Tropical Cyclone Hazards in Relation to Propagation Speed

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Background

- Tropical Cyclone(Hurricanes) are one of the most damaging and expensive natural disasters that regularly affect the East Coast.
- Research has shown that TC propagation speed has slowed down in the recent years between 1949-2016. (Kossin 2018)
- The observation of slower TC translation speed has the potential for elevating hazards.
- The consequences of storm surges and flooding bring about social, political, and economical problems that stunt the growth of the US.
- We must adapt, and overcome these challenges by computing and predicting the trends of future hurricanes to better prepare ourselves in dealing with the intensity of tropical storms.

Satellite Image of Tropical Cyclone (Hurricane)

Hurricane Katrina [Tropical Cyclone in late August 2005]
https://www.britannica.com/event/Hurricane-Katrina

Annual Frequency of Tropical Cyclone (Hurricane)

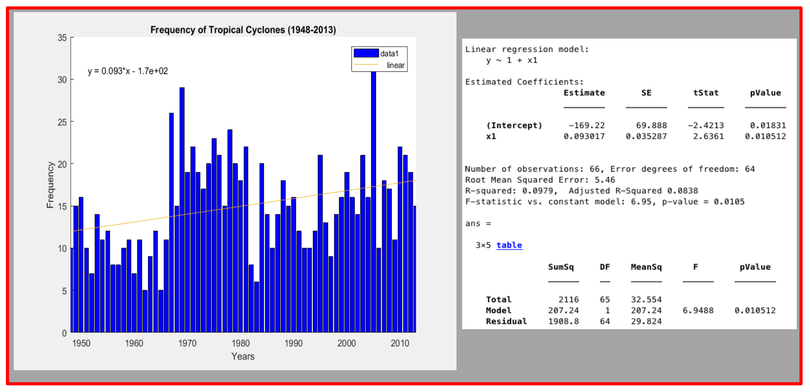

Figure 1 describes the annual frequency for Tropical Cyclone from 1948 to 2013. Linear regression model and anova summary table applied to examine the significance of trend.

Methods & Definitions

- Tropical Cyclone track data is from 1948-2013 with Lagrange evolution, each time step is 6 hourly for individual TC.
- The TC propagation speed is computed by total distance over total time along the full TC track.
- The propagation angle of TC are under the calculation of $\theta = \arctan(y/x)$. where y is vertical movement of hurricane to the North pole while x is the horizontal movement either westward or eastward directions.
- Angular displacement calculated by the absolute value of the deduction of two successive angles.
- The analysis for overall trends are computed by linear regression model with nova summary.

Results I

Top 50 Hurricanes Examples: Longest vs Fastest

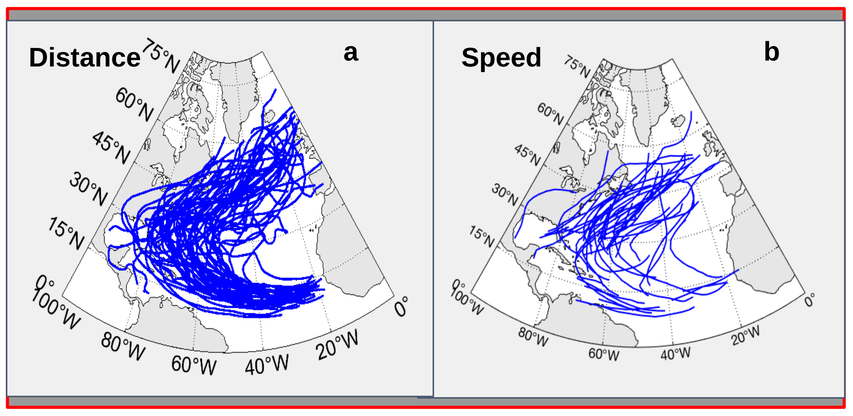

Figure 2a describes examples of hurricanes with the top 50 longest distance on regional plot(1948-2013). Figure 2b describes examples of hurricanes tracks with the top 50 fastest speed on a regional plot(1948-2013).

