



Fusing Multiple Satellite Datasets to Define and Understand Organized Convection

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Acknowledgements:
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Booth, Bill Rossow

**Rossow Retirement
Symposium
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Tropical "Organized Convection":

- Probably comprises clustered raining convective towers;
- Probably occurs in more moist environments;
- Associated with a well-developed stratiform component, which probably implies large cold IR shields.

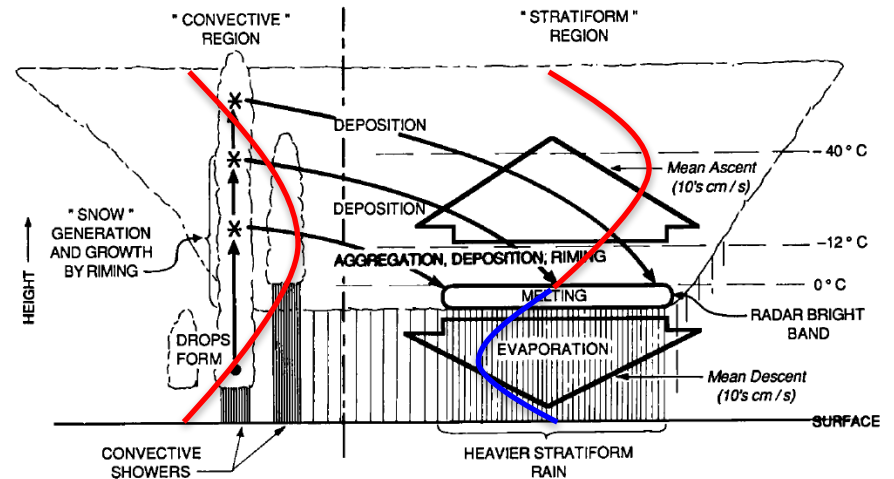
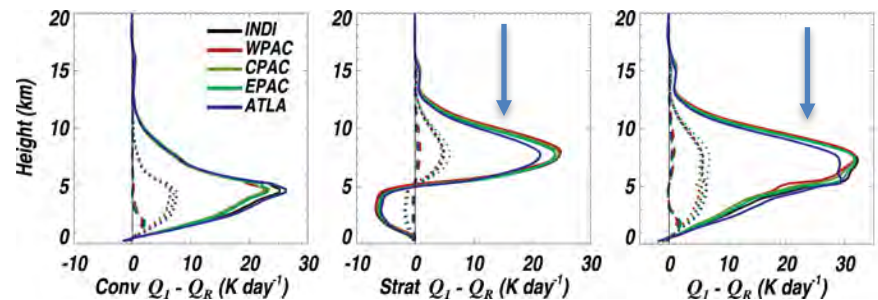


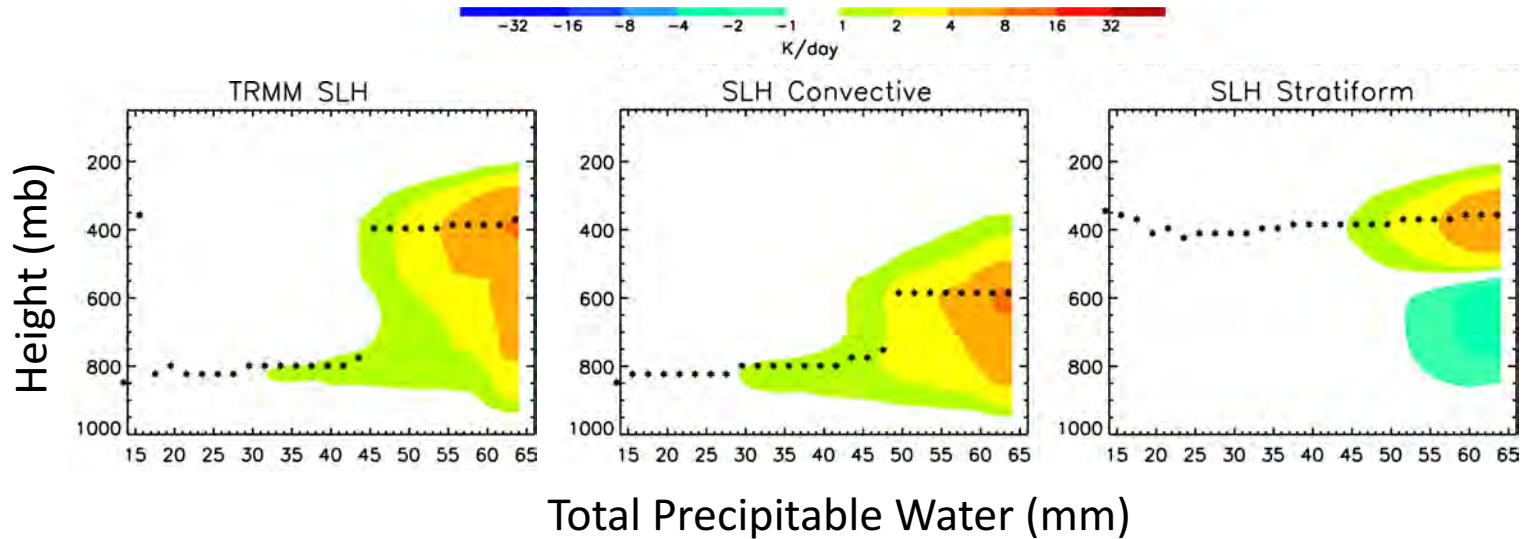
Figure 2. Schematic diagram of the precipitation mechanisms in a tropical cloud system. Solid arrows indicate particle trajectories (adapted from Houze 1989).

-Is well-developed stratiform synonymous with top-heavy diabatic heating profiles?



Elsaesser et al. (2010), Figs 5 and 6.

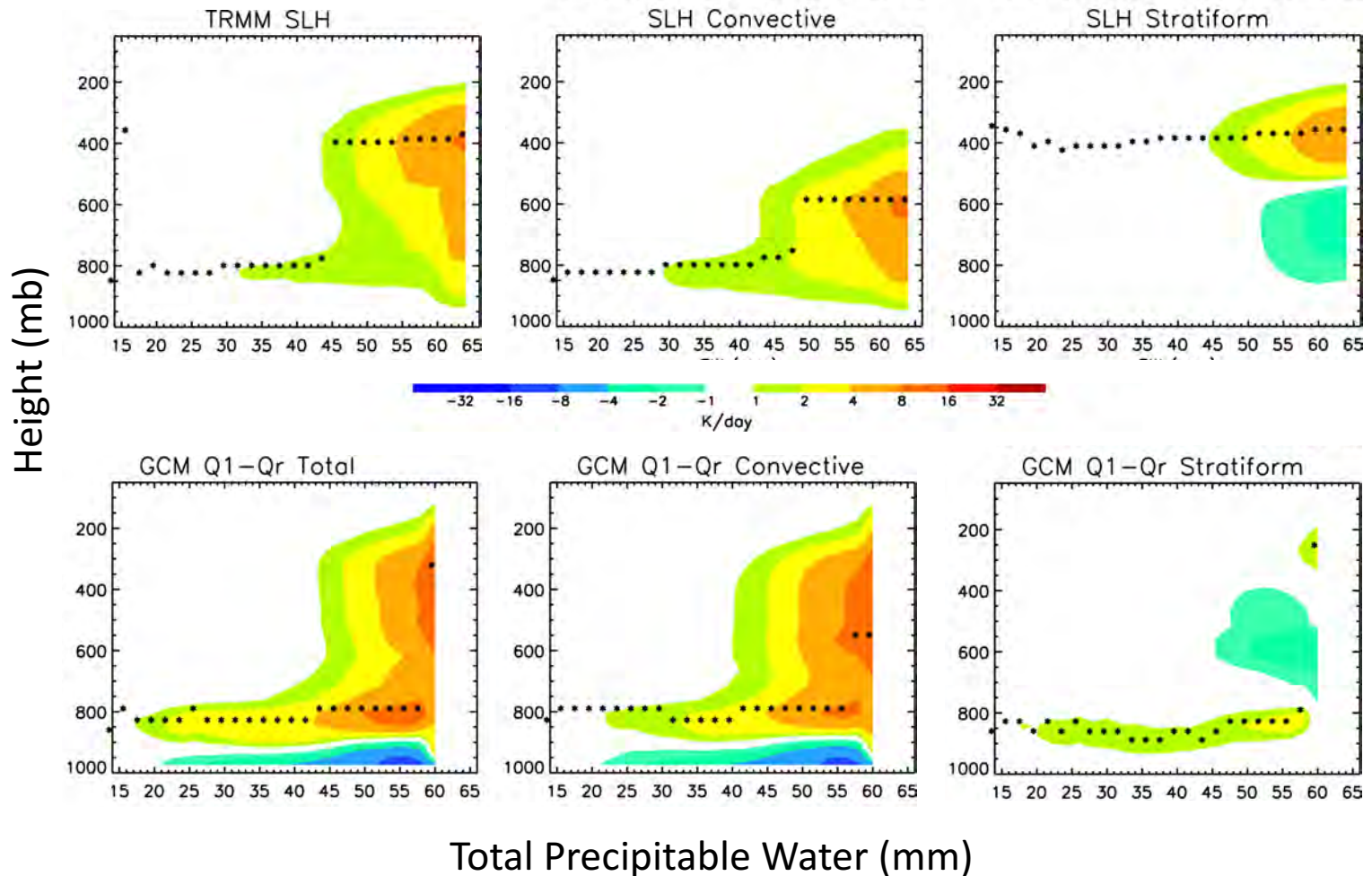
TRMM Results: “We find what we expected to find”



**Del Genio et al. (2012), JCLI.
(select panels of Figs 1).**

A large-scale GCM grid cares about the diabatic heating profiles.

