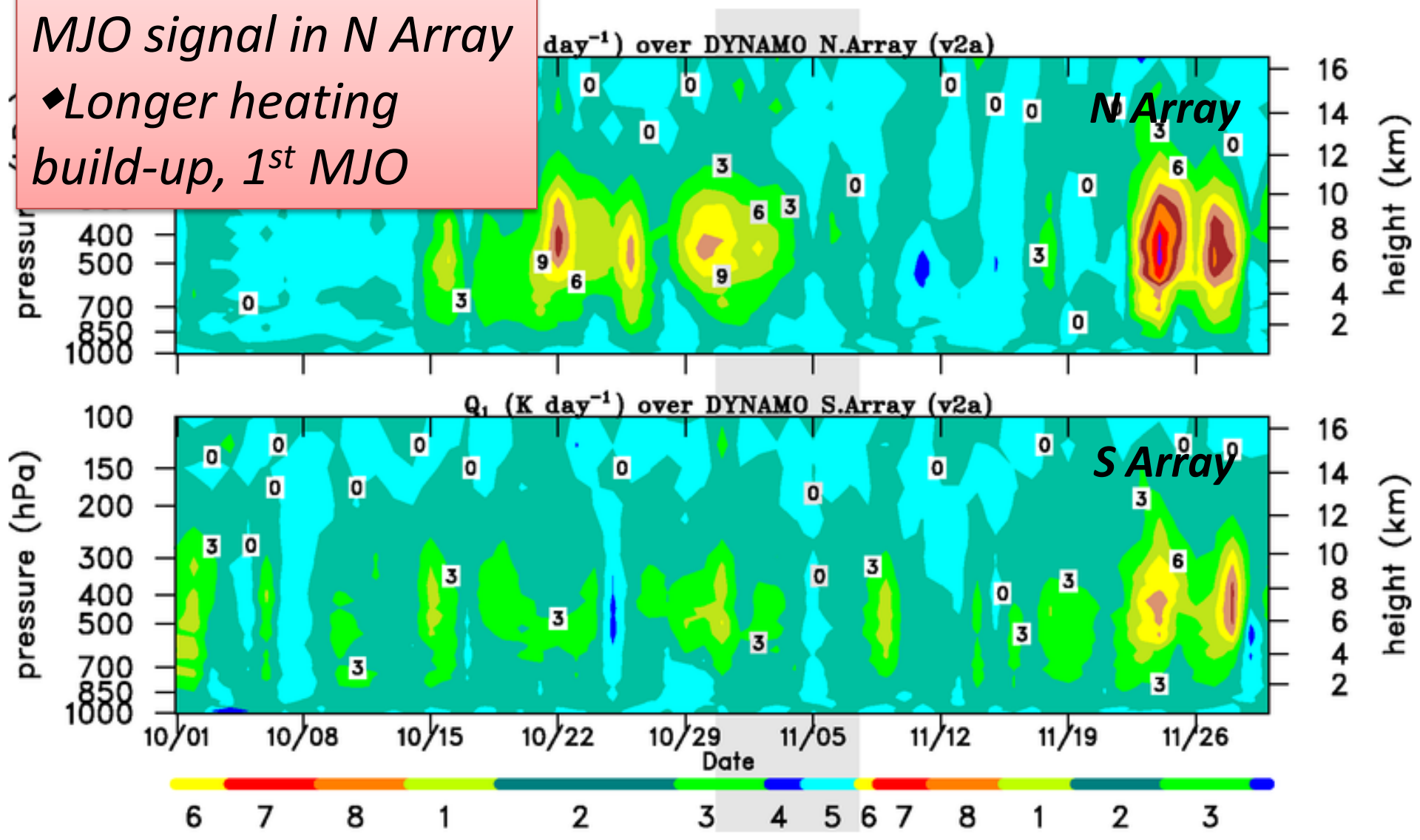
- *Diurnal cycle over Sumatra, Borneo, esp. 1st MJO*
- *Two-day disturbances over DYNAMO array prominent during 1st MJO*
- *Two prominent Kelvin waves with 2nd MJO*




Daily averaged TRMM 3B42 V7 rainfall over DYNAMO N Array
3B42v7
RAINFALL
NORTHERN
ARRAY
(mm/day)
Reasonable agreement between peaks in rainfall and peaks in heating/drying
Q1 (K day-1) over DYNAMO N Array (v2a)
Q1
pressure (hPa)
height (km)
Q2 (K day-1) over DYNAMO N Array (v2a)
Q2
10/01
10/09
10/17
10/25
11/02
11/10
11/18
11/26
12/04
12/12
Date
MJO
Phase 6 7 8 1 2 3 4 5 6 7 8 1 2 3 4 5 4

