Agenda

- Courtney Schumacher (observational overview)
- Dick Johnson (DYNAMO)
- Andrea Neumann (MC3E)
- Feng Zhe (mid-latitude life cycles)
- Leo Donner (modeling update)

Mesoscale organization from an observational perspective

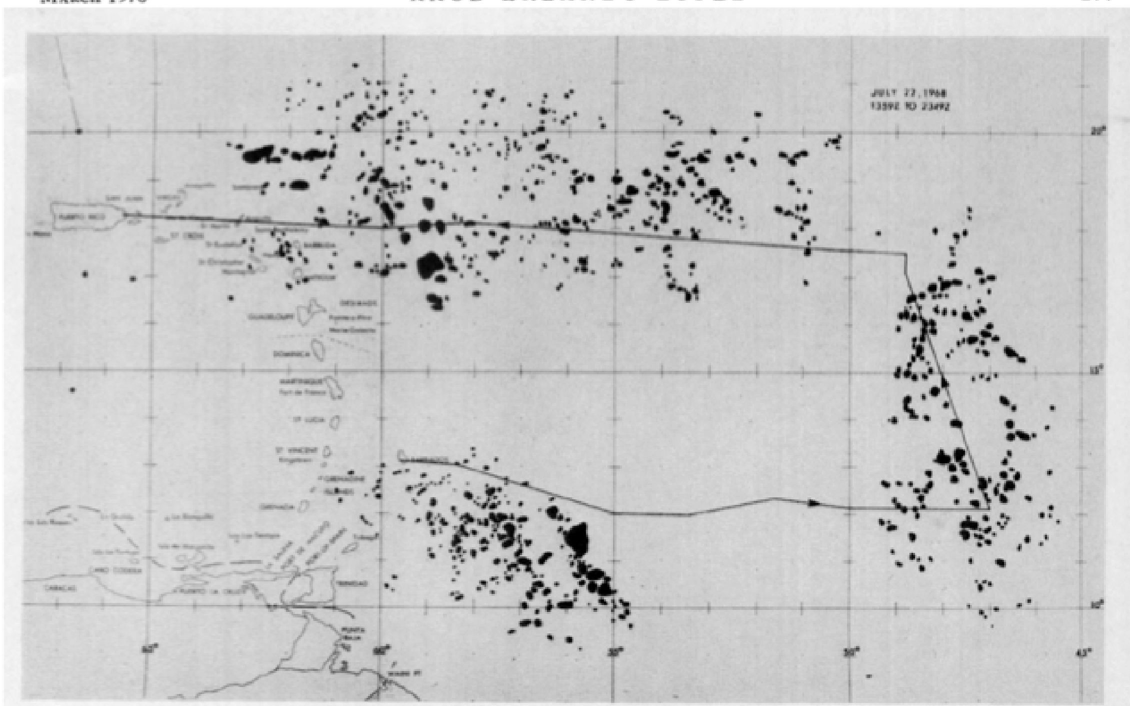
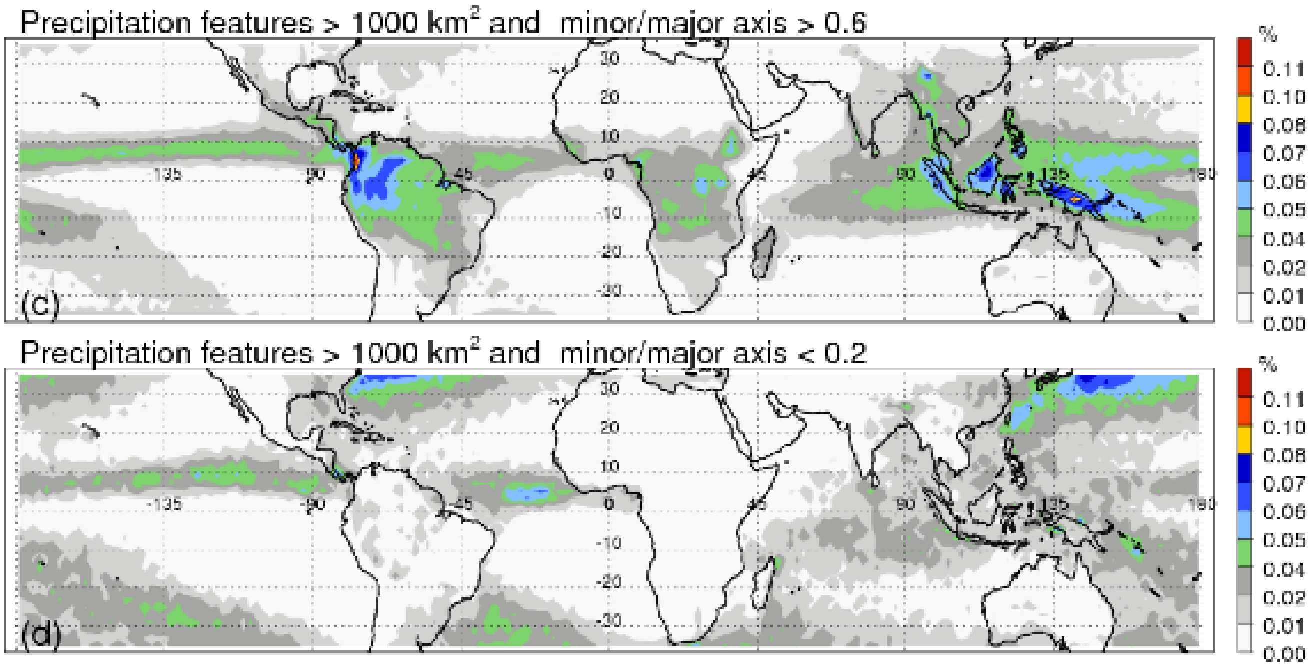


FIG. 14. Composite radar map for 22 July 1968. C-scale echoes predominate.

