THE RELATIONSHIP BETWEEN PRECIPITATION IN THE TROPICS AND TROPICAL CYCLONE FREQUENCY

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Abstract

A previous modeling study found that the June-November Atlantic precipitation from the GFDL CM2.1 coupled atmosphere-ocean general circulation model was highly correlated with and seemed to be a good proxy for tropical cyclone frequency derived from a 20th century run of the model. This study examines this relationship in observations. The frequency of tropical cyclone genesis is compared to TRMM satellite-based rainfall estimates over specified regions in each ocean basin, on both monthly and seasonal time scales. It is found that there is a statistically significant correlation of r ~ 0.4 between the monthly regionally averaged rainfall anomaly from the mean annual cycle and the monthly tropical cyclone frequency anomaly from the mean annual cycle in each ocean basin. This result is consistent between the ocean basins, while results from similar analysis on seasonal time scales and on monthly time scales without the annual cycle removed vary from region to region.

Data & Methods

- Rainfall estimates are from TRMM Multi-Satellite Precipitation Analysis and are monthly estimates on a 0.25° x 0.25° grid
- Tropical cyclone data are from NOAA's National Hurricane Center and the US Navy's Joint Typhoon Warning Center
- **Seasonal Analysis:** summed rainfall over the course of the tropical cyclone season in that ocean basin, compared with number of TC's
- **Monthly Analysis:** averaged rainfall over region for each month and counted the number of TC's forming in that month
- **Monthly Anomaly Analysis:** created mean annual cycle and subtracted this from the monthly analysis to create monthly rainfall and TC count anomalies from the seasonal cycle

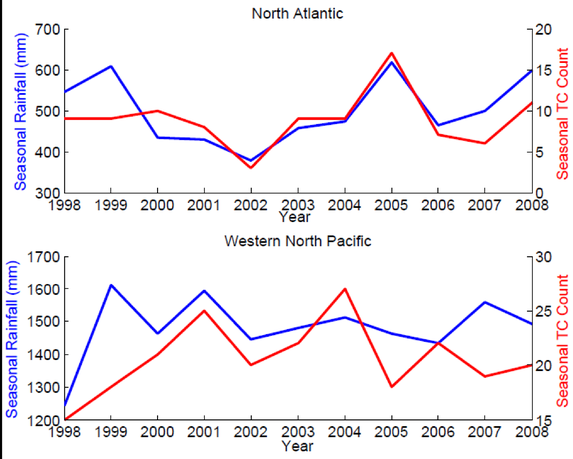

Figure 1: Seasonal regionally averaged rainfall (blue) and seasonal TC count (red) for the North Atlantic (top) and Western North Pacific (bottom)

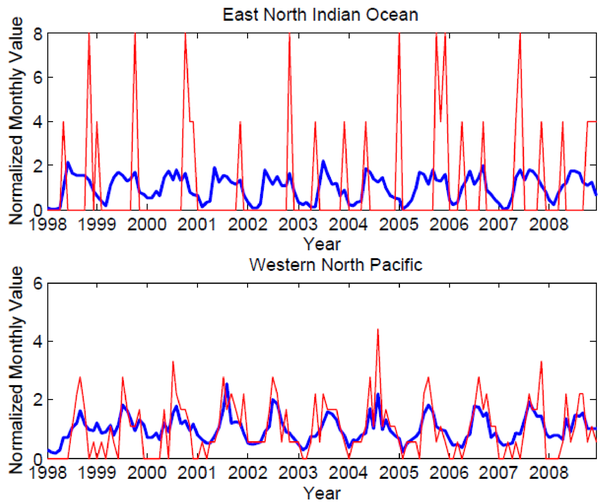

Figure 2: Monthly regionally averaged rainfall (blue) and monthly TC count(red) for the East North Indian (top) and Western North Pacific (bottom)

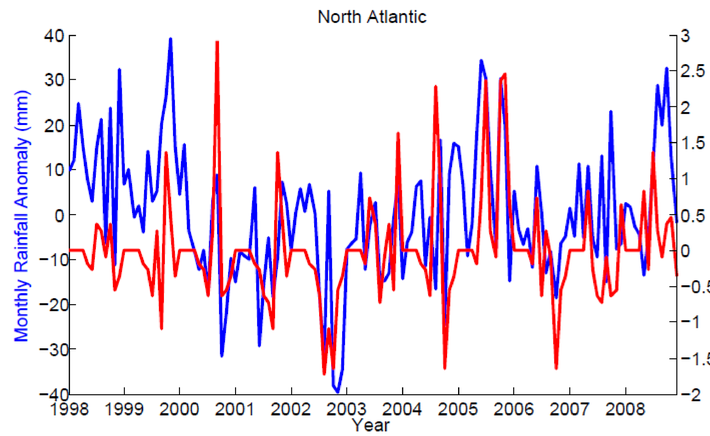

Figure 3: Monthly rainfall (blue) and TC count (red) anomalies from the mean annual cycle for the North Atlantic

Results	seasonal		monthly		monthly anomaly	
	r	p	r	p	r	p
N. Atlantic	0.70	0.02	0.70	0.00	0.42	0.00
W. N. Pacific	0.47	0.15	0.79	0.00	0.44	0.00
E. Pacific	-0.27	0.42	0.84	0.00	0.32	0.00
W. N. Indian	0.57	0.07	0.42	0.00	0.41	0.00
E. N. Indian	0.78	0.00	0.20	0.00	0.35	0.00
S. Indian	0.76	0.01	0.71	0.02	0.36	0.00
S. Pacific	0.65	0.04	0.61	0.00	0.43	0.00

Discussion

- Results indicate some sort of relationship between regionally averaged tropical precipitation and TC frequency.
- **Possible Explanation:** Correlation is due to fact that tropical cyclones are contributing to the rainfall totals themselves. However, near state of radiative-convective equilibrium in the tropics constrains the overall precipitation independently from tropical cyclones.
- **Possible Explanation:** There is a cofactor causing both precipitation and TCs to vary together. Both convection and TC activity depend on X_m , a nondimensional parameter measuring the thermodynamic disequilibrium between the ocean and atmosphere and the dryness of the middle troposphere compared to the boundary layer. X_m is a term in the convective updraft mass flux in boundary layer quasi-equilibrium and is a term in a genesis index that captures TC variability.