Evolution of Precipitating Convective Systems over the Equatorial Indian Ocean in Active Phases of the MJO

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Atmospheric and Oceanic Variability Associated With the MJO in the Tropical Indian and Western Pacific Oceans session
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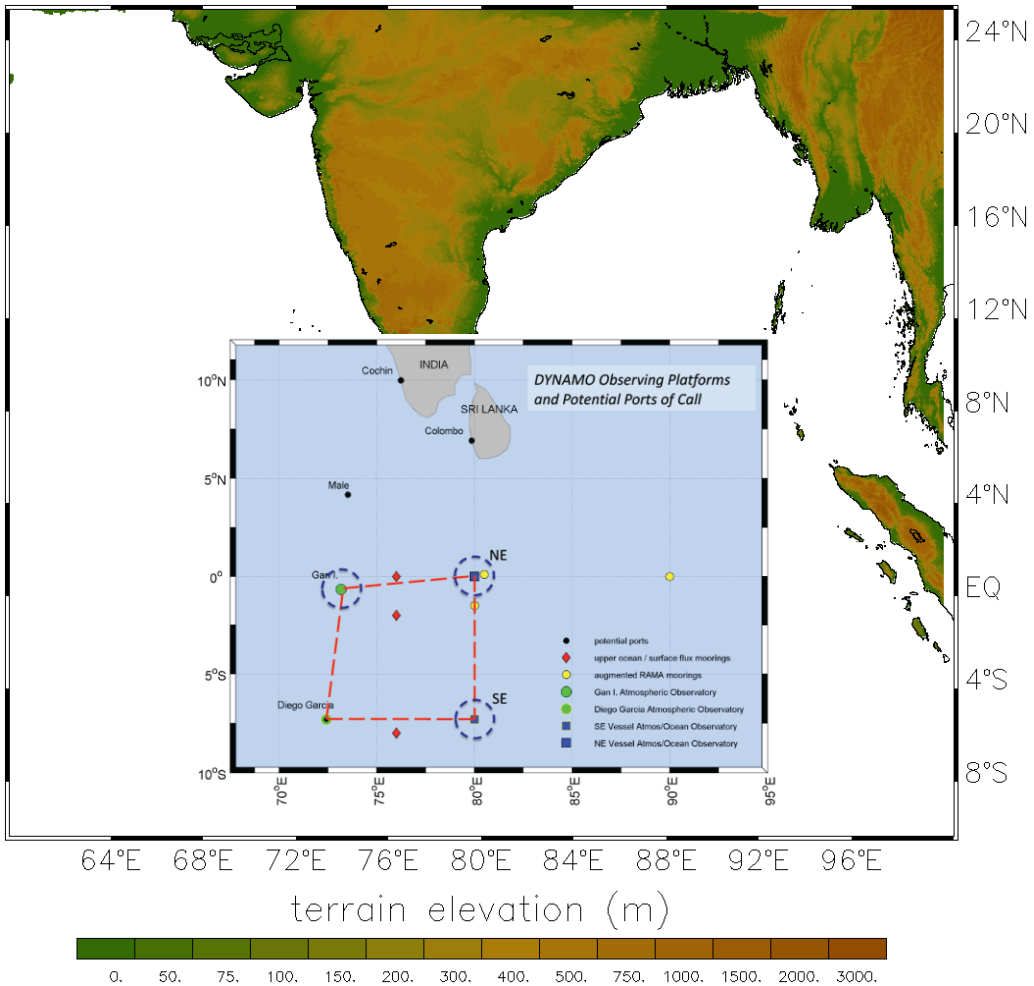
Objective

- Relate the occurrence of various types of cloud phenomena within the convective cloud population to changes in large-scale environmental conditions during the active phases of the MJO
  - Using radar reflectivity and rain type from ground radar
  - Using soundings and ERA-interim reanalysis datasets

DYNAMO/AMIE field project

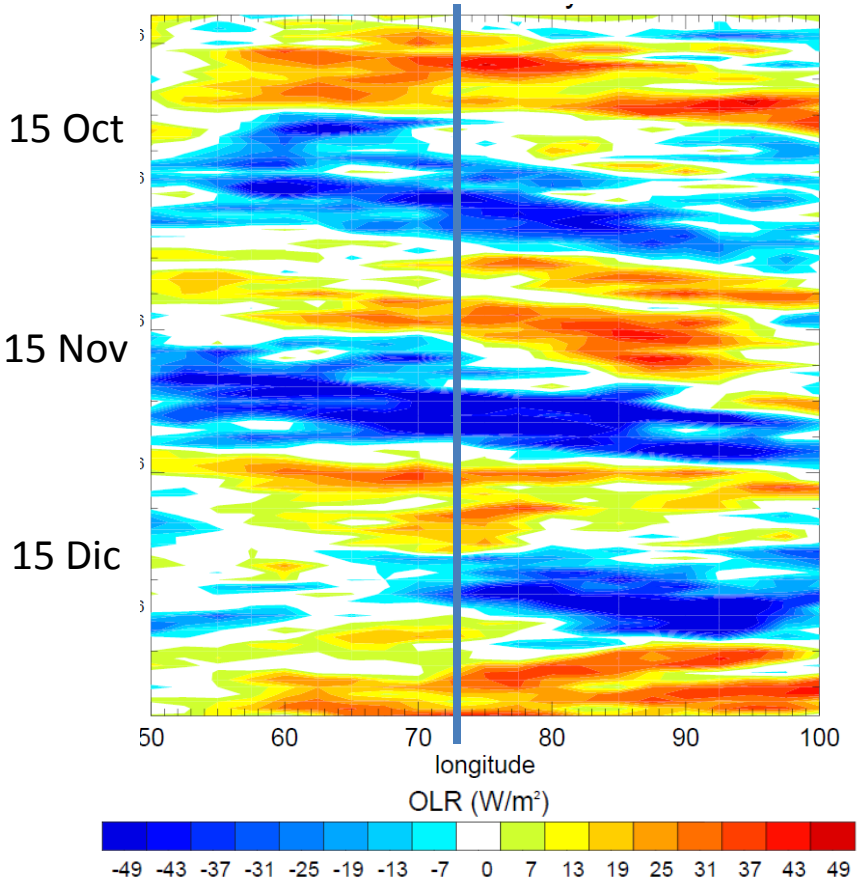
1 October 2011 - 15 January 2012

- **Radar**:
  - NCAR dual polarimetric **S-PolKa radar**
- **Soundings**:
  - Island and ship array
  - 3 hourly launches
- **Model:**
  - ERA interim datasets

