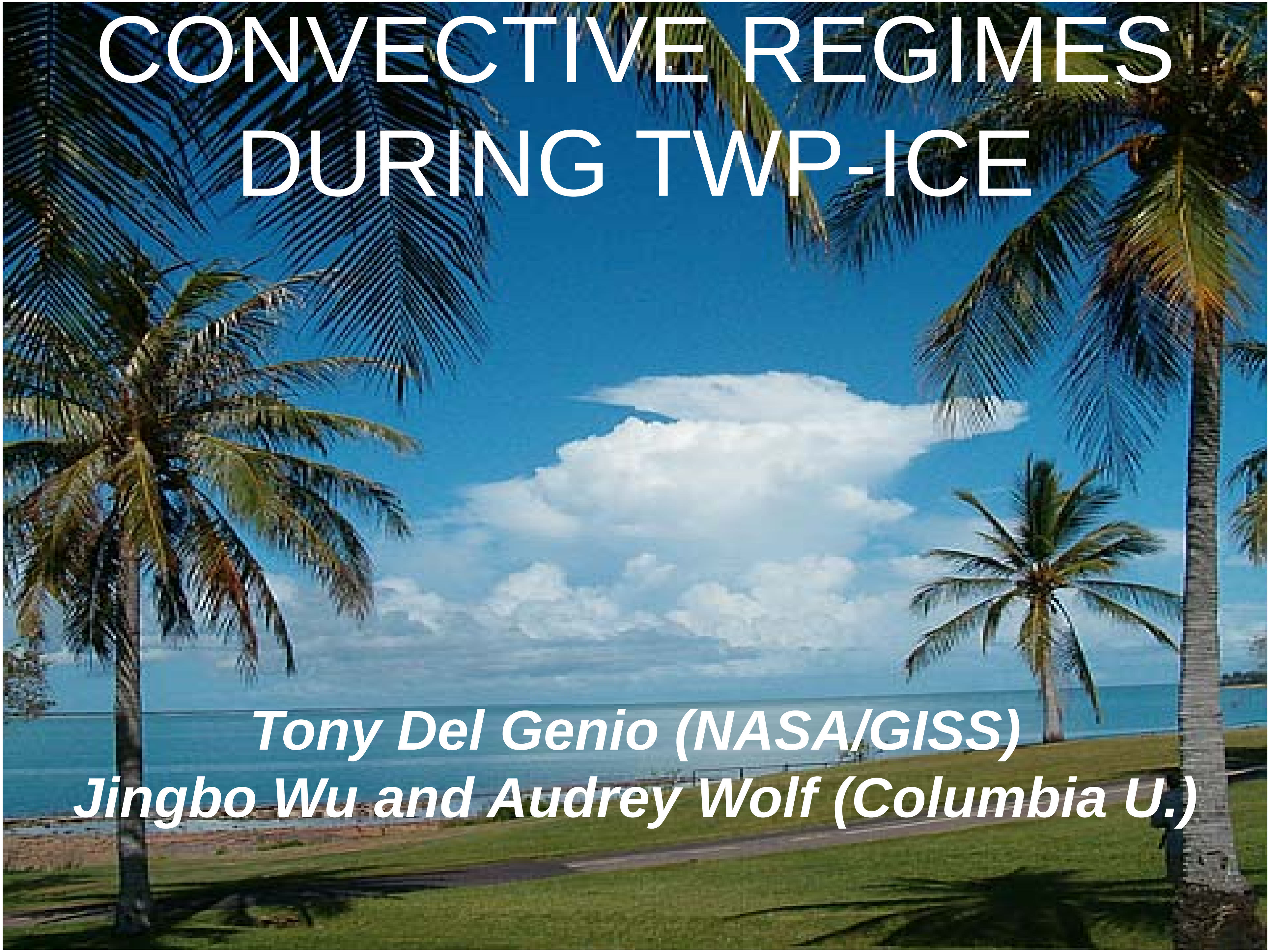
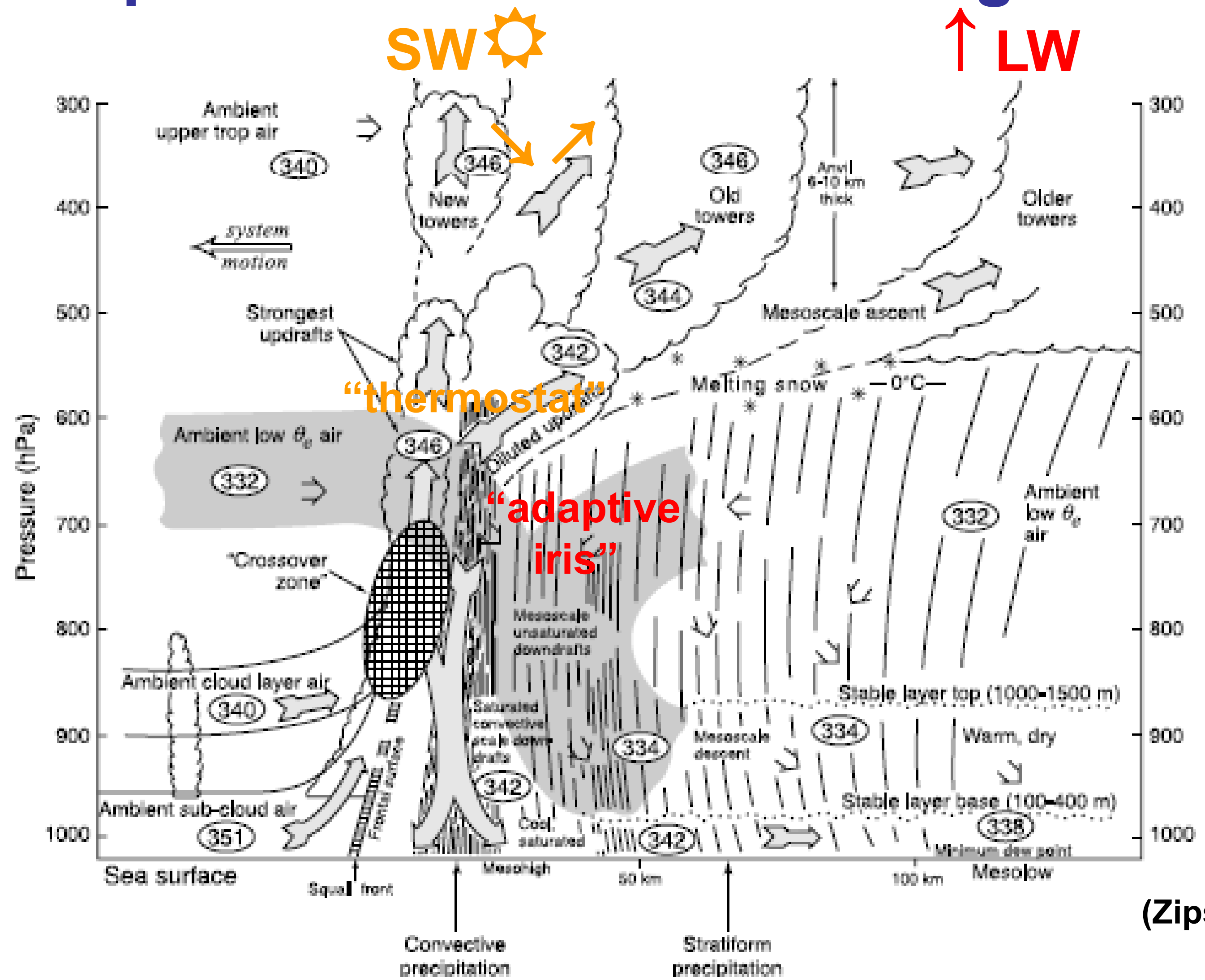