Courtney Schumacher
Texas A&M University

Definitions of organization

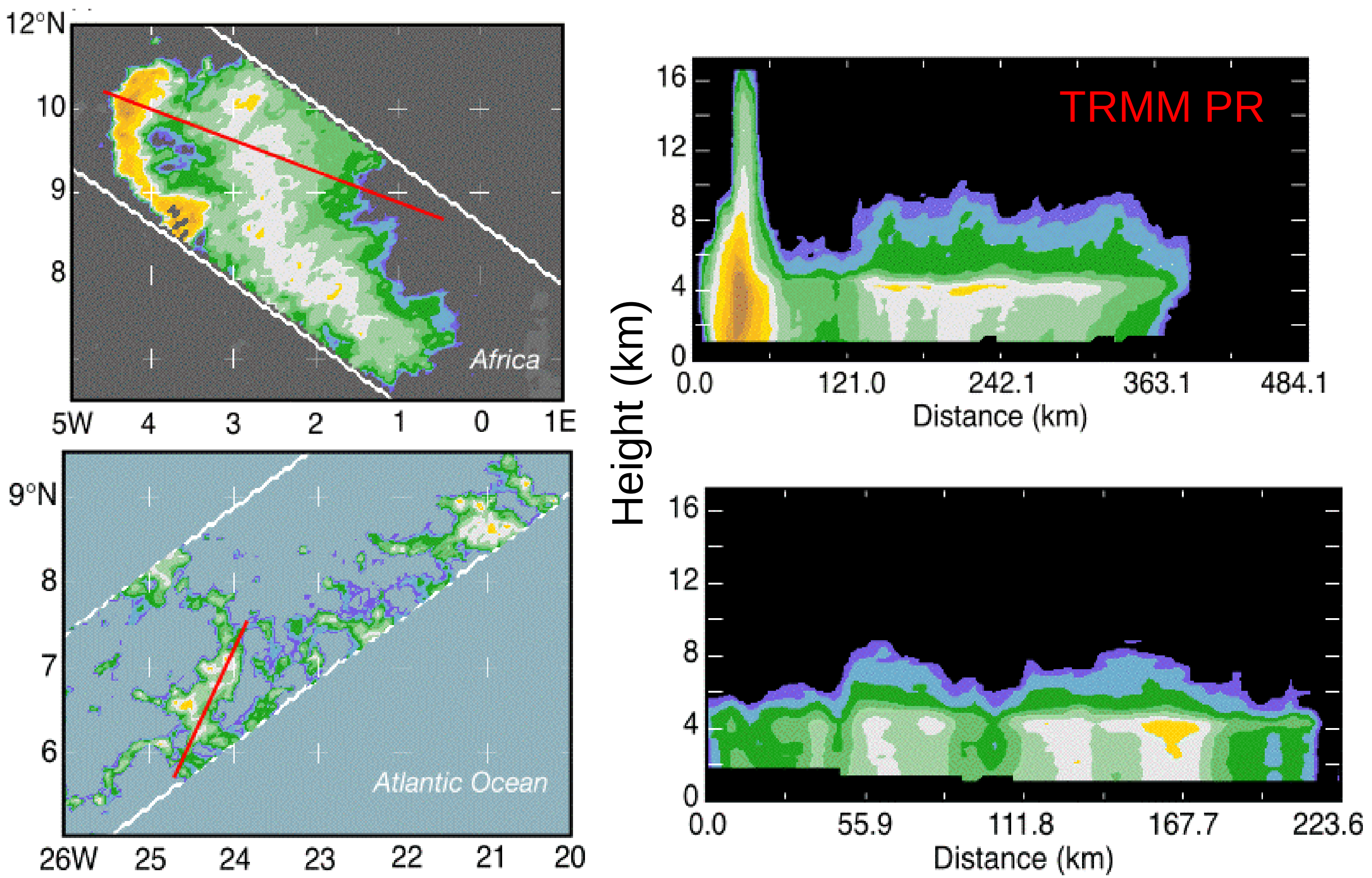
- Size (> 100 km in horizontal extent, Houze 1994)
- Shape (linear)
- Lifetime (> 6 hours)
- Existence of a mesoscale updraft or bright band



Liu and Zipser (2013)

Targets

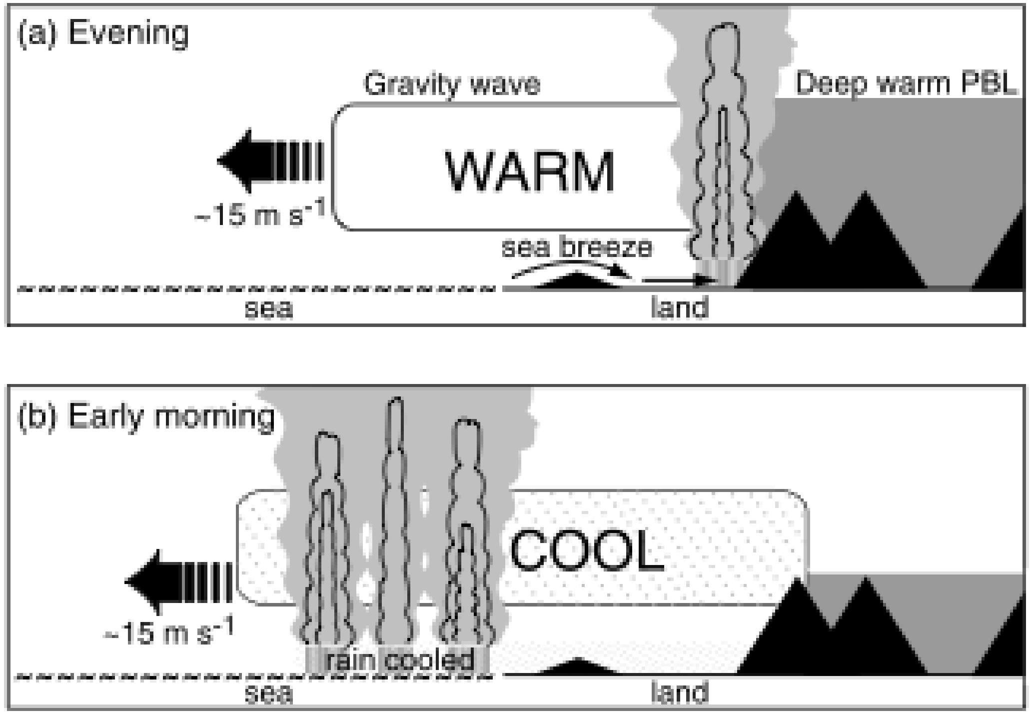
- MCSs (classic LL-TS, messy oceanic systems)



Schumacher and Houze (2006)

Targets

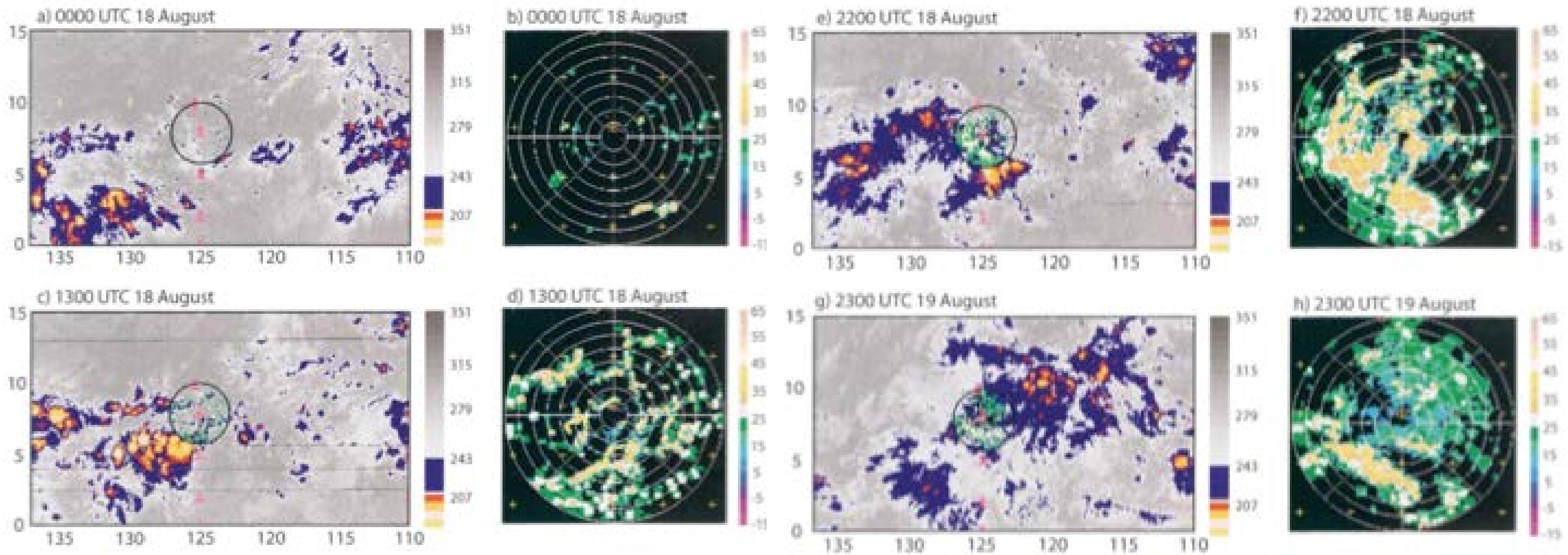
- MCSs (classic LL-TS, messy oceanic systems)
- Diurnally forced systems (nocturnal jets near topography, coastal, radiatively driven)



Mapes et al. (2003)