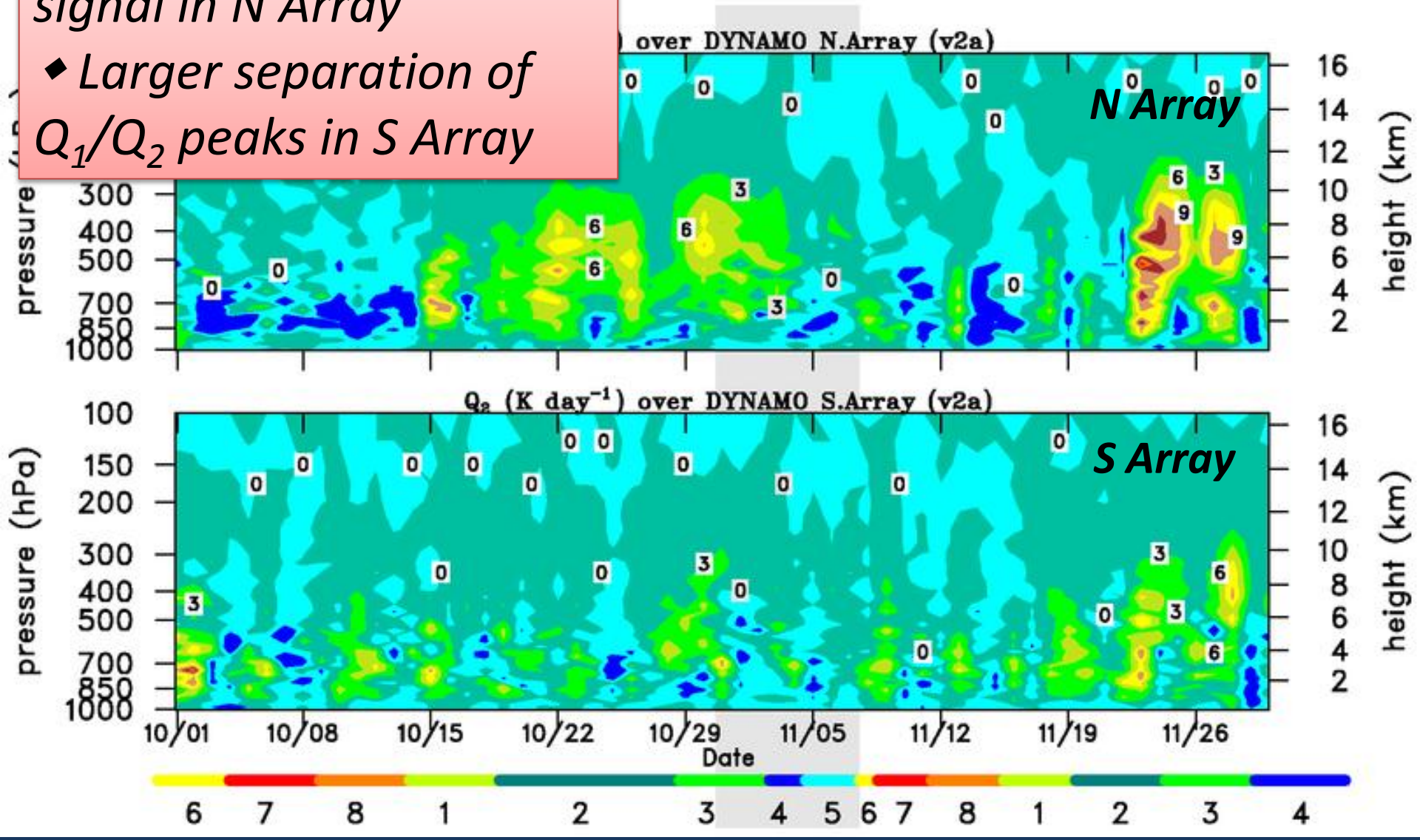
Apparent Heat Source Q_1

- *More prominent MJO signal in N Array*
