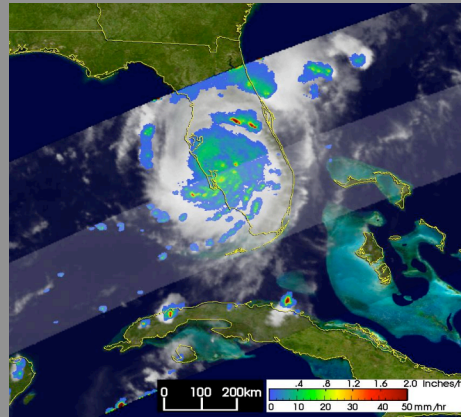
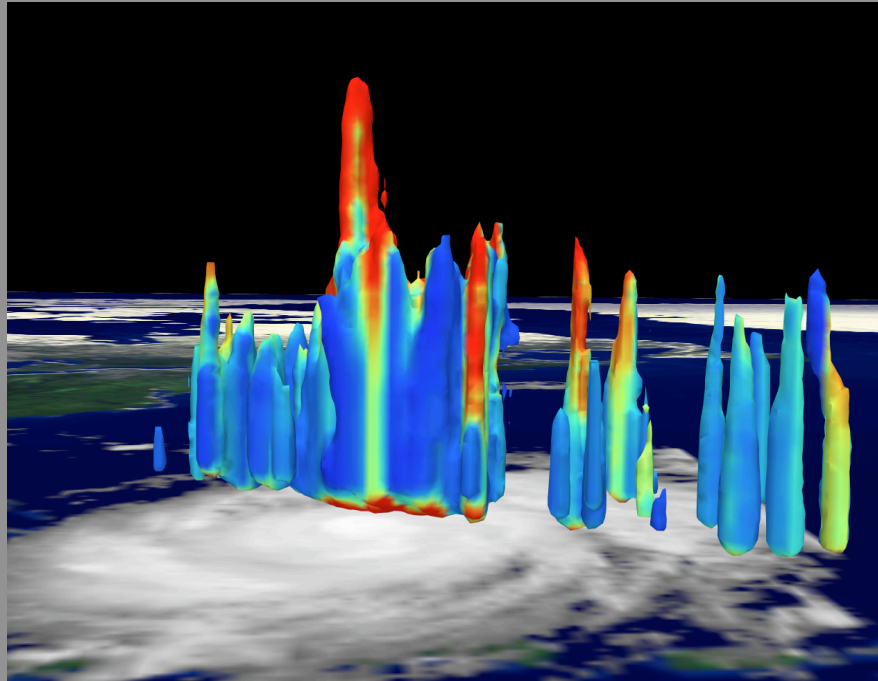
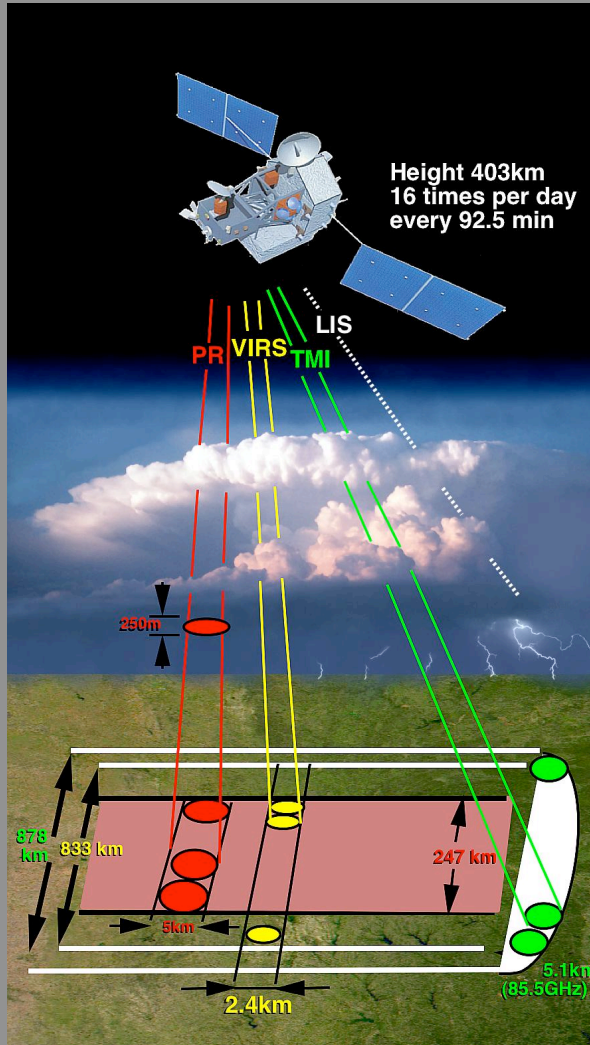




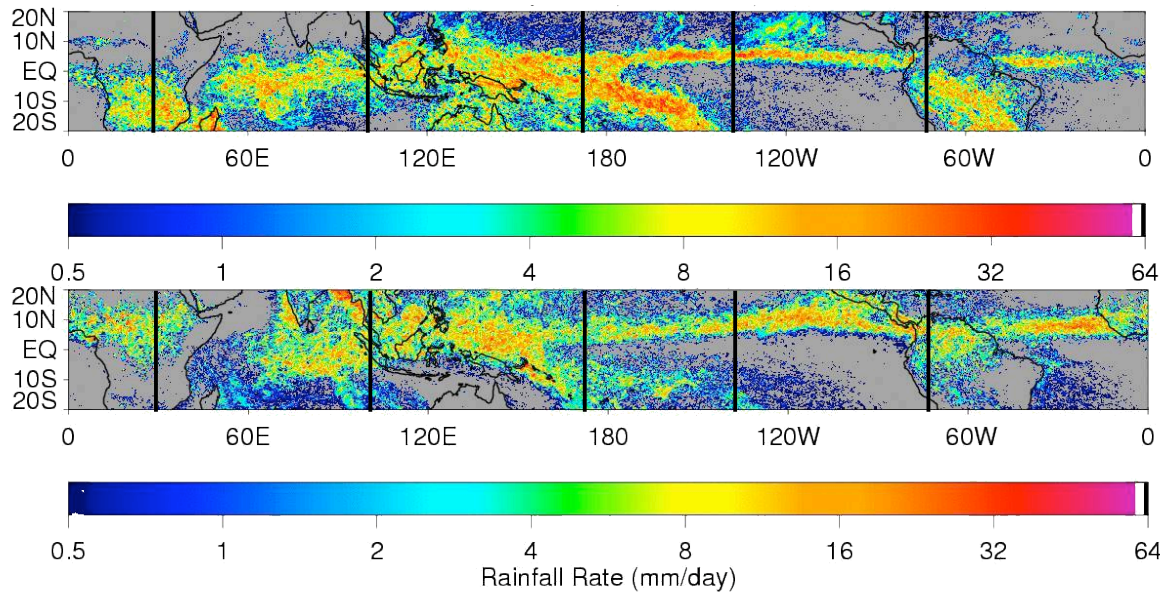
**Tropical Rainfall Characteristics as observed
from TRMM and some comparisons with the CSU
MMF**

