Examining Intensity Trends during Extratropical Transition

Justin Stark — Florida International University

Christopher J. Slocum — Colorado State University

Wayne H. Schubert — Colorado State University

Introduction

- Most Atlantic and Western North Pacific Tropical Cyclones (TC) go through a transition called extratropical transition (ET)
- During ET the TC will lose its warm core characteristics and become a extratropical cyclone (mid-latitude cyclone)
- ET occurs mostly in the late Atlantic hurricane season between 30°N to 40°N latitude when most storms recurve
- Forecasting the future track and intensity has always been a challenge for models and forecasters

What is a Tropical Cyclone?

- A storm system characterized by rapidly rotating wind and rain band features.
- In mature systems the heaviest rain and winds can be found at the outer edge of the eye called the eye wall
- TCs extract latent heat from warm sea surface temperatures (SST) above 26.7° C

What is Extratropical Transition?

- ET occurs when a TCs starts interacting with upper-level troughs or shortwaves
- TCs lose their symmetric warm-core structure and develop into a mid-latitude cyclone with pronounced fronts
- During the process, the TC will lose its warm core, its wind field will expand and its forward movement speed will increase meaning a larger area will be effected by winds and rain

Why is This Important?

- ET is a big challenge for forecasting timing and intensity
- Effects commercial boating (Perfect Storm 1991)
- The north east could be affected (Hurricane Sandy 2012)

Data and Methods

- Used best track data from the National Hurricane Center to find what TCs went ET from 1982-2014. Best track data is archived observational data
- Developmental large scale diagnostics files (lsdiag) to look at environmental features; lsdiag contains predictors used by the Statistical Hurricane Intensity Prediction Scheme (SHIPS) model
- SHIPS archived files. SHIPS is used to predicted intensity change in TCs
- Evaluate distributions of intensity change and environmental parameters using techniques such as bootstrap

Results

Figure 1: This shows all the TCs that went ET (blue dots) from 1982-2014.

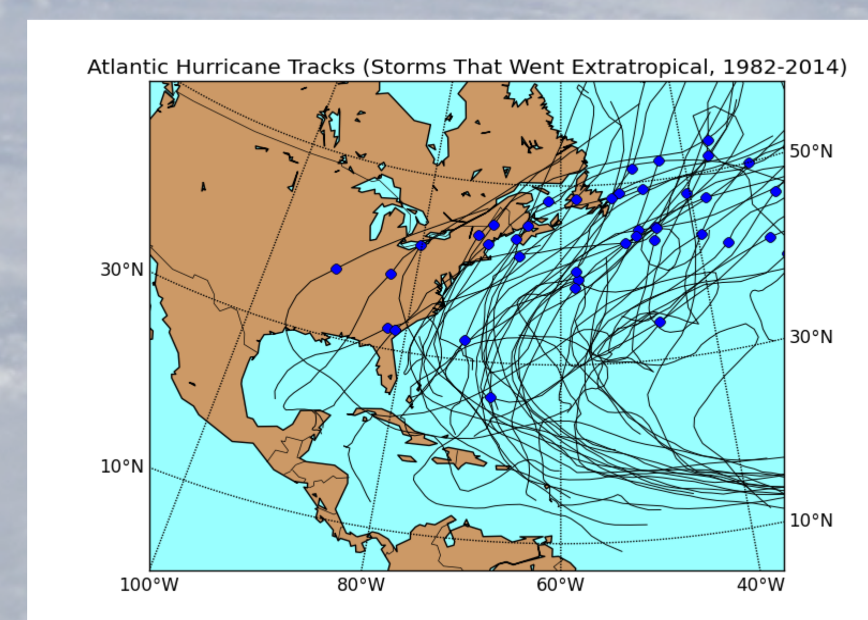


Figure 2: This is a probability density function (PDF) of the change of intensity. During ET, hurricanes showed signs of weakening, compared to tropical storms, which showed strengthening.