- *Longer heating build-up, 1st MJO*

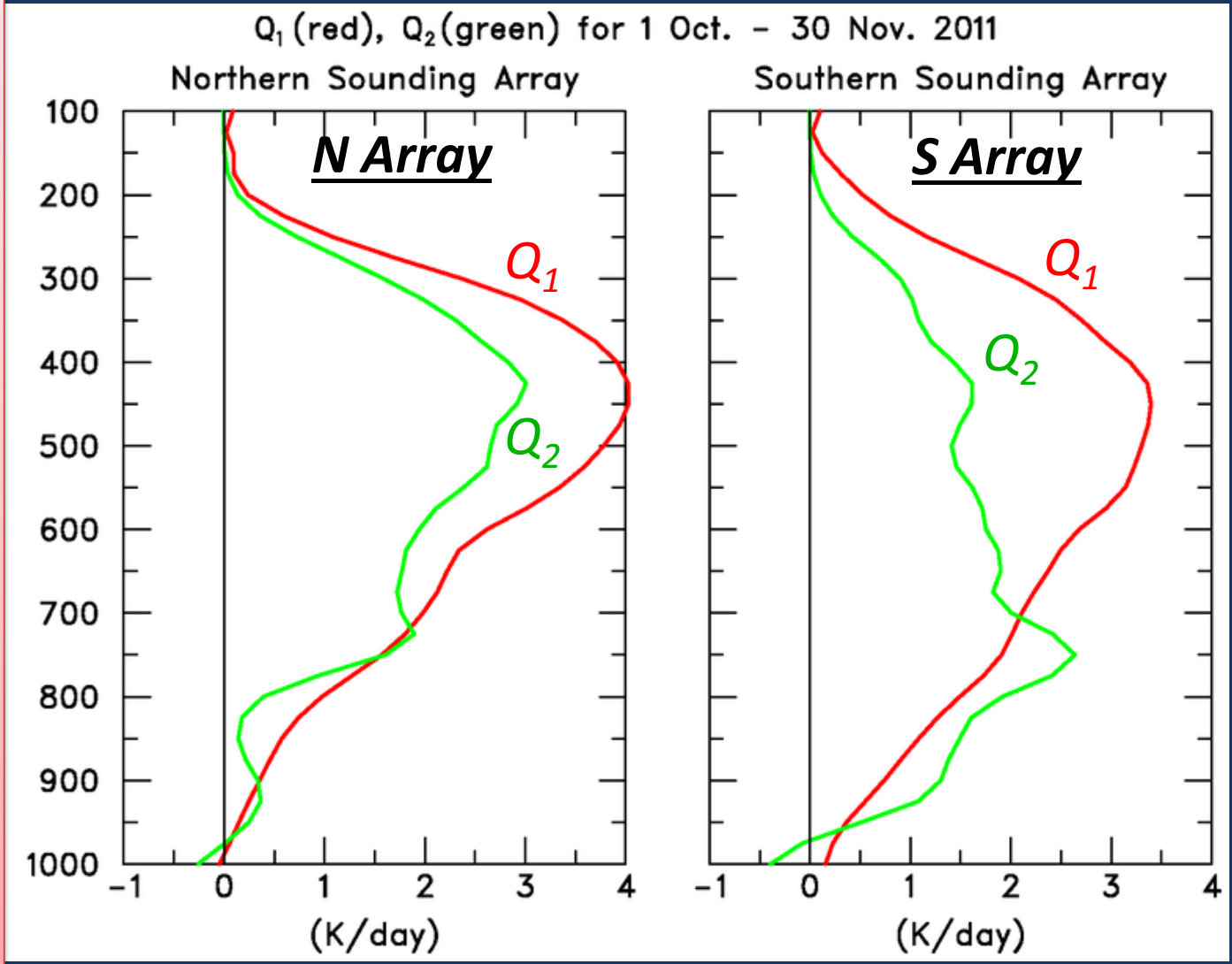