CONVECTIVE REGIMES DURING TWP-ICE

Tony Del Genio (NASA/GISS)

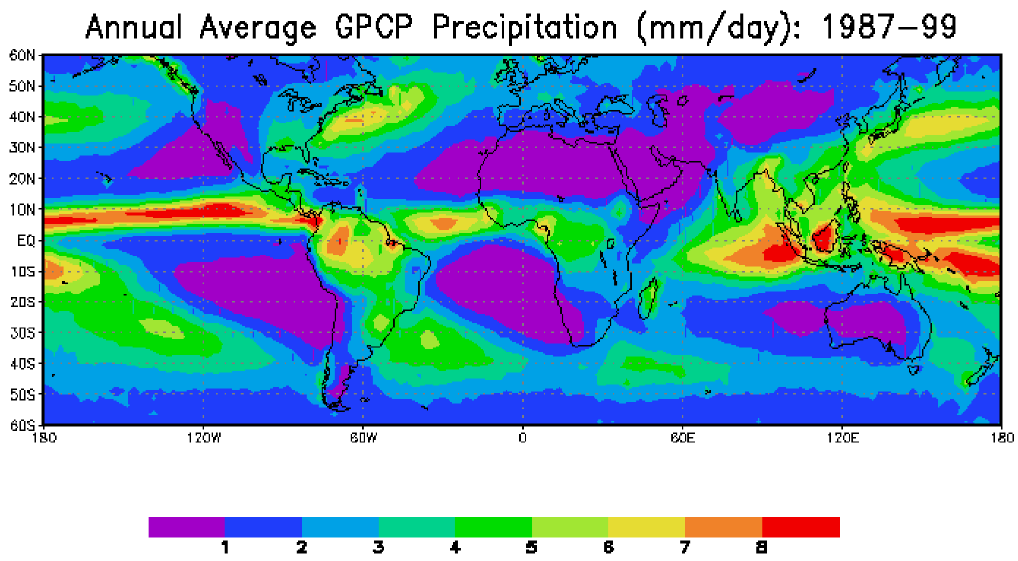
Jingbo Wu and Audrey Wolf (Columbia U.)

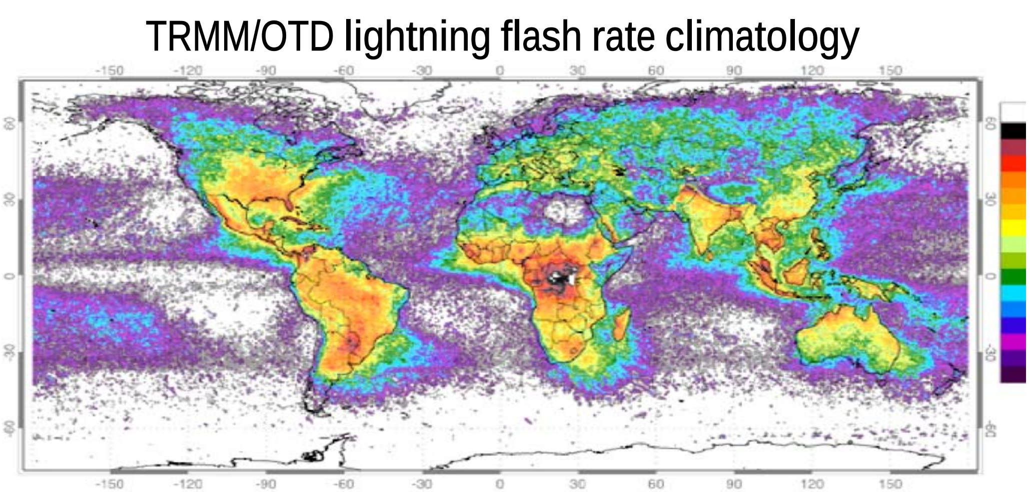
Effect of moist convection on cloud feedback depends on convection strength



