MID-LEVEL AND DEEP CONVECTIVE CLOUD CHARACTERISTICS ACROSS THE TROPICAL PACIFIC

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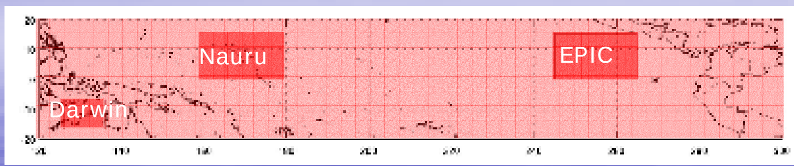


Study Regions
EPIC oceanic, ITCZ [0 – 15° N / 95 – 115° W]
Darwin land/island, monsoon [7 – 17° S / 126 – 136° E]
Nauru oceanic, descending Walker [0 – 15° N / 160 – 180° E]

Factors limiting mid-level congestus cloud top heights

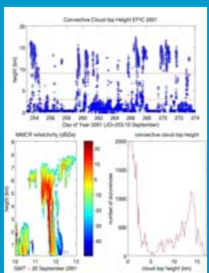


Figure 1 Summary of convective cloud characteristics during EPIC 2001 ITCZ cruise. (a) Time series of convective cloud-top heights where convective clouds are defined as those with cloud-base height below 1 km. (b) Millimeter cloud radar reflectivity for one example of a cumulus congestus cloud during EPIC 2001. (c) Histogram of convective cloud-top heights during EPIC 2001 ITCZ cruise.

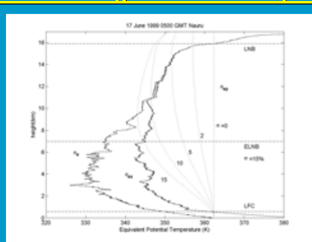
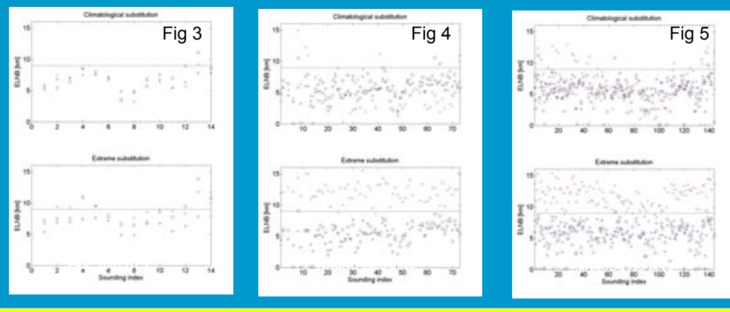


Figure 2 Plots of the environmental θ_e and θ_{es} (solid) for the 0500 UTC 17 June 1999 sounding from Nauru99 with θ_{ep} for entrainment rates of 0%, 2%, 5%, 10%, and 15% km^{-1}. The level of neutral buoyancy (LNB) and entraining LNB (ELNB) are indicated by the horizontal dashed lines.

From **Jensen, M.P. and A. D. Del Genio, 2006: Factors Limiting Convective Cloud-Top Height at the ARM Nauru Island Climate Research Facility. J.Clim., 19, 2105-2117.**

For each cumulus congestus case we estimate the entrainment rate by iteratively increasing the rate until the ELNB matches the cloud-top height from the cloud radar.

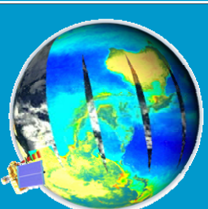
Figure 3-5 ELNB for each sounding (+) using the estimated entrainment rate (see Fig. 2) and for the substitution of climatological values (top): [temperature (circle) and relative humidity (X)] and extreme values (bottom) [temperature profile of a sounding that is unstable near the freezing level (circle) and the relative humidity profile of a sounding with a moist mid-level (X)].