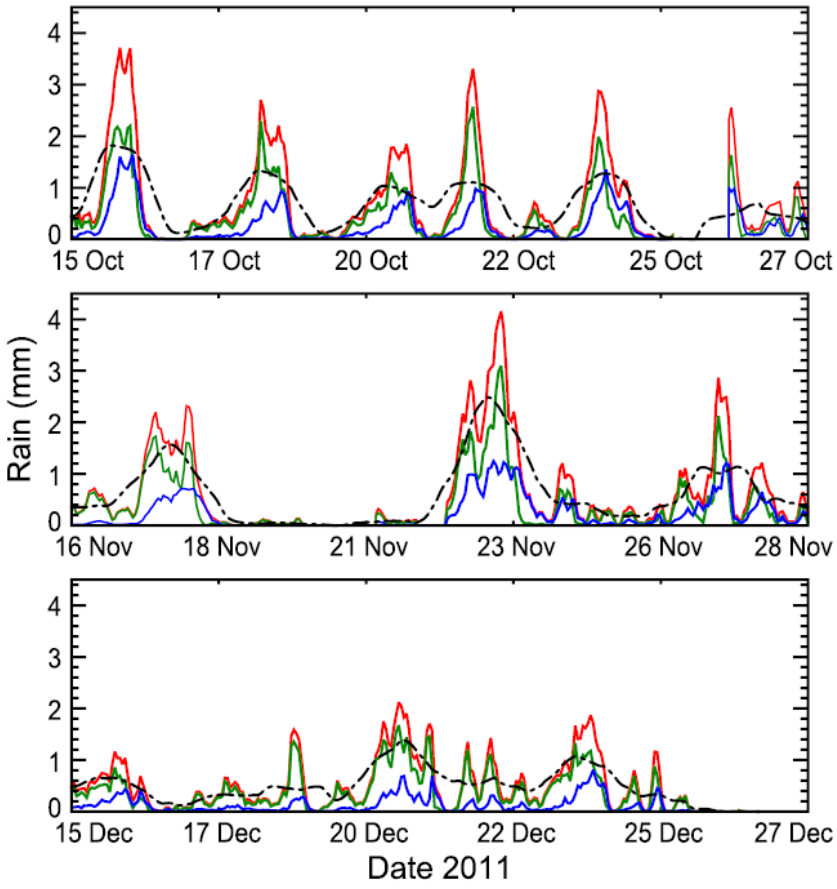


MJO during DYNAMO period

OLR anomaly



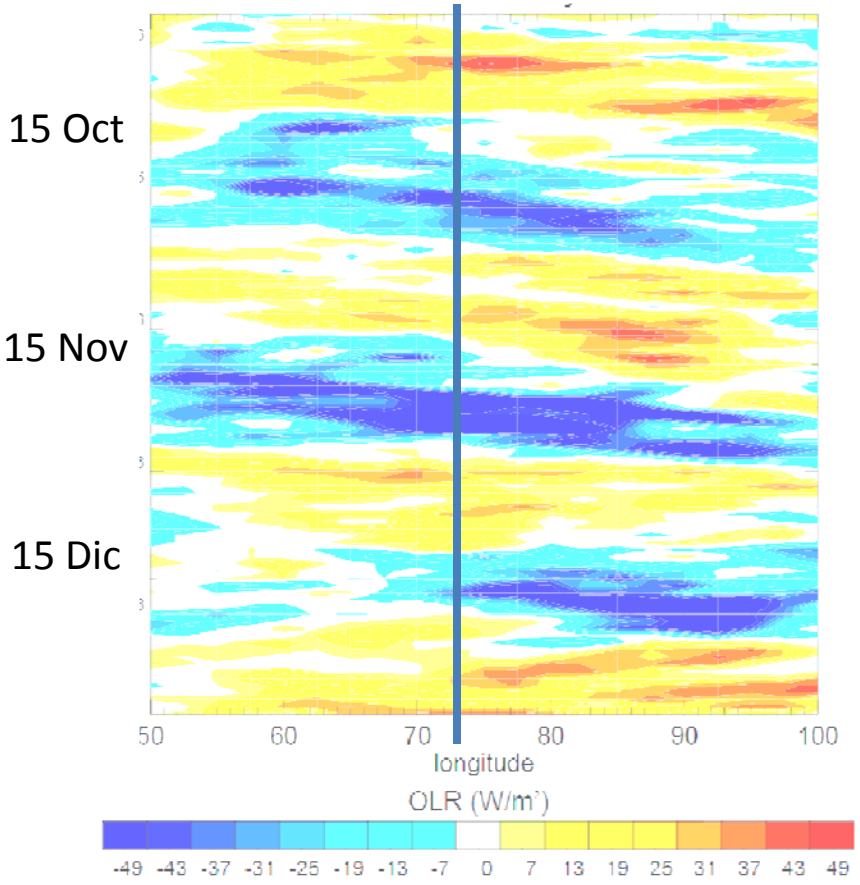
S-PolKa rain accumulation



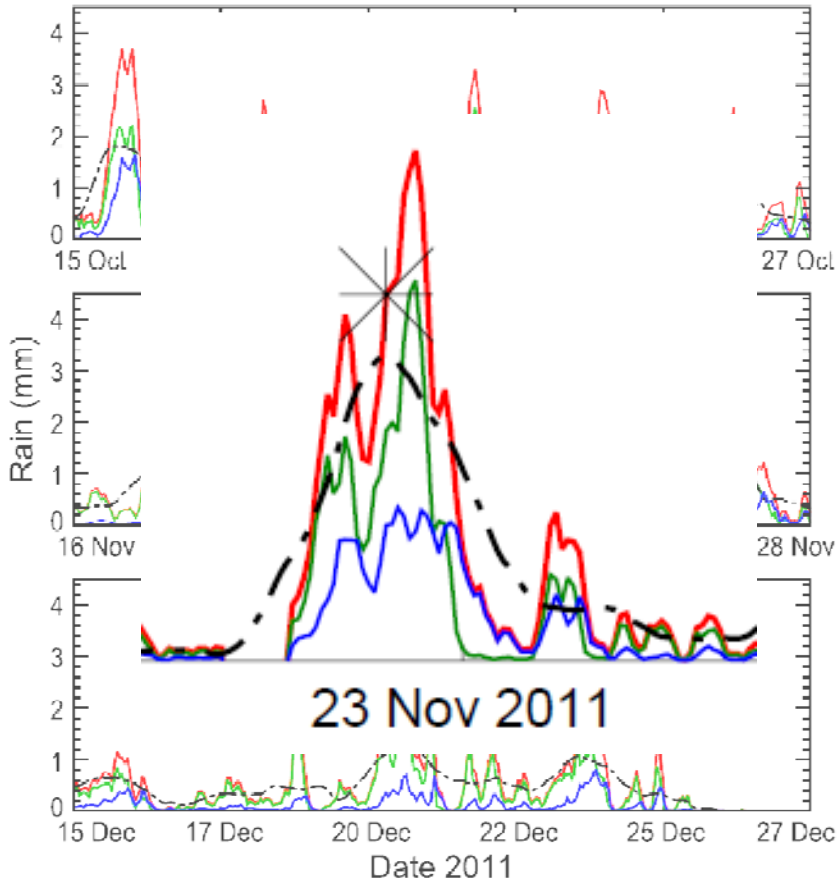
- Three main periods of enhanced precipitation occurred over the S-PolKa area