GPM Retrieved Diabatic Heating (LH + eddy components) vs. GISS GCM 5 years ago



**Del Genio et al. (2012), JCLI.
(select panels of Figs 1, 2).**

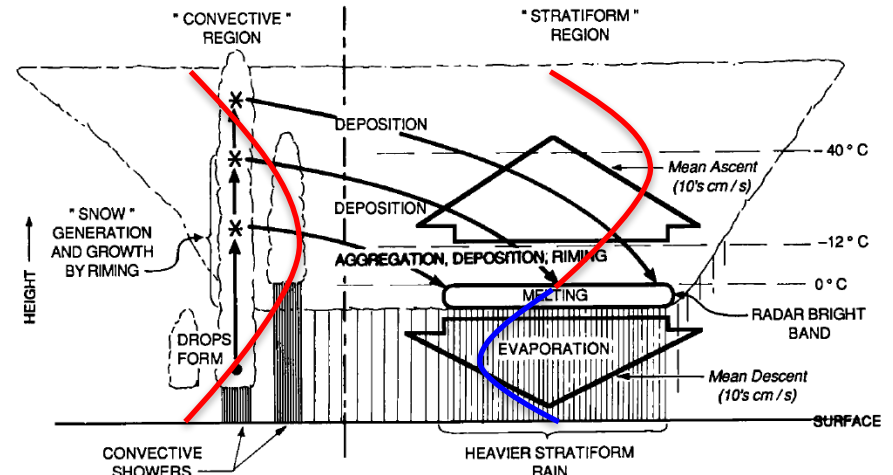


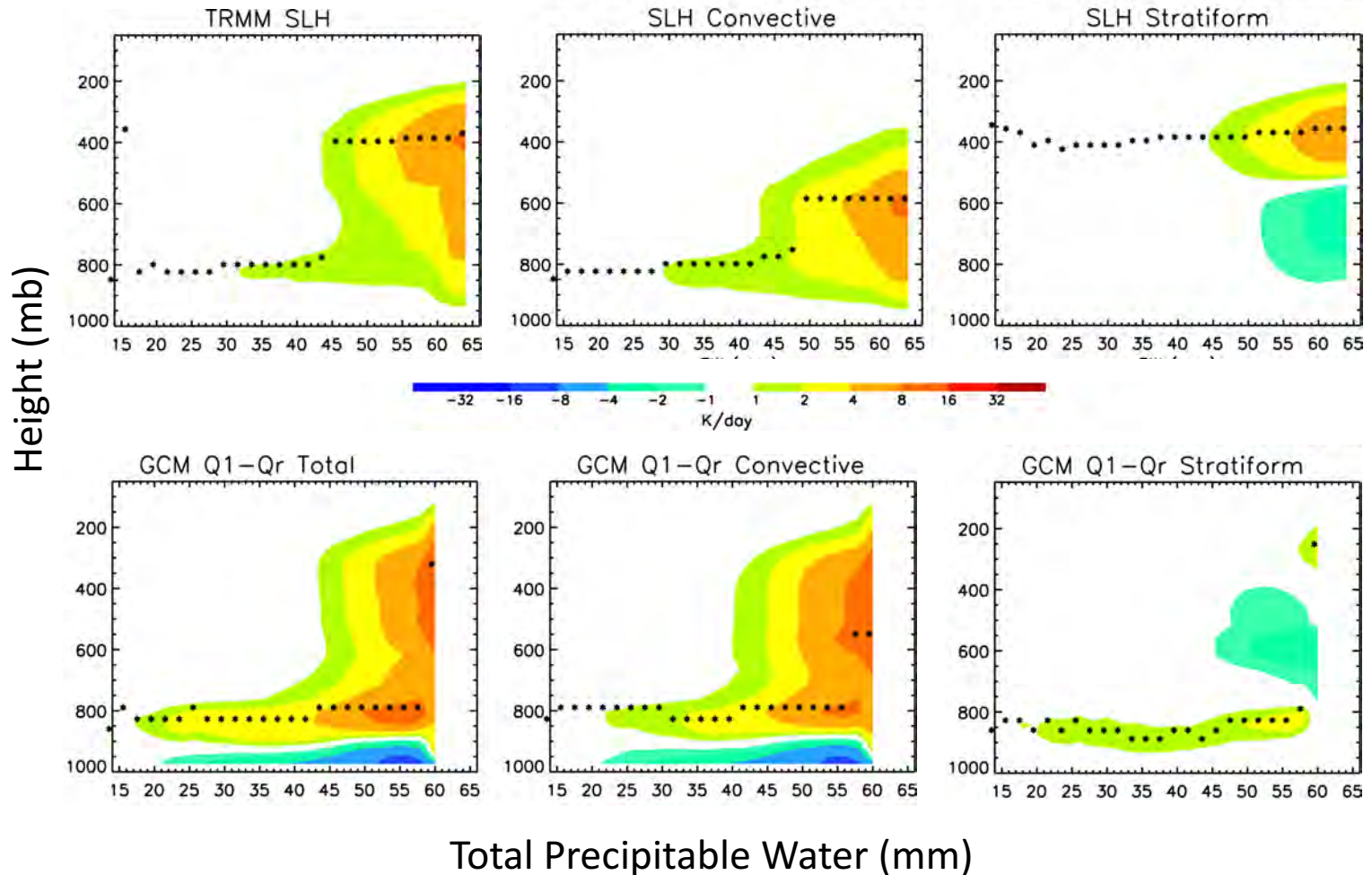
Figure 2. Schematic diagram of the precipitation mechanisms in a tropical cloud system. Solid arrows indicate particle trajectories (adapted from Houze 1989).

Representing such systems in a GCM is complicated, but we're making progress in aggregating the component physics.

Last couple years:

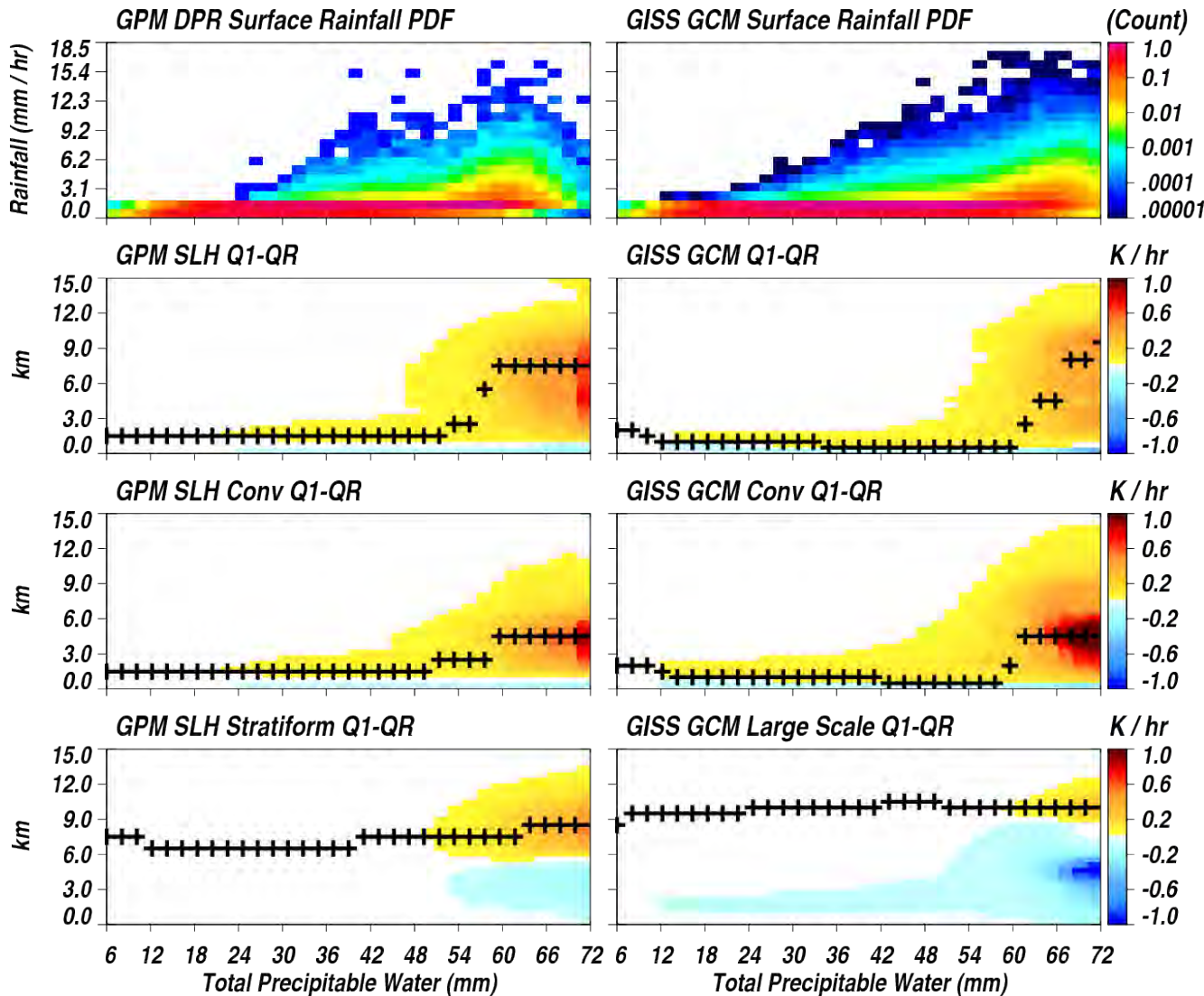
- **Cold Pools (Del Genio et al. 2015);**
- **Convective Ice Parameterization (Elsaesser et al. 2017);**
- **Morrison-Gottelman 2 (MG2, 2015) Microphysics;**
- **Convective Liquid Parameterization, detrainment of number concentrations (last 4 months work, unpublished).**