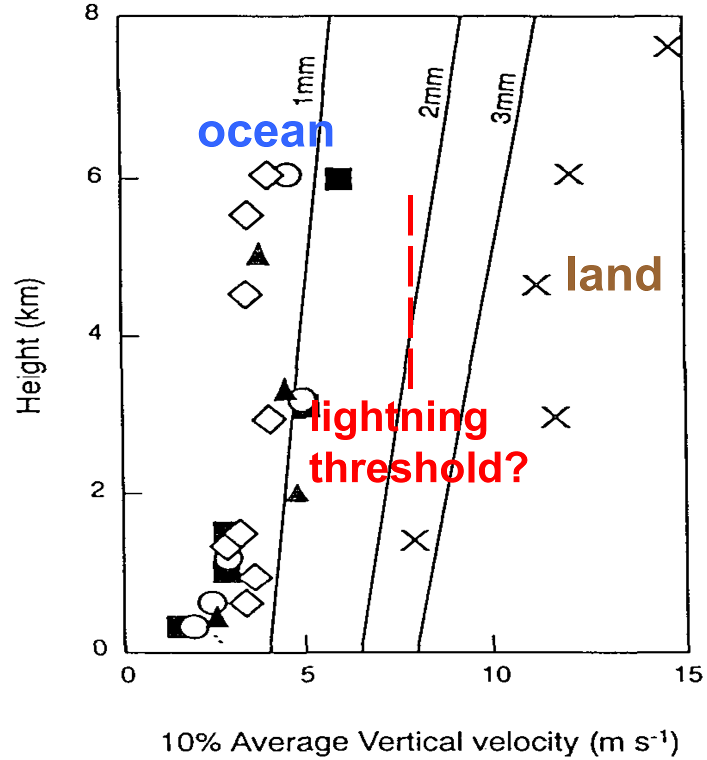
(Zipser, 1977)

"thermostat" → detrainment control **"adaptive iris" → precipitation control**





Almost all lightning occurs over land – a proxy for convection strength … but why is convection stronger over land?



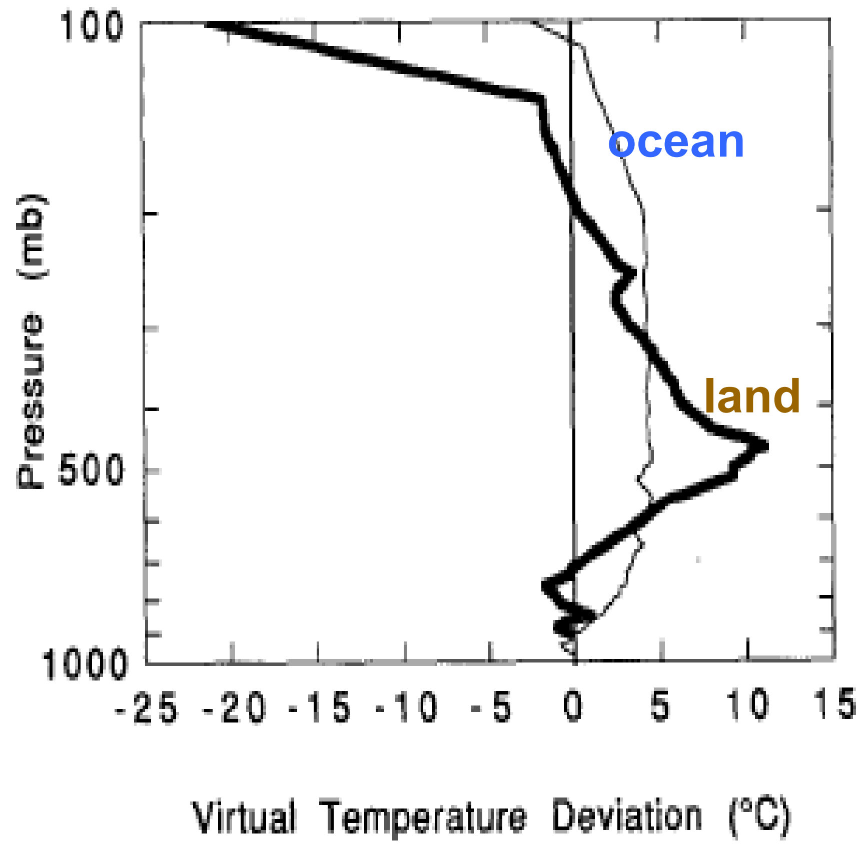
Zipser and Lutz (1994)

CAPE (vertically integrated buoyancy) similar in sampled maritime and continental soundings, so…

1. “Shape of the CAPE”: Rising parcels more buoyant, but over smaller depth, over land than ocean

2. Different boundary layer depth and cloud base height over land and ocean: Bigger land bubbles, less entrainment dilution