**Gregory Elsaesser
Chris Kummerow
Colorado State University
CMMAP Team Meeting, January 2011**

Tropical Rainfall Measuring Mission (TRMM) Satellite



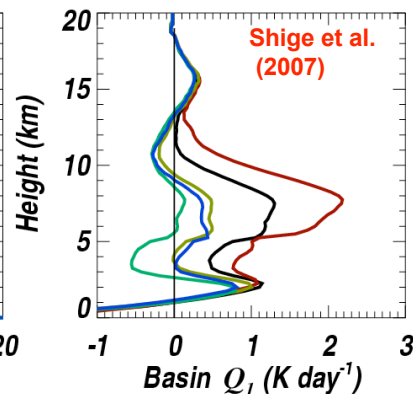
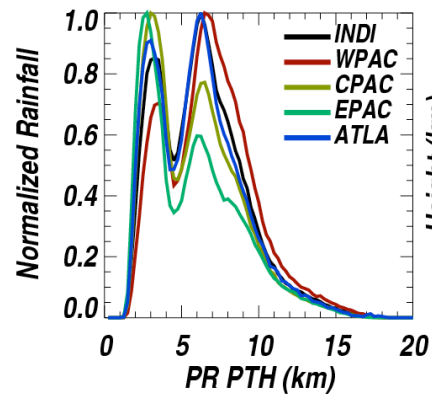
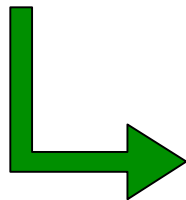
Average Tropical Rainfall according to TRMM



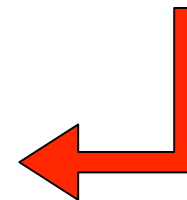
January
Rainfall

July
Rainfall

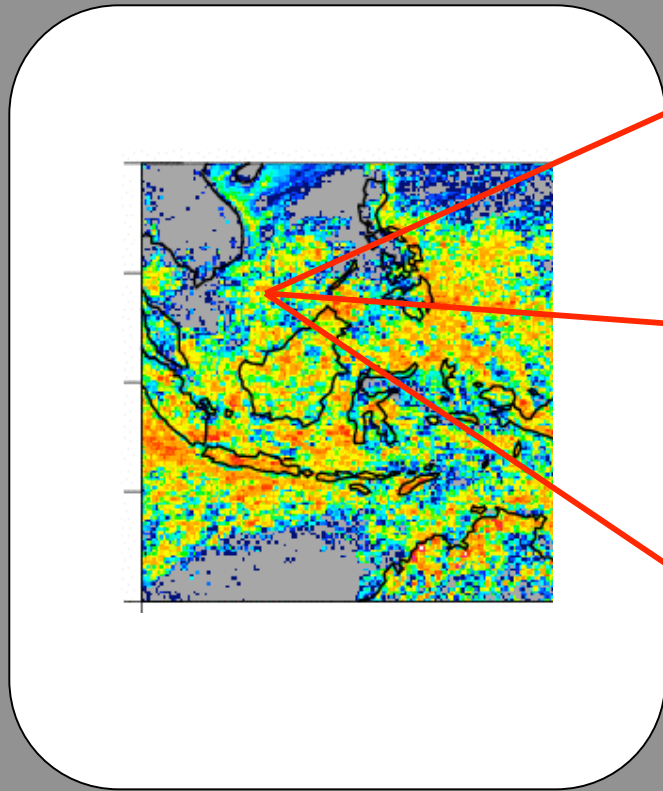
Average Rainfall
Per Cloud Type



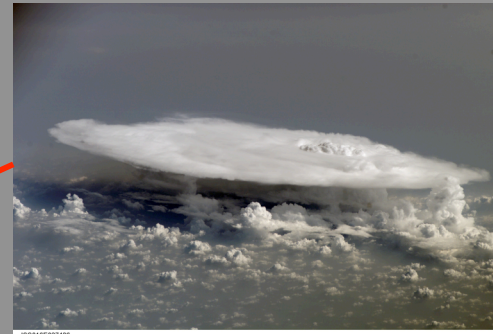
Average Heating



What might a collection of raining clouds look like at ~100 km?



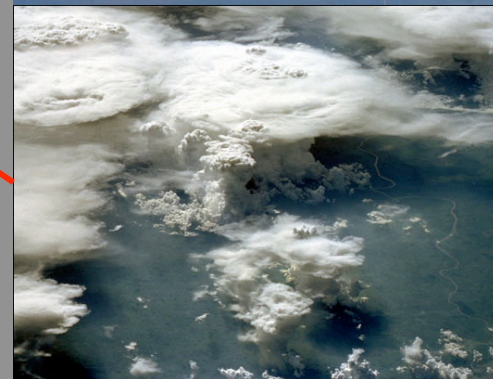
?



?

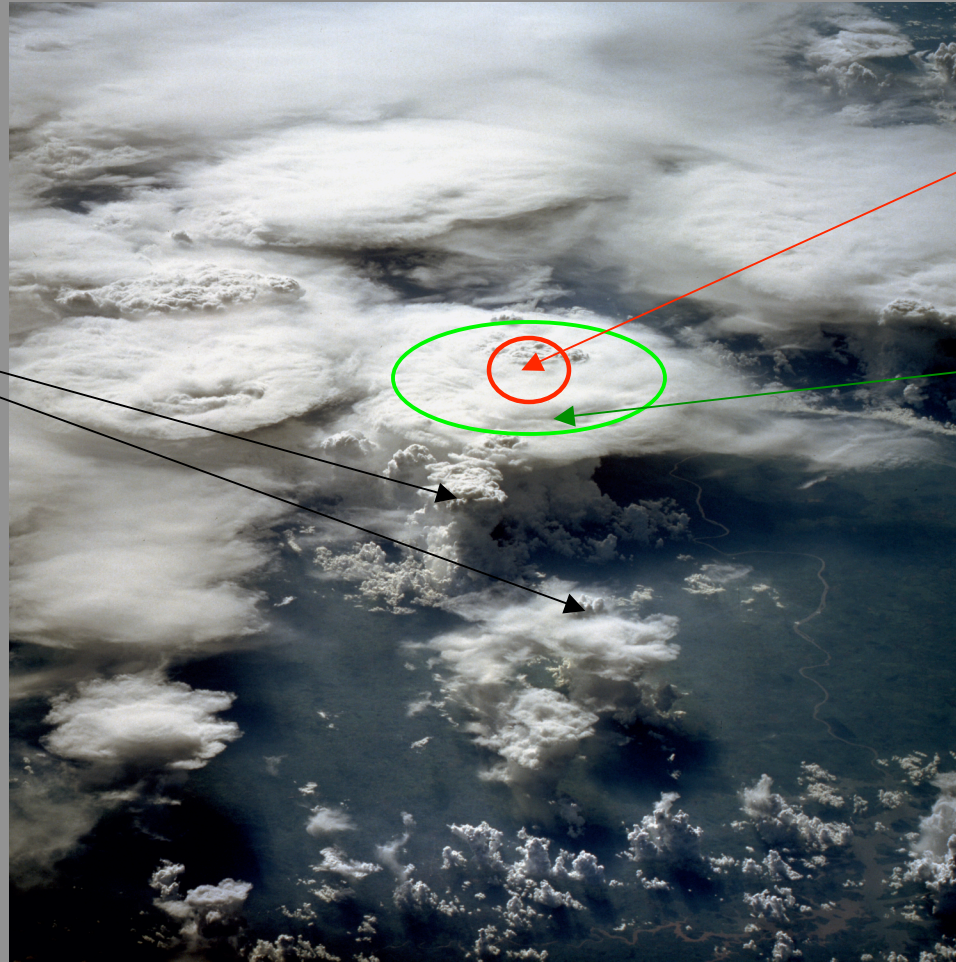


?



