MJO Latent Heating/Drying Profiles during DYNAMO

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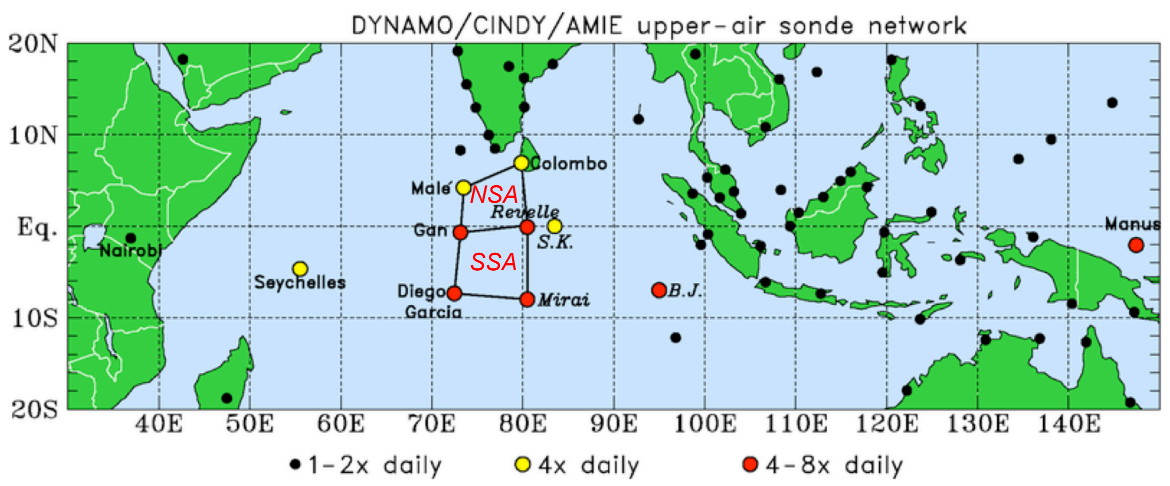
Introduction

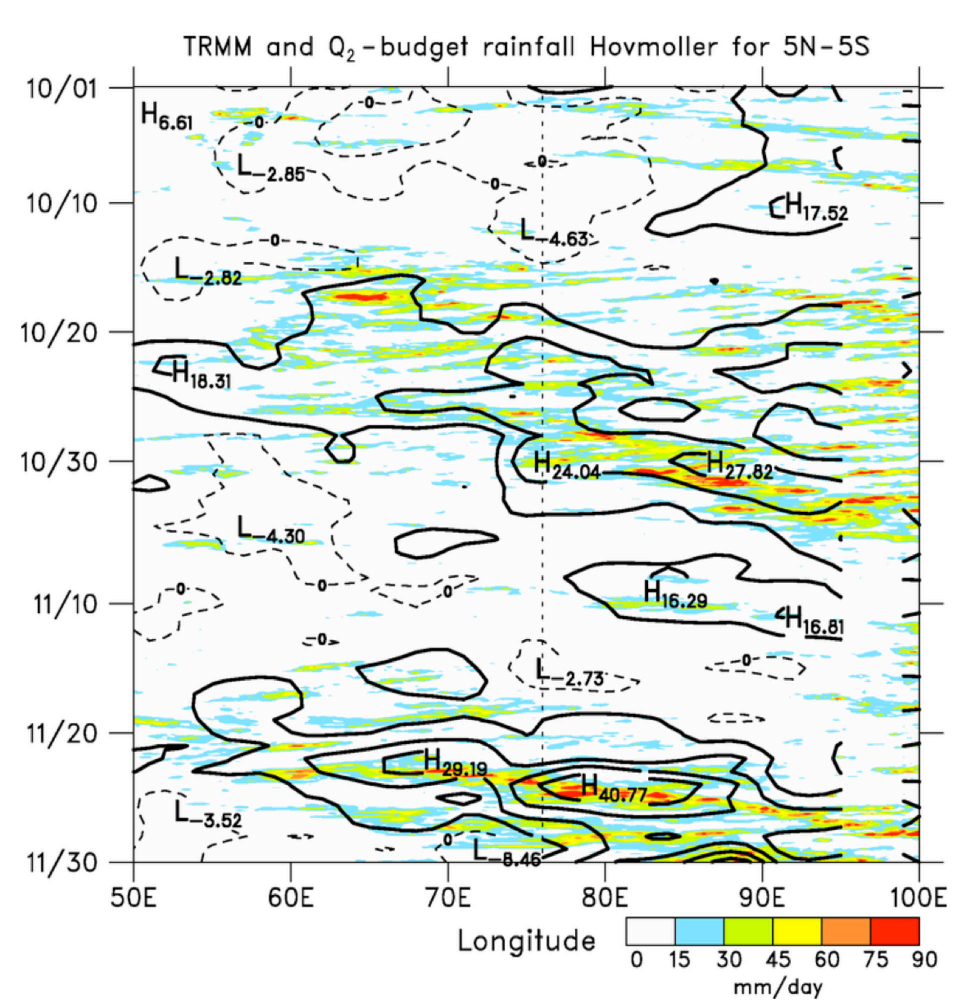
The Dynamics of the MJO (DYNAMO) field campaign was carried out in the Indian Ocean to study atmosphere and ocean processes associated with the initiation of the Madden-Julian Oscillation (MJO). This presentation reports on apparent heat sources and moisture sink (Q_1 and Q_2) profiles determined from the DYNAMO sounding arrays and comparisons of those profiles with two TRMM latent heating algorithm estimates, CSH (Tao et al. 2010) and SLH (Shige et al. 2007).



