Decreasing ITCZ width due to suppression of deep convection by mid-tropospheric dry layers in the Pacific ITCZ

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Motivation

BACKGROUND:

- Recent long-term characterization of the Pacific Intertropical Convergence Zone (ITCZ) shows that the ITCZ has narrowed over the last 36+ years
- Some hypotheses suggest that the changes in ITCZ width may be related to enhanced transport of dry air layers from the subtropics

THIS RESEARCH:

- Use ERA-Interim reanalysis to create a 36-year mid-troposphere dry layer climatology for the Pacific ITCZ
- Investigate relationships between dry layer frequency, ITCZ characteristics, and precipitation features

Dry Layer Identification

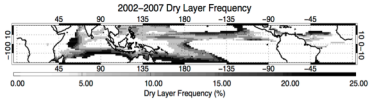
TIME PERIOD AND LOCATION:

- January 1979 – December 2014
- Pacific region between 160°E to 80°W and 20°S to 20°N

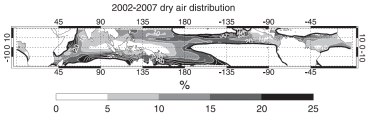
DATA SETS:

- Relative humidity (RH) from ERA-Interim Reanalysis
- ITCZ characteristics from Wodzicki and Rapp (2016)
- Precipitation features (PF) from Liu et al. (2008)

ERA-Interim Reanalysis:



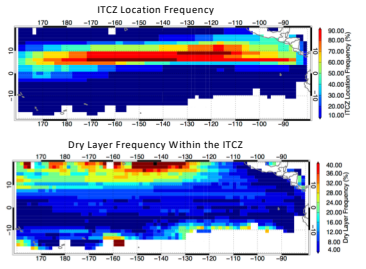
AIRS Observations (from Casey et al. 2009):



METHODOLOGY:

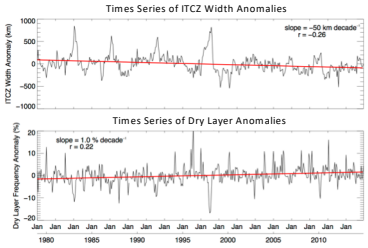
- Monthly ITCZ location mask from Wodzicki and Rapp (2016) applied to RH data
- Mid-troposphere dry layers identified as the lowest 10% (RH < 20%) of the mean 400 - 600 hPa RH distribution in the ITCZ
- Composite PFs for wide and narrow ITCZs defined by upper and lower ITCZ width quartiles

ITCZ Dry Layer Climatology

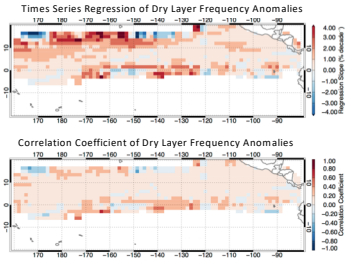


- Less frequent dry layers near center and eastern portions of the ITCZ
- More frequent dry layers on northern boundary than the southern
- Peak frequencies are over 40% in regions where the ITCZ is less frequent

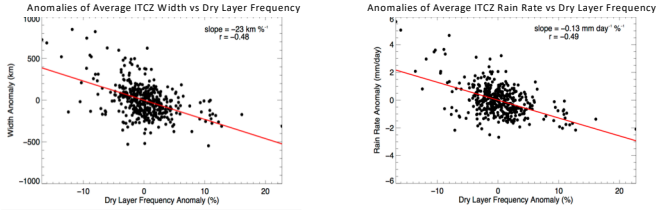
Long-term Trends in ITCZ Dry Layers



- ITCZ dry layer frequency has increased by ~1% per decade, consistent with long-term decreases in ITCZ width (Wodzicki and Rapp 2016)
- Significant decreases in dry layers during El Niño periods
- Largest positive trends in dry layer frequency occur along the central northern and southern borders

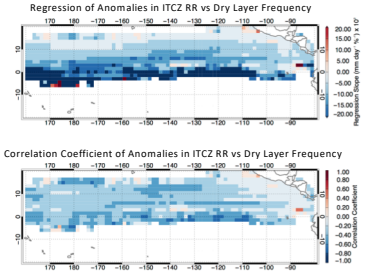


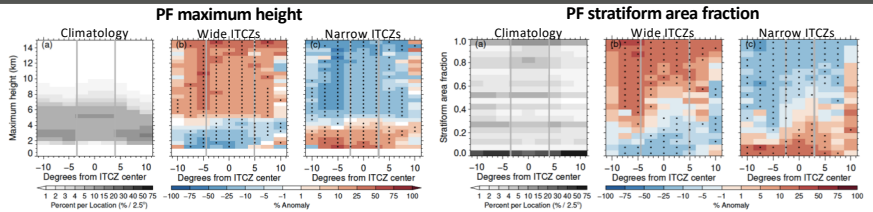
Dry Layers vs. ITCZ Characteristics



- On monthly timescales, positive dry layer anomalies are correlated with negative ITCZ width and RR anomalies

Dry Layers vs. ITCZ Convection





- Strong negative correlations between RR and dry layer frequency especially on southern ITCZ edge
- Increase in dry layer frequency for narrow ITCZs consistent with:
  - Suppressed PF maximum height on narrow ITCZ boundaries
  - Suppression of large convective systems (not shown) primarily due to reduction in stratiform area

Summary

- ERA-Interim dry layer climatology compares well with AIRS observations
- The long-term increase in dry layers is consistent with decreasing ITCZ width
- Narrower ITCZs and lower ITCZ rain rates are associated with more frequent dry layers
- Increase in dry layers leads to suppression of organized deep convection on ITCZ boundaries

➢ **The largest increases in dry layer frequency corresponds to the central Pacific region that shows the greatest ITCZ narrowing**

Papers:

Wodzicki, K., and A. Rapp, 2016: Long-term characterization of the Pacific ITCZ using TRMM, GPCP, and ERA-Interim. *Journal Of Geophysical Research: Atmospheres*, **121**, 7, 3153-3170, doi:10.1002/2015JD024458.

Bartos, E. A., A. D. Rapp, and K. R. Wodzicki, 2018: Increasing frequency of midtropospheric dry layers in the Pacific Intertropical Convergence Zone. *Geophys. Res. Lett.*, **45**, 13523-13529.

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