**For each 100 x 100 km box, using TRMM PR, save distribution
Of Precipitation Top Heights (PTHs), and ratio of convective to
stratiform rainfall**

PTH

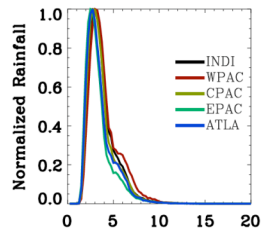


Convective

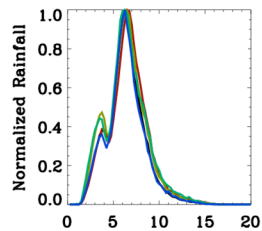
Stratiform

Apply K-means algorithm using the PTH distributions and Rainfall ratios for each 100 x 100 km box over tropical oceans. What emerges?

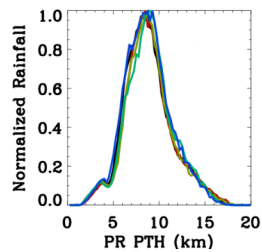
Shallow/
Congestus



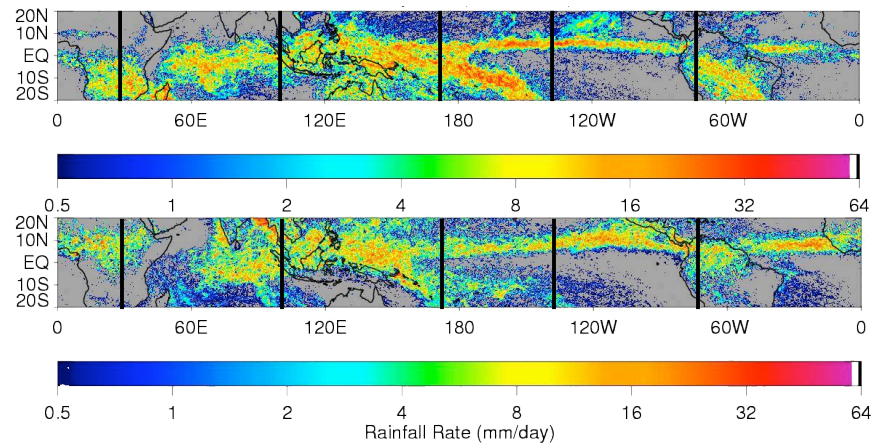
Deep



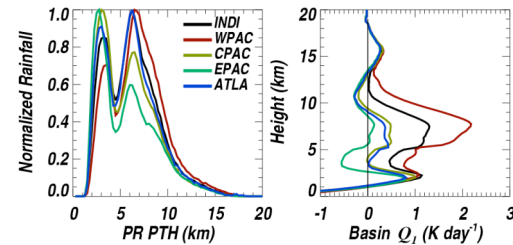
Deepest



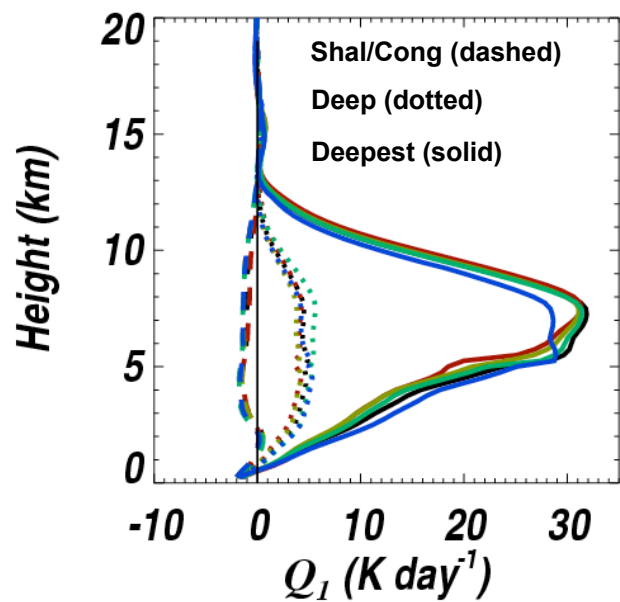
TRMM PR RR CLIMATOLOGY (JAN & JULY)



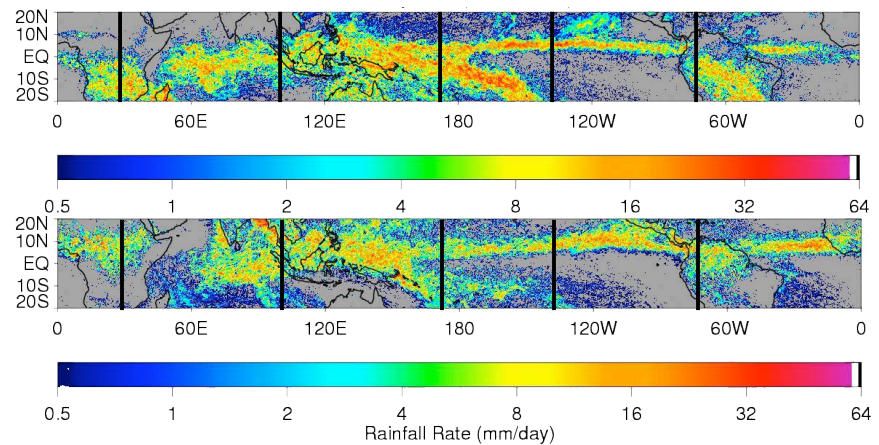
Average Rainfall Distributions and Heating



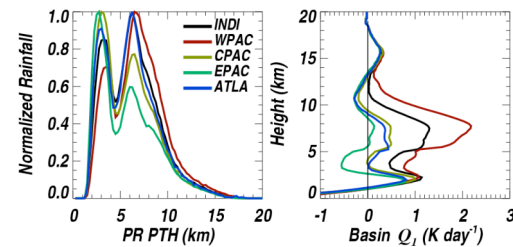
Cluster Heating Using Shige et al. (2007) Heating Algorithm



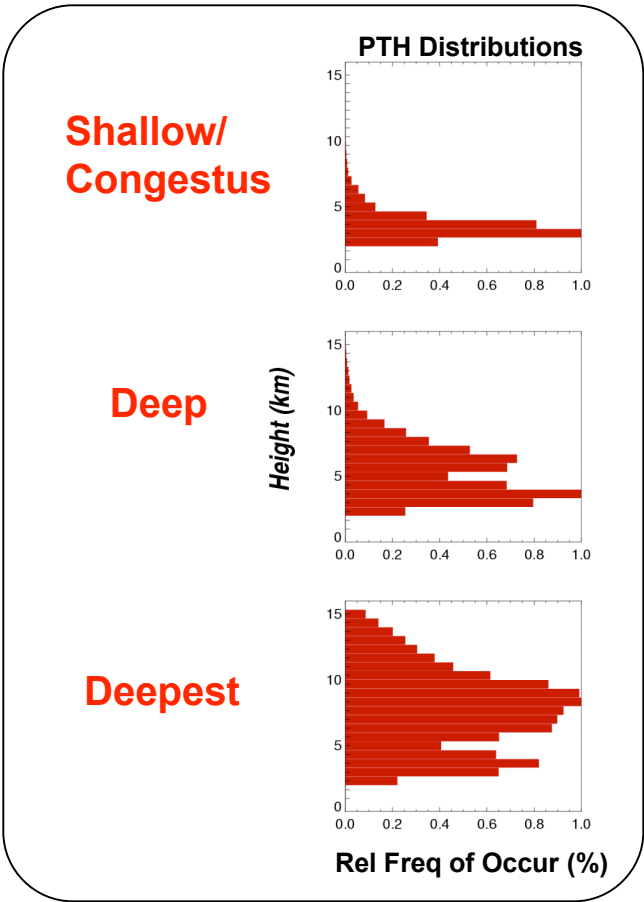
TRMM PR RR CLIMATOLOGY (JAN & JULY)