- **For Nauru and Manus convection it is clear that mid-level humidity plays the more critical role in limiting deep convective cloud-top heights compared to freezing level stability**
- **In the EPIC ITCZ region both the mid-level humidity and freezing level stability are important limiting factors, more cases are needed to verify this result**

Deep convective cloud characteristics from MODIS observations

MODIS clouds data acquisition

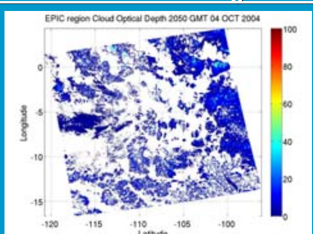


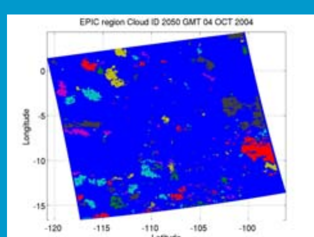
MODIS Cloud data acquisition

- MODerate Imaging Spectroradiometer
- 36 spectral bands from 0.4 -14 .4 μm
- 2330 km swath
- horizontal resolution 250-1000m
- MODIS team retrieves cloud physical and radiative properties
- Terra (1030 LT) and Aqua (1330 LT)

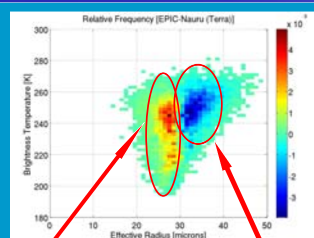
We have acquired 5 years of Terra/Aqua MODIS cloud data for the EPIC, Nauru and Darwin regions. (~ 2 TB)

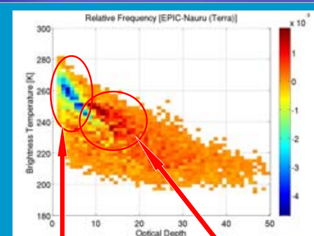
Cloud identification algorithm





- The Lagrangian algorithm used here is similar to the Detection and Spread (DAS) algorithm by Boer and Ramanathan (1997).
- The algorithm detects convective cloud elements and associates neighboring cloud pixels with each convective element through a type of successive 'relaxations.'
- We identify several tens of thousands of clouds systems for each region, and determine MODIS observed cloud mean quantities for: Optical Depth, Liquid Water Path, Effective Radius, IR Brightness Temperature, Cloud-Top Pressure.



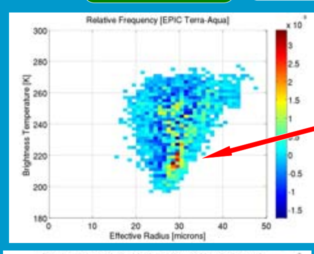


EPIC, Deeper and/or thicker clouds, smaller particles

Nauru, thinner anvils, larger particles, influence of precip?

Nauru, shallower, thinner, smaller

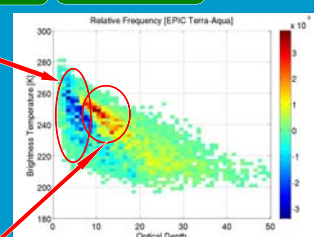
EPIC deeper, thicker, larger

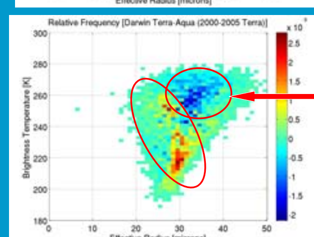


Aqua (PM) – More optically thin anvil cloud

Difficult to quantify AM/PM differences in EPIC region

Terra (AM) – Deeper, thicker anvil cloud





Aqua (PM) – larger particles, more precip?

Terra (AM) – smaller particles regardless of TBB

Initial Conclusions

- **We are able to identify clear differences in deep convective cloud properties for different regions of the tropics**
- **Compared to the EPIC region, Nauru cloud systems tend to be:**
  - Warmer
  - Optically thinner
  - larger cloud particles