3. Aerosol effects on autoconversion and ice phase initiation: Smaller droplets lofted more easily into ice phase region

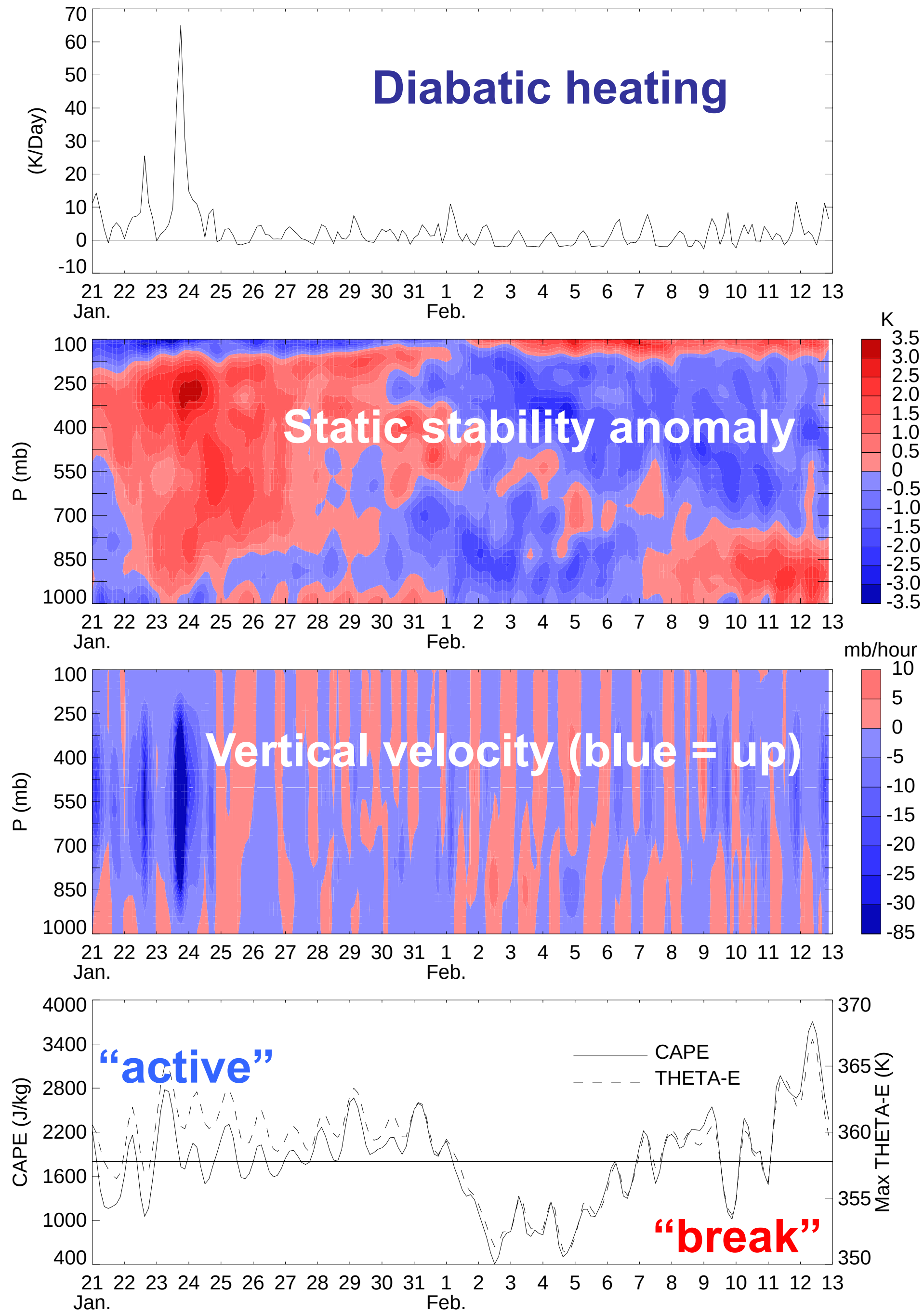


(Lucas et al. 1994)

A problem for GCMs, because

- Most cumulus parameterizations don't calculate updraft speed, only mass flux (proportional to updraft speed x area)
- GCMs don't account for different sizes of buoyant parcels rising from boundary layer
- Few GCMs include aerosol effects on both convection and the ice phase

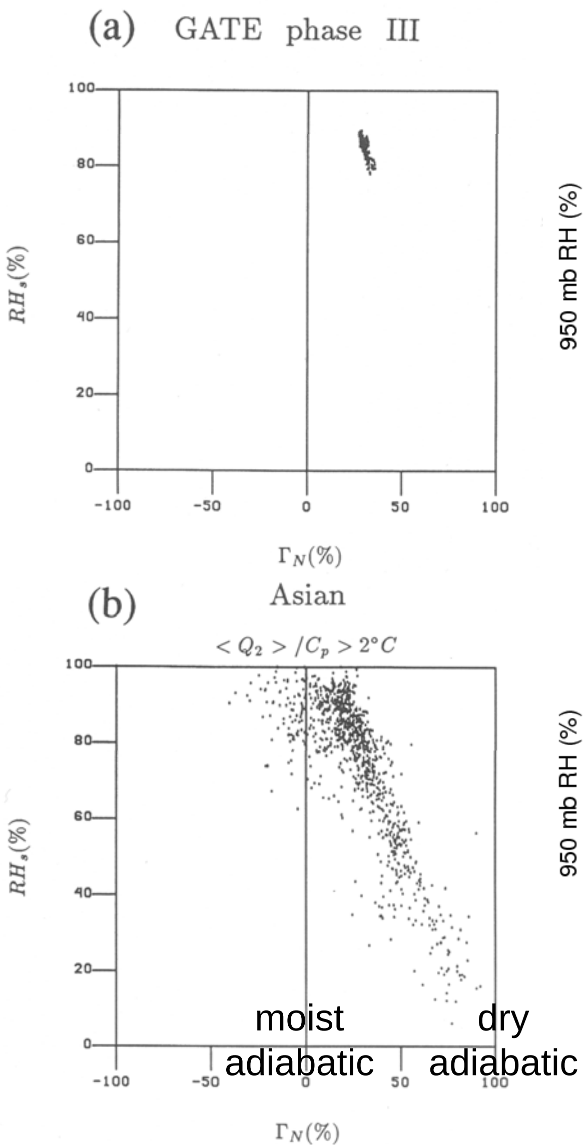
What did TWP-ICE have to say about this?