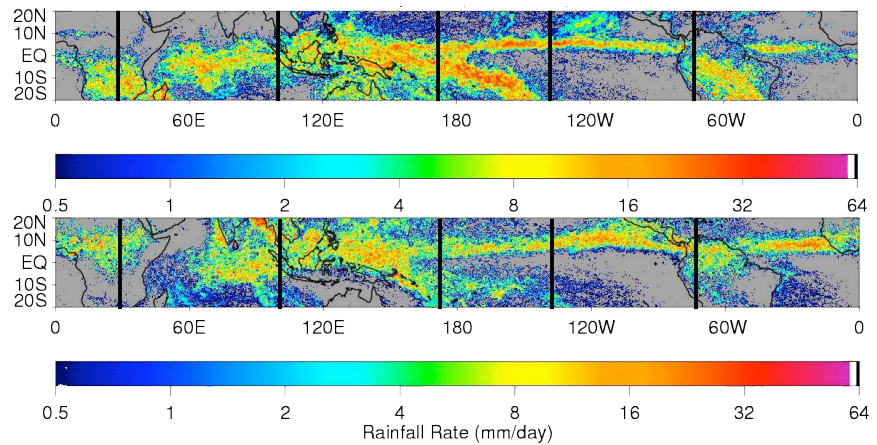
Average Rainfall Distributions and Heating



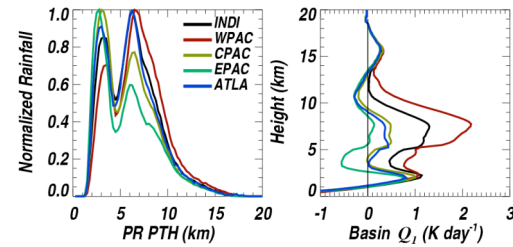
Precipitation Top Heights (PTH) Distributions



TRMM PR RR CLIMATOLOGY (JAN & JULY)



Average Rainfall Distributions and Heating

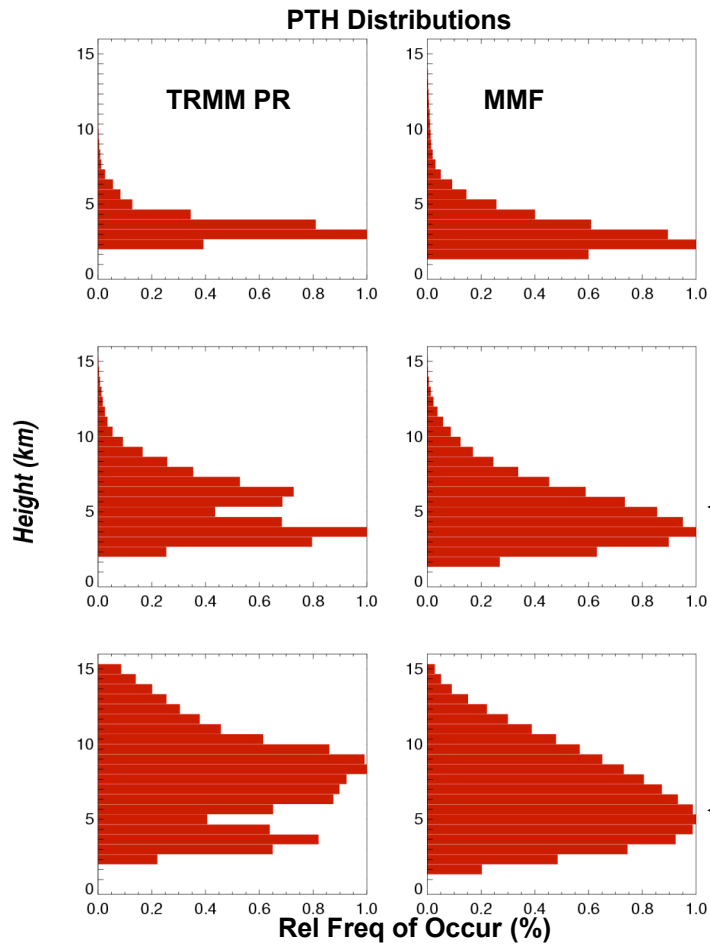


Does a model such as the CSU MMF produce the same spectrum of raining clouds and ensemble heating profiles?

- **Compare “apples to apples” - simulate TRMM Precipitation Radar reflectivity profiles using water and ice profiles provided from embedded CRM curtain in GCM grid.**
- **Develop stratiform/convective algorithm for MMF that mimics the TRMM algorithm to determine relative amounts of convective and stratiform rainfall.**