Targets

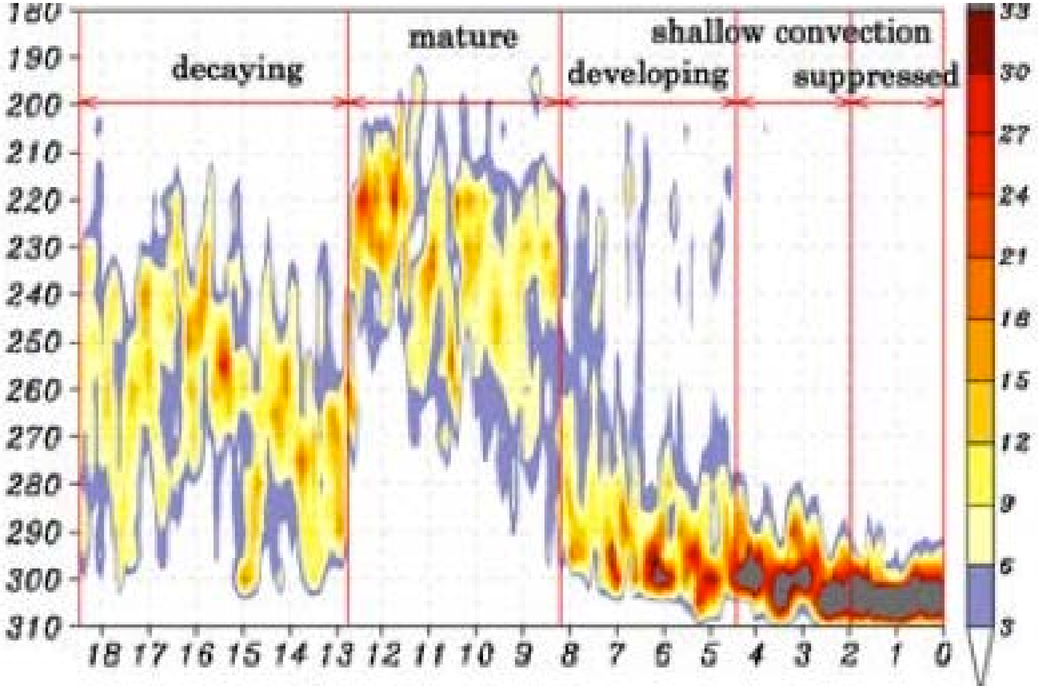
- MCSs (classic LL-TS, messy oceanic systems)
- Diurnally forced systems (nocturnal jets near topography, coastal, radiatively driven)
- Convectively coupled waves (2-day, Kelvin, etc.)



Straub and Kiladis (2002)

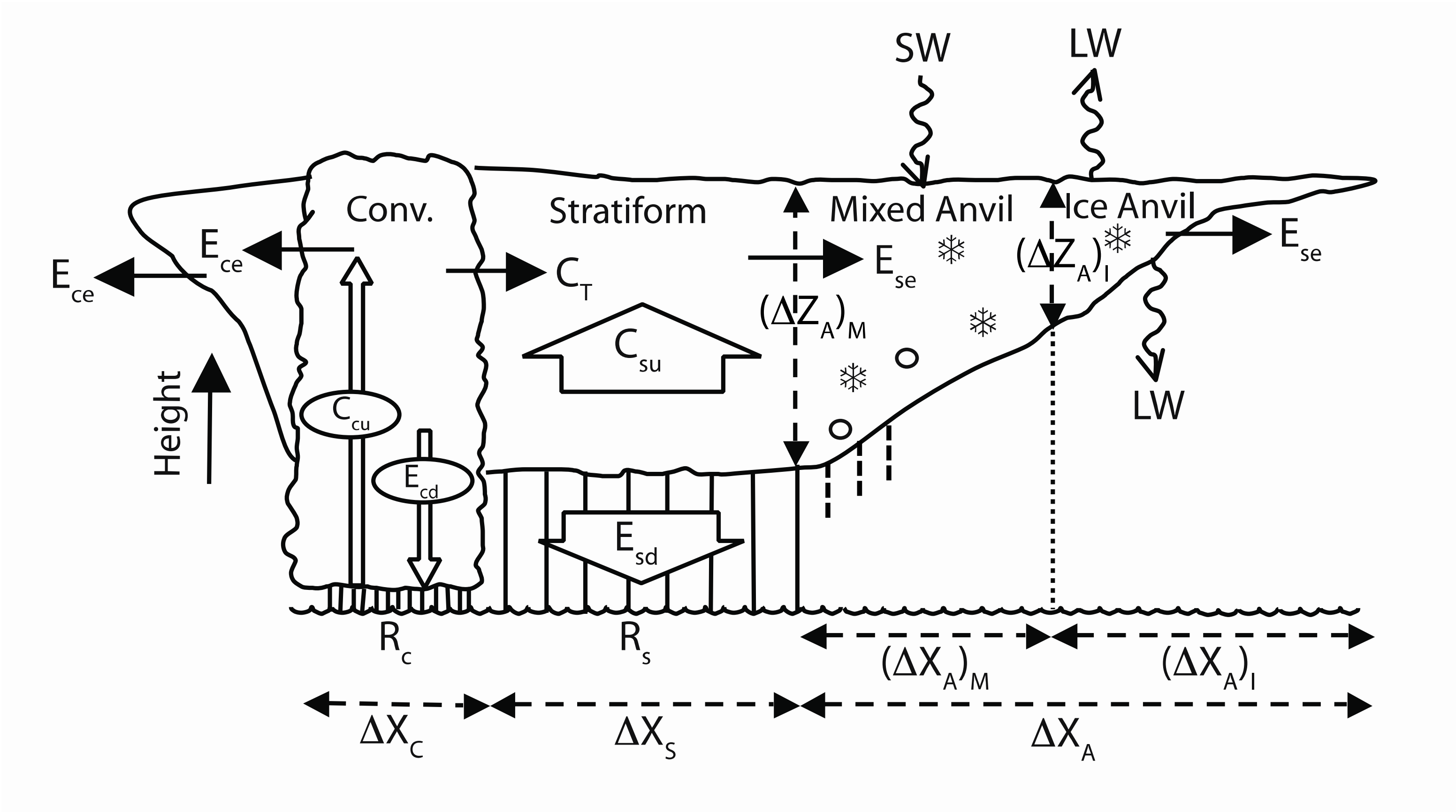
Targets

- MCSs (classic LL-TS, messy oceanic systems)
- Diurnally forced systems (nocturnal jets near topography, coastal, radiatively driven)
- Convectively coupled waves (2-day, Kelvin, etc.)
- MJO



Kikuchi and Takayabu (2004)