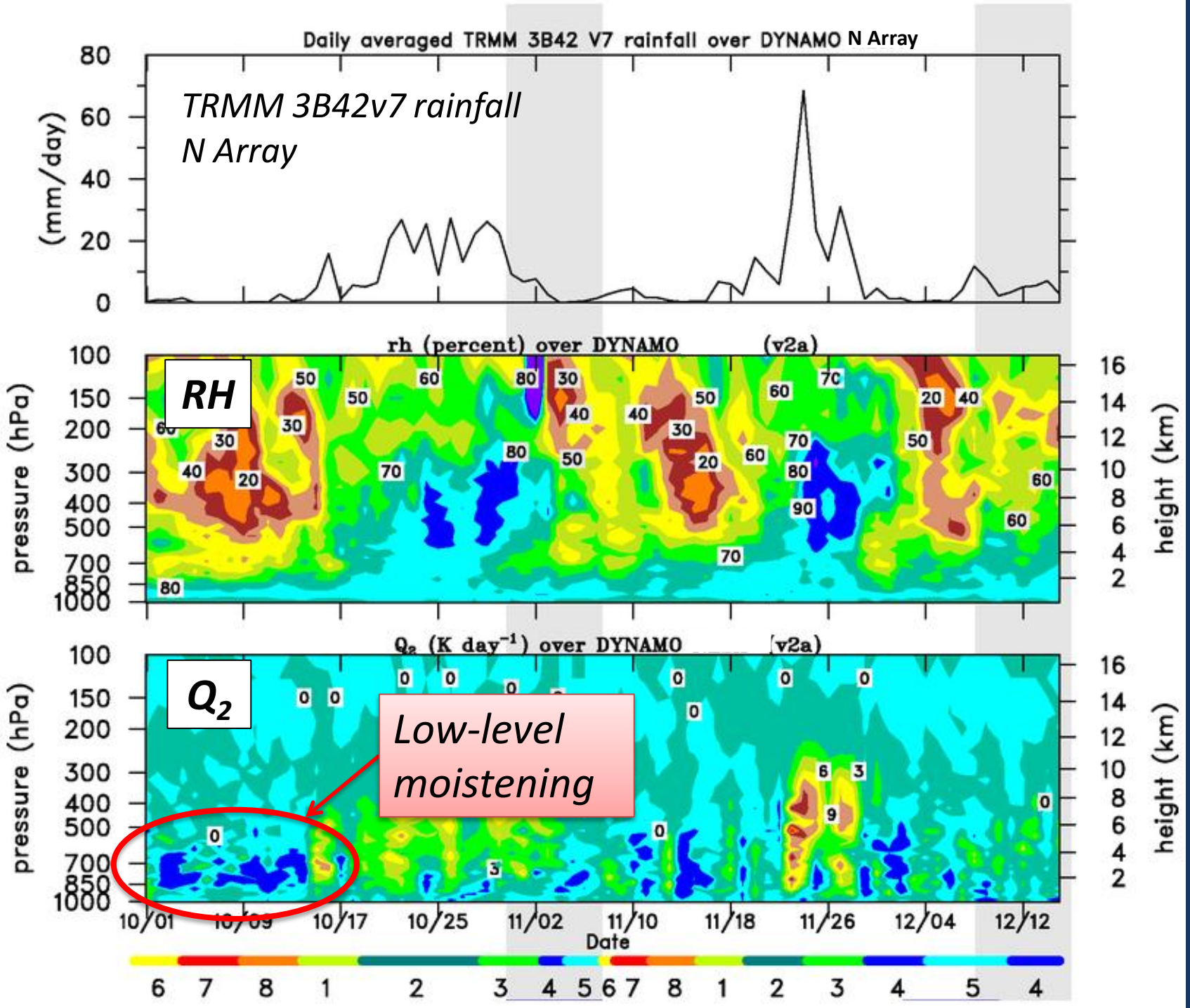
Moisture Sink Q_2

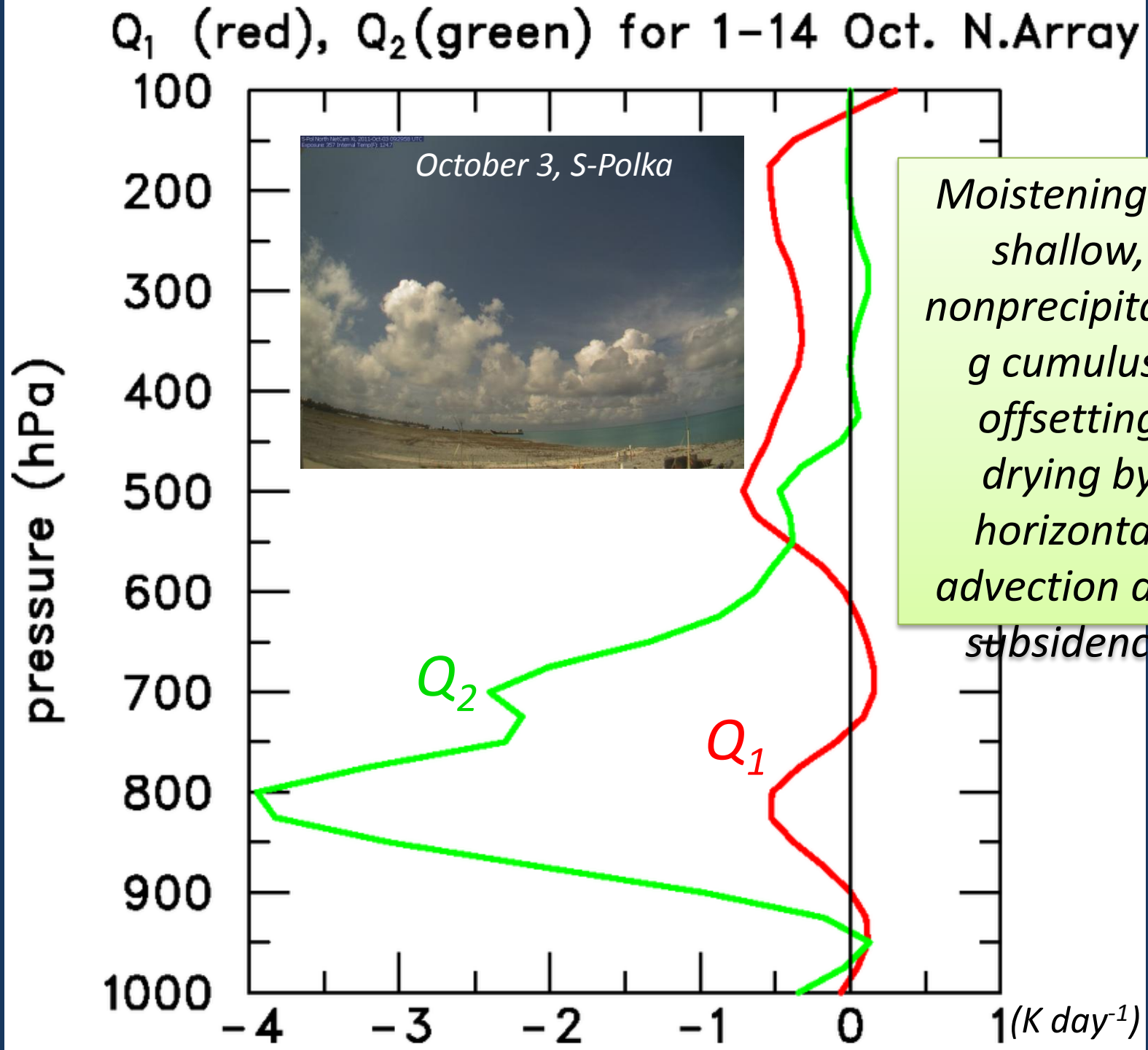
- *More prominent MJO signal in N Array*
- *Larger separation of Q_1/Q_2 peaks in S Array*