Heating and moistening profile comparisons are made for both the northern and southern sounding arrays (NSA and SSA, respectively, depicted above). The MJO signals were strongest in the NSA, while the SSA experienced more persistent precipitation associated with an ITCZ convective band that frequently existed between the equator and 10°S (Johnson and Ciesielski 2013).

October/November MJOs

Two prominent MJOs occurred in October and November. Precipitation determined from the moisture budget (using surface evaporation from TropFlux) agrees well with the precipitation envelopes based on TRMM 3B42.

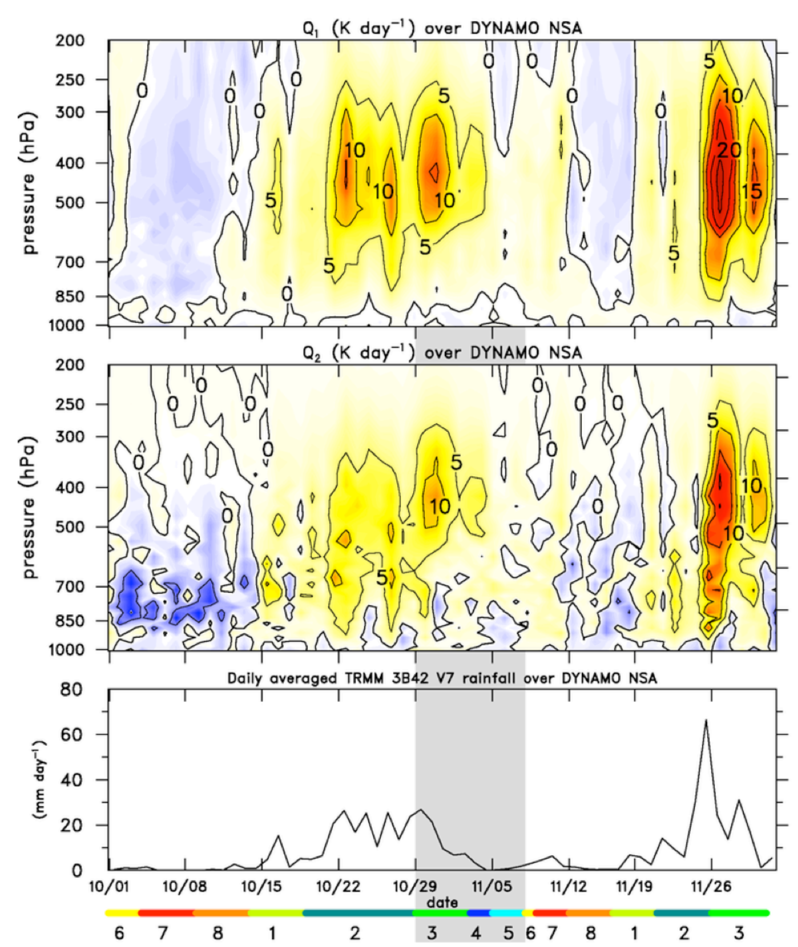


Time-longitude diagram for October-November 2011 of 3-hourly TRMM 3B42 precipitation and 3-day running mean of daily-averaged rainfall from Q_2 budget.