MJO during DYNAMO period

OLR anomaly

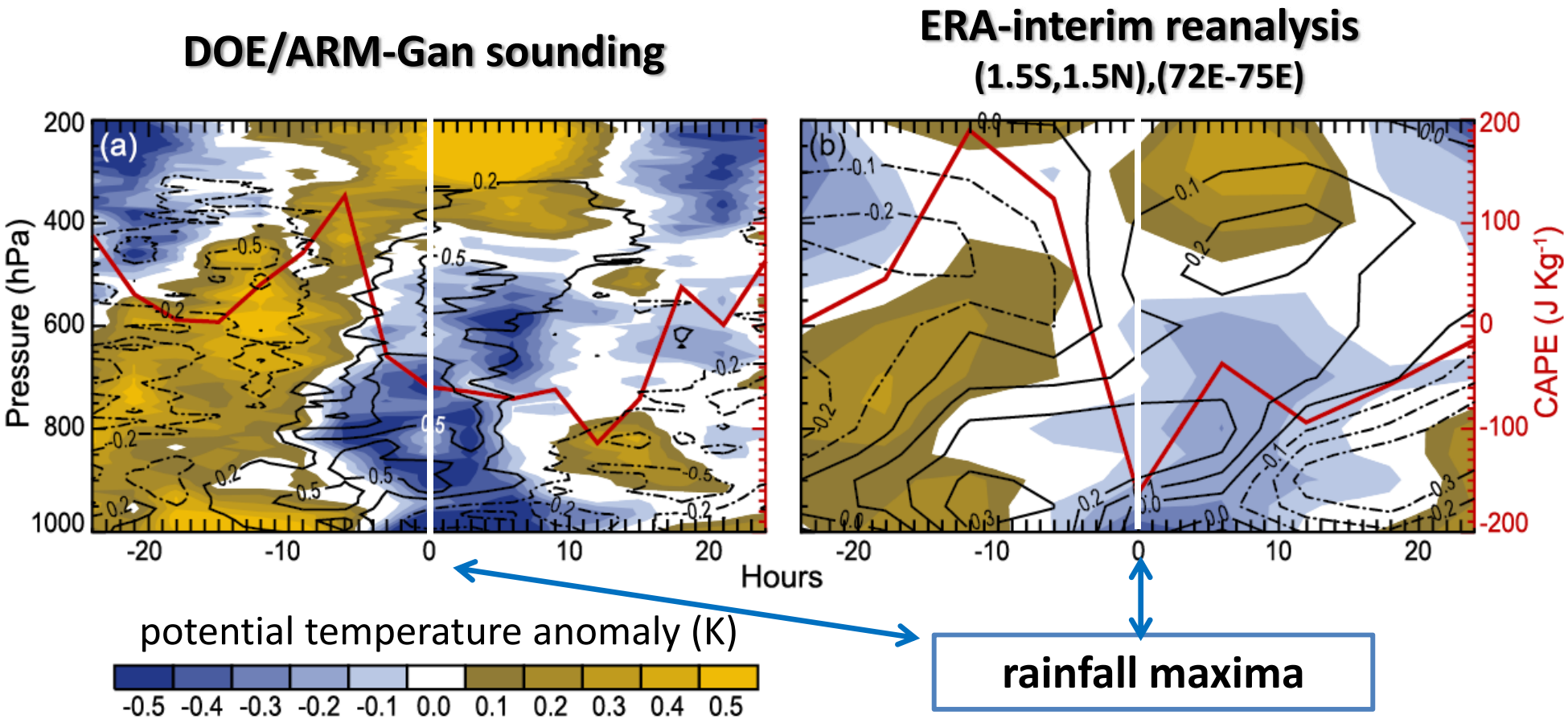


S-PolKa rain accumulation



Zero time for composites based on maximum value in 24 h running mean

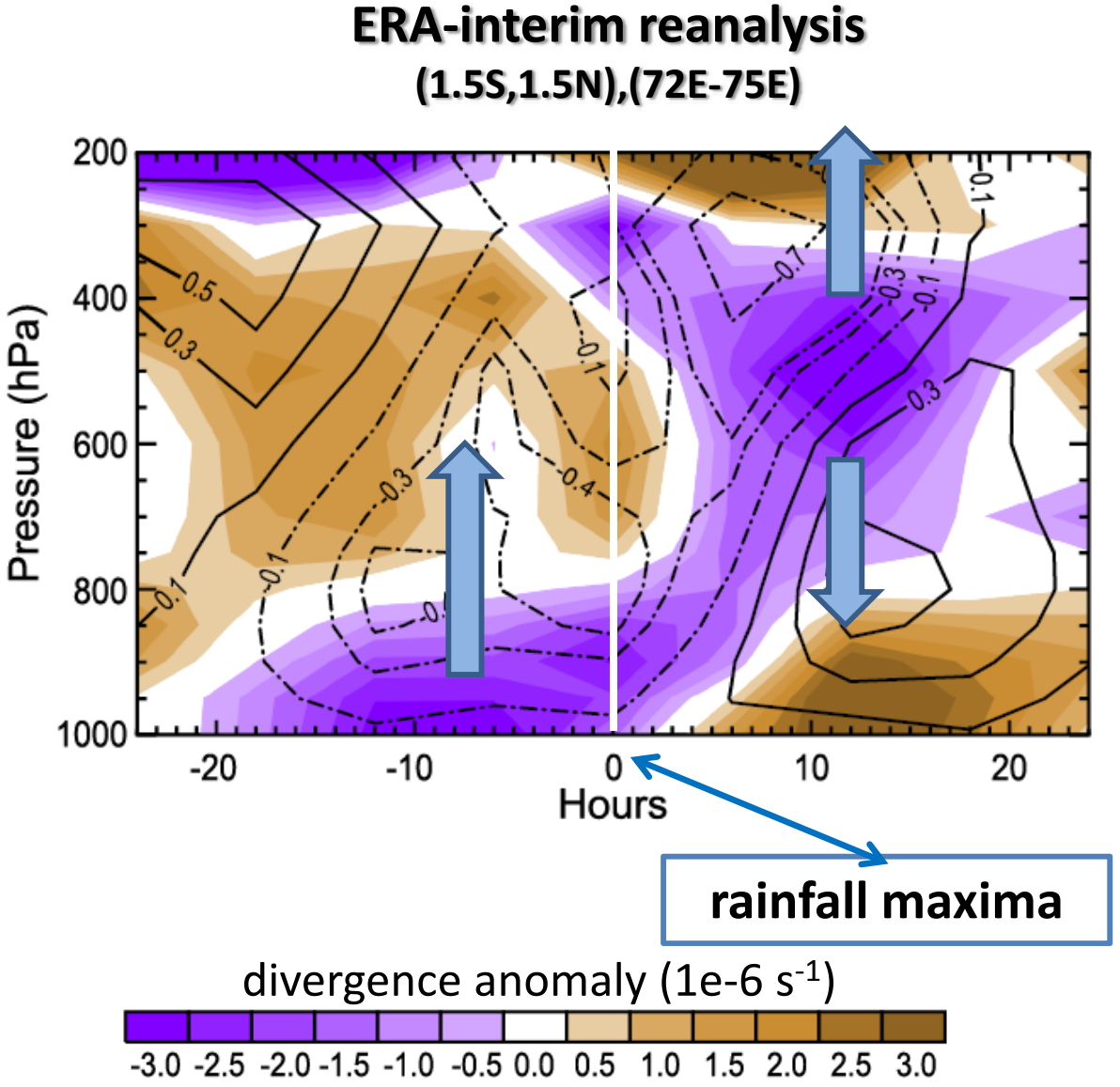
Composites of potential temperature, specific humidity and CAPE anomalies



- Atmospheric destabilization occurring before the maximum in rain accumulation.