Spectrum of precipitating clouds from TRMM and CSU MMF

Shallow/
Congestus

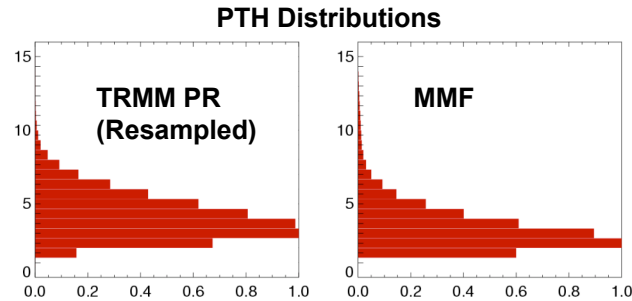


Deep

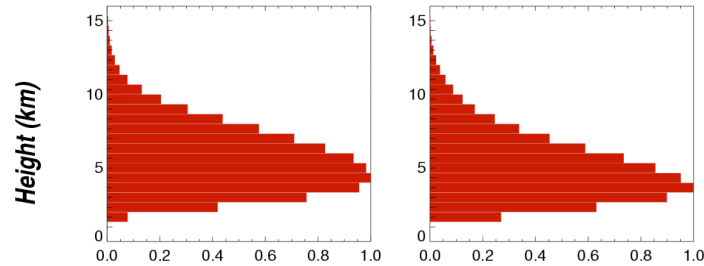
Deepest

Spectrum of precipitating clouds from TRMM and CSU MMF

Shallow/
Congestus

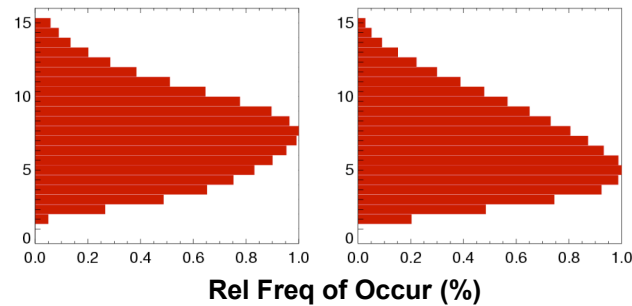


Deep



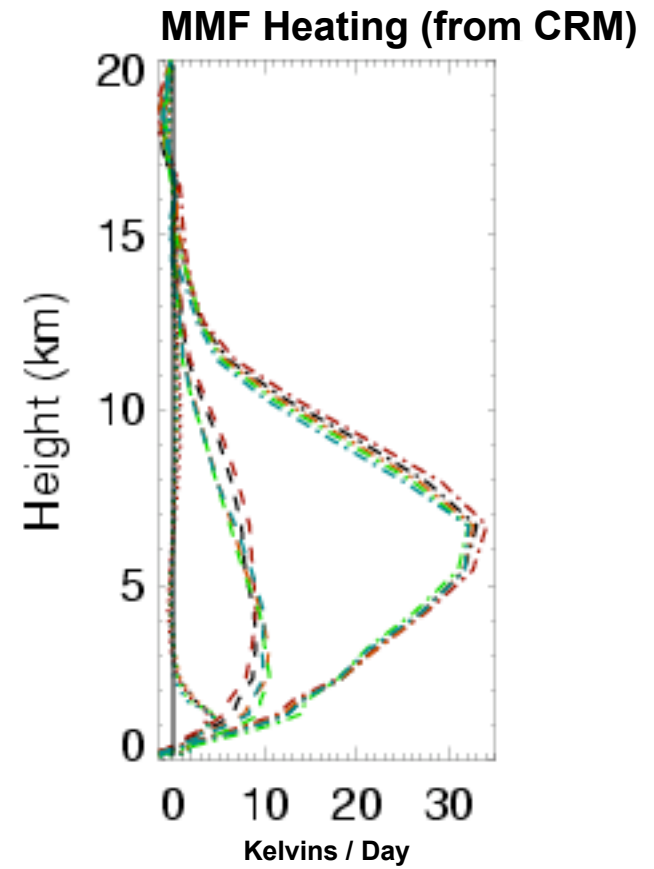
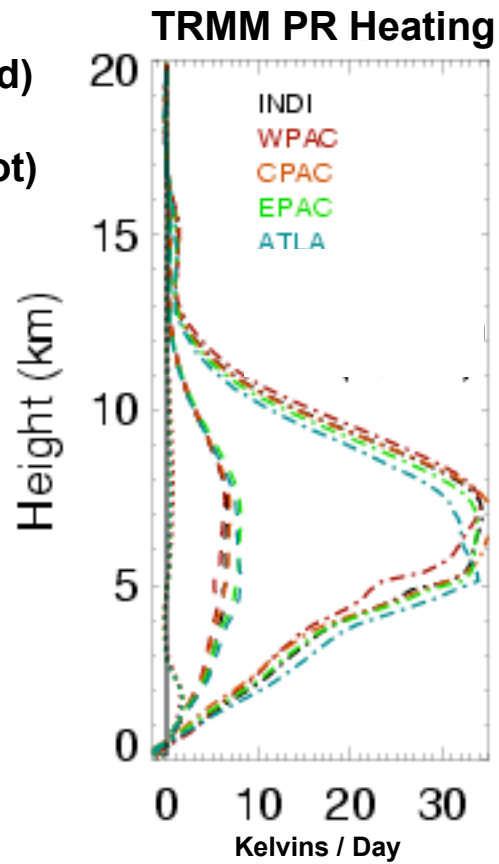
← What is going on
At these altitudes?
Is it as simple as
vertical resolution
differences?

Deepest



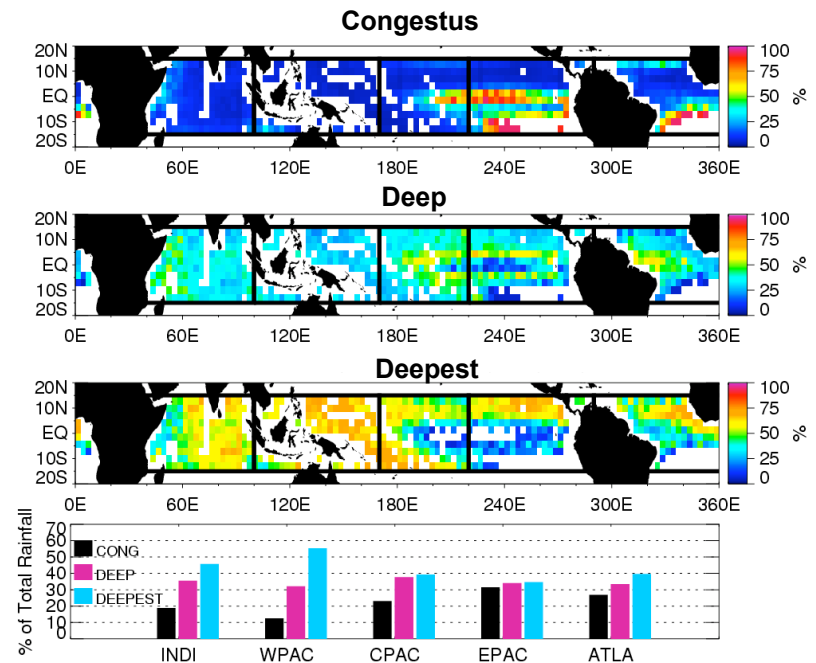
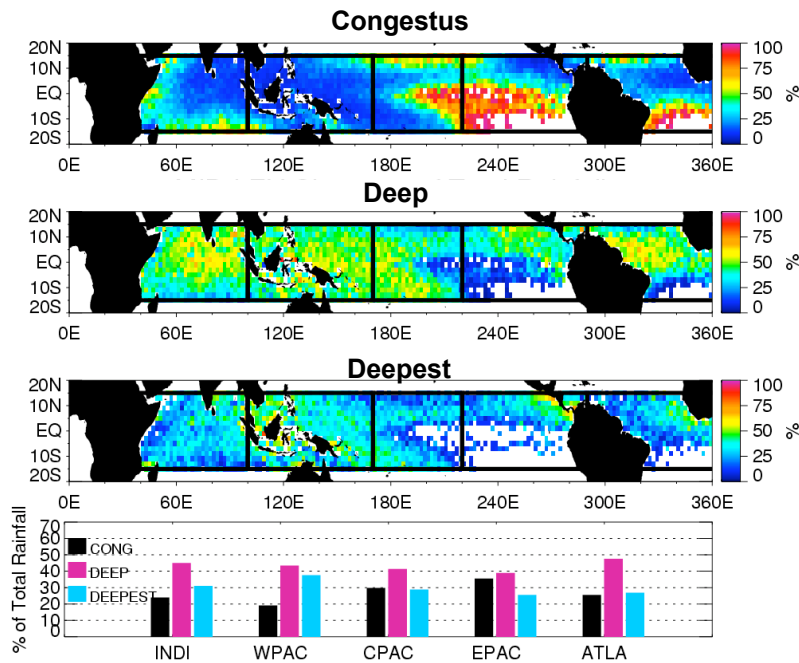
Heating Profiles from TRMM and CSU MMF

Shal/Cong (Dotted)
Deep (Dash)
Deepest (Dash-dot)



Similar heating/raining cloud ensembles for each cluster - do clusters contribute to the average rainfall in similar manners as a function of location?