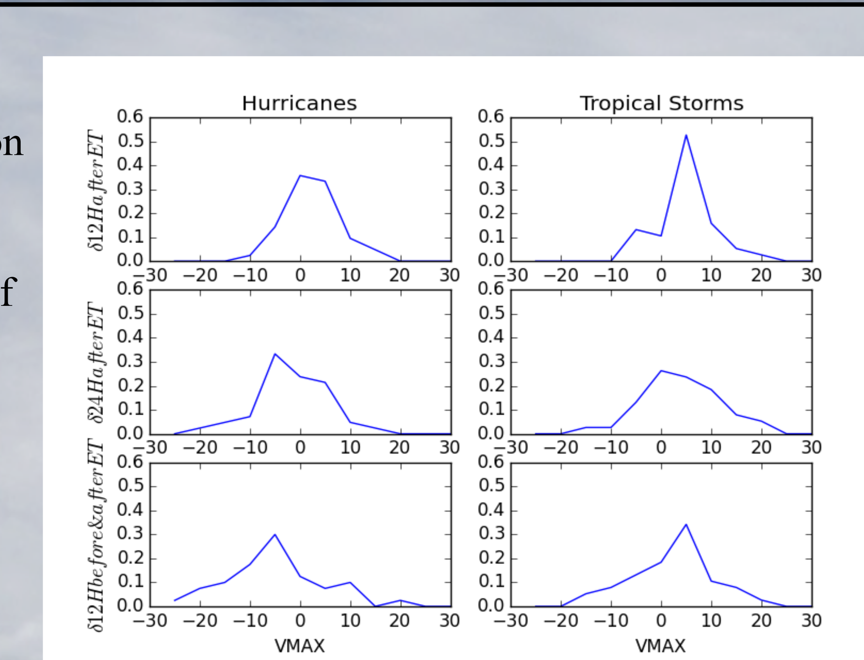
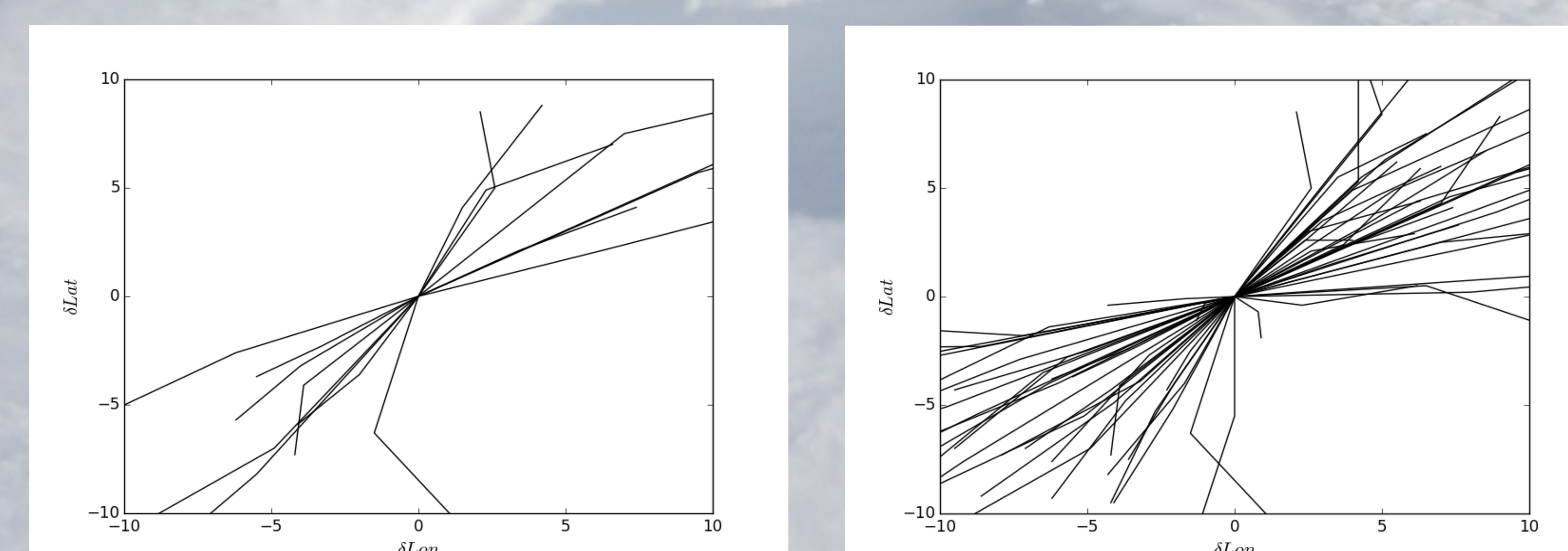


