Local and remote effects of subtropical shallow convection

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ABSTRACT

Subtropical shallow cumulus convection has been suggested as an indirect mechanism for regulation of tropical deep convection by controlling the horizontal moisture advection from the subtropics into the ITCZ. TRMM and other satellite cloud and water vapor observations are combined to study the local moistening effects of shallow cumulus convection in the subtropics and the remote effects of subtropical shallow cumulus moistening on the development of tropical dry intrusions and to test the viability of the Neggers et al. (2007) shallow cumulus humidity throttle mechanism.

LOCAL EFFECTS

Motivation

- Previous work in the tropics using a TRMM multisensor retrieval suggests variability in shallow *precipitating* convection is more correlated with lower tropospheric moistening than *non-precipitating* convection

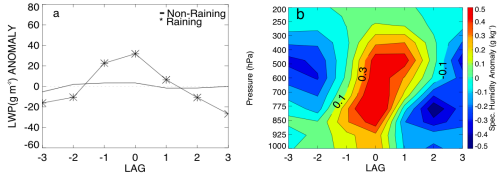

Figure 1. (a) Anomaly in cloud LWP for raining and non-raining warm clouds and (b) specific humidity anomaly prior to deep convective events in the west Pacific near near Kwajalein.

Scientific objectives

- Characterize the relationship between properties of shallow convection and lower and midtropospheric water vapor in the subtropics
  - *Is enhanced subtropical low and midlevel moisture related to shallow cumulus frequency and/or their properties?*

Future work

- Identify precipitating and non-precipitating shallow clouds using VIRS brightness temperatures and PR 2A25 rain rates
- Analyze AIRS and reanalysis water vapor profiles and perform correlation analysis with shallow cloud frequency and properties

REMOTE EFFECTS: Tropical Dry Intrusions

Motivation

- Tropical dry layer source regions are centered in subtropics (Casey et al. 2009)

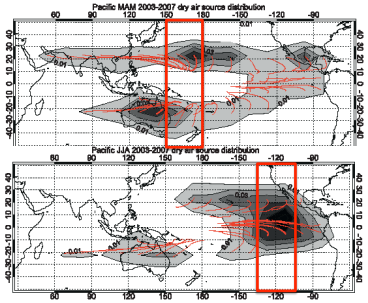

Figure 2. Dry layer source climatology for the Pacific from Casey et al. (2009). The red boxes indicate the two main regions investigated in this study.

- Shallow convection is very prevalent in the dry layer source regions (Schumacher and Houze, 2003)

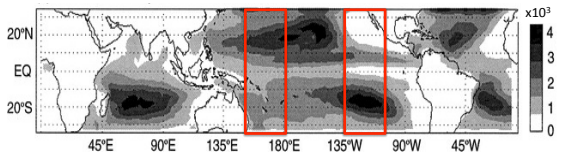

Figure 3. TRMM PR shallow, isolated rain frequency from Schumacher and Houze (2003).

Scientific objectives

- Investigate the link between subtropical shallow convection and tropical dry intrusions
  - *Are tropical dry layers more frequent in periods of reduced subtropical cumulus activity?*

Future work

- Develop tropical dry layer frequency distribution maps and create composites of subtropical water vapor profiles using AIRS and reanalysis data
- Compare dry layer frequency with time-latitude analysis (for boxed regions above) of subtropical column water vapor, moist layer depth, and precipitating and non-precipitating cloud frequency and properties

REMOTE EFFECTS: Shallow Cumulus Humidity Throttle

Motivation

- Shallow cumulus humidity throttle (cu-q) mechanism proposed by Neggers et al. (2007) links subtropical shallow cumulus convection to ITCZ deep convection

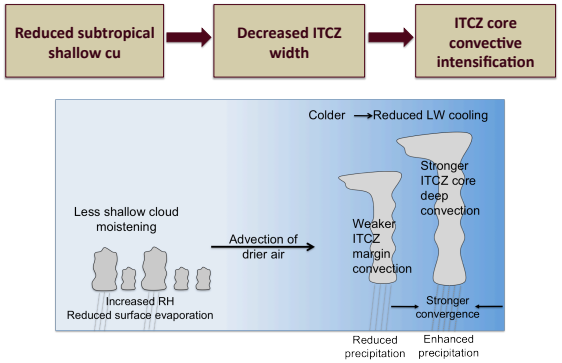

Figure 4. Schematic of the shallow cumulus humidity throttle mechanism adapted from Neggers et al. (2007).

Scientific objectives

- Examine the relationship between subtropical shallow convection and tropical deep convection
  - *Are periods of increased subtropical cumulus convective moistening observed with greater ITCZ widths?*
  - *Is decreased subtropical cumulus activity observed with more intense ITCZ convection?*
  - *What is the relative importance of precipitating vs. non-precipitating subtropical cumulus for the cu-q mechanism?*

Future work

- Use TRMM rainfall products to compute ITCZ width and intensity
- Perform analysis of longitudinal cross sections of temperature and humidity profiles and shallow and deep convection for periods of enhanced and decreased subtropical shallow convection

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