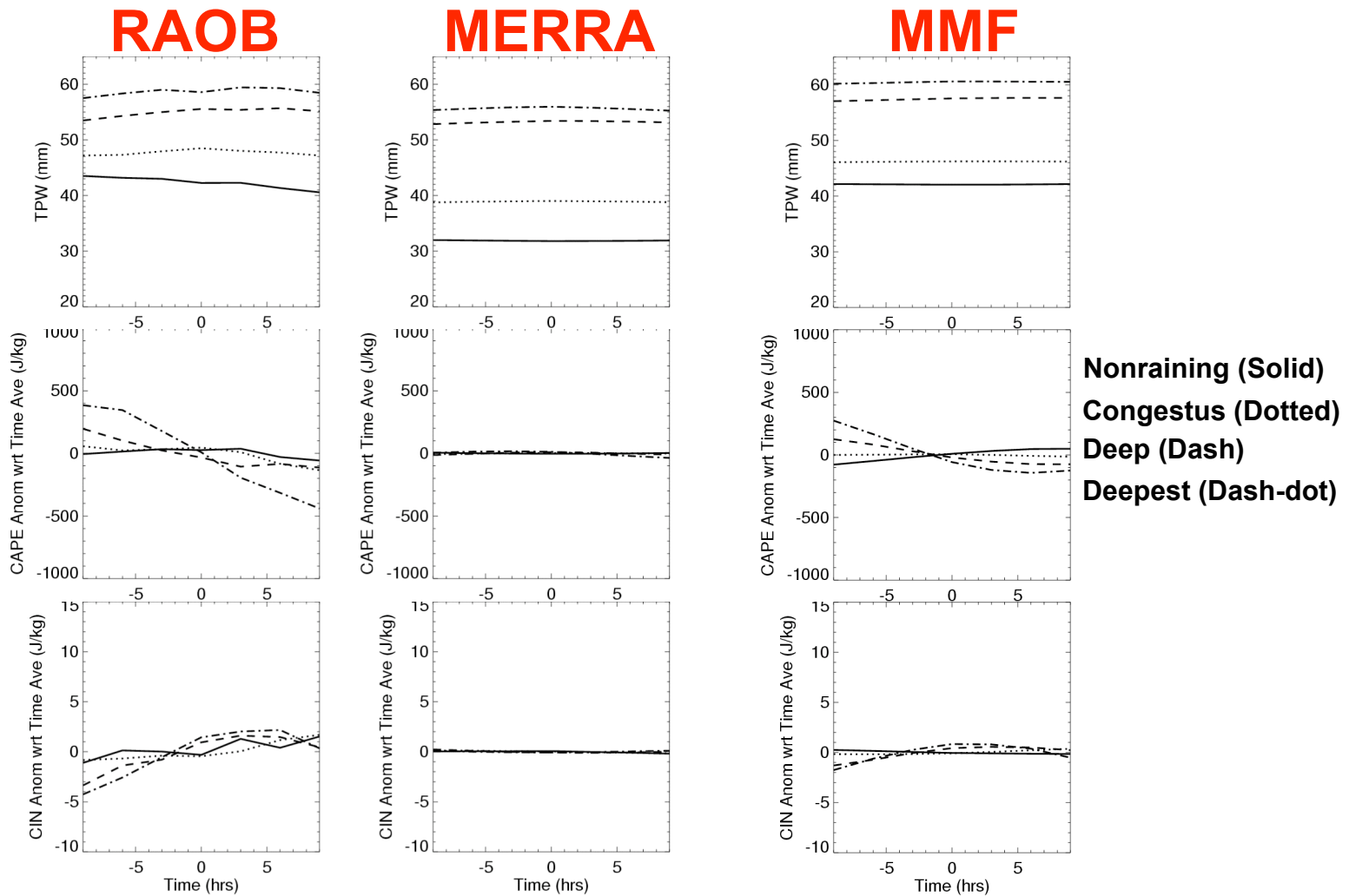
% Contribution to Total Rainfall by each cluster



TRMM

MMF

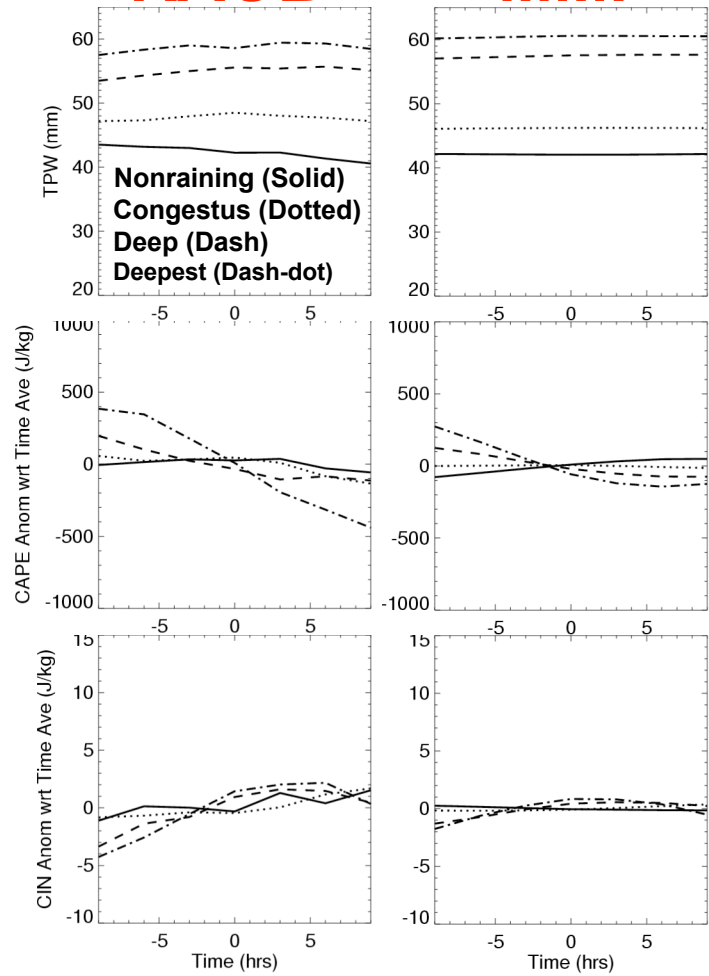
Column Total Water Vapor for clusters, and Evolution of Convective Available Potential Energy (CAPE) and Convective Inhibition (CIN)



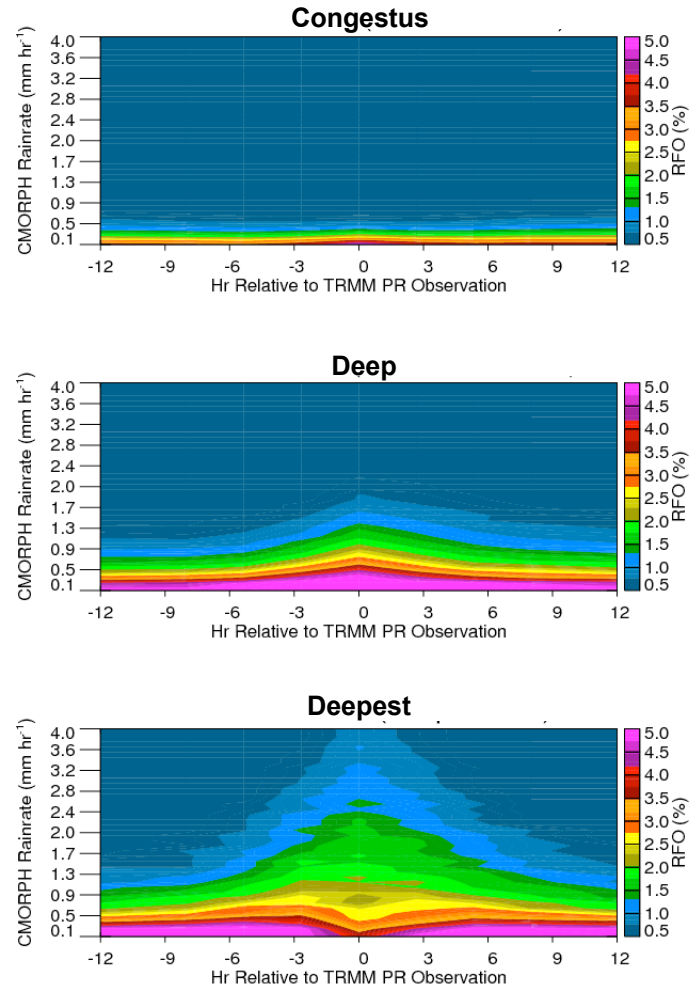
Column Total Water Vapor for clusters, and Evolution of Convective Available Potential Energy (CAPE) and Convective Inhibition (CIN)