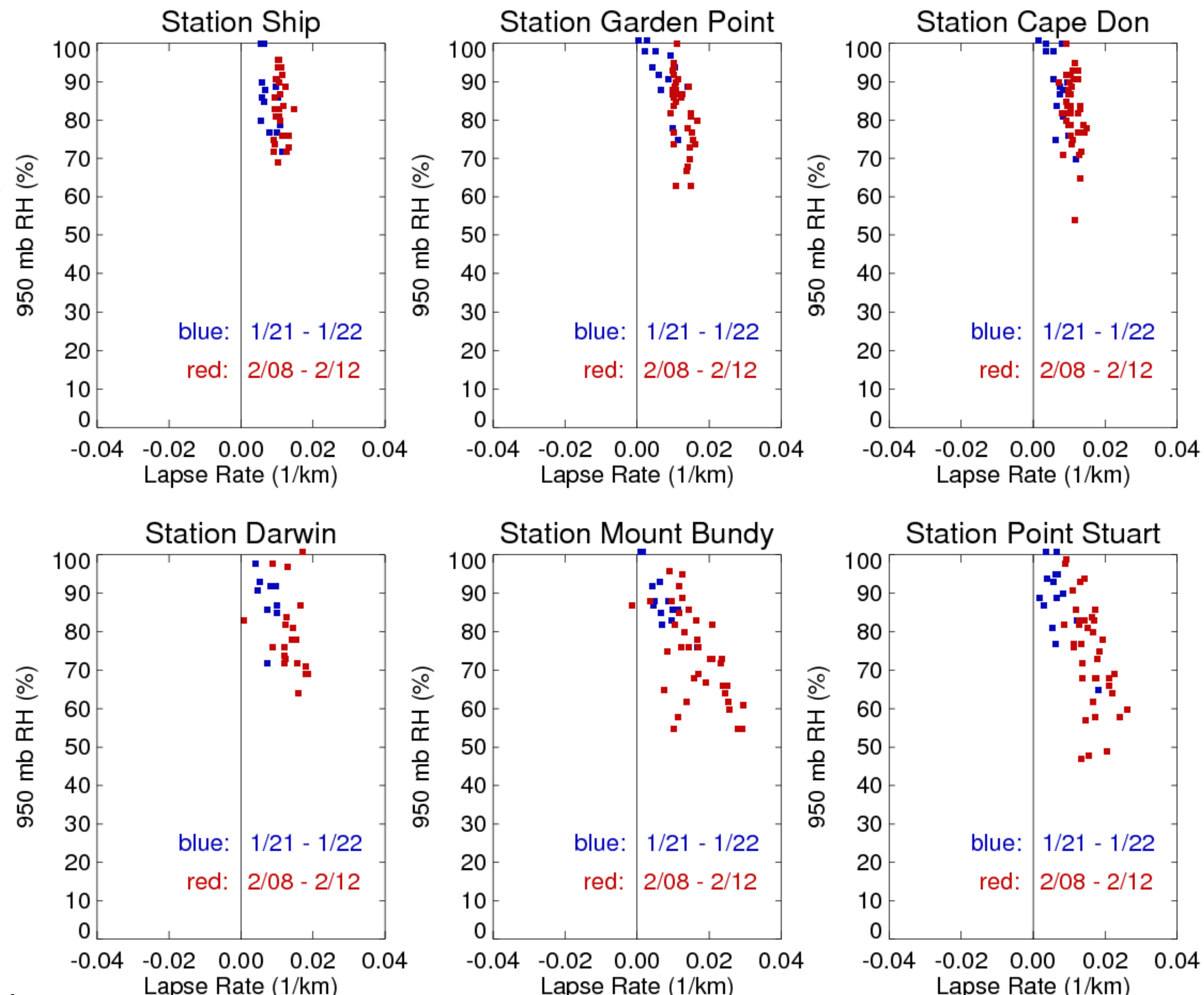
“Active monsoon” early period: strong large-scale dynamical forcing, lots of convection, near-neutral stability

“Break” late period: weak dynamical forcing, more surface flux control, sporadic convection, steeper lapse rate

CAPE larger during break period than active period



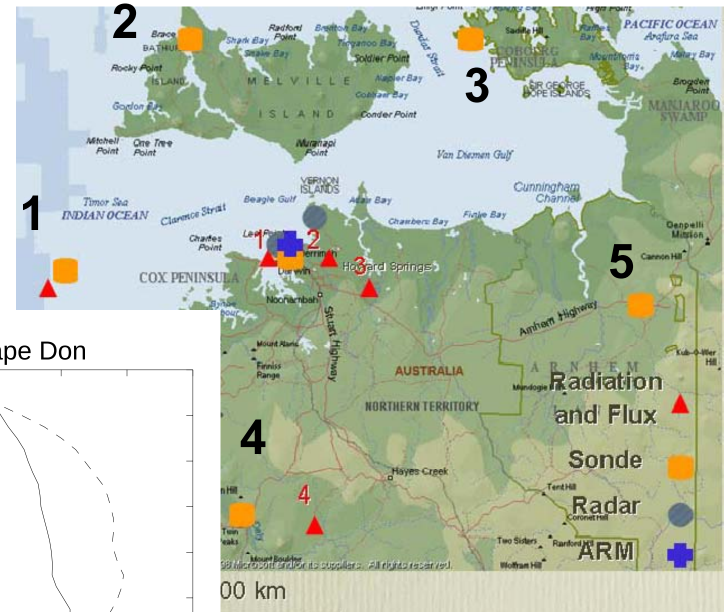
Arakawa (1993)