Again, this is where we were.



**Del Genio et al. (2012), JCLI.
(select panels of Figs 1, 2).**

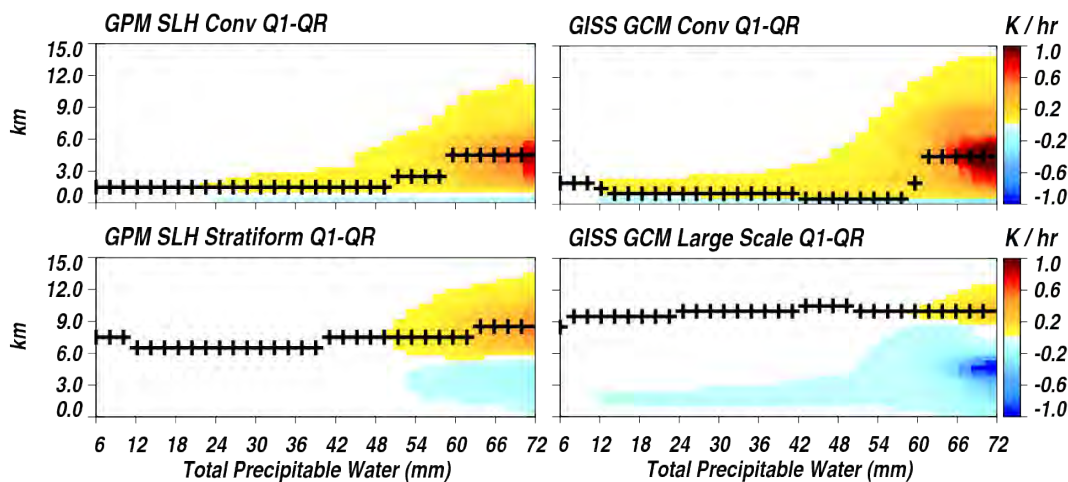
Where we are now: GPM Retrieved Diabatic Heating (LH + eddy components) Vs. GISS GCM



Cloud Parameterization Development Toward CMIP6:

- We now have a second baroclinic mode. OK, but why?
- Ice Mass/num conc are leading to small enough detrained particles that slowly fall and grow via deposition (a process simulated well enough using MG2)

- ◆ **Microphysics and detrainment get us so far. What might be the next step?**
- ◆ **We now have to allow our seeds to evolve with a mesoscale updraft/downdraft.**



We hypothesize *transition to top-heaviness is associated with deep convective systems, and lifecycle characteristics where particular heating profiles and TPW values are associated with distinct system stages.*

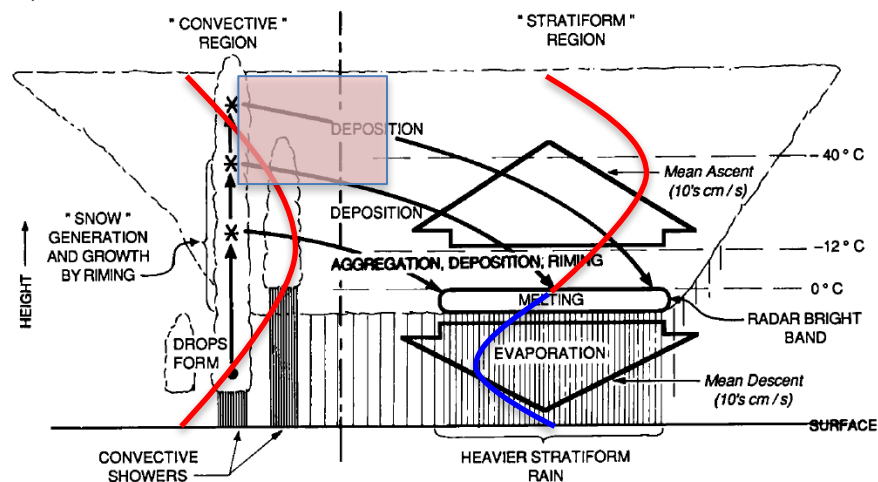
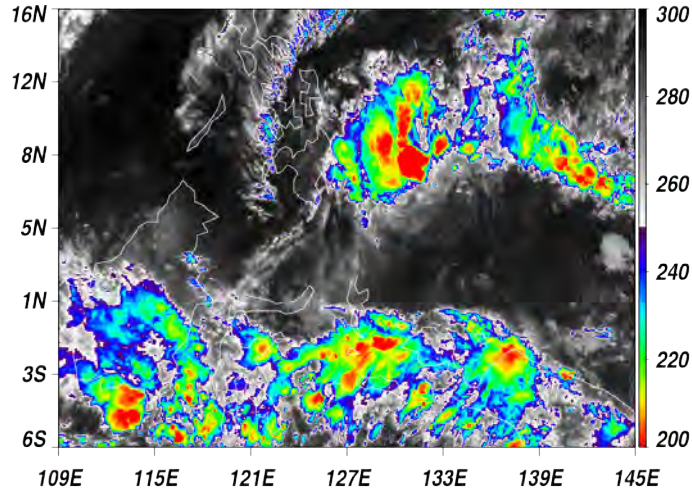


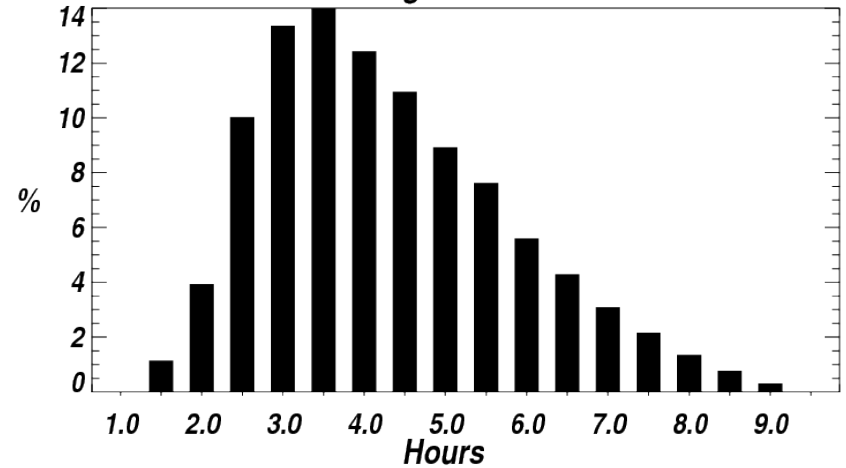
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GPM Overpasses Mapped to Tropical Convective Systems