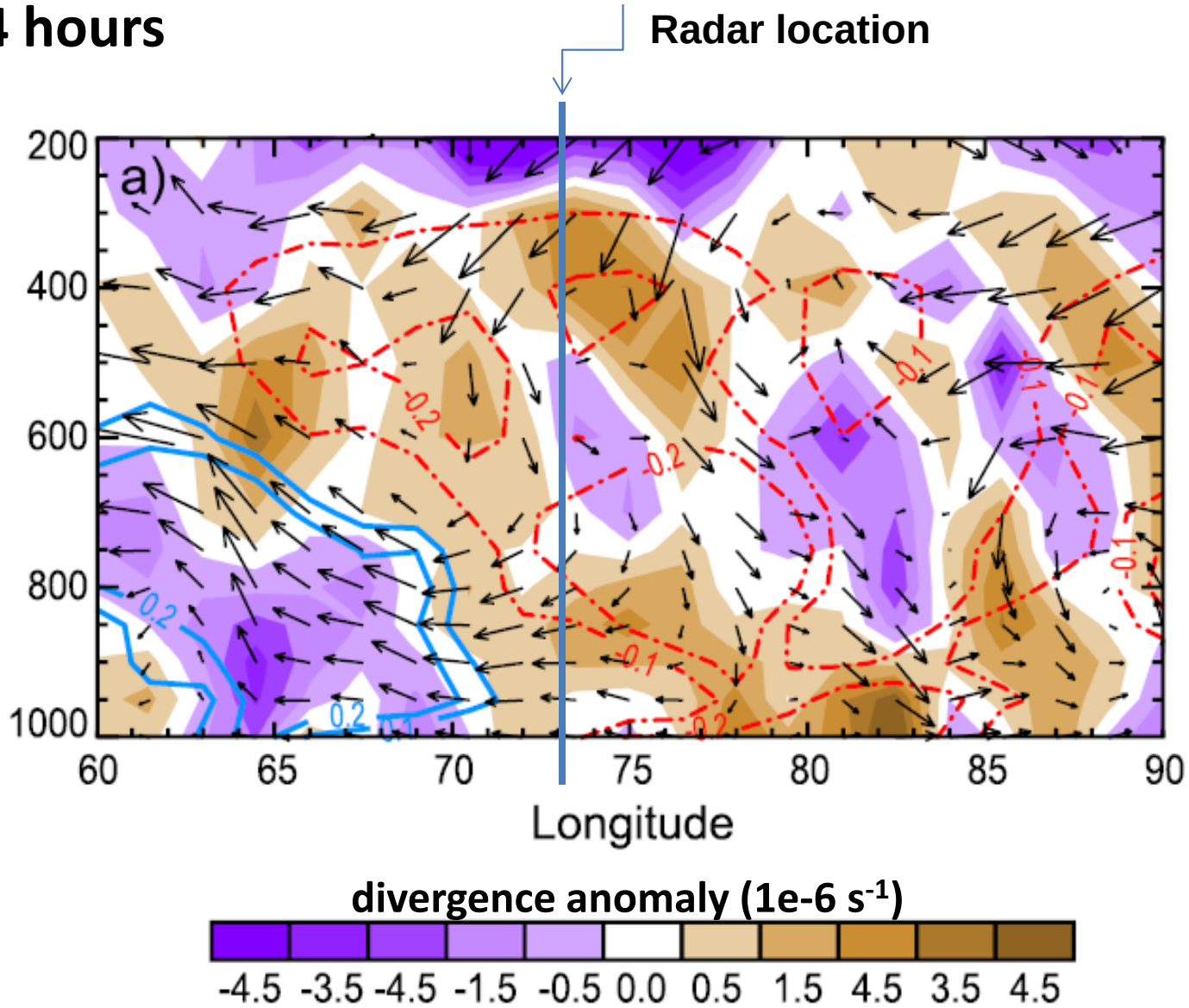
Composites of divergence and pressure velocity anomalies

- Lower-level convergence and middle-level divergence before maximum in rain
- As peak in rain advances, convergence tilts upward and a middle-level convergence sets



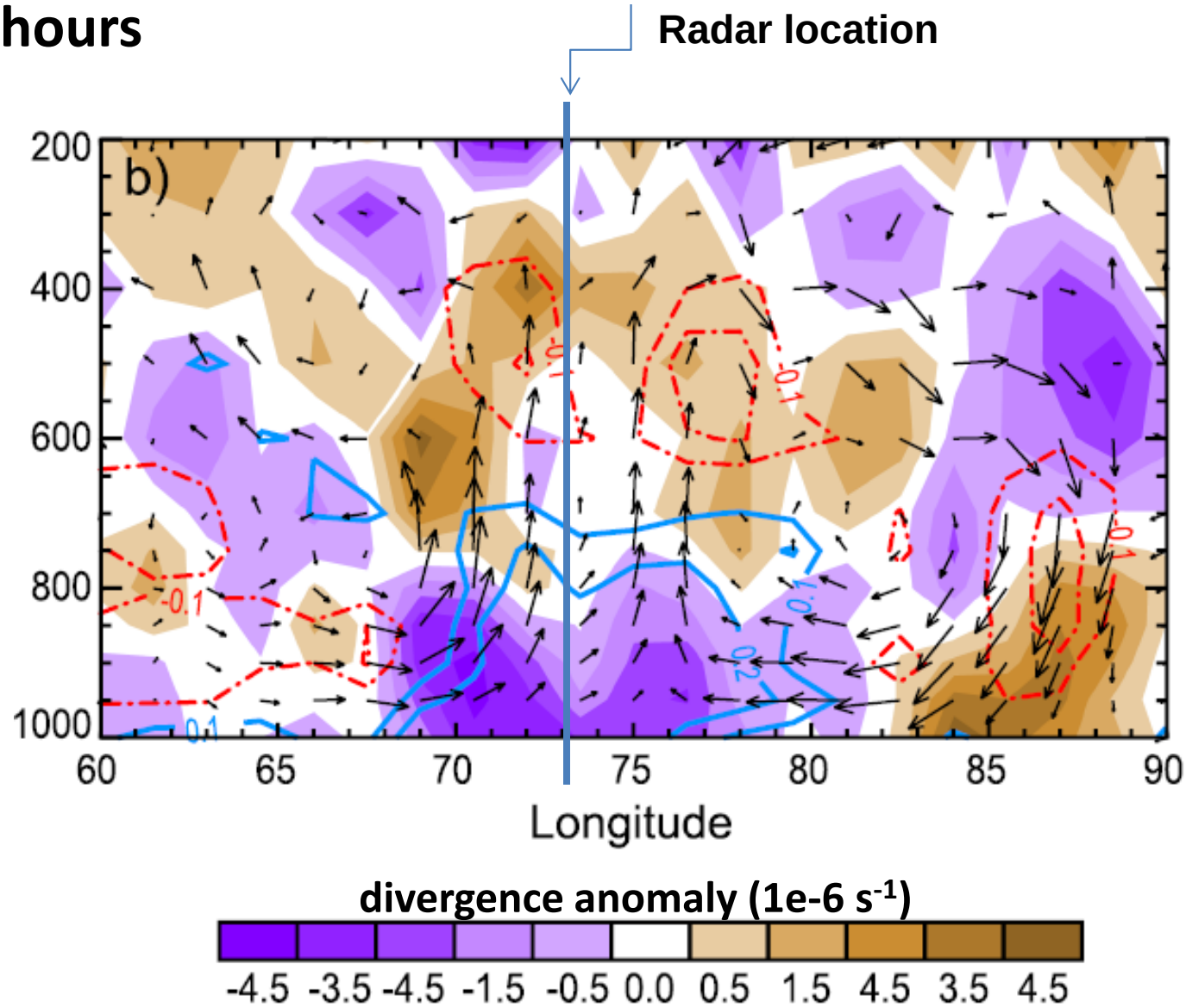
Longitudinal composites of divergence, humidity and zonal-vertical wind anomalies