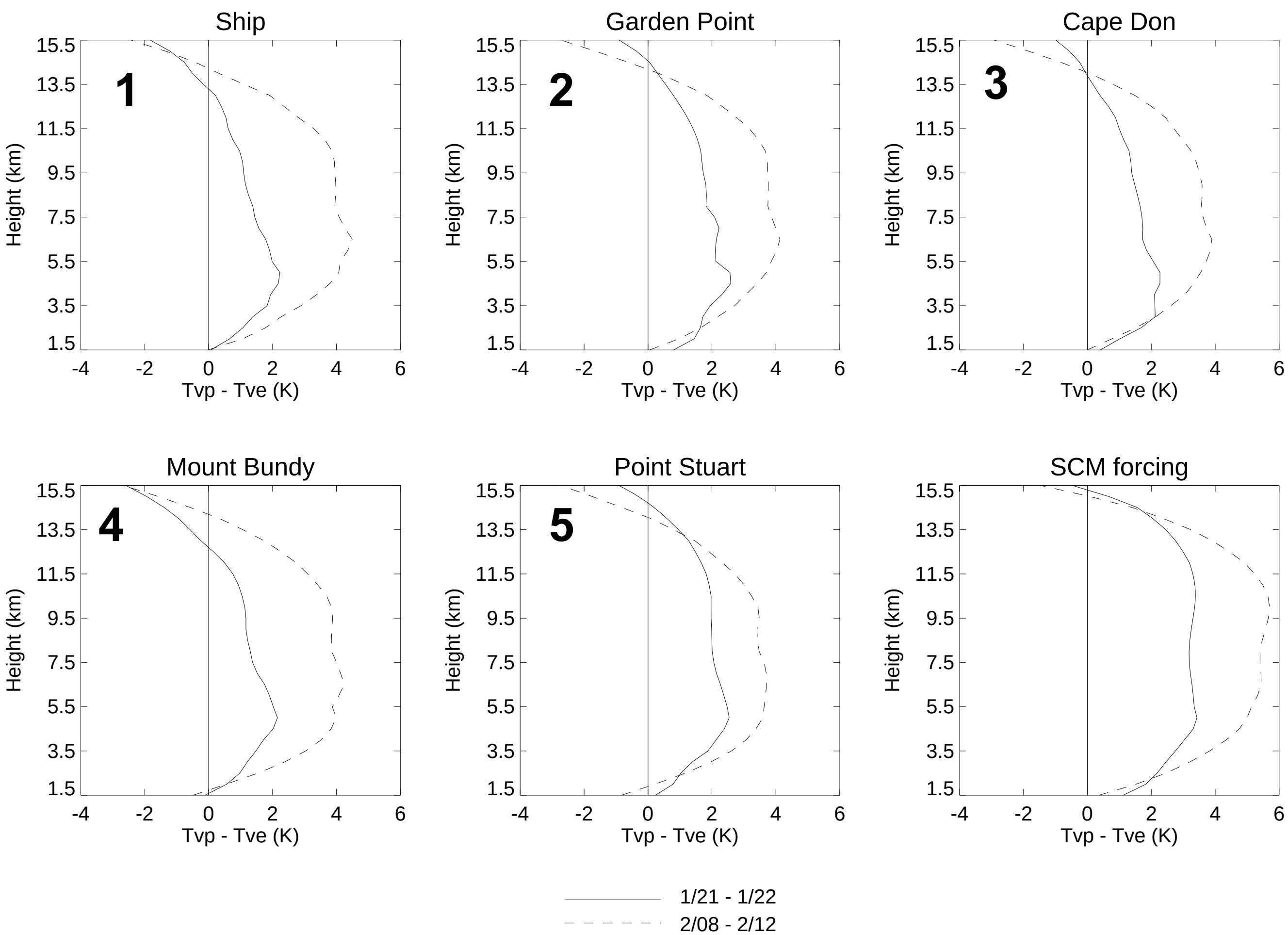


Active ~ maritime, break ~ continental
… to some extent

Parcel buoyancies greater at all sites during break period

SCM forcing datatset buoyancies exceed those from all sounding locations…





… effect of sonde dry bias correction? Difference matters for convective intensity

Diagnosis of growth of cumulus updraft speed from thermodynamic structure in SCM (Gregory 2001)

$$\frac{1}{2}\frac{\partial \overline{w}^{c2}}{\partial z} = ag\overline{\left(\frac{T_v{}'}{\overline{T_v}} - l\right)}^{c} - b\delta\overline{w}^{c2} - \overline{w}^{c2}\epsilon$$