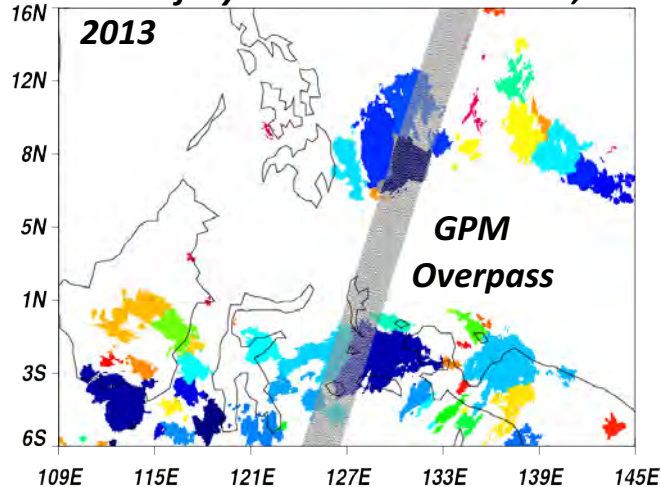
CPC Globally-Morphed IR



Histogram of Lifetimes



MCS lifecycle: Fiolleau and Roca, 2013

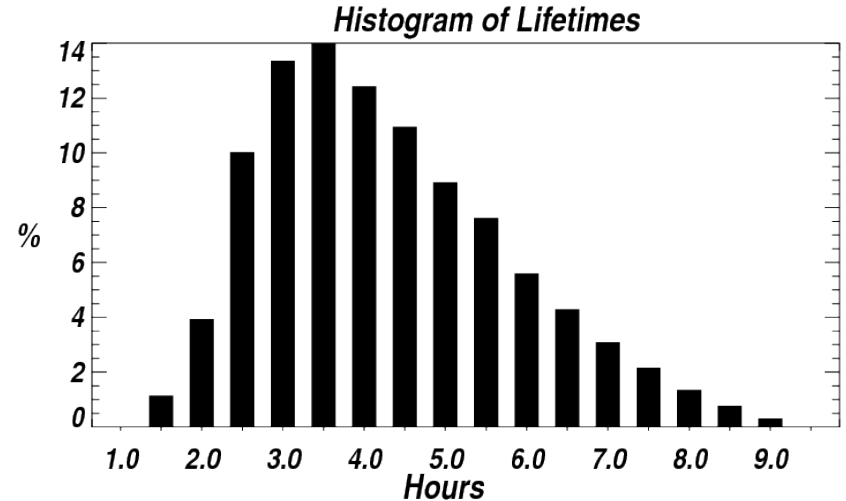
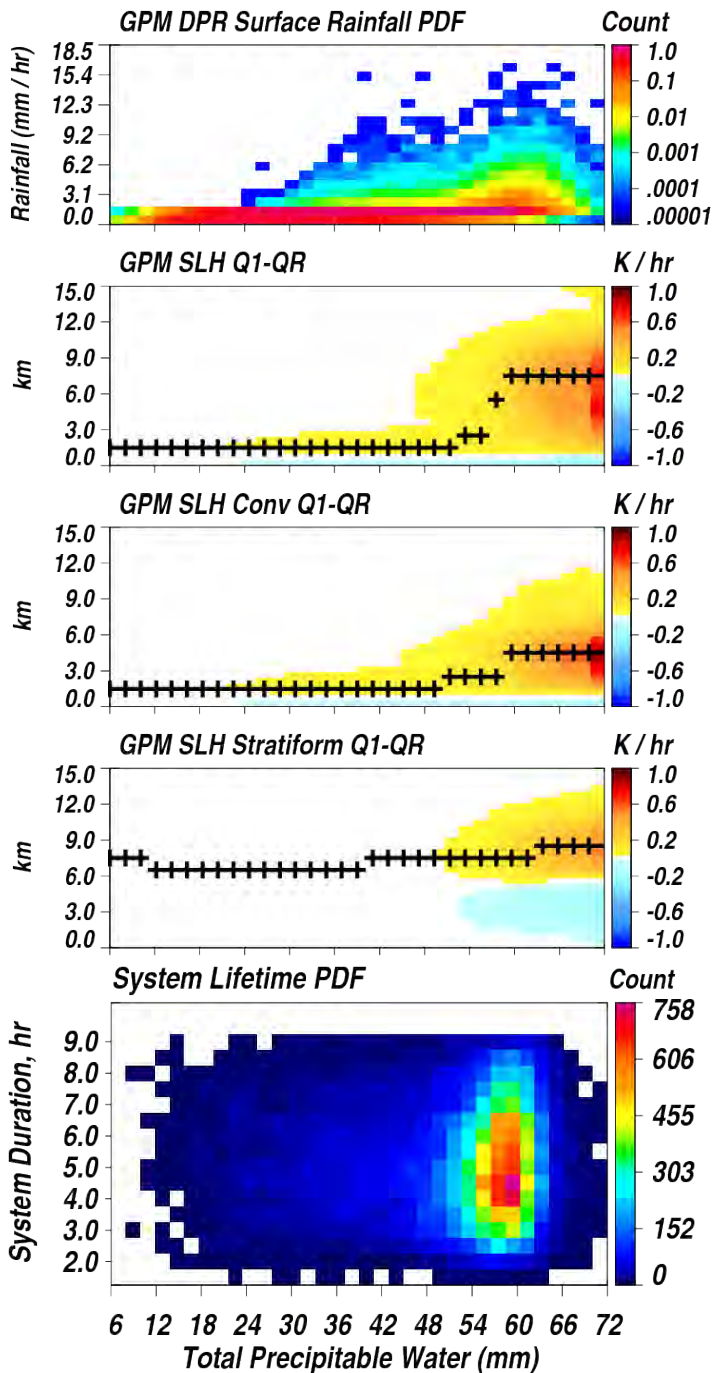


***30 min, 4 km IR dataset (50S-50N).**

***One size requirement: system must be over 25 x 25 km² in spatial extent at some point in lifecycle.**

***90% of IR Tbs < 235K are tracked (remaining associated with longer-lived systems, but results are not shown)**

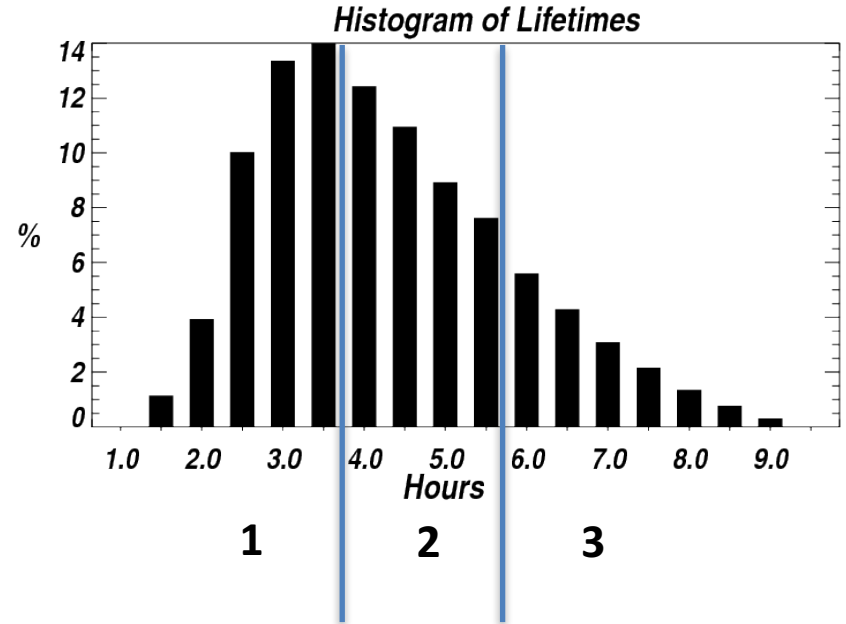
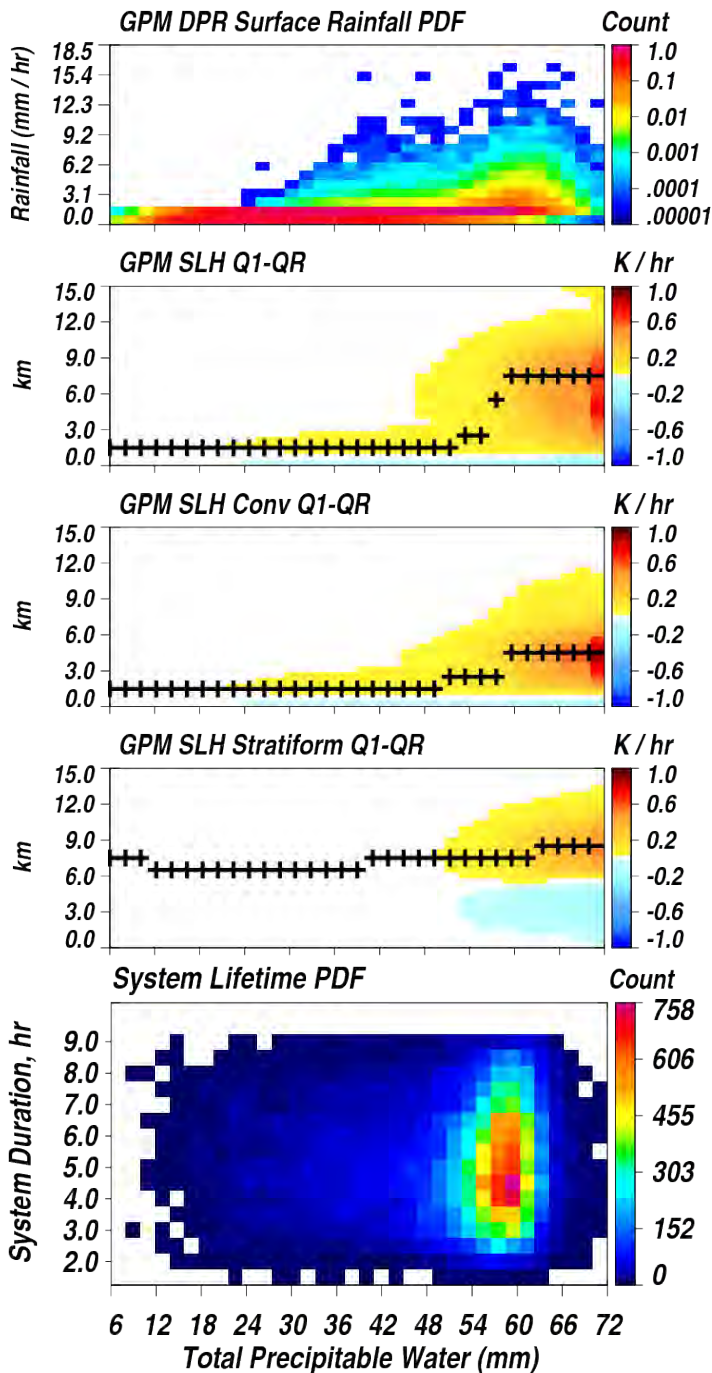
GPM Retrieved Diabatic Heating and Convective Systems