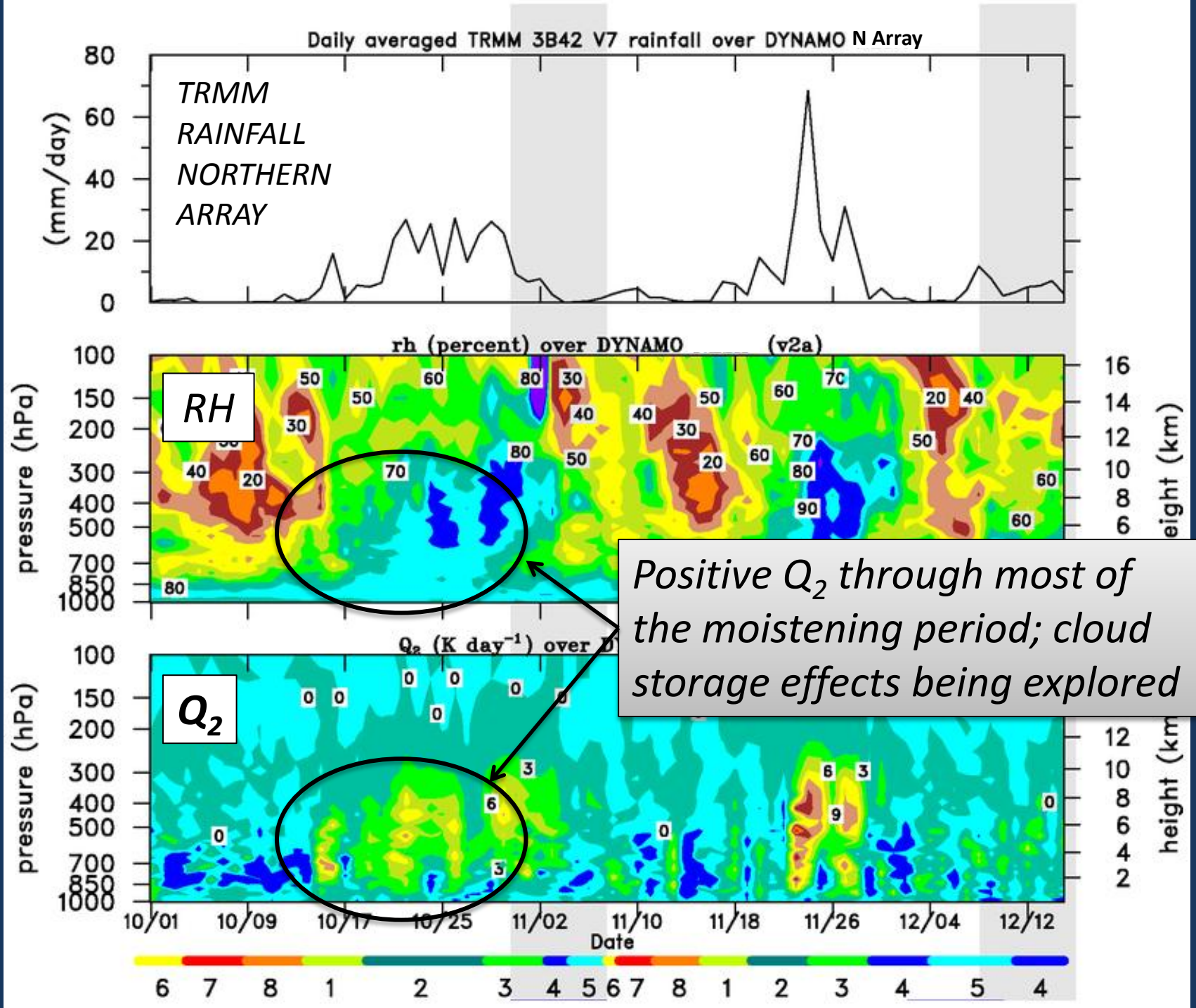


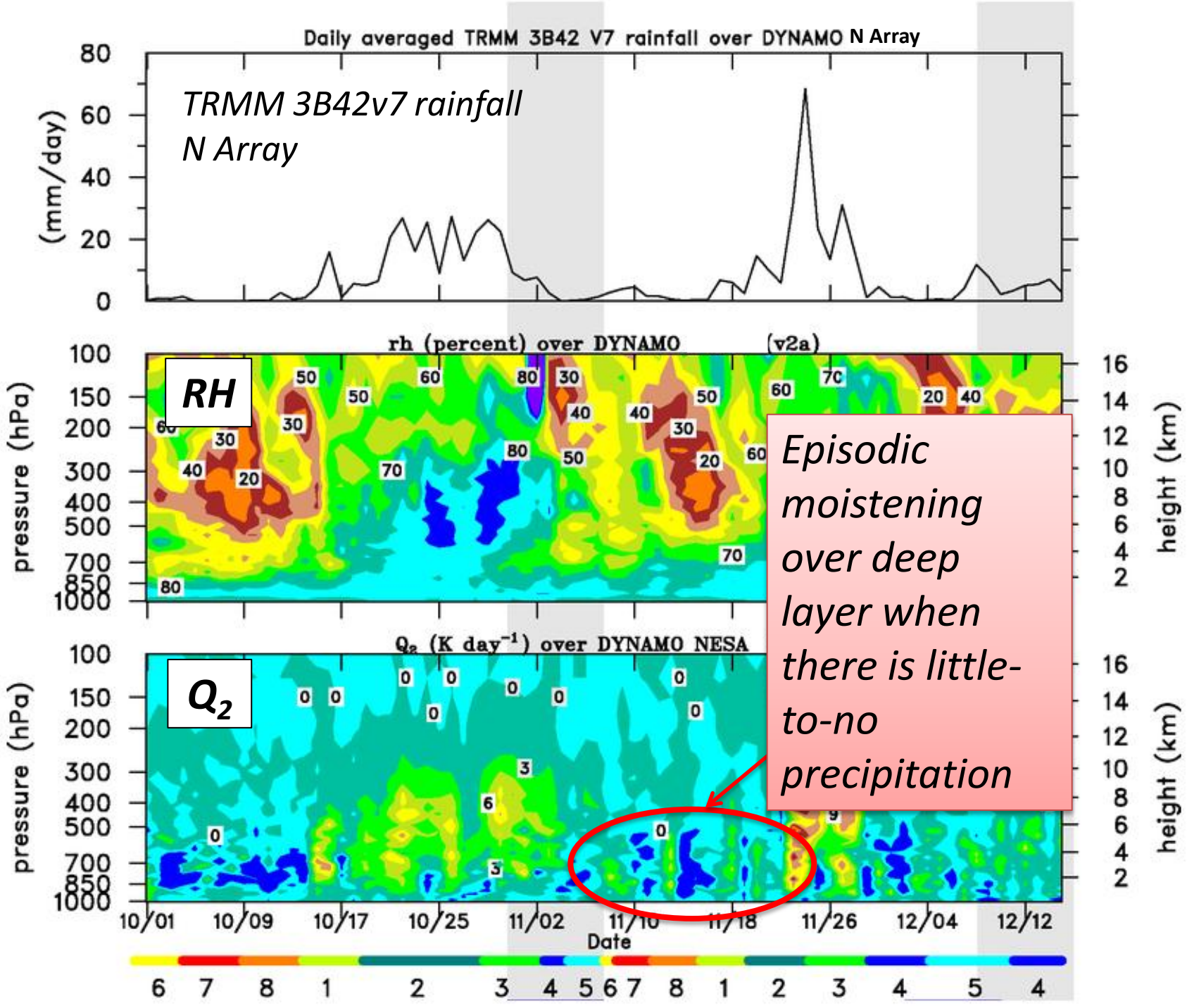
- *Greater separation of Q_1 and Q_2 peaks in S Array*
- *Suggests higher stratiform fraction in N Array*
- *Consistent with Lin et al. (2004), who found MJO has larger stratiform rain fraction than annual mean*
- *Results yet to be corroborated*