buoyancy due to parcel T, q excess

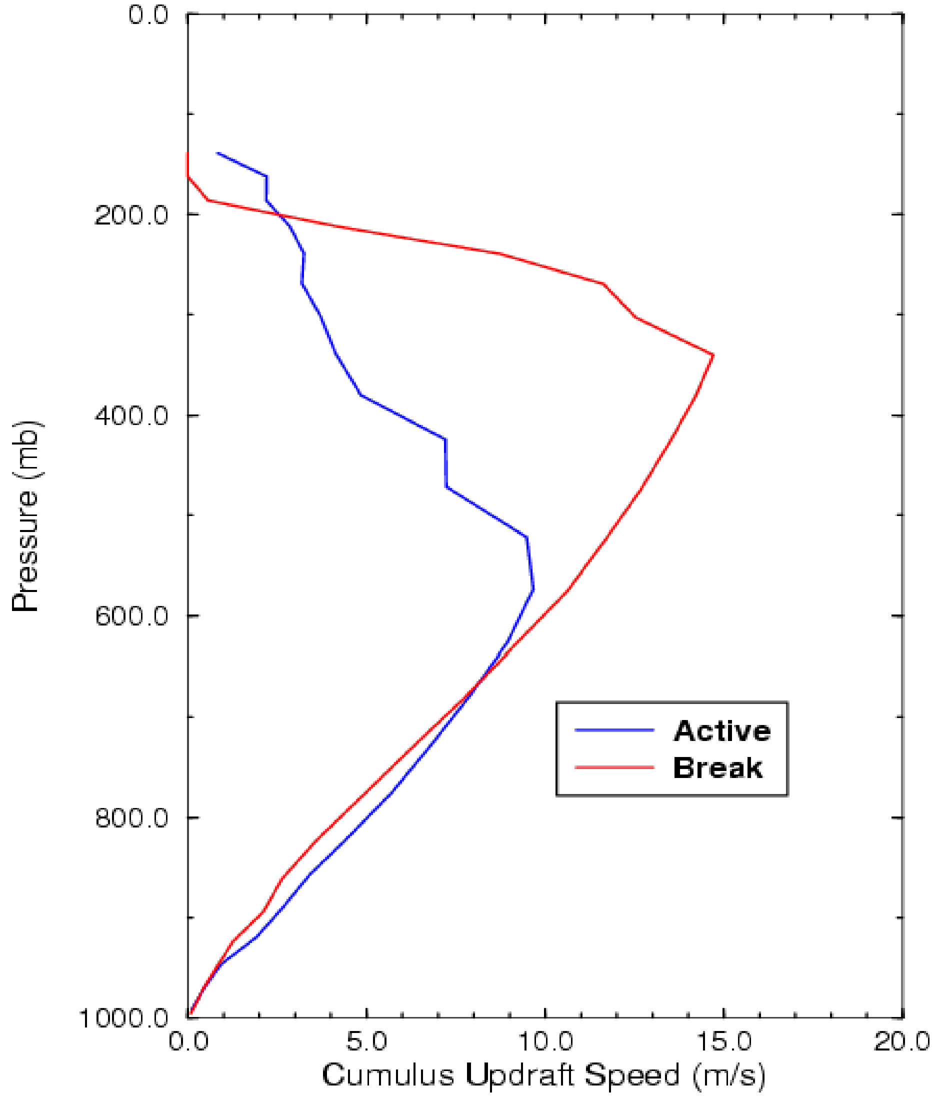
drag due to condensed water loading

downward cumulus pressure gradient force

dilution by entrainment

$$\epsilon\overline{w}^{c2} = C_\epsilon ag\overline{\left(\frac{T_v{}'}{\overline{T_v}} - l\right)}^{c}$$

Combined with Marshall-Palmer DSD and empirical size-fallspeed relations for liquid/graupel/ice, allows for interactive estimates of convective precipitation efficiency and effect on anvil cloud



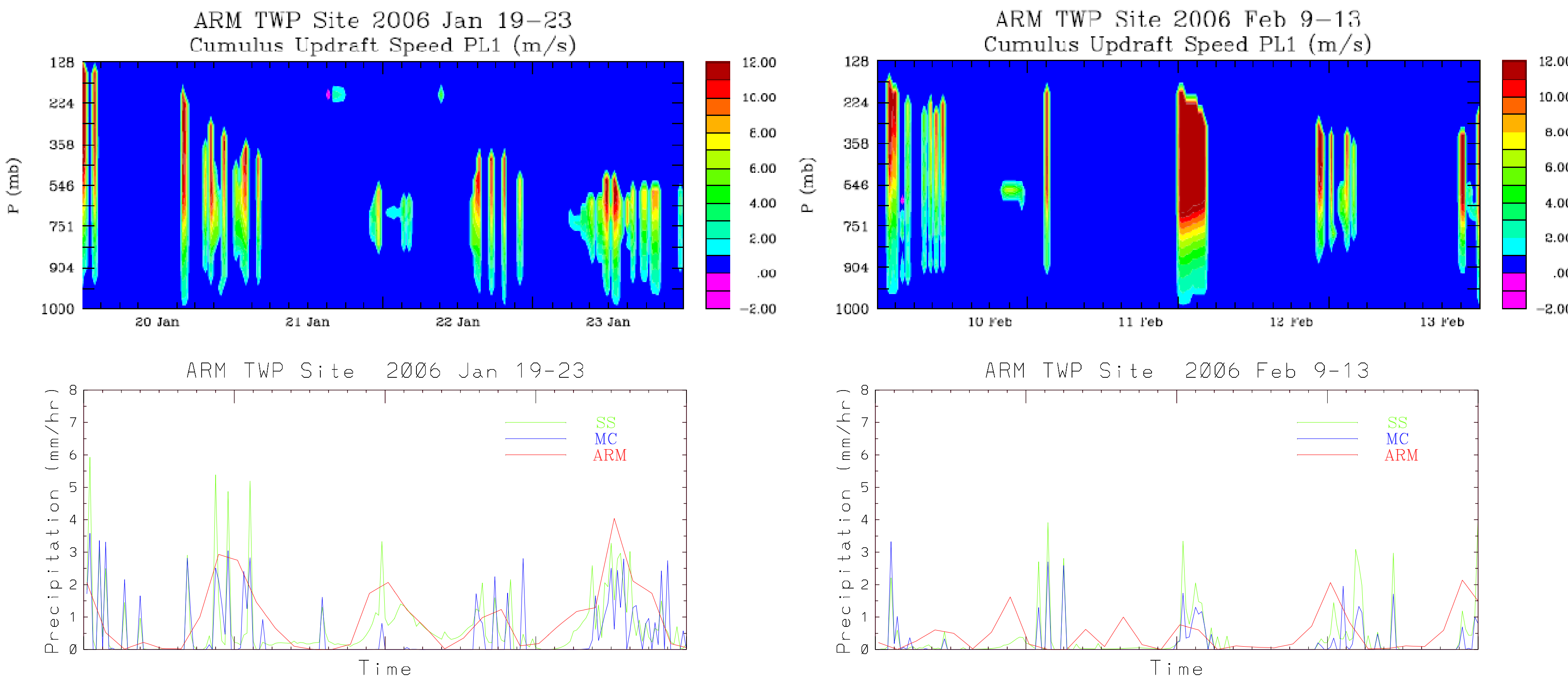
SCM does simulate a difference in mean updraft speed during deep convective events …

But speeds are probably too large during active period

SCM forcing? Soundings, surface fluxes?

Boundary layer mixing?

