Investigating the Relationship between Precipitation in the Tropics and Tropical Cyclone Frequency and a Possible Feedback Mechanism between Tropical Cyclone Activity and Column Water Vapor

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Part I: Precipitation & TC Frequency

•A previous modeling study indicated a close relationship between TC frequency and tropical rainfall. Here we examine that relationship in observations.

Methods

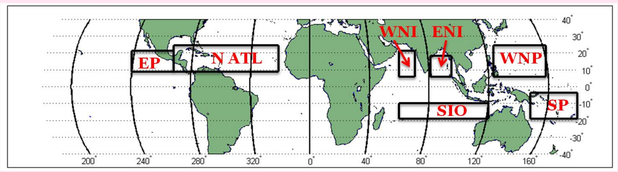


Figure 1: Basin definitions for Part I

•Seasonal Analysis: summed rainfall over the course of the tropical cyclone season in that ocean basin, compared with number of TC's

•Monthly Anomaly Analysis: created mean annual cycle and subtracted this from monthly analysis to create monthly rainfall and TC count anomalies from seasonal cycle

Results

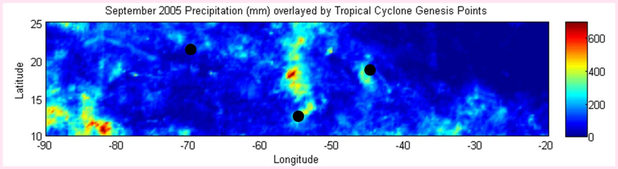


Figure 2: Example of monthly precipitation and TC frequency

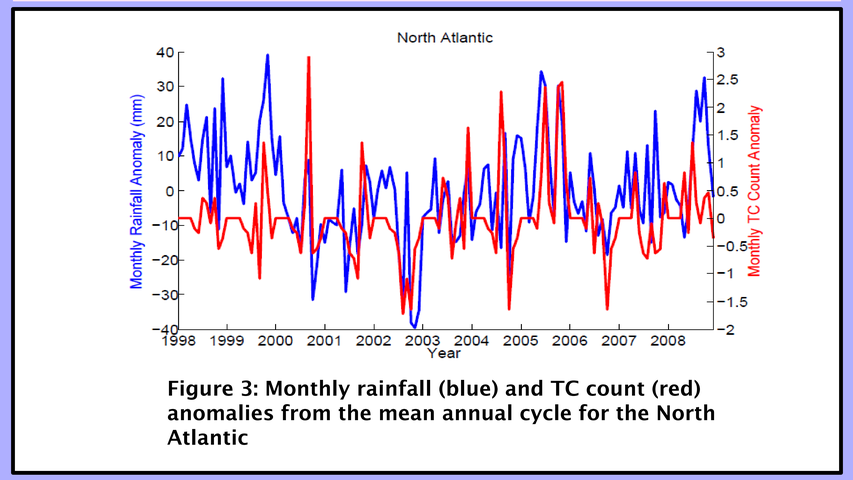


Figure 3: Monthly rainfall (blue) and TC count (red) anomalies from the mean annual cycle for the North Atlantic

Data

•Tropical cyclone data are from NOAA's NHC and the US Navy's JTWC

•Monthly rainfall estimates from TRMM Multi-Satellite Precipitation Analysis on a 0.25˚ x 0.25˚ grid

•3-day average CWV estimates at 0.25˚ resolution from TRMM Microwave Imager provided by RSS[4].

Part I Results	seasonal		monthly anom	
	r	p	r	p
N. Atlantic	0.70	0.02	0.42	0.00
W. N. Pacific	0.47	0.15	0.44	0.00
E. Pacific	-0.27	0.42	0.32	0.00
W. N. Indian	0.57	0.07	0.41	0.00
E. N. Indian	0.78	0.00	0.35	0.00
S. Indian	0.76	0.01	0.36	0.00
S. Pacific	0.65	0.04	0.43	0.00

Results

•Suggest relationship between regionally averaged tropical precip anomalies and TC frequency anomalies

Possible Explanations

•Cofactor causing both precipitation and TCs to vary together? Both convection and TC activity depend on $X_m = (S_b - S_m)/(S_o^* - S_b)$

•Correlation due to fact that TCs contribute to rainfall totals themselves? However, near state of radiative-convective equilibrium in tropics constrains overall precipitation independently from TCs.

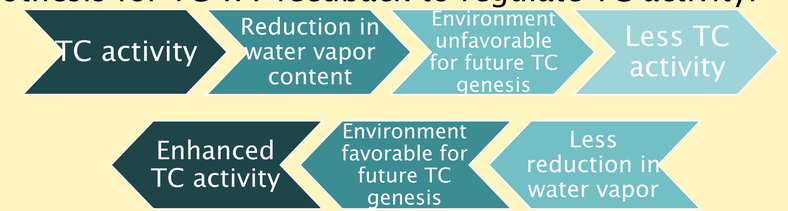
•TCs might modify this equilibrium and enhance overall convection. ➔ **Part II**

Part II: TC Activity and Column Water Vapor

•TC-WV feedback is a possible mechanism for TCs to enhance overall convection, as suggested in ➔ **Part I**

•More TCs → less WV →more radiative cooling → overall precipitation must be enhanced to stay in equilibrium

•Hypothesis for TC-WV feedback to regulate TC activity:



•Previous evidence: Self-aggregation of convection into a single cluster in idealized simulations of convection is accompanied by decrease in domain averaged water vapor[1,2].

•Previous evidence: Reanalysis data suggests that times of anomalous TC activity are immediately followed by a dry anomaly overlapping primary TC region.[3]

•This study: Here we investigate this in observations by comparing satellite-estimates of CWV to measures of TC activity.

Methods

•CWV was averaged over and TC indices (TC days, PDI, ACE) were accumulated over 6,15, and 30 day periods for different regions

$$PDI = \sum_{0}^{\tau_{storm}} V_{\max}^3 \qquad ACE = 10^{-4} \sum_{0}^{\tau_{storm}} V_{\max}^2$$

•Lagged correlations of anomalies from mean annual cycle were computed

Results

•Would expect TC index and CWV to be negatively correlated when CWV lagging TC index

•*No correlations* are found to support the TC-CWV feedback hypothesis

•Results indicate such a feedback does not exist or that it is so efficient it is undetectable by the methods used here.

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