Most systems observed to occur in total precipitable water state-space from 45-65 mm.

For a given system duration, how is lifecycle intertwined with water vapor evolution?

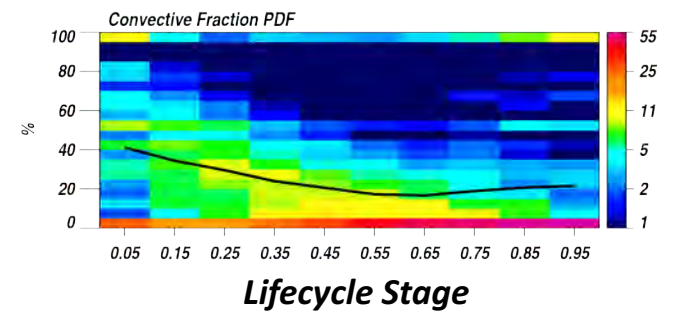
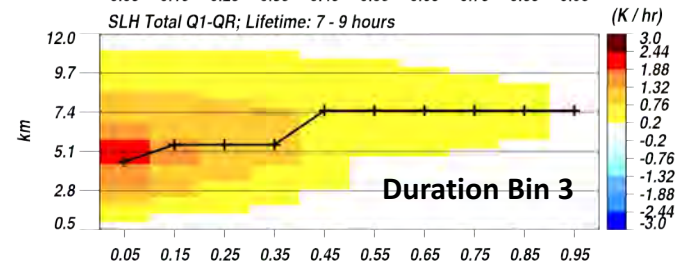
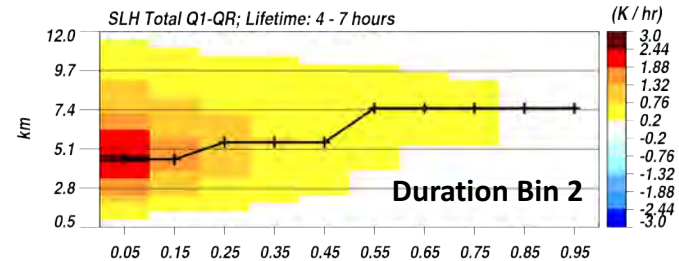
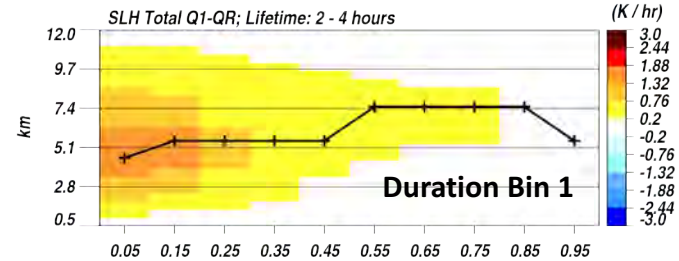
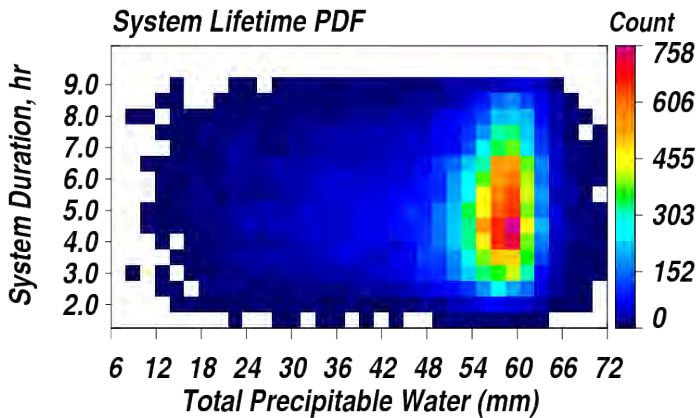
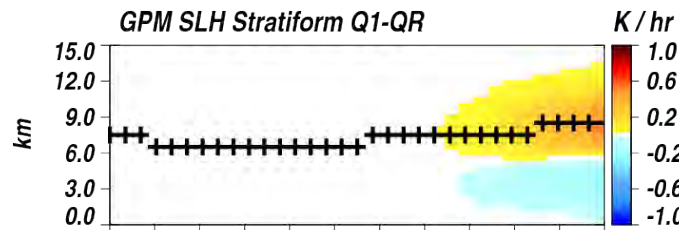
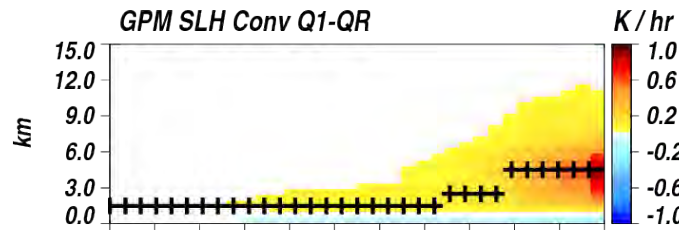
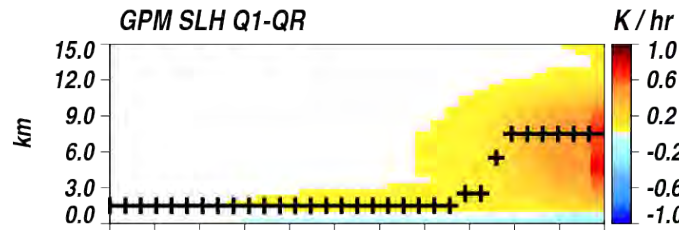
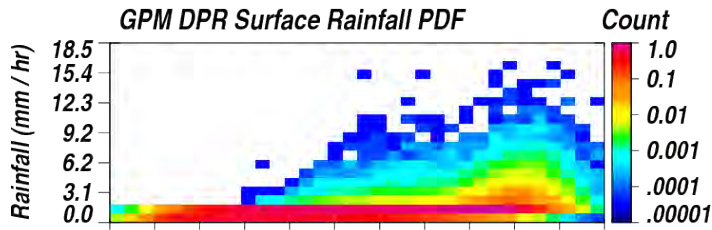
GPM Retrieved Diabatic Heating and Convective Systems