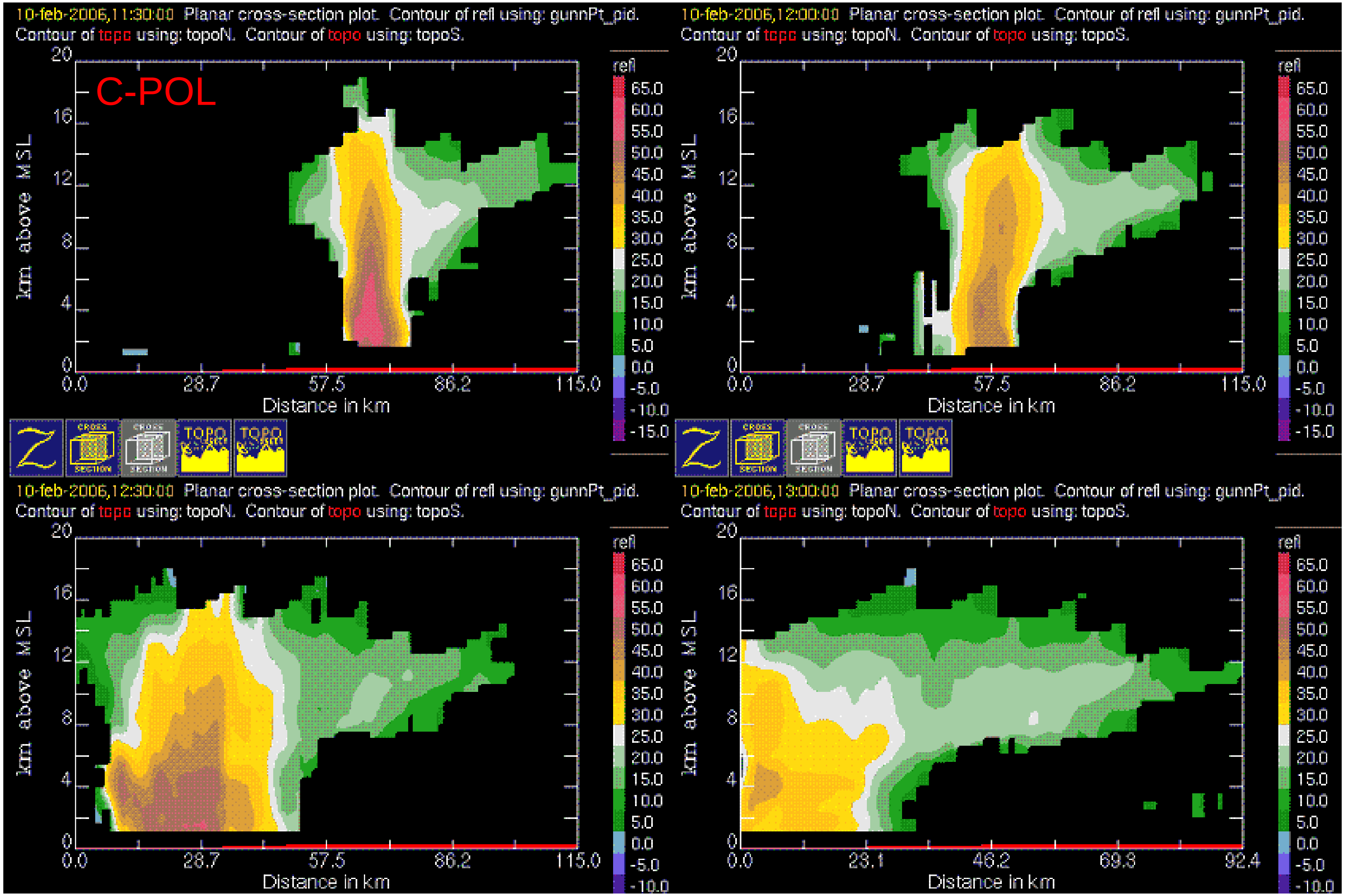
Some processes to consider…



Latent heating dominates in the precipitating regions while radiation dominates in the non-precipitating anvil.

Leary and Houze (1980), Frederick and Schumacher (2008)

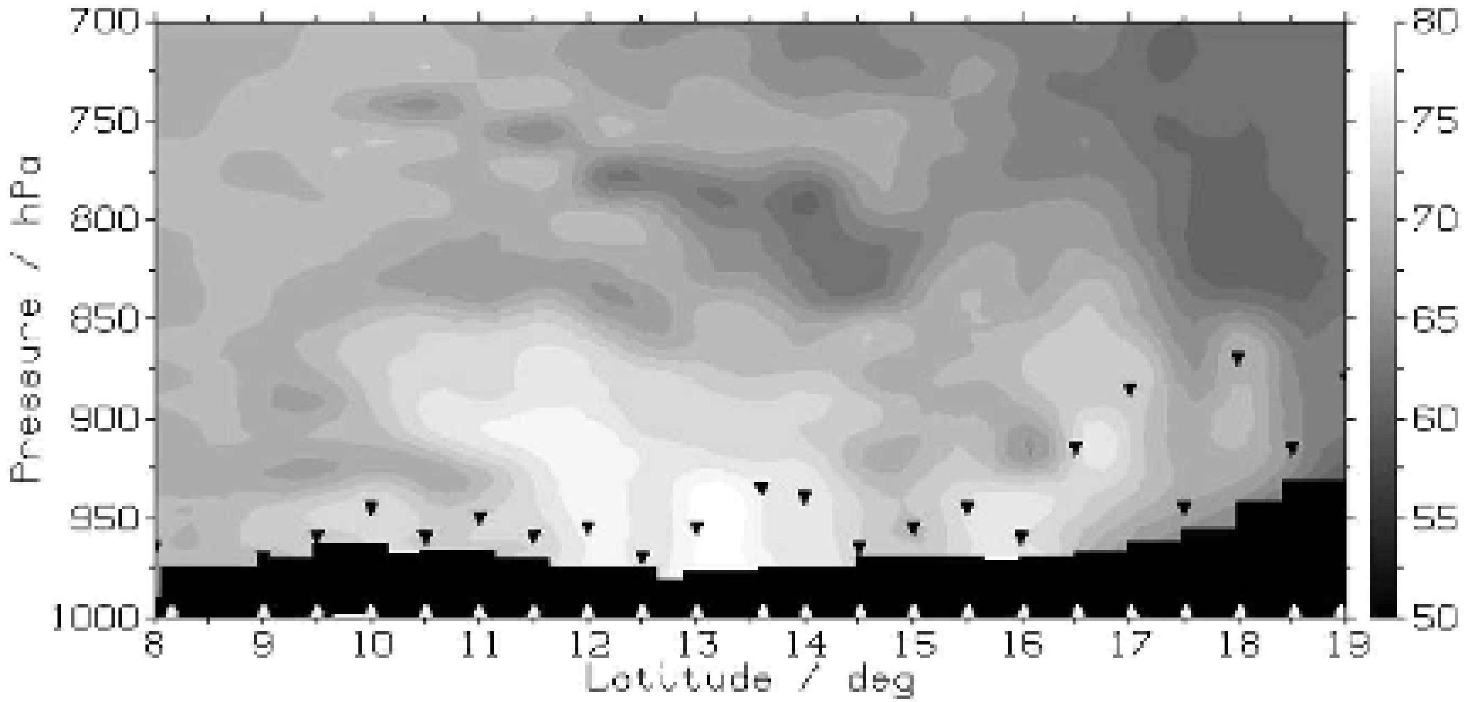
Don't forget the evolution…



Frederick and Schumacher (2008)

How does convection organize?

- Warm, moist boundary layer

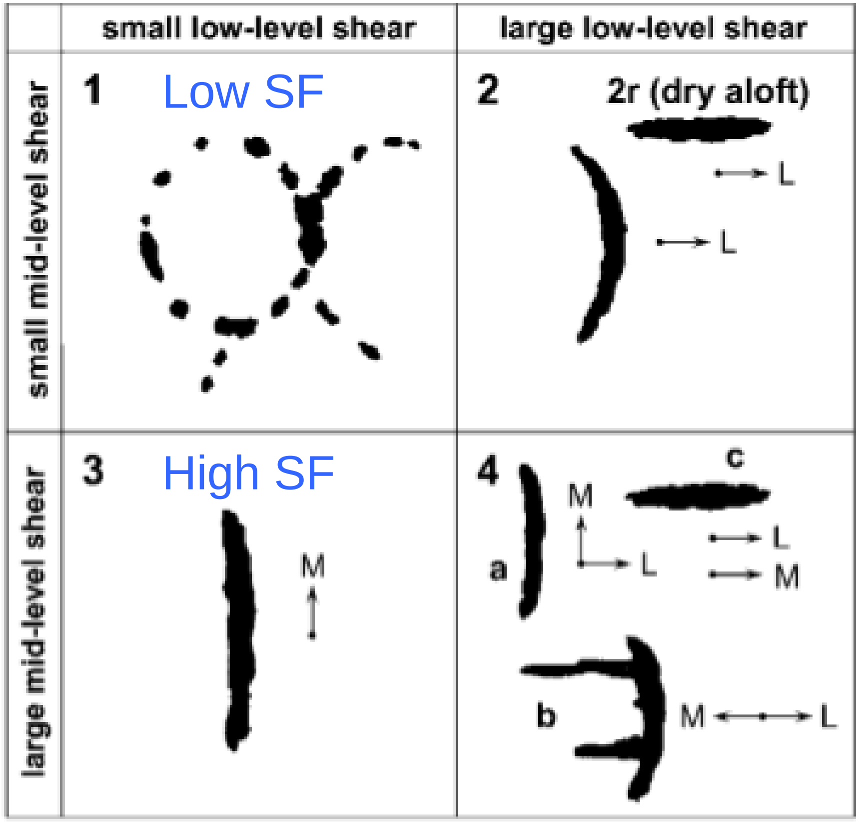


Equivalent potential temperature profiles from dropsondes over the African Sahel show significant PBL variability.