RAOB

MMF

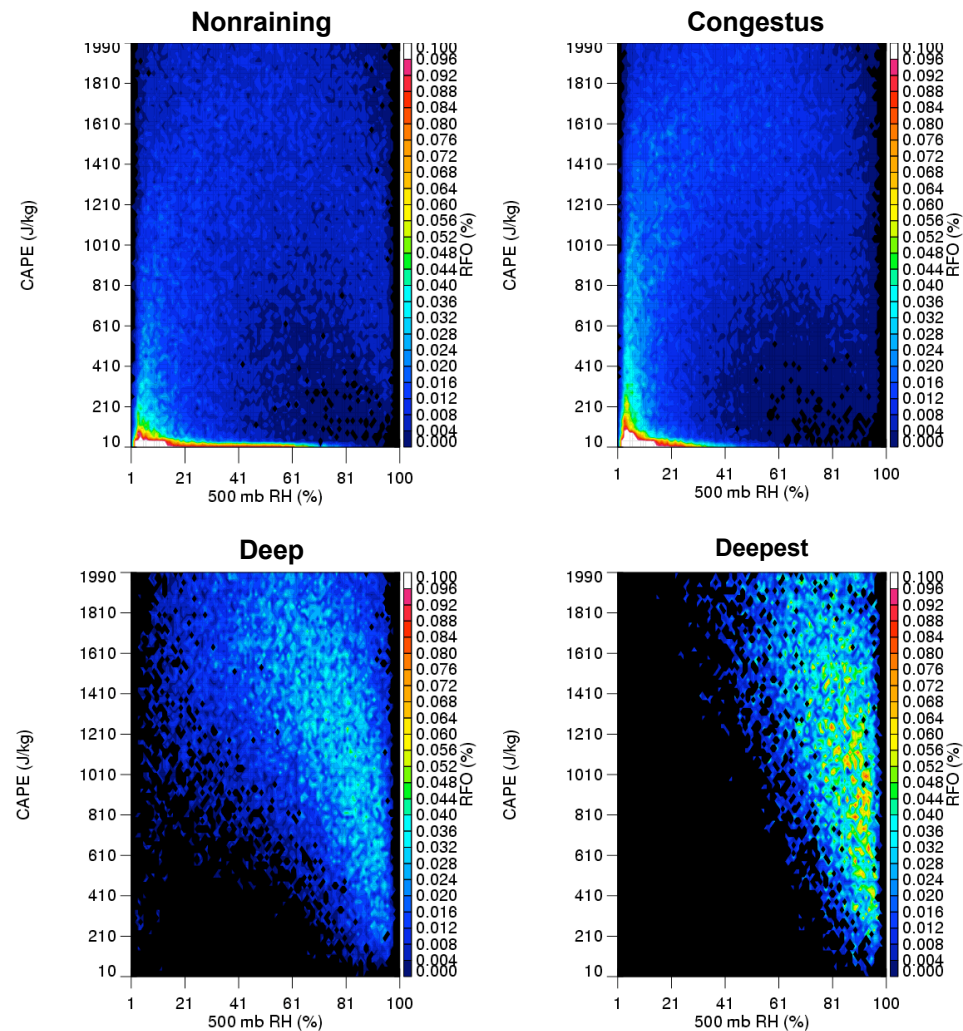


What happened 9 hours prior to cluster time?



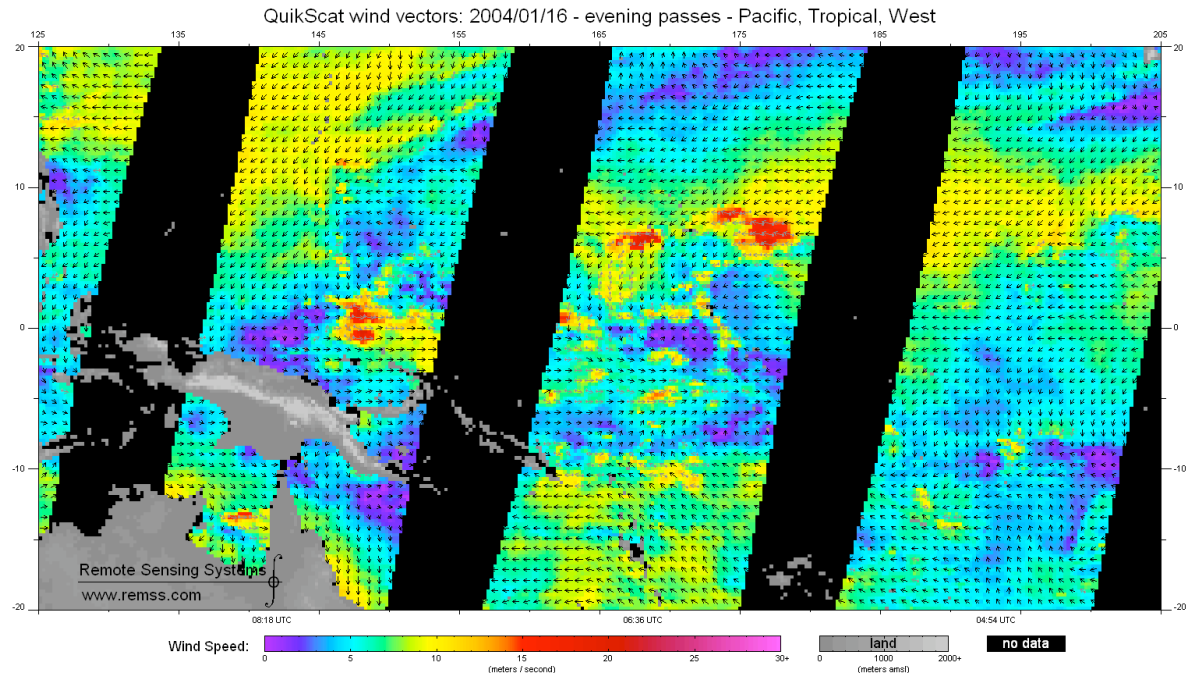
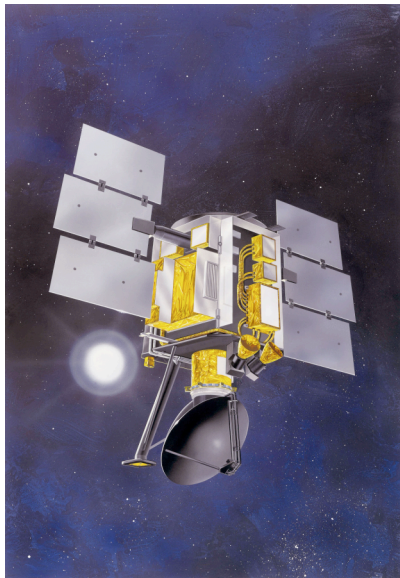
Frequency of precipitation cluster occurrence given CAPE and 500 mb relative Humidity (RH) before pick-up of rainfall (9 hours prior to cluster time).