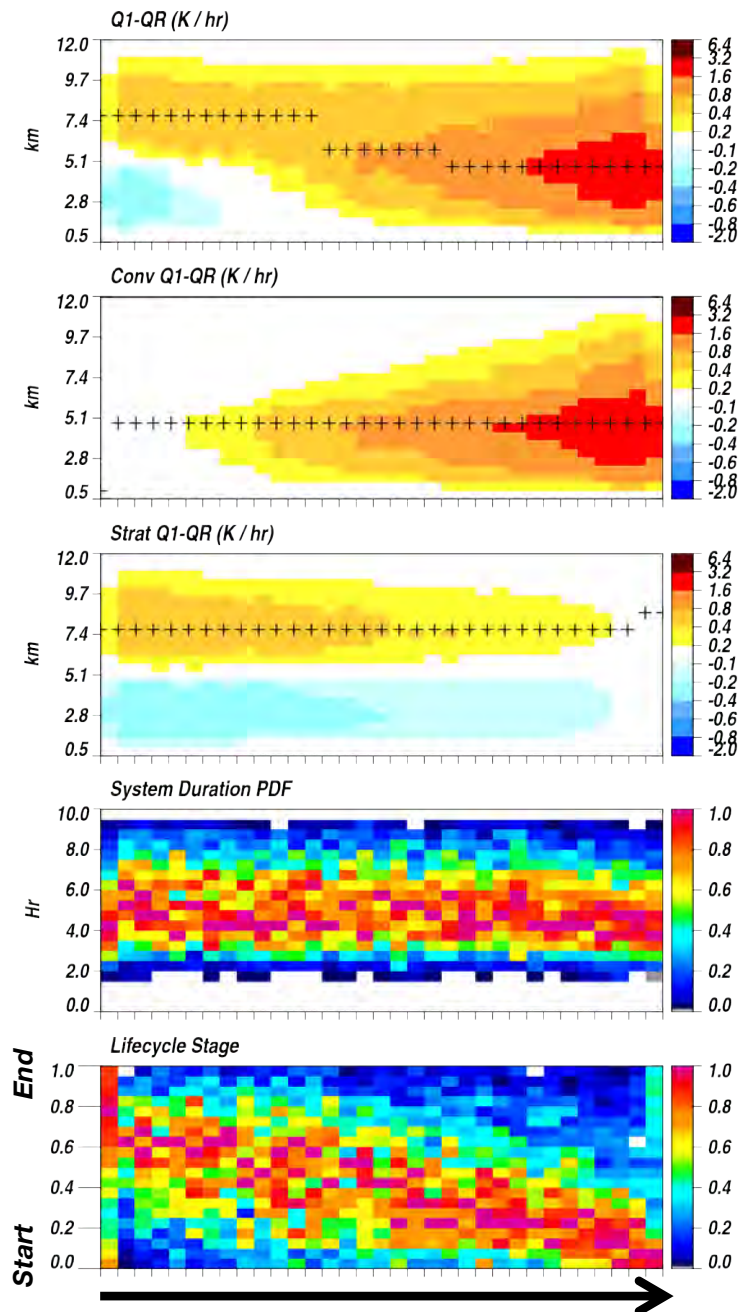


Composite SLH Q1-QR to convective systems, and for each of the 3 lifetime bins, look at variation as function of lifecycle stage.

GPM Retrieved Diabatic Heating and Convective Systems

Organized: stratiform (top-heavy), larger, longer





Sorting instead of compositing to avoid being misled.

Expected: Convective lifecycle evolution characterized by:

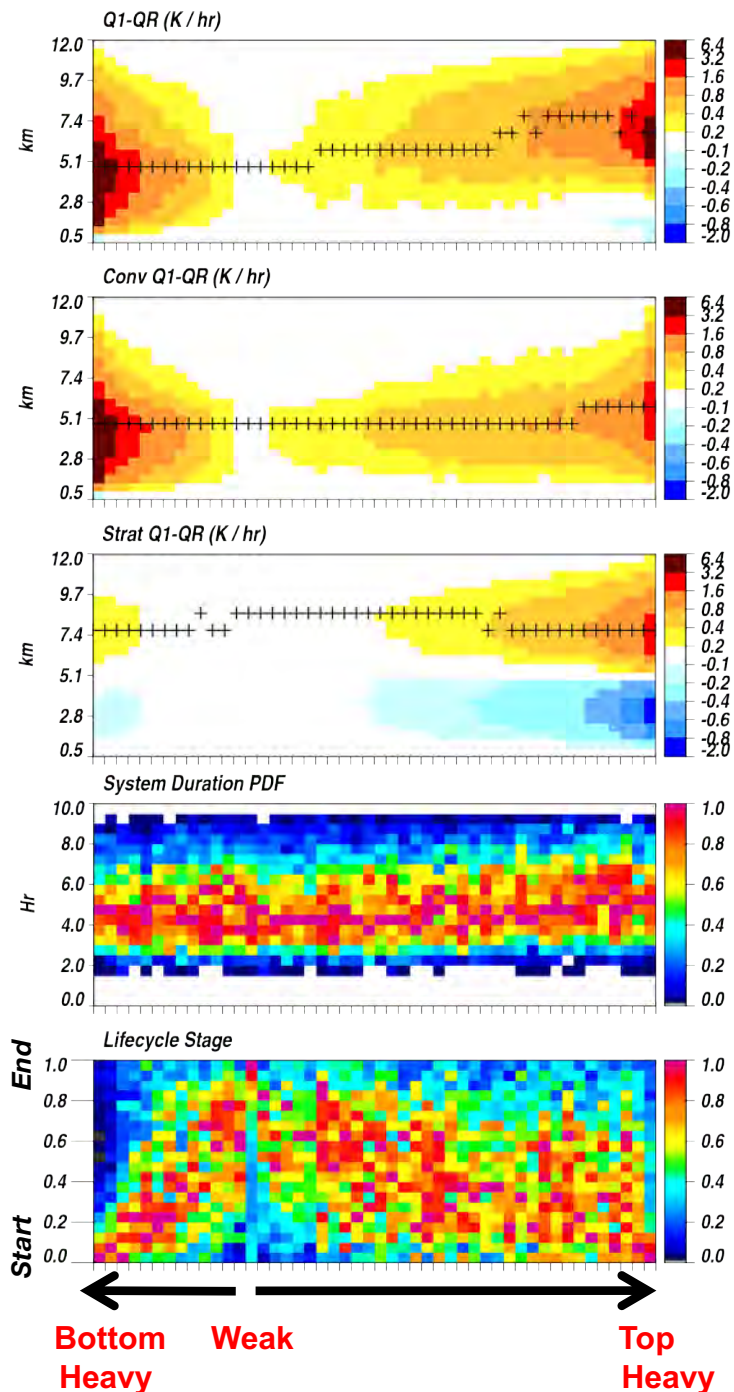
-top heavy heating later

-larger when more top-heavy

-longer (it takes time to become well-developed)

Finding: Something similar to composites, but there seems to be little relationship to duration (i.e. near fixed-composite evolution of convective systems).

Sort Index: Convective Rainfall Fraction



Sorting instead of compositing to avoid being misled.

Expected: Convective lifecycle evolution characterized by:

-top heavy heating later

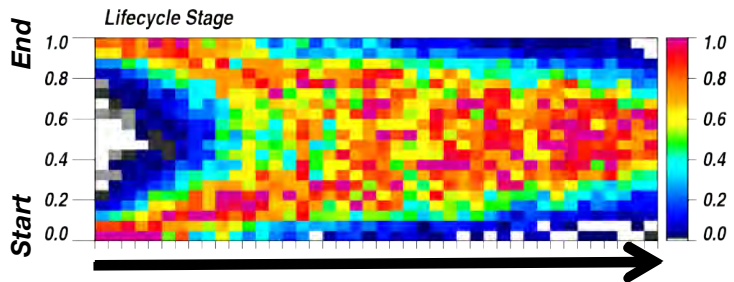
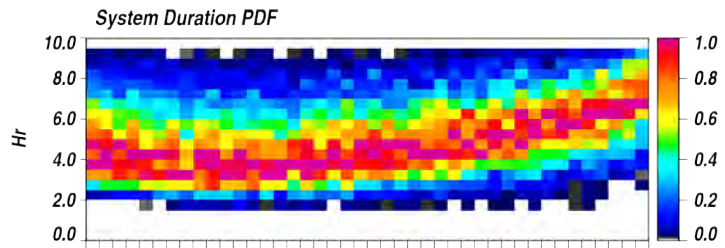
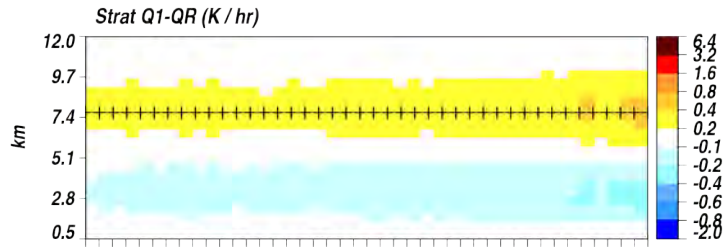
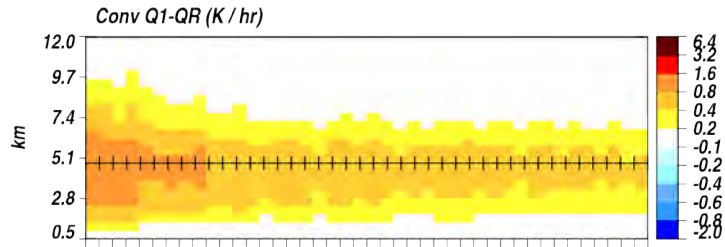
-larger when more top-heavy

-longer (it takes time to become well-developed)

Finding: Strongest amplitude 1st and 2nd baroclinic modes are **both** found earlier in the lifecycle; strongest convective mode is rare in later stages.

Possible Interpretations:

-Oscillations instead of systematic progression of organization with stage/duration.