Taylor et al. (2003)

How does convection organize?

- Warm, moist boundary layer
- Low-level/mid-level shear



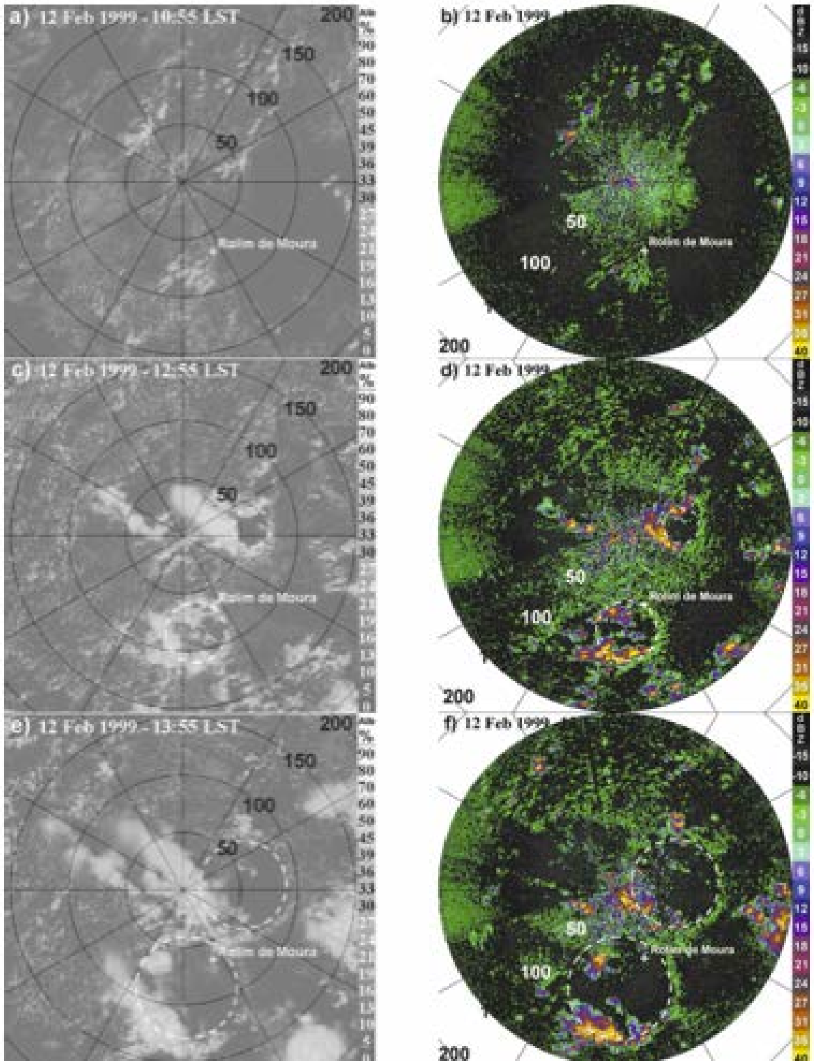
Variations in low (1000-800 hPa) and mid (800-400 hPa) level shear cause convective structures with different orientations and stratiform rain fractions (based on TOGA COARE and SCSMEX data).

Lemone et al. (1998), Johnson et al. (2005)

How does convection organize?

- Warm, moist boundary layer
- Low-level/mid-level shear
- Downdrafts/cold pools

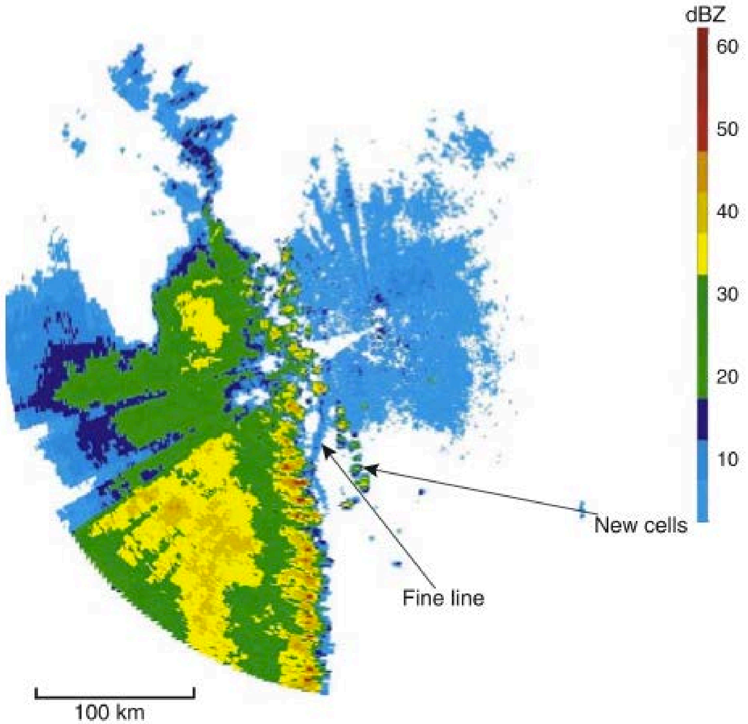
Gust fronts (including colliding gust fronts) caused more than half of the storm cell initiations on a weakly forced day during TRMM-LBA.



Lima and Wilson (2008)

How does convection organize?

- Warm, moist boundary layer
- Low-level/mid-level shear
- Downdrafts/cold pools
- Synoptic and mesoscale boundaries

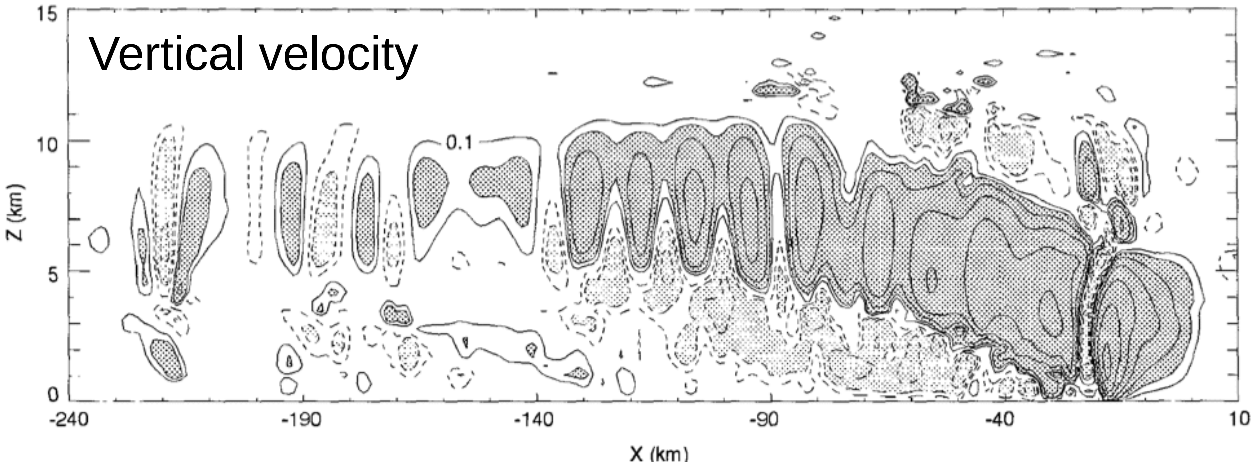


Fronts and discrete propagation provide additional boundaries for convective cells to form upon.