Annual Mean of Propagation Speed

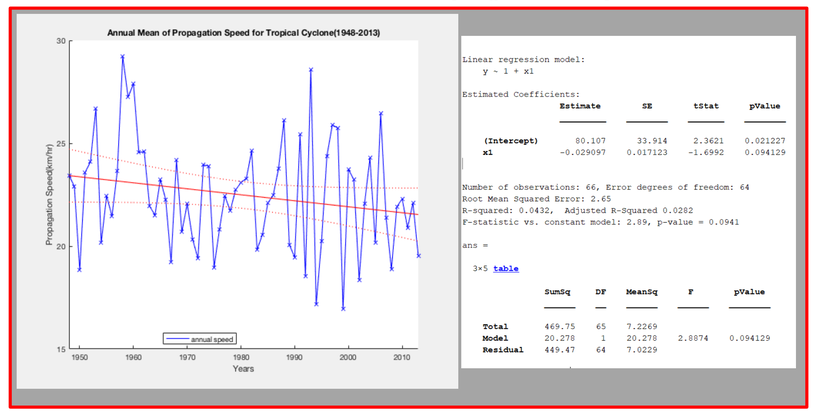

Figure 3 describes the Annual Mean Propagation Speed for Tropical Cyclone from 1948 to 2013. All TCs speed are average calculated for each year. Linear regression model and anova summary table applied to examine the significance of trend. Results agree with Kossin paper 2018 on TC speed.

Results II

Mean Propagation Speed vs Mean Cyclone Wind Speed

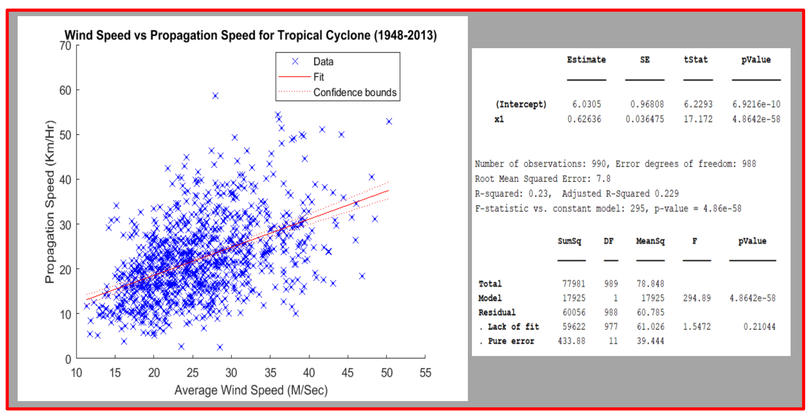

Figure 4 describes a correlation analysis between wind speed and propagation speed for hurricanes(1948-2013). Linear regression model and anova summary table applied to examine the significance of trend.

Annual Mean of Cyclone Wind Speed Intensity

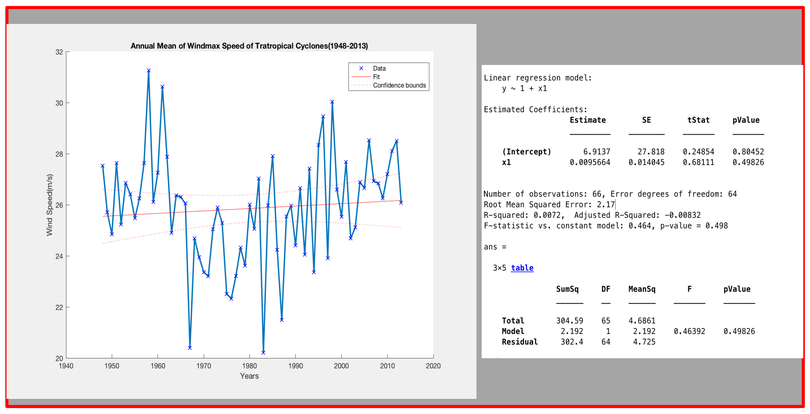

Figure 5 describes annual mean of wind max speed for Tropical Cyclone(1948-2013). Linear regression model and anova summary table applied to examine the significance of trend.