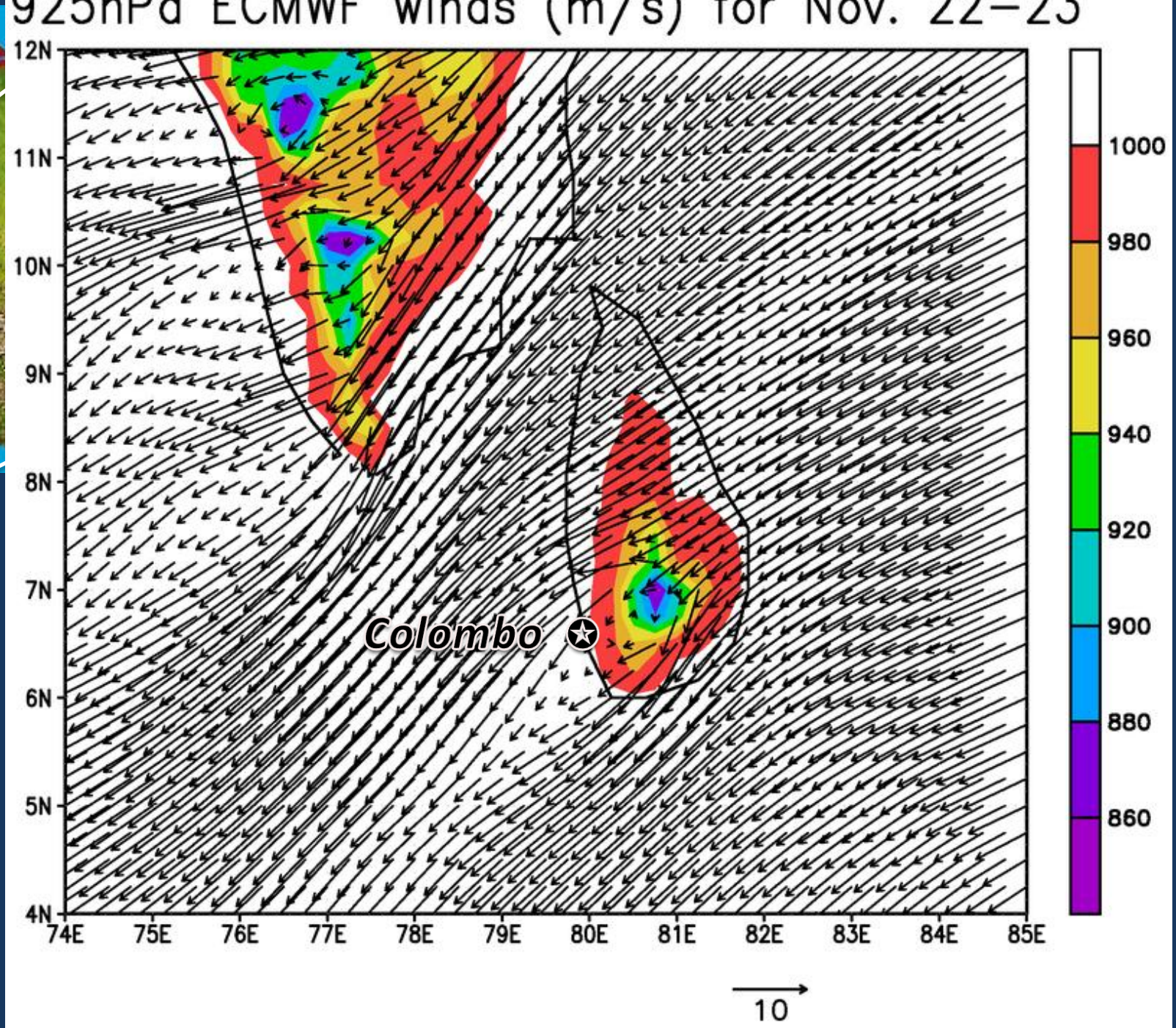

Daily averaged TRMM 3B42 V7 rainfall over DYNAMO N Array
TRMM 3B42v7 rainfall
N Array
(mm/day)
rh (percent) over DYNAMO (v2a)
RH
pressure (hPa)
height (km)
Q2 (K day-1) over DYNAMO (v2a)
Q2
Low-level moistening
10/01
10/09
10/17
10/25
11/02
11/10
11/18
11/26
12/04
12/12
Date


Q1 (red), Q2(green) for 1–14 Oct. N.Array
pressure (hPa)
100
200
300
400
500
600
700
800
900
1000
−4
−3
−2
−1
0
1
(K day-1)
October 3, S-Polka
Q2
Q1
Moistening by shallow, nonprecipitating cumulus, offsetting drying by horizontal advection and subsidence


Daily averaged TRMM 3B42 V7 rainfall over DYNAMO N Array
(mm/day)
TRMM
RAINFALL
NORTHERN
ARRAY
rh (percent) over DYNAMO (v2a)
RH
pressure (hPa)
height (km)
Positive Q_2 through most of the moistening period; cloud storage effects being explored
Q_2 ($K\ day^{-1}$) over D
Q_2
10/01
10/09
10/17
10/25
11/02
11/10
11/18
11/26
12/04
12/12
Date


Daily averaged TRMM 3B42 V7 rainfall over DYNAMO N Array
TRMM 3B42v7 rainfall
N Array
(mm/day)
rh (percent) over DYNAMO (v2a)
RH
pressure (hPa)
height (km)
Episodic moistening over deep layer when there is little-to-no precipitation
Q2 (K day-1) over DYNAMO NESA
Q2
10/01
10/09
10/17
10/25
11/02
11/10
11/18
11/26
12/04
12/12
Date


Colombo *


925hPa ECMWF winds (m/s) for Nov. 22–23
12N
11N
10N
9N
8N
7N
6N
5N
4N
74E
75E
76E
77E
78E
79E
80E
81E
82E
83E
84E
85E
Colombo
1000
980
960
940
920
900
880
860
10

SUMMARY

- *Two prominent MJOs, October and November*
- *Two MJOs quite different:*
  - *October: gradual moistening, multiple 2-day disturbances*
  - *November: more rapid moisture build-up, 2 strong Kelvin waves*
- *MJO signal more prominent in N Array*
- *Apparent stepwise moistening in MJO developing phases; mechanisms/relation to cloud populations TBD*
- *Q_2 profiles differ between N and S Arrays; implies greater stratiform fraction in N Array*
- *Trade-like cumulus regime in first half of October*
- *Work underway to remove Sri Lanka flow blocking effects*