Houze (2004)

How does convection organize?

- Warm, moist boundary layer
- Low-level/mid-level shear
- Downdrafts/cold pools
- Synoptic and mesoscale boundaries
- Gravity waves



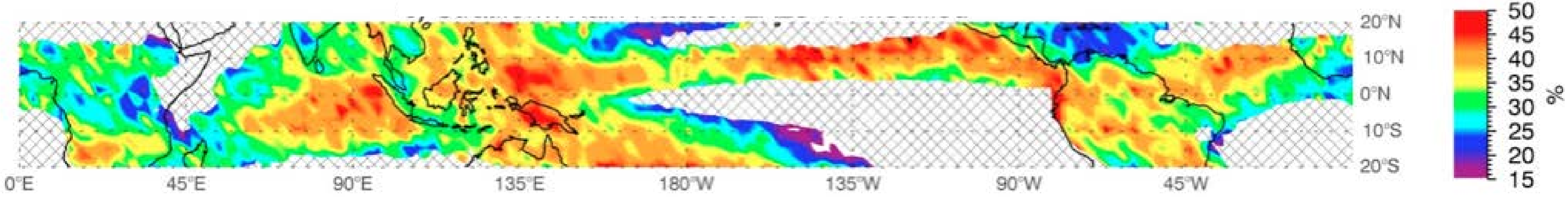
Thermal forcing in convective region creates realistic mesoscale circulation and anvil region in non-linear, dry numerical simulations.

Pandya and Durran (1996)

How do stratiform rain and anvil regions persist?

- Convective sustainability

Stratiform rain fraction V7

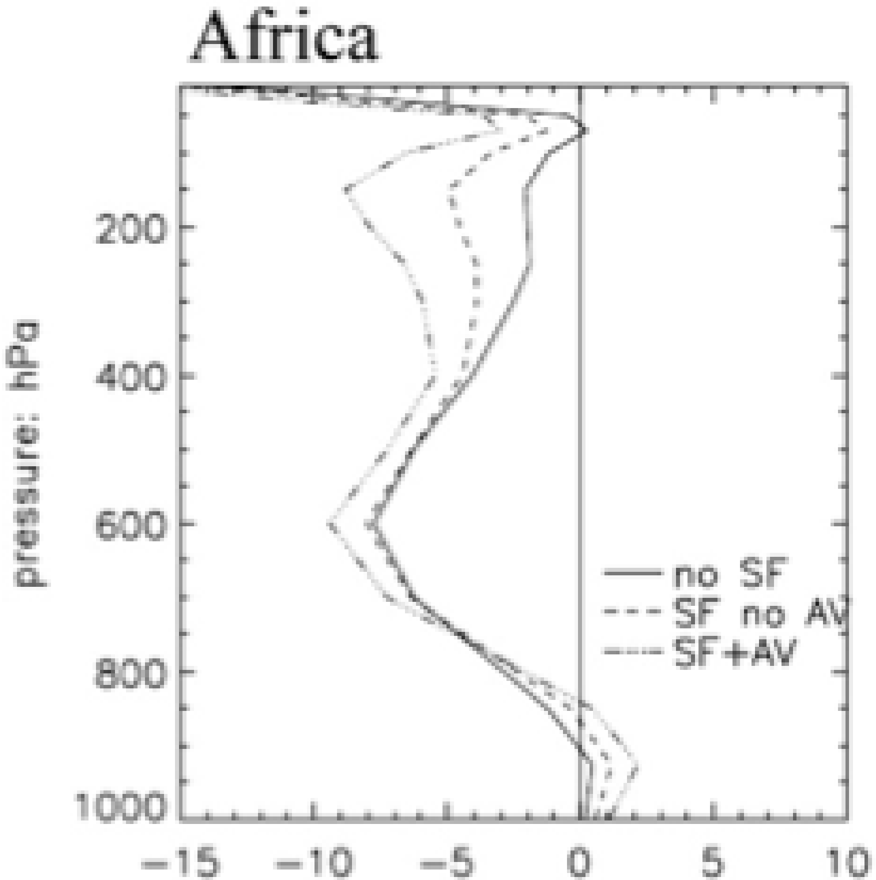


Regions with a warm, moist boundary layer may be more likely to sustain convection throughout the diurnal cycle.

Schumacher and Houze (2003), Funk et al. (2013)

How do stratiform rain and anvil regions persist?

- Convective sustainability
- Upper level shear/hydrometeor advection



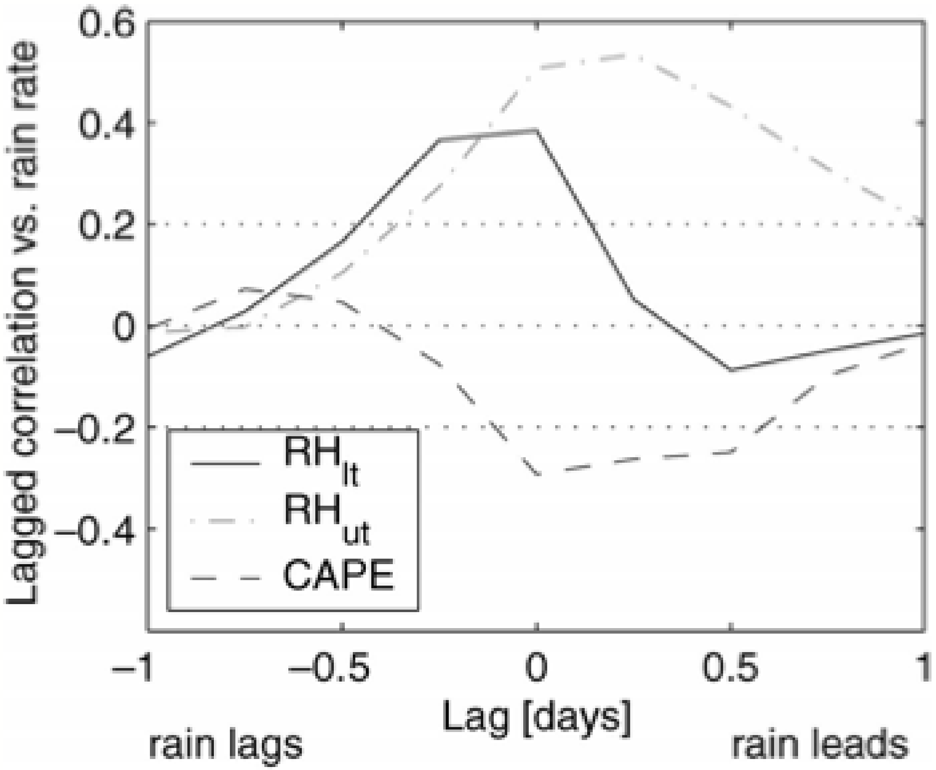
Zonal wind (m/s)

The stronger the upper level shear, the more likely there is to be stratiform rain and anvil rain regions over Africa as observed by TRMM.

Li and Schumacher (2011)

How do stratiform rain and anvil regions persist?