- **-24 hours**



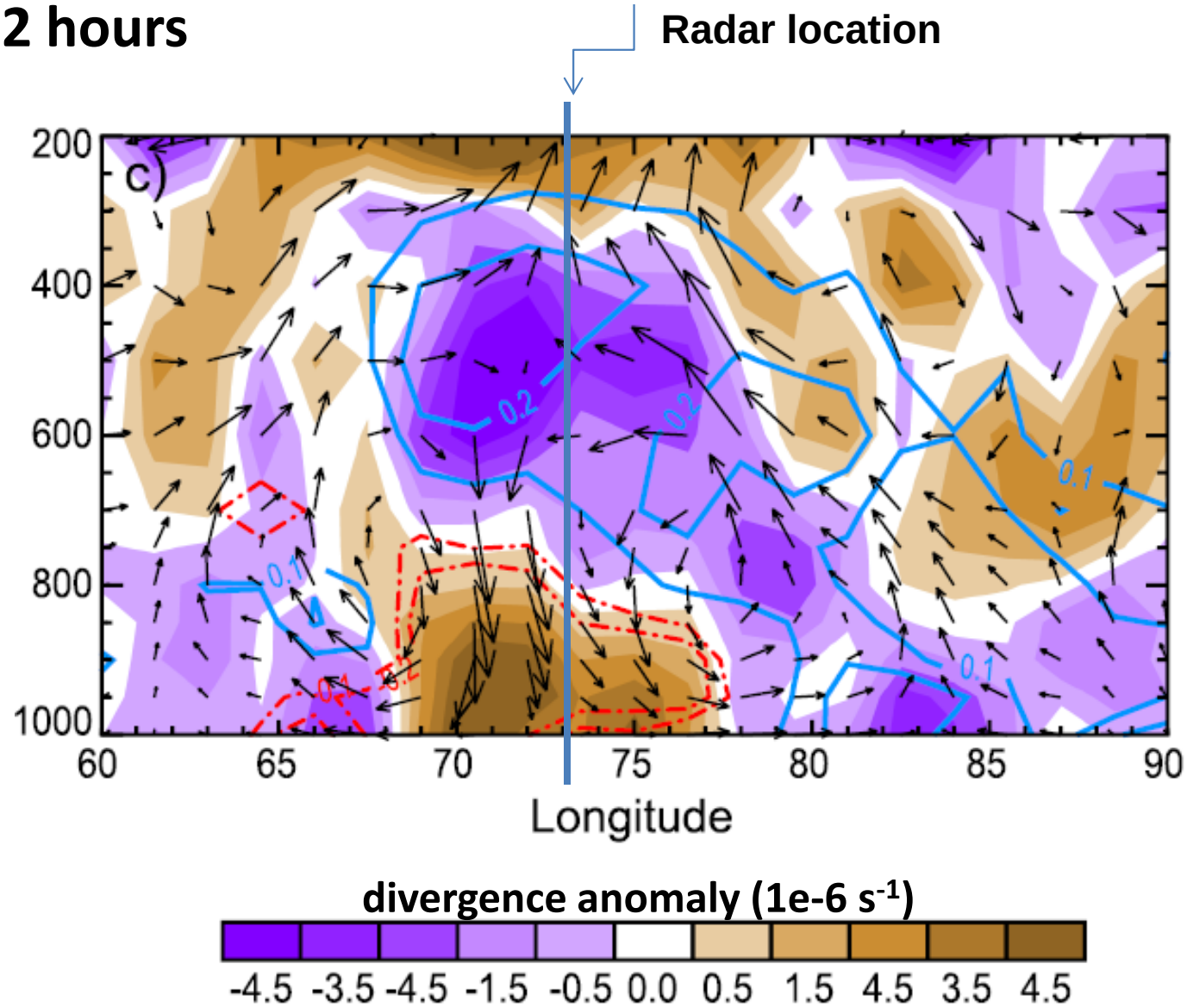
Longitudinal composites of divergence, humidity and zonal-vertical wind anomalies

- **-6 hours**

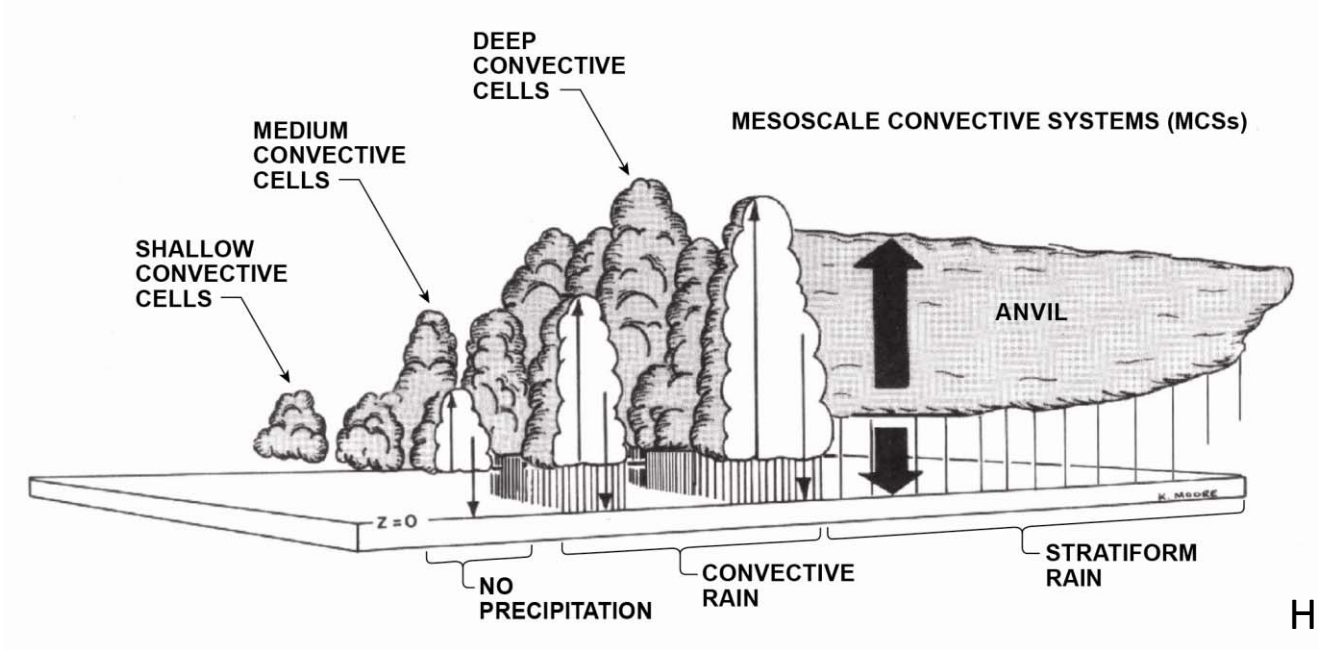


Longitudinal composites of divergence, humidity and zonal-vertical wind anomalies