Is it possible in general to use a state parameter (e.g. CAPE, RH) to separate clusters?



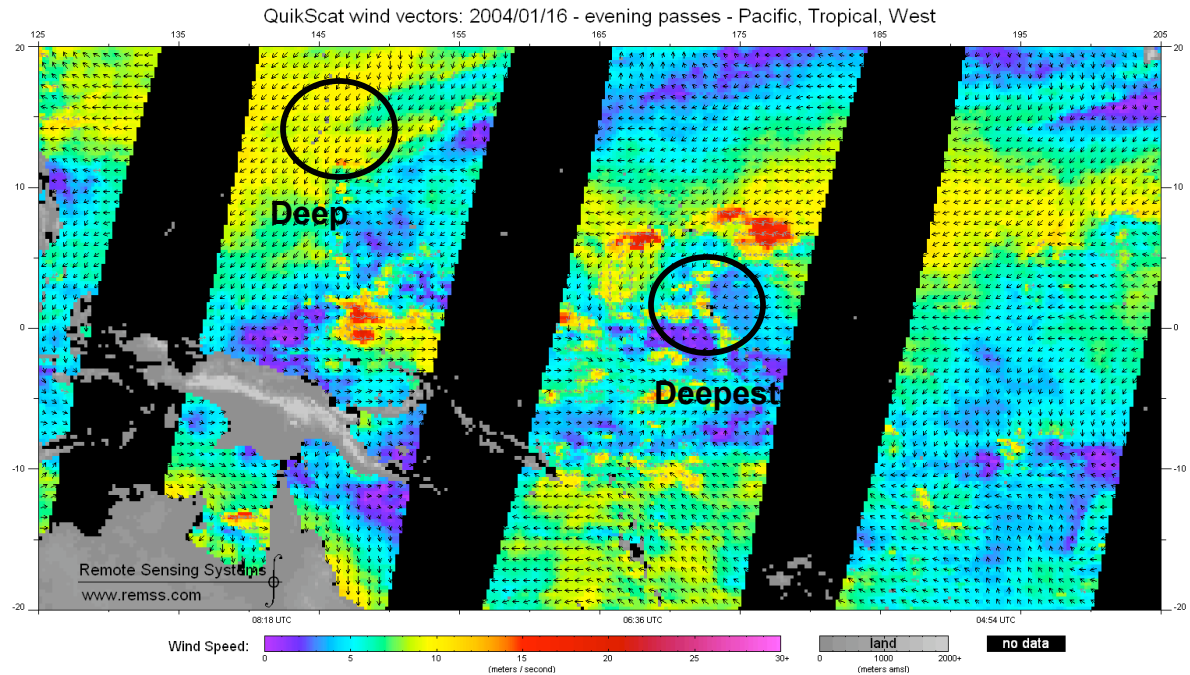
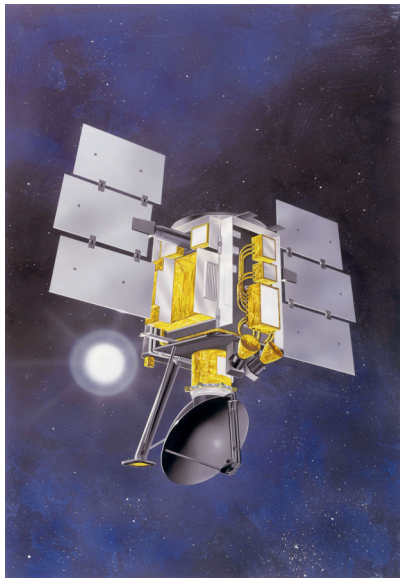
Another field we've been looking at...

Variability in the field of surface divergence, through analysis of QuikSCAT surface wind vector retrievals.

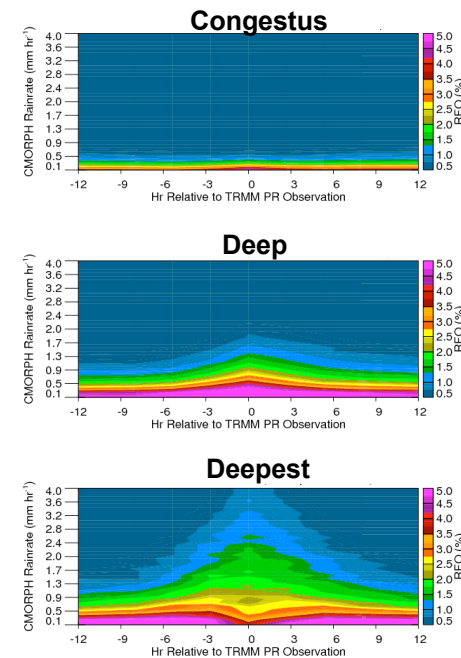
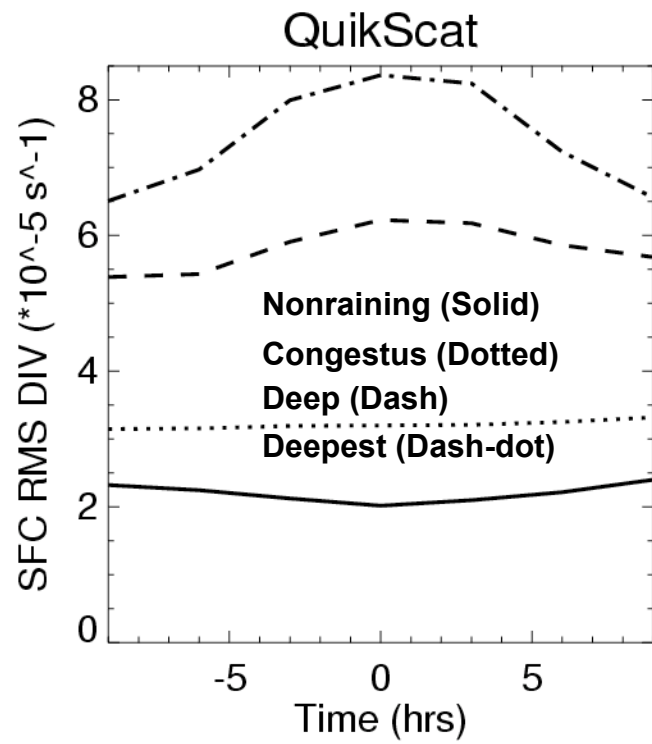


TRMM Overpass ~6-9 hours after this QuikSCAT snapshot.

Variability in the field of surface divergence, through analysis of QuikSCAT surface wind vector retrievals.



Compute the standard deviation of the surface divergence from QuikSCAT, and composite for clusters. Are these cold pools (?) “hanging around” serving to both aid in the development and organization of deepest precipitation? Activity is present before pick-up in rainfall (see panels at right).



Summary and Future (as in now) Work

- **Much similarity between heating profile structures and precipitating cloud populations between TRMM PR and the MMF, with three precipitation clusters that emerge in all basins and look quite similar to each other. Deepest regime occurs more often than is found according to TRMM in the Indian and W. Pacific ocean basins.**
- **Similar evolution of background parameters in each basin too (some shown, many not shown). Thermodynamic parameters don't necessarily allow for separation among deepest convection regimes. Role of cold pools?**
- **Have been looking at the evolution of these precipitation clusters composited around the initiation period of the MJO in the western Indian Ocean (cloud populations and evolution a big focus of upcoming DYNAMO campaign)**