- Convective sustainability
- Upper level shear/hydrometeor advection
- Mid and upper level moisture

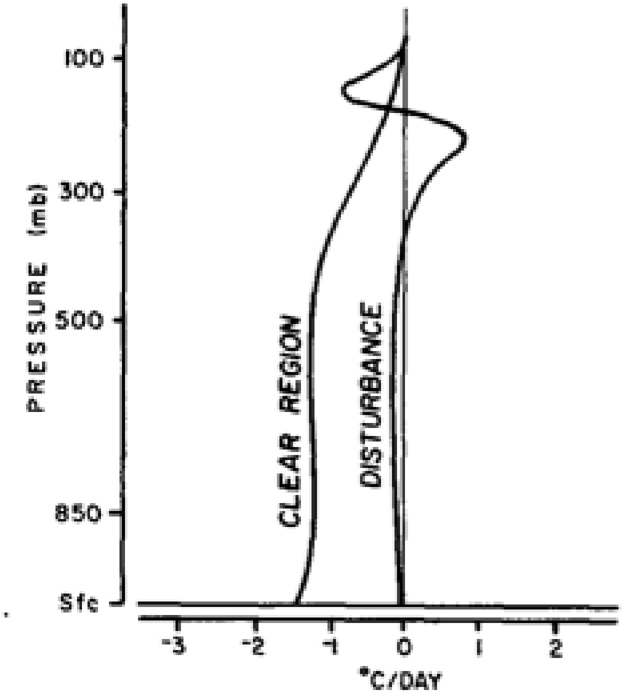


Lower level RH is high prior to max rainfall, while upper level RH lags rainfall maximum by ~6 h during KWAJEX.

Sobel et al. (2004)

How do stratiform rain and anvil regions persist?

- Convective sustainability
- Mid and upper level moisture
- Upper level shear/hydrometeor advection
- Radiative feedbacks

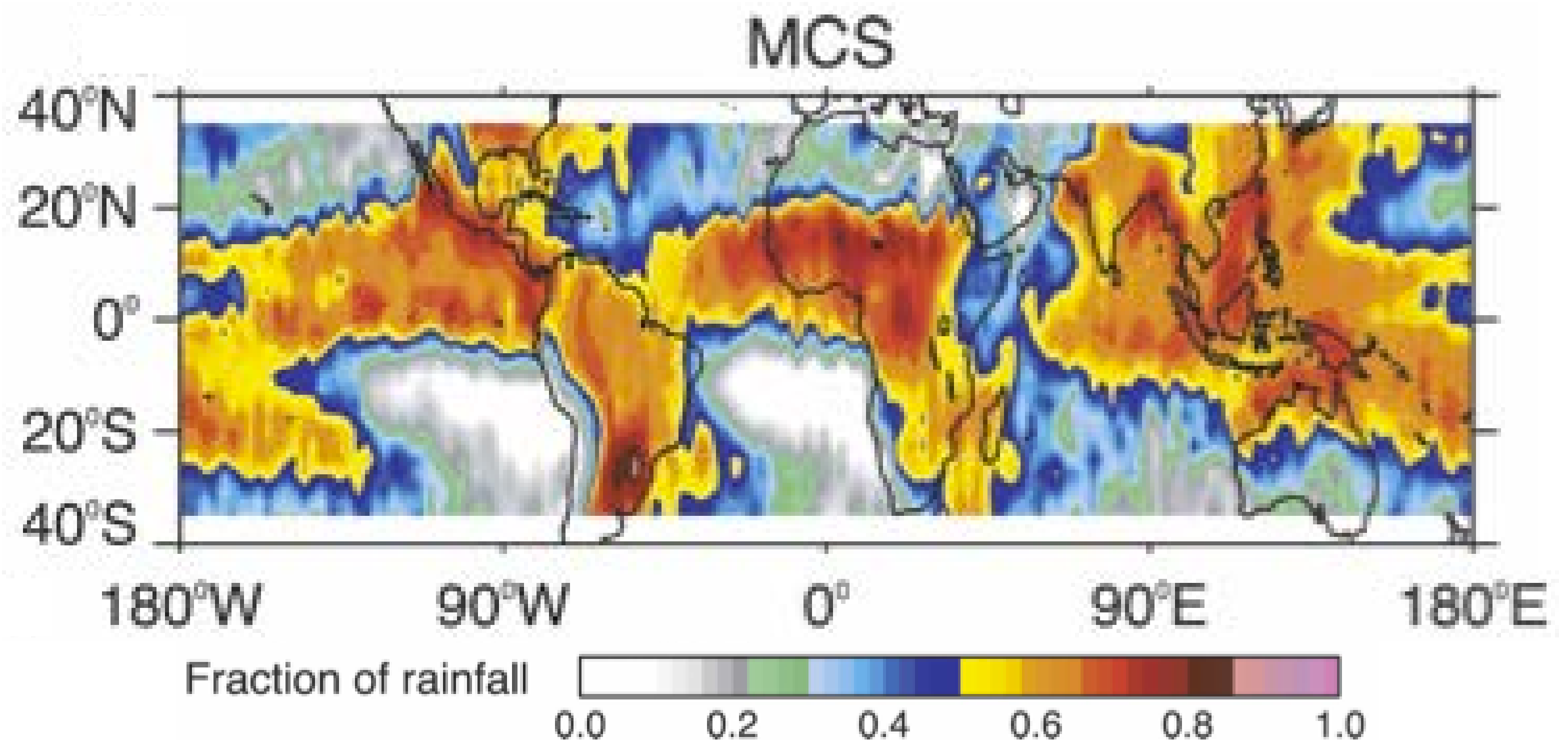


One possible explanation of the diurnal cycle of precipitation over ocean is the differential radiative heating between cloudy and cloud-free regions.

Gray and Jacobson (1977)

How does organized convection impact the environment?

- Rainfall

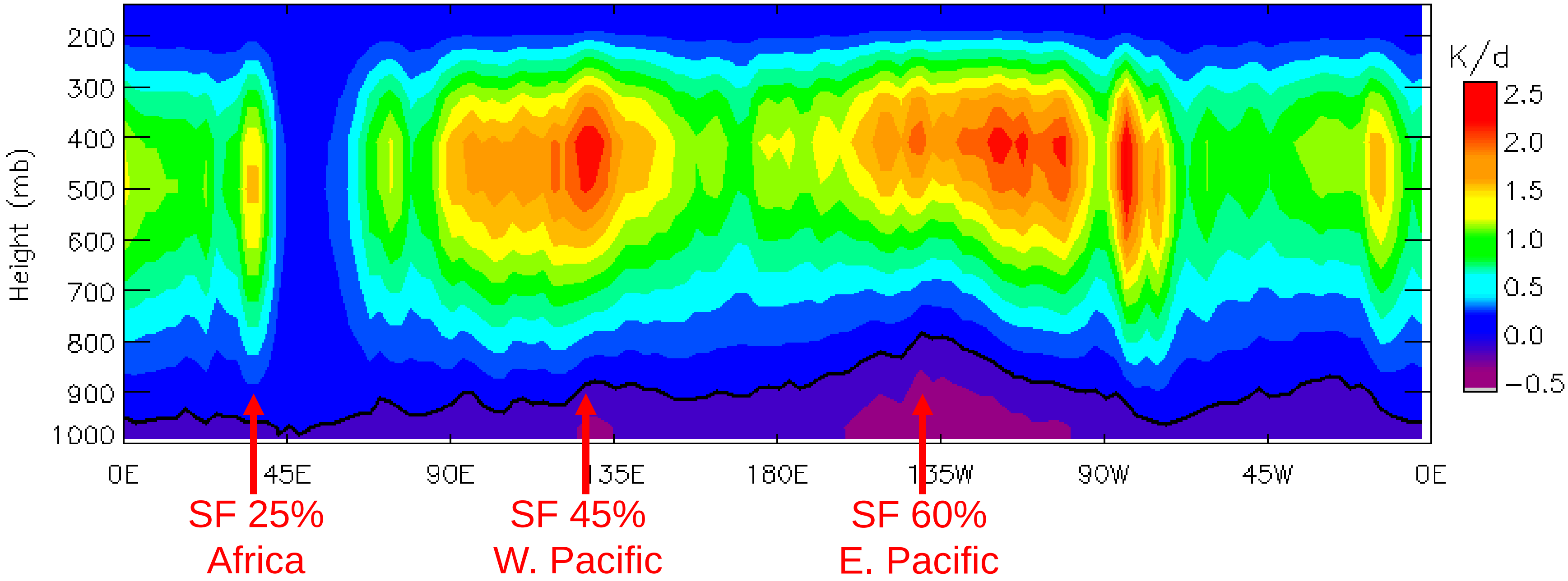


TRMM-observed MCSs account for more than 50% of rain in regions with average annual > 3 mm/day.