Figure 3: This shows track patterns with the change of longitude and latitude. The figure to the left shows the storms that intensify and the ones to the right are the weakening ones. There were not any differences in the patterns found for intensifying and weakening cyclones.



Figures 4-7: Bootstrap (random sampling with replacement) distribution of sample means using 1 million resamples for weakening cases (blue) with the mean from the intensifying cases (black). The bootstrap method was used to determine significance for average Θe difference between a parcel and its environment (EPOS) shown in figure 4, temperature gradient between 850 and 700mb shown in figure 5, deep layer shear (SHDC) shown in figure 6, and 500 hPa tangential velocity (V500) shown in figure 7.

Figure 4:

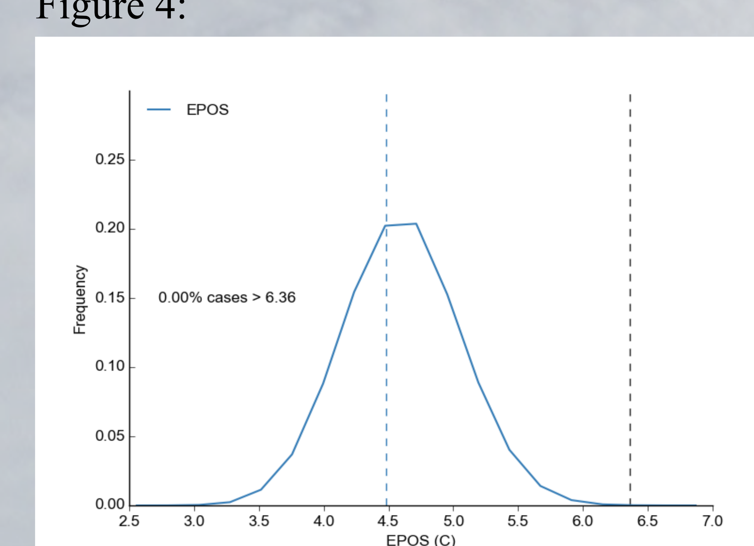


Figure 5:

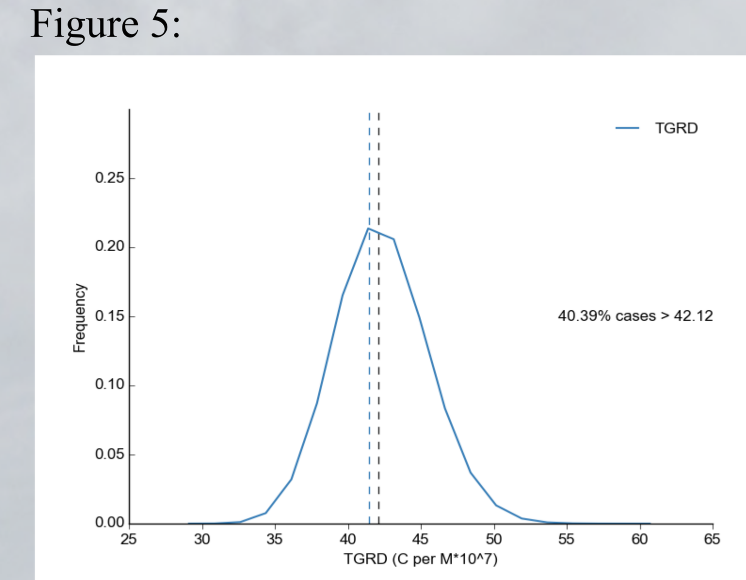


Figure 6:

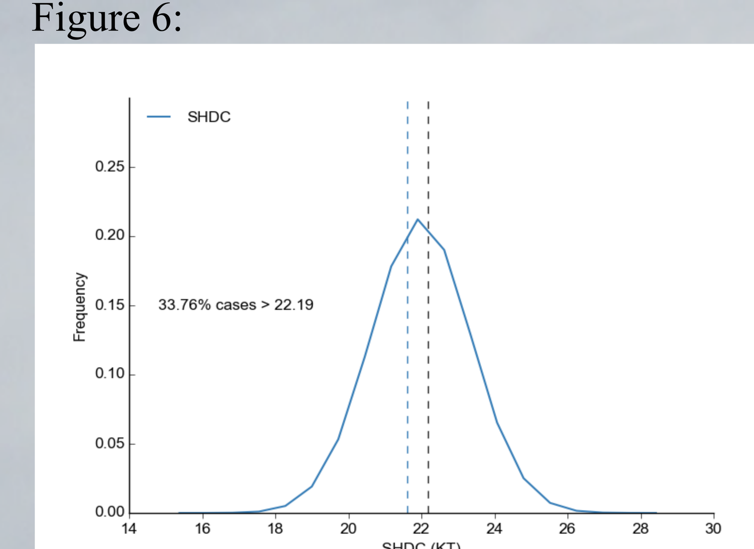
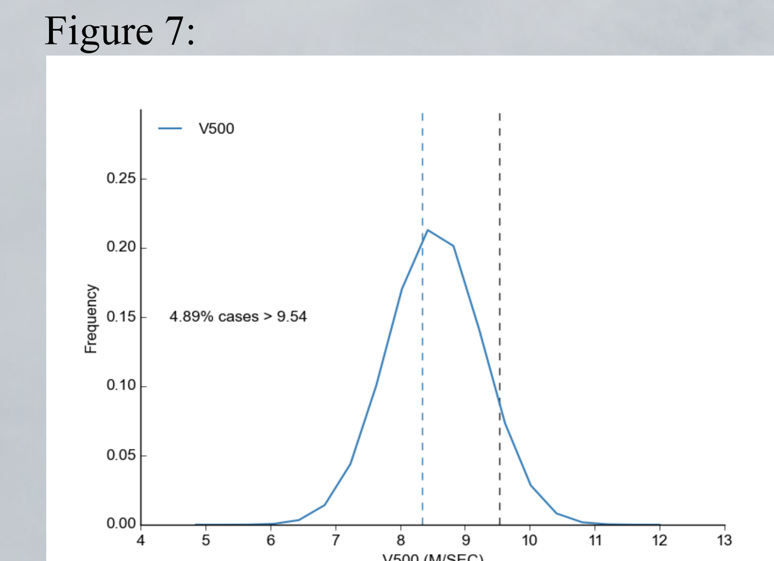


Figure 7:



Conclusions

- While most TCs weaken during ET, ~10% of hurricanes (TCs with winds greater than 64 kts) intensify
- Intensifying hurricanes do not have unique storm tracks, but tend to occur at lower latitudes
- 24-h prior to transition, systems that intensify appear to be protected from the environment thermodynamically even though the storms experience similar deep layer shear as weakening storms

Future Work

- Study the tropical storm cases and see why a large percentage intensify during ET
- See how well SHIPS did with intensity and predicting ET
- See if the GOES satellite predictors can access the thermodynamic environment of the storm to predict weakening or intensification

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