~20x20 km²

Sort Index:
System Size

~250x250km²

Sorting instead of compositing to avoid being misled.

Expected: Convective lifecycle evolution characterized by:

-top heavy heating later

-larger when more top-heavy

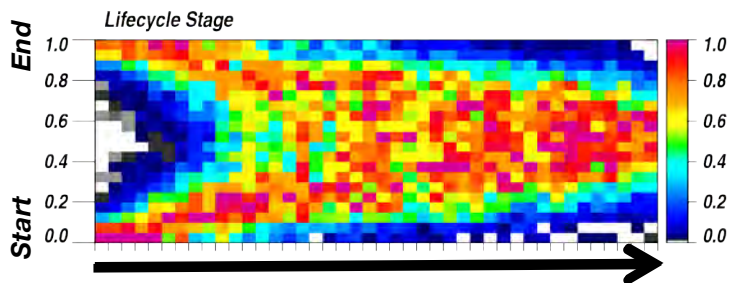
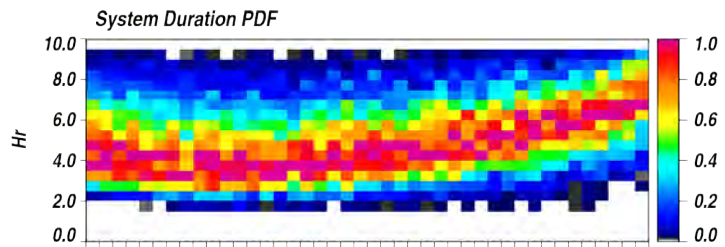
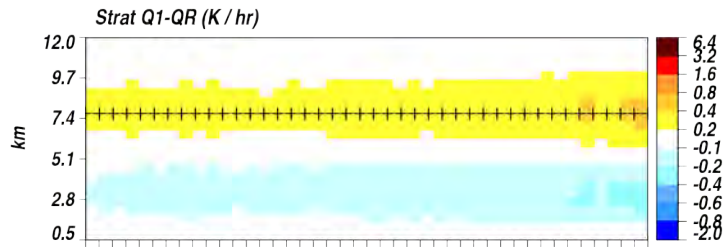
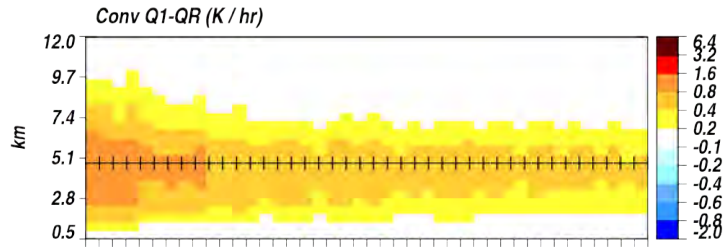
-longer (it takes time to become well-developed)

Finding: Sorting by size yields mix of heating mode states; system size is clearly tied to duration.

Possible Interpretations:

-Oscillations instead of systematic progression of organization with stage/duration.

-Organization, if defined by “heating structures”, may be independent of system size, and mostly independent of duration.



~20x20 km² Sort Index: ~250x250km²
 System Size

Sorting instead of compositing to avoid being misled.

Expected: Convective lifecycle evolution characterized by:

- top heavy heating later
- larger when more top-heavy
- longer (it takes time to become well-developed)

Finding: Sorting by size yields mix of heating mode states; system size is clearly tied to duration.

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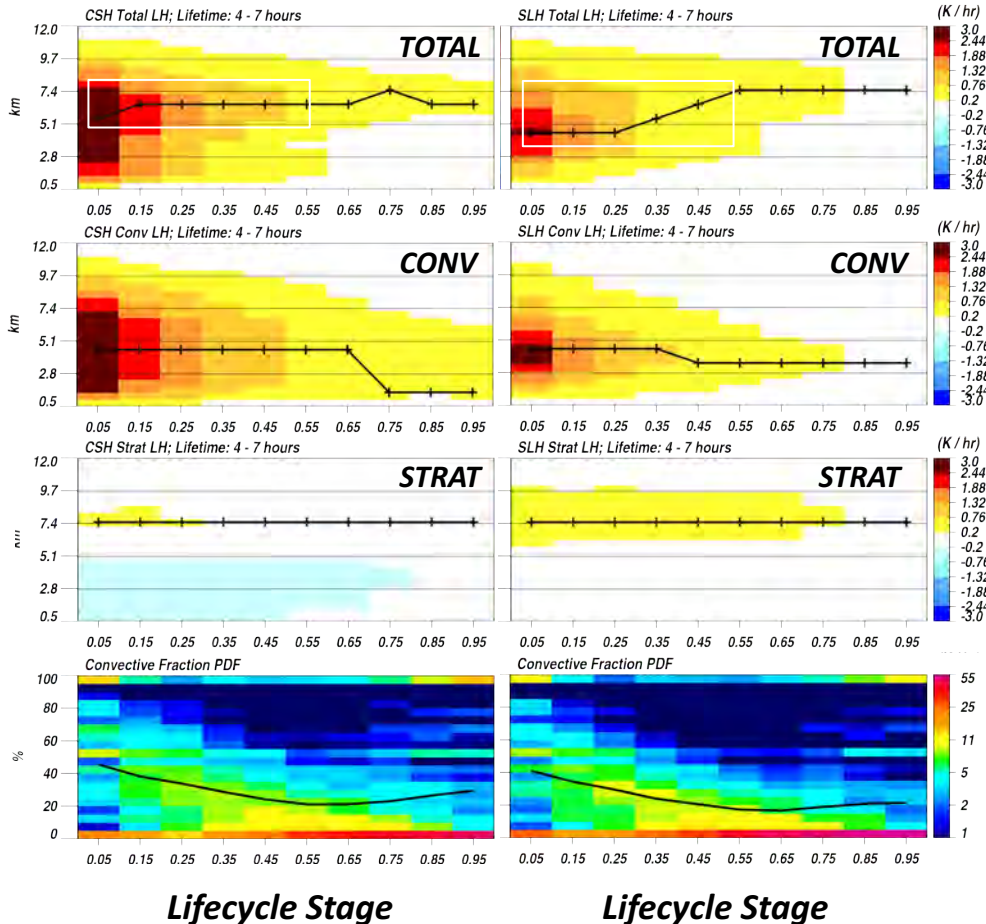
Thank you.

Questions?

Extra slide: Latent Heating -vs- Lifecycle Stage

CSH

SLH



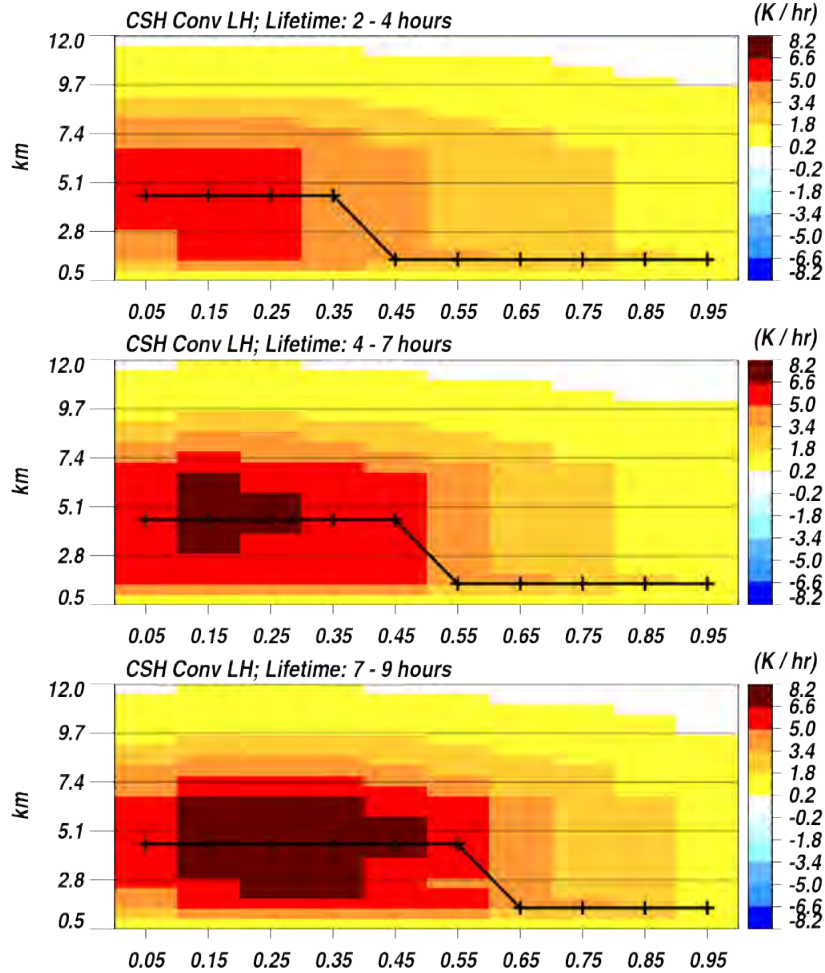
TOTAL = CONV + STRAT

CONV LH: larger in CSH; peak magnitudes at similar altitudes.