- **+12 hours**

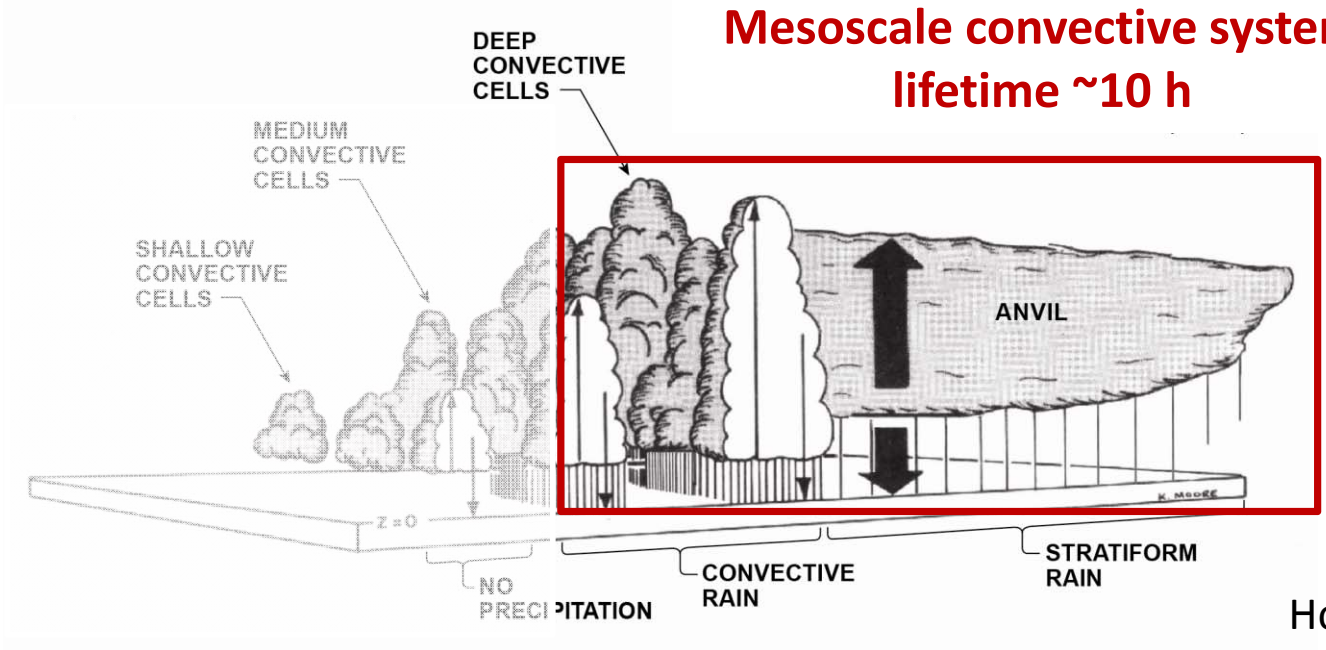


Idealized convective cloud population



Houze et al. 1980

Idealized convective cloud population



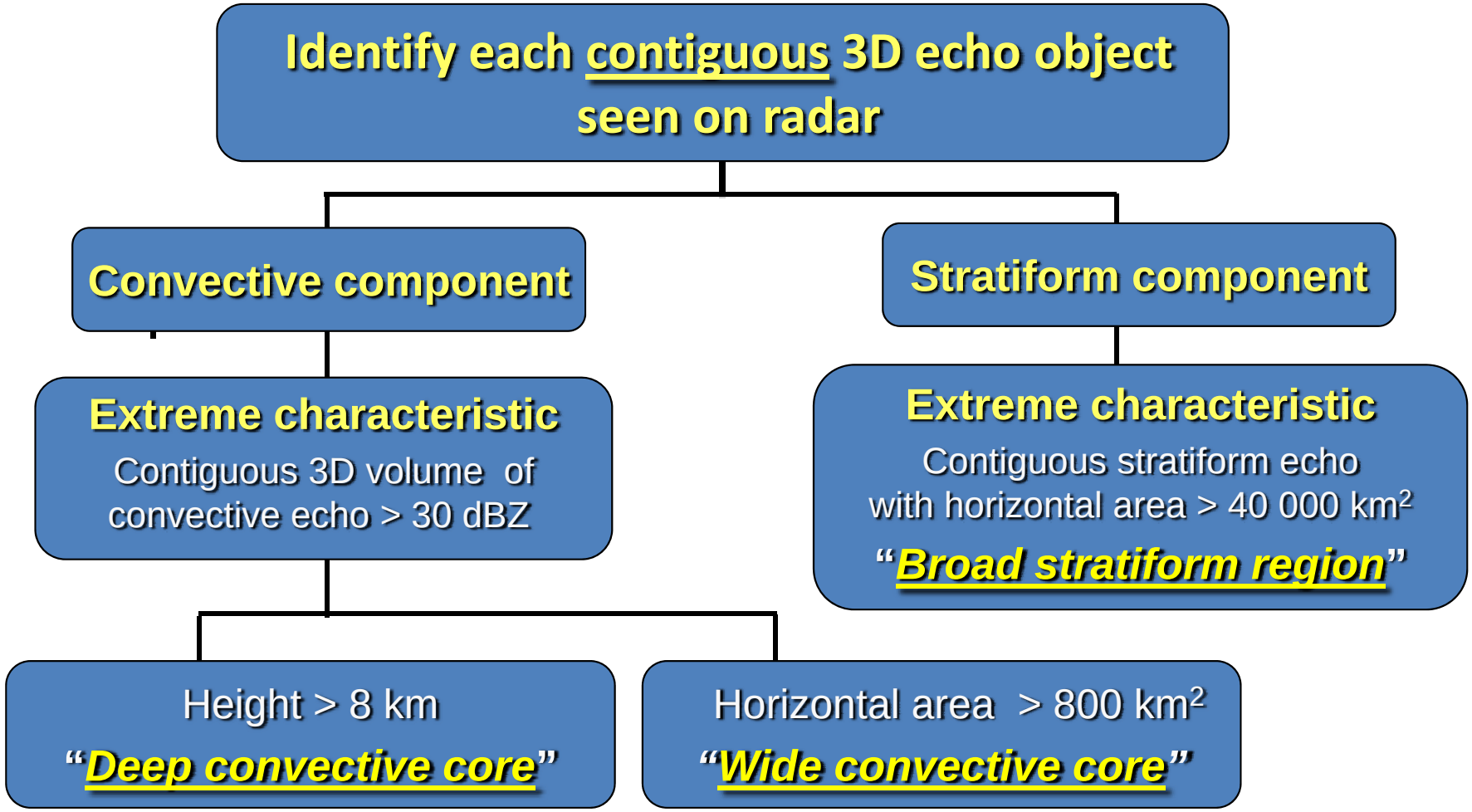
Mesoscale convective system lifetime ~10 h

Houze et al. 1980

- Three important types of radar echo
  - **Deep intense convective cores** -> early stages of development
  - **Wide intense convective cores** -> middle stages of development
  - **Broad stratiform regions** -> late stages of development