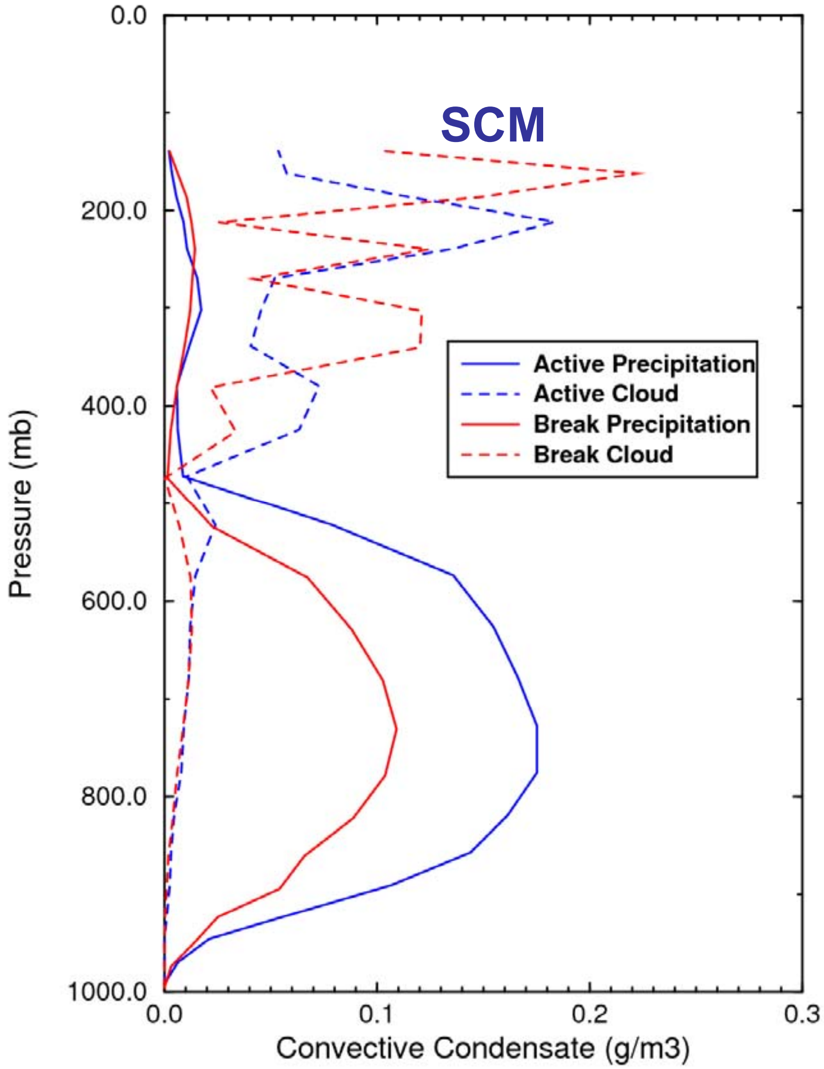
Updraft parameterization?

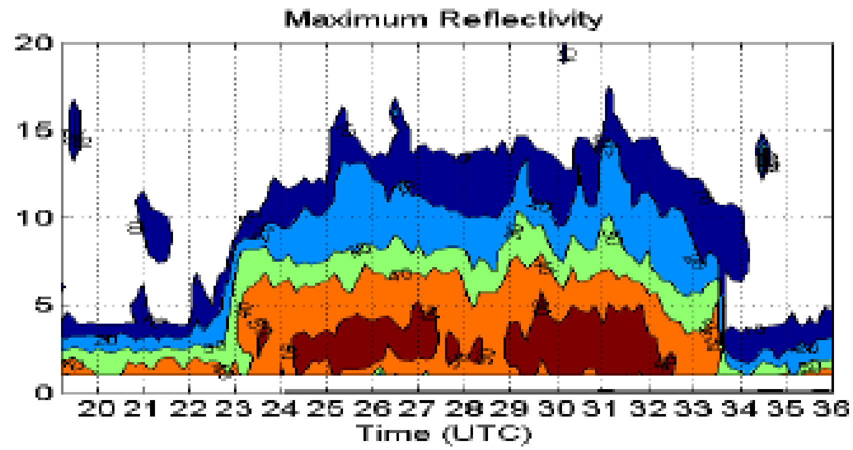


Active-break difference in individual events not so obvious except for Feb. 11 case, response to PBL moisture error buildup

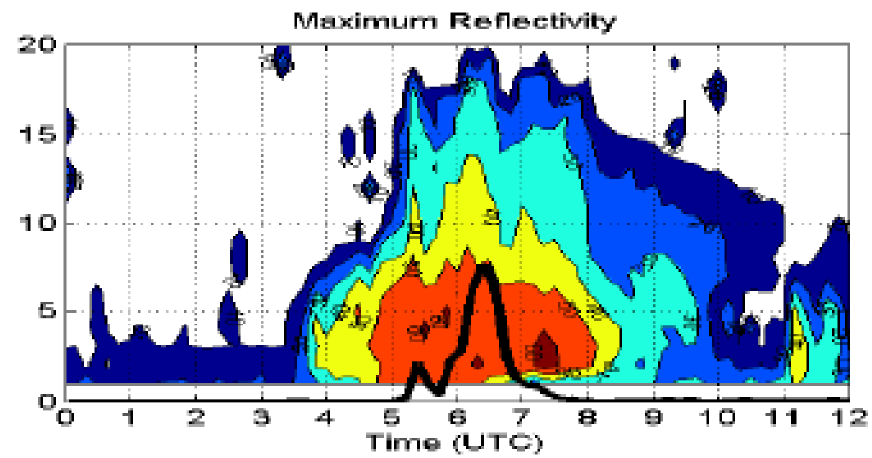
Timing of events good when dynamical forcing is strong, not so good when surface-flux driven

Lots of stratiform anvil rainfall … in fact, too much (> 50% at times)





Monsoon case – no lightning



Break case - lightning

SCM detrains more into anvil during stronger break convection

(courtesy of Peter May)

Summary

- **Updraft speed differences may be due to differences in CAPE/buoyancy after all (at least in some places)**

- **SCM capable of qualitatively simulating active-break differences in convection strength, but may be sensitive to errors in forcing or deficiencies in PBL**

- **Looking to interact with others interested in the convective regime problem (observers, CRMers, other SCMers)**