- The two MJOs consisted of both westward- and eastward-moving convective disturbances within an overall eastward-moving envelope
- The duration of rainfall over the sounding arrays centered near 75°E (vertical dashed line) was longer for the October MJO than the November MJO

Time series of Q_1 and Q_2

Q_1, Q_2, and rainfall over Northern Sounding Array

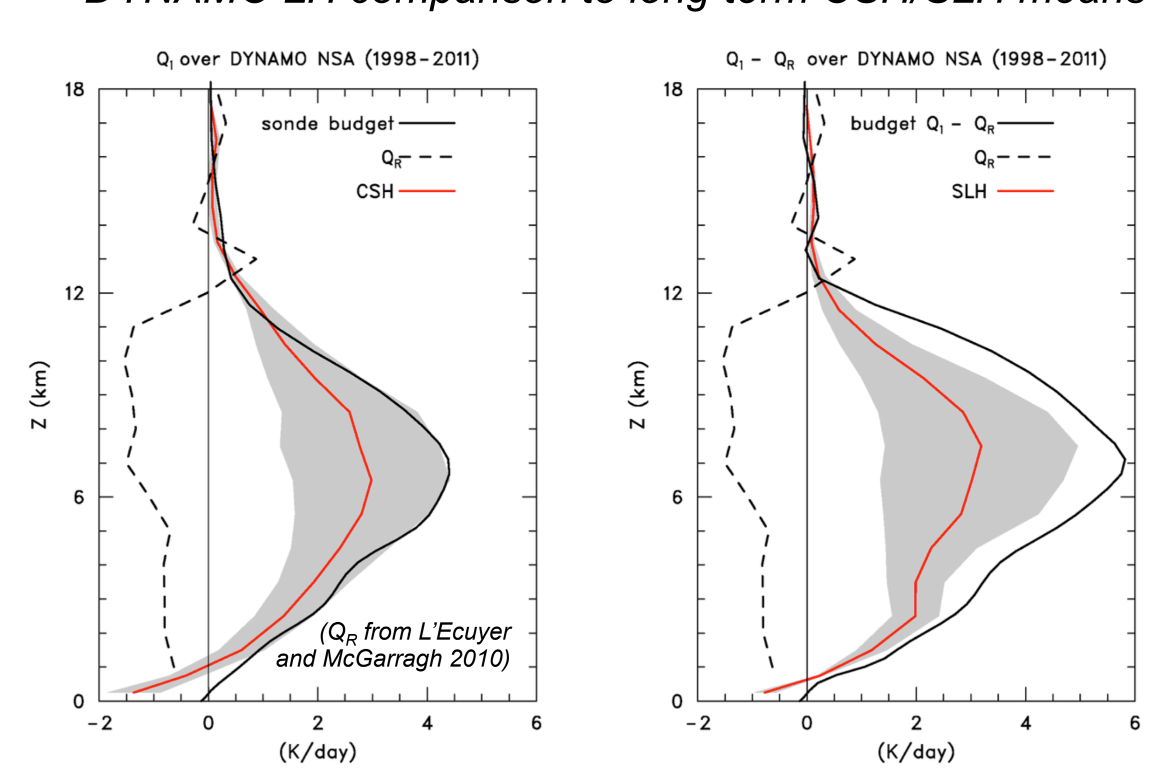


Time series of Q_1 and Q_2 for NSA, TRMM 3B42 rainfall and Wheeler-Hendon MJO Index (bottom color bar). Shading denotes time when R/V Revelle was off station.

- Northern array sounding network captures prominent signals of heating/drying associated with active phases of each MJO
- Inferred evolution of dominant convective modes for both MJOs: shallow, non-precipitating clouds to congestus to deep convection to stratiform precipitation
- Shorter duration of each convective mode for November MJO than October

Comparison of Q_1/Q_1 – Q_R profiles to 14-yr means

DYNAMO LH comparison to long-term CSH/SLH means



- Shapes of October-November mean DYNAMO heating profiles for NSA similar to 14-year TRMM means (Q_1 for CSH, Q_1 – Q_R for SLH), but amplitude was greater for DYNAMO year (corresponding to above-normal rainfall)