Nesbitt et al. (2006)

How does organized convection impact the environment?

- Rainfall
- Latent heating/Q_1

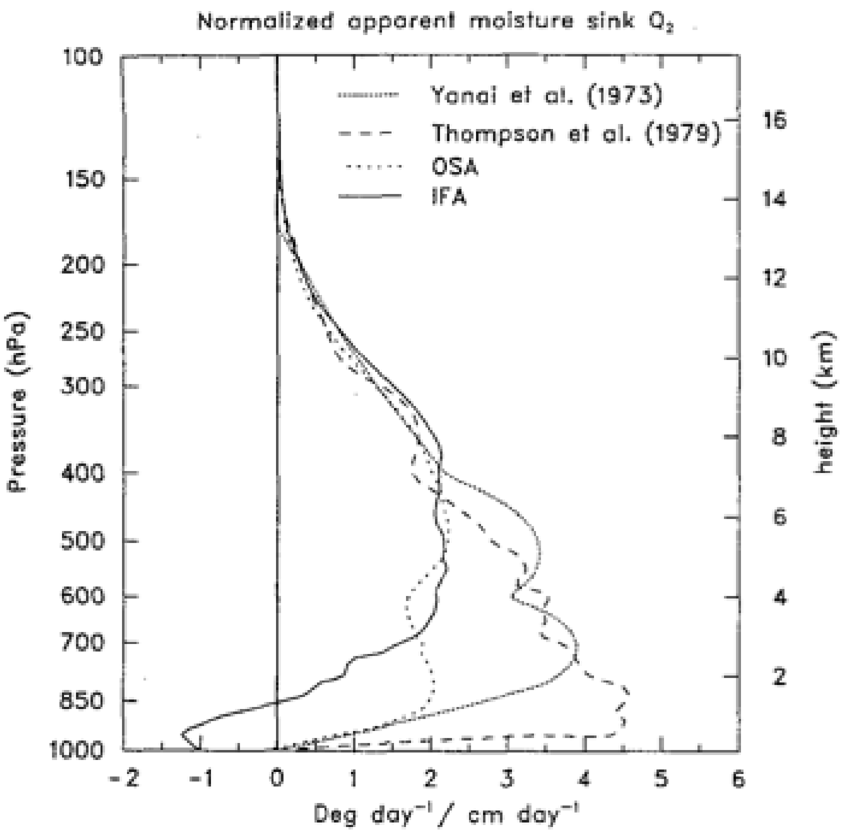


Horizontally varying stratiform rain fraction dictates the geographical distribution of the height of maximum latent heating.

Schumacher et al. (2004)

How does organized convection impact the environment?

- Rainfall
- Latent heating/Q_1
- Moisture/Q_2

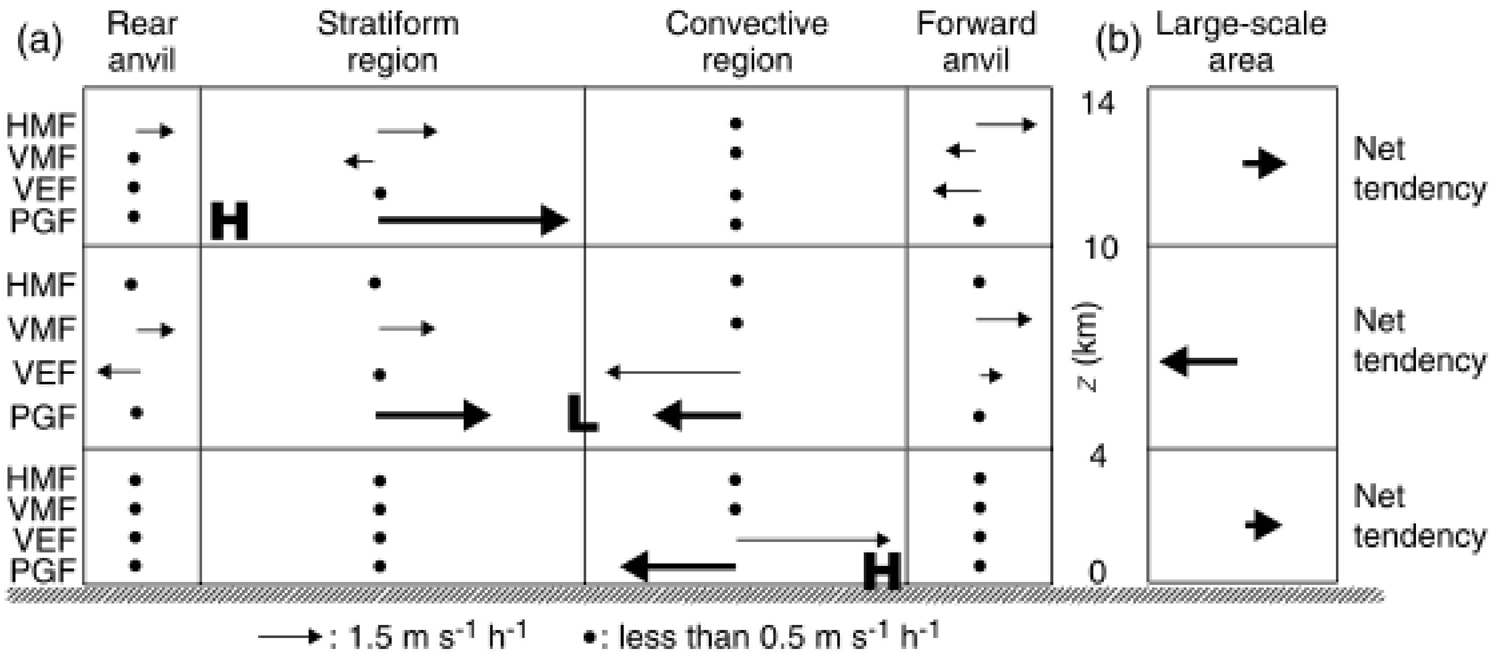


The apparent moisture sink also shows distinct variations in height depending on location/convective organization.

Lin and Johnson (1996)

How does organized convection impact the environment?

- Rainfall
- Latent heating/Q_1
- Moisture/Q_2
- Momentum/Q_3



Yang and Houze (1996)

DOE opportunities

- Long-term (SGP, TWP)
  - Statistically robust relations between convection and humidity/temperature/shear
- Field campaigns (TWP-ICE, AMIE, MC3E, GOAmazon)
  - Enhanced observations, case studies, community focus
- Focus/interest groups: VV, entrainment, CStAT, MJO

Questions to prompt discussion

- How do existing focus and interest groups fit in (VV, entrainment, CStAT, MJO)?
- Are there other important processes or targets to make an interest group or even a set of PI products? [cold pools or gravity waves, anyone?]
- How do we answer Tony's question from the fall meeting, "When should a GCM organize convection?"…a multivariate problem…
- What is the equivalent question for CRMs?

Mesoscale organization

- There is a spectrum of organization (not binary) and we would like to create a (telescoping) library of organization cases and long-term data sets using ARM (and beyond?) data and models
- Special considerations:
  - Impact of system on large scale
  - Multivariate statistics with environment
  - Scale dependency/gray zone
  - Time evolution of systems
  - Microphysics
- Case studies to test library, then include long-term statistics: MC3E (25 Apr, 20 May, 23 May), AMIE (Nov 2011 MJO, Dec 2011 ~MJO), …