Houze et al. 2007; Romatschke and Houze 2010

Objective identification of echo features



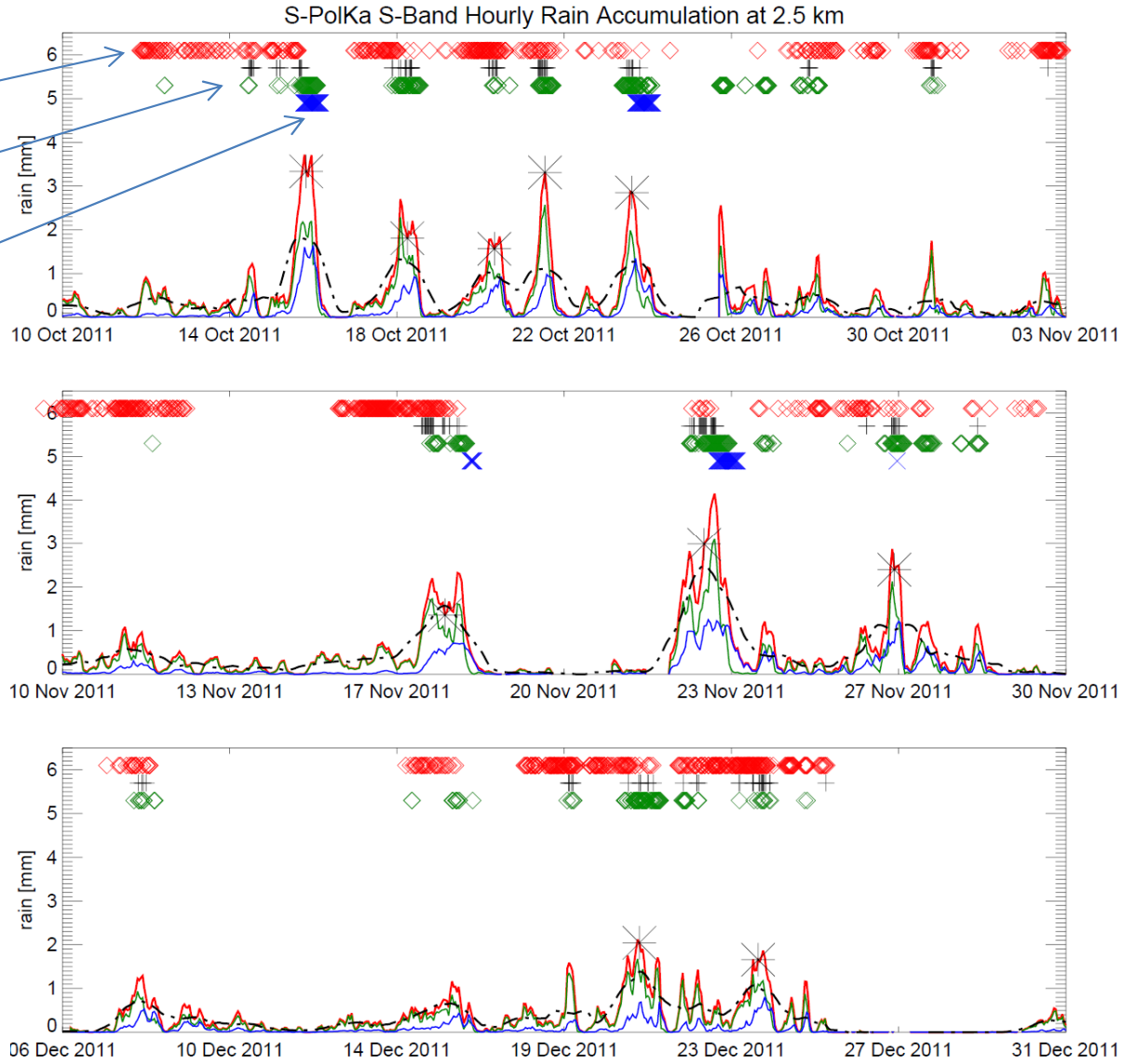
Houze et al. 2007; Romatschke et al. 2010, Romatschke and Houze 2011; Barnes and Houze 2012