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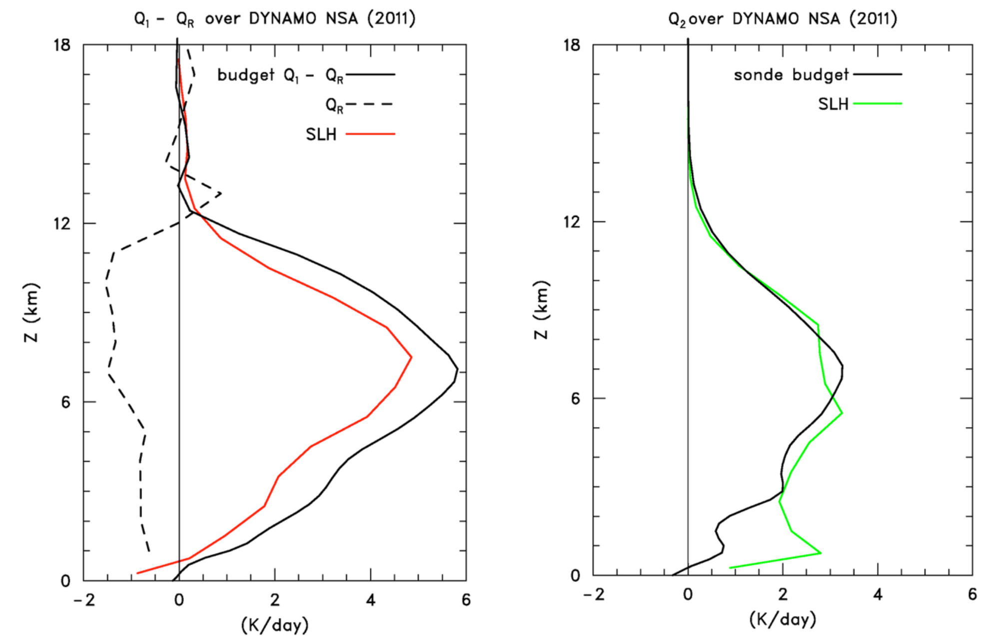
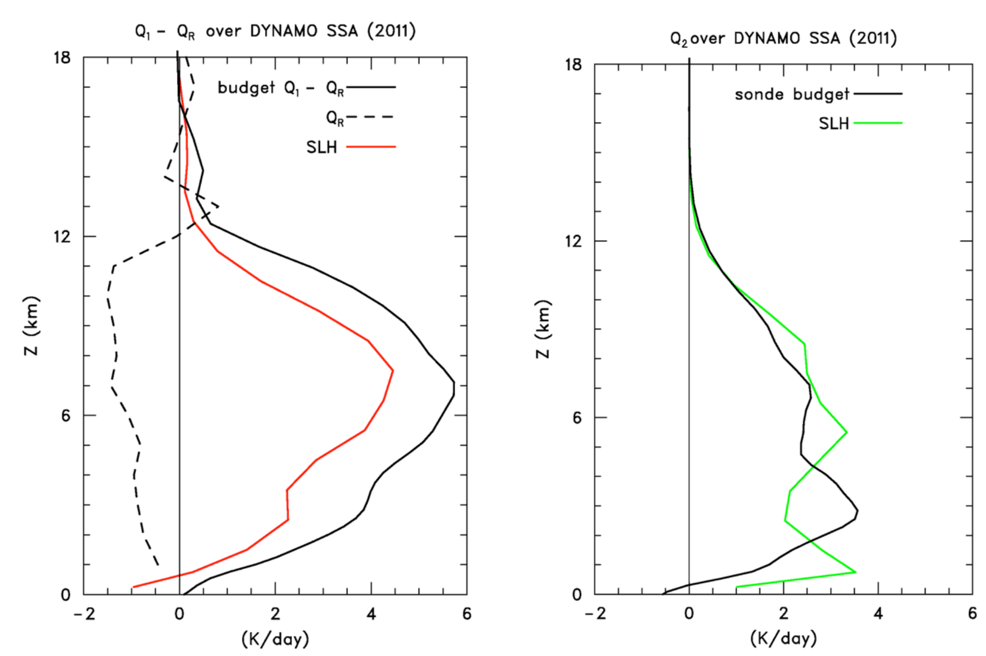
Comparison of Q_1 – Q_R/Q_2 profiles for DYNAMO year

DYNAMO budget/SLH comparisons for NSA



- Slight underestimate of heating amplitude, excessive moistening in lower troposphere for SLH algorithm
- Similar results for CSH (not shown)

DYNAMO budget/SLH comparisons for SSA



- Sounding estimates show coincident Q_1/Q_2 peaks for NSA, separation for SSA ⇒ greater stratiform rain fraction (SF) for NSA than SSA (2A25 gives 55% SF for NSA, 50% for SSA)
- SLH does not capture differing Q_2 profiles between NSA and SSA

Conclusions

- ***Both CSH (3H25) and SLH (3H31) latent heating profiles (Q_1 and Q_1 – Q_R) show good agreement with budget profiles for DYNAMO***
- ***Budget and TRMM LH algorithm Q_2 profiles show disagreement in lower troposphere, possibly related to inadequate representation of moistening by shallow, non-precipitating cumulus in algorithms***

References

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