STRAT LH: max heating at same altitudes, more heating aloft in SLH, more cooling below freezing level in CSH.

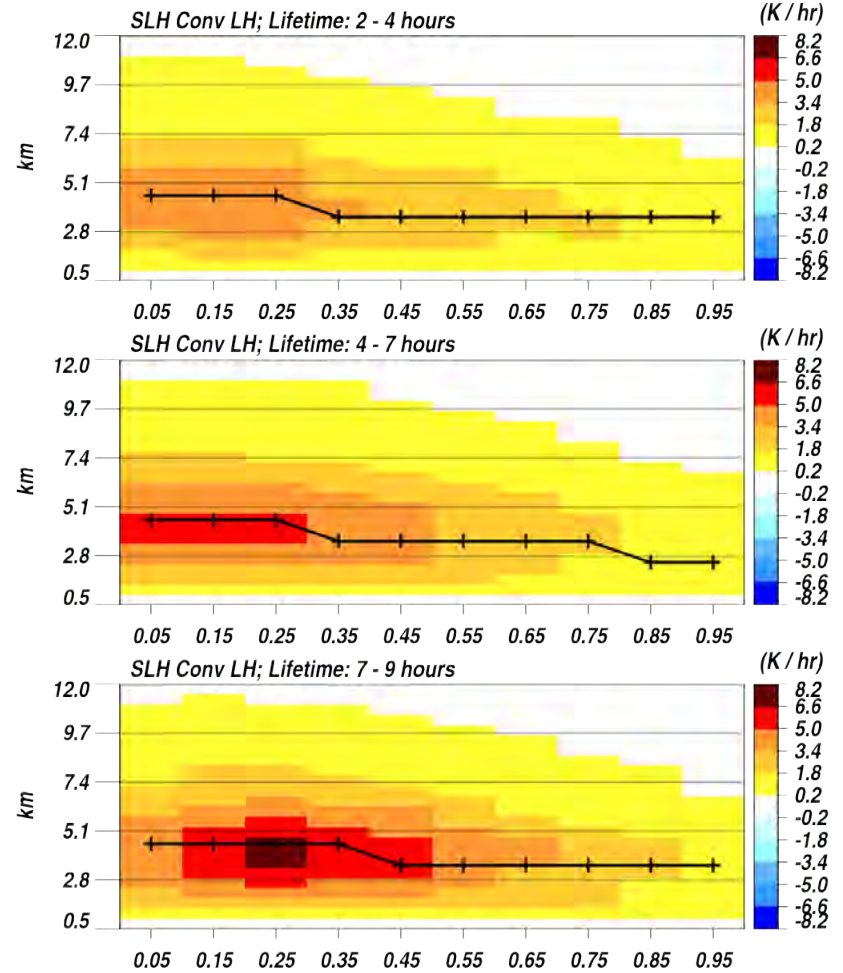
Extra slide: CONV Latent Heating -vs- Lifecycle Stage

CSH



Lifecycle Stage

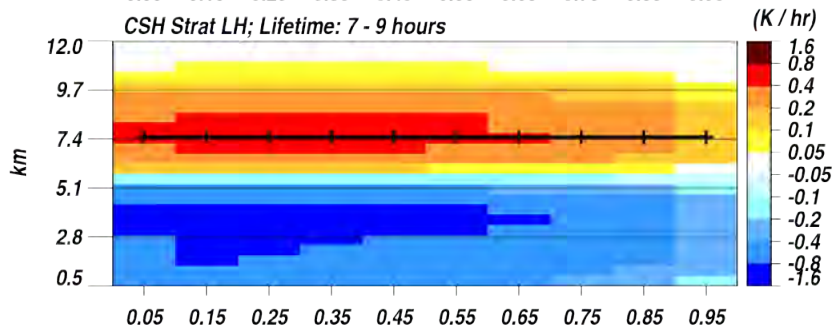
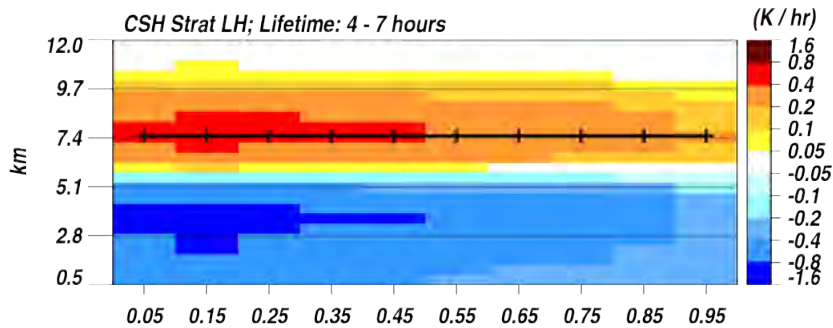
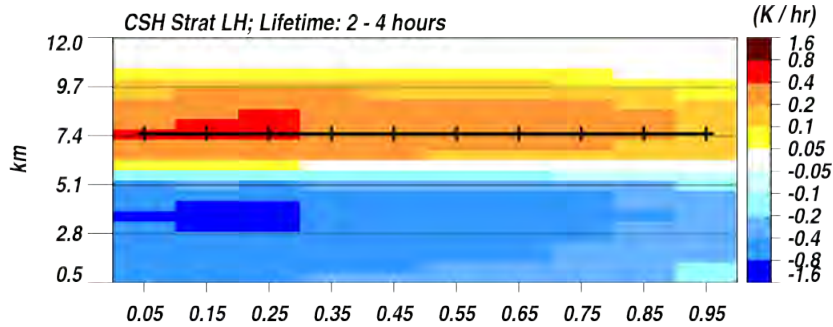
SLH



Lifecycle Stage

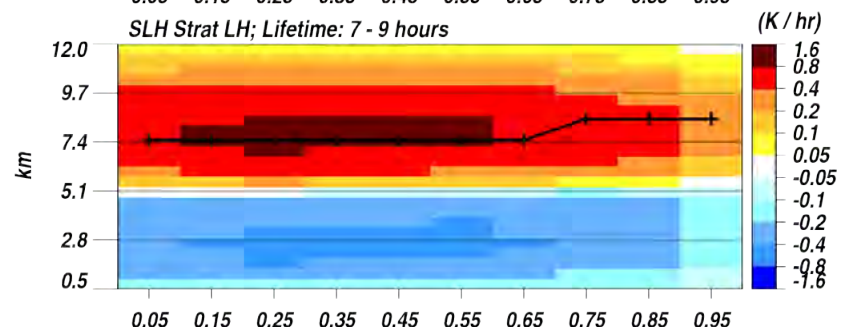
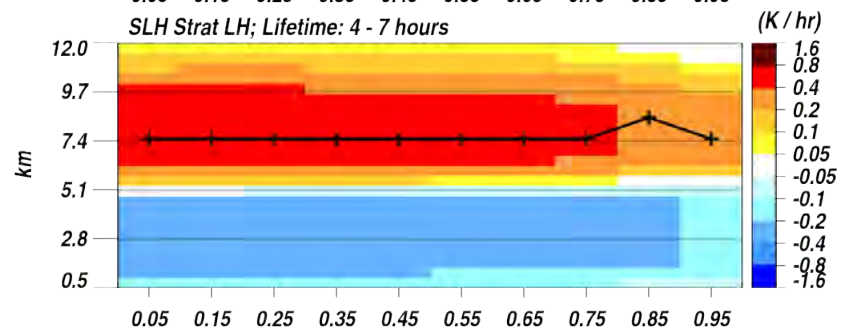
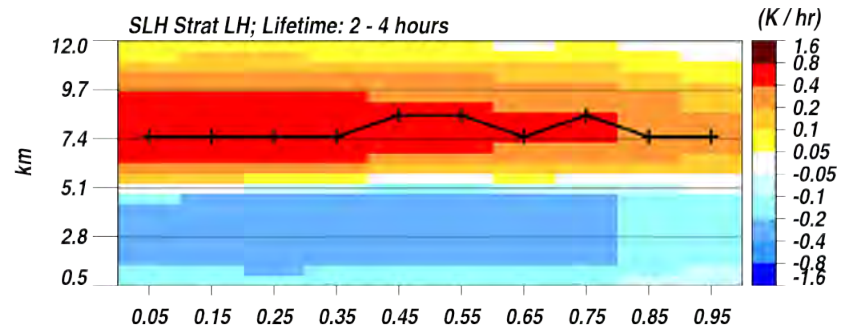
Extra slide: STRAT Latent Heating -vs- Lifecycle Stage

CSH



Lifecycle Stage

SLH



Lifecycle Stage