Time series of echo occurrence and accumulated precipitation

Deep convective

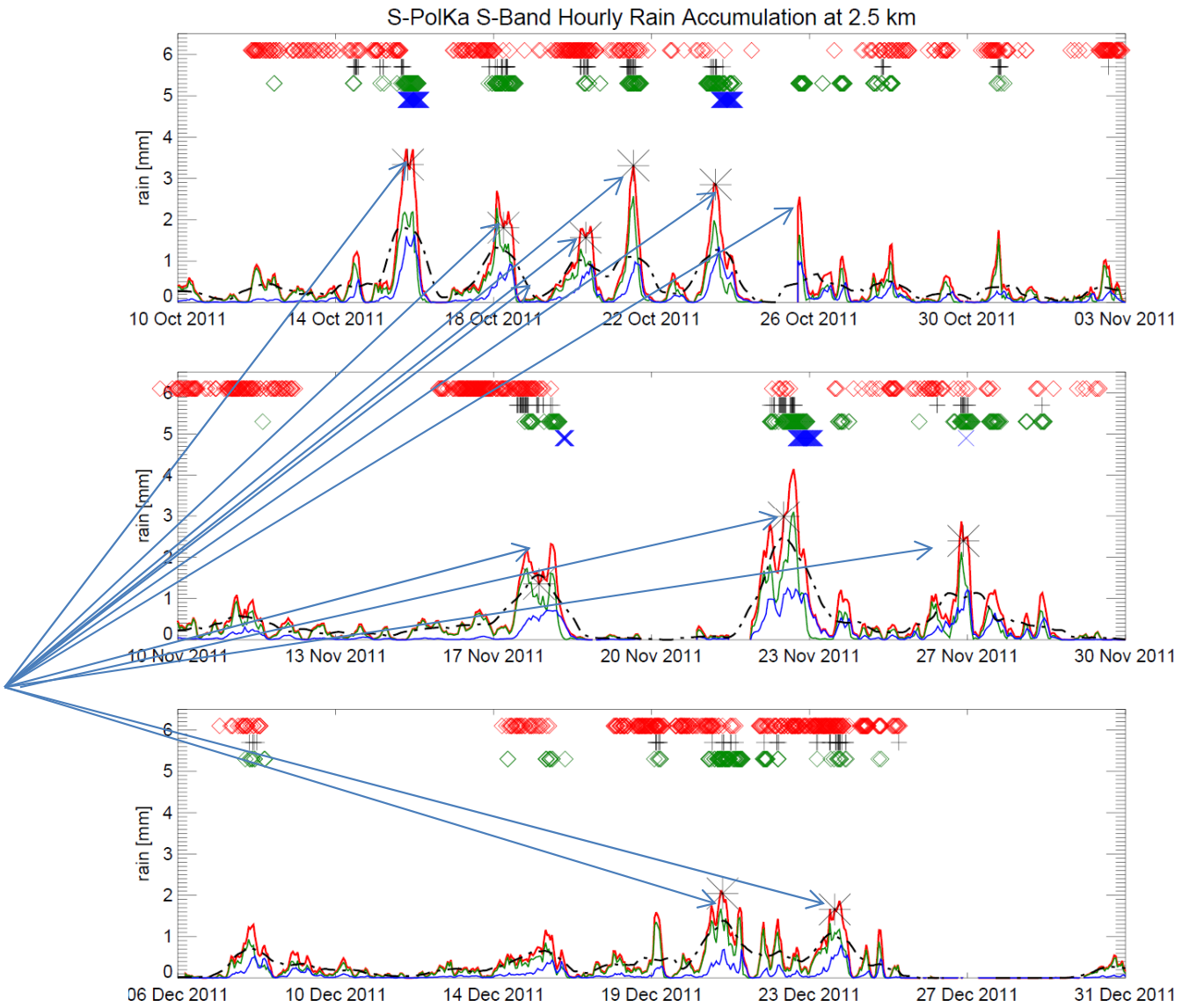
Wide convective

Broad stratiform

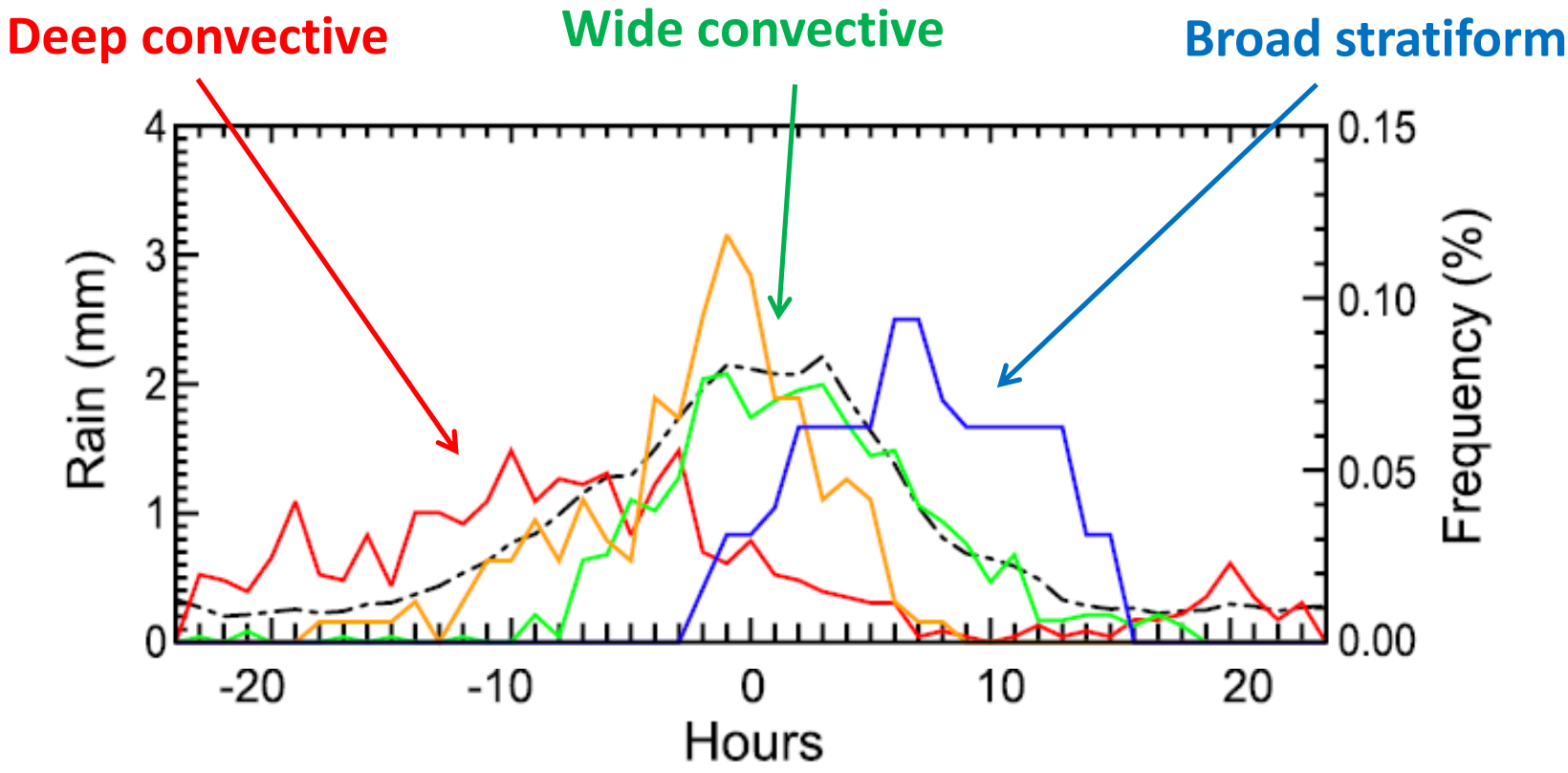


Selection of the time of rainfall maximum

- 11 rainiest events within 24 hours duration



Composites relative to rainfall maximum



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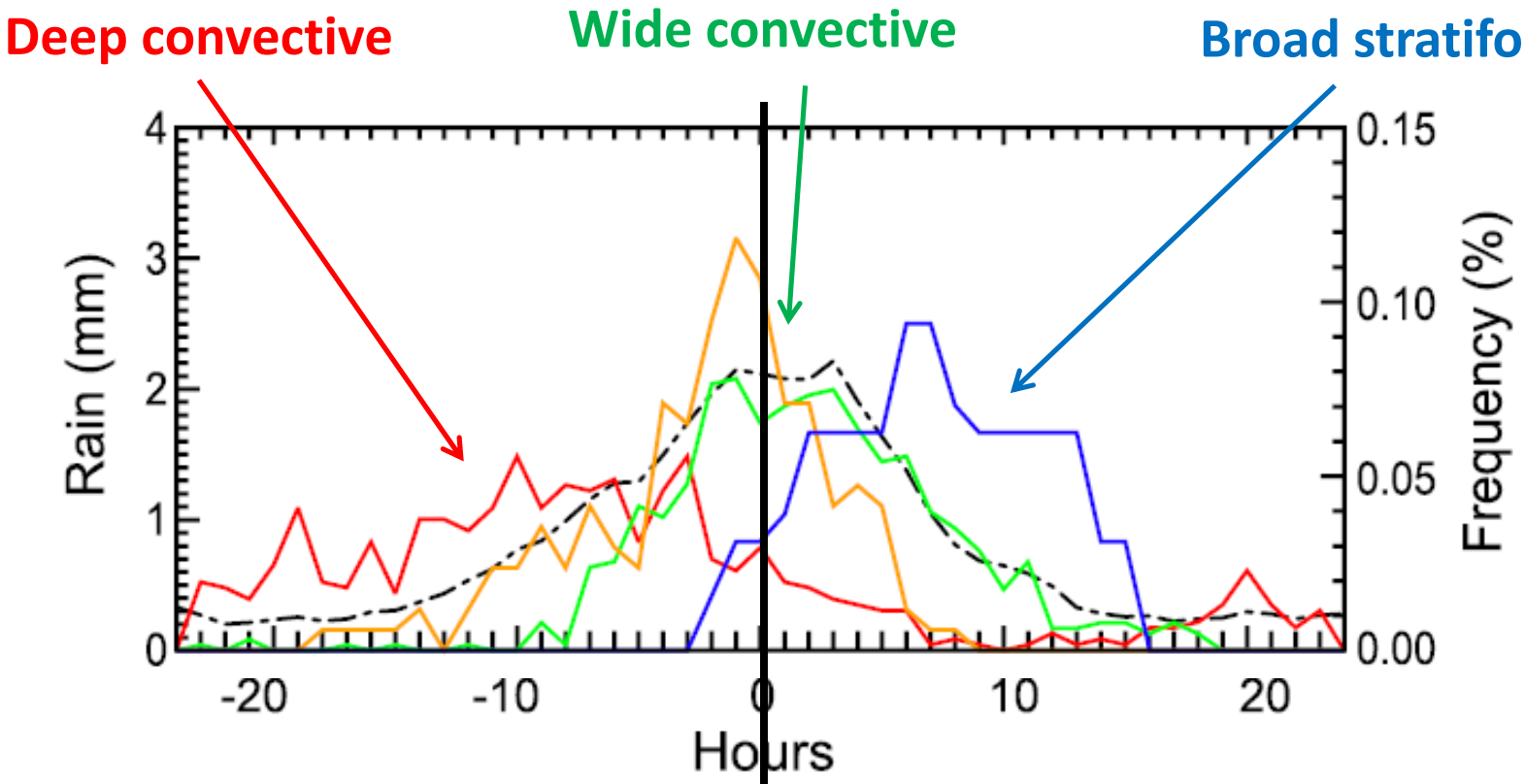

- Unstable atmosphere
- CAPE maximizes
- Low-level convergence
- Upward motion

- Atmosphere stabilizes
- CAPE minimizes
- Low-level divergence and middle-level convergence

Conclusions

- Rainfall during the active phases of MJO was concentrated in episodes of approximately 2-day duration

- The 2-day episodes showed analogous states to the lifecycle stages of an individual MCS:
  - Unstable conditions and deep upward motion in early part of rainfall episodes
  - Stable conditions with upward motion aloft and downward motion below during declining in rain accumulation

Conclusions

- The 2-day rain episodes had maximum frequency of:
  - **Deep Convective cores** before the maxima in rain accumulation
  - **Wide convective cores** around the same time of the maxima in rain accumulation
  - **Broad stratiform regions** after the maxima in rain accumulation

- This behavior is consistent with the changing large-scale conditions that take on the aspect of a “stretched” analog (Mapes et al. 2006) to the typical MCS lifecycle