Propagation Speed vs Wind Speed During TC life Cycle

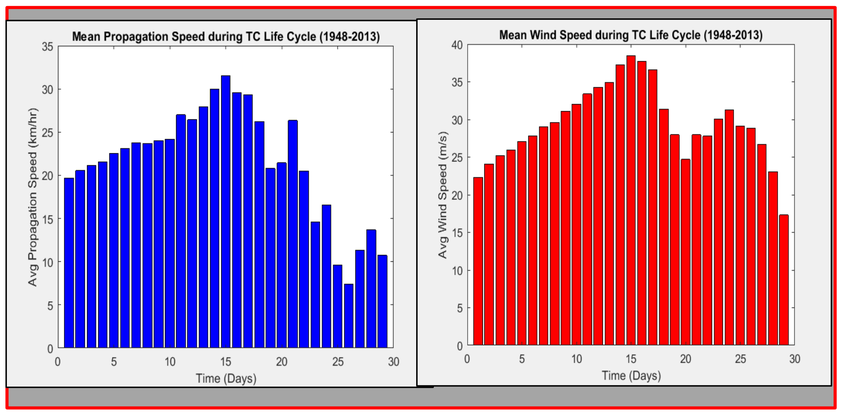

Figure 6 describes correlation analysis between the maximum 6 hour time step wind speed with corresponding propagation speed for Tropical Cyclone(1948-2013).

Results III

Directional Shift Tendency of Hurricane

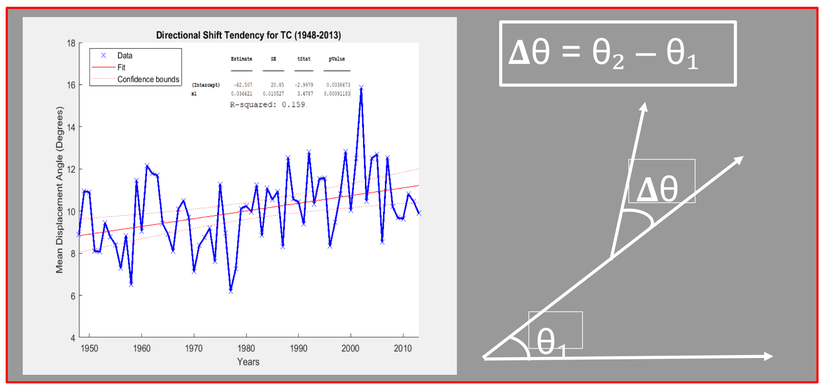

Figure 7 describes annual mean of directional angles created by hurricanes path for each 6 hour time steps.Linear regression model and anova summary table applied to examine the significance of trend.

Propagation Speed Based on Direction

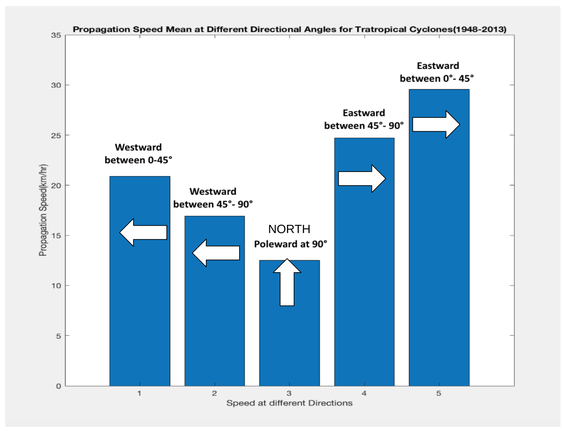

Figure 8 describes speed of average for each direction TC travel: westward, poleward and eastward at different angles. All the angular velocity are average into these three directions.

Conclusions

- We observed an increasing trend on annual frequency of TC from 1948 to 2013 with p-value of 0.01.
- Annual mean of propagation speed showed a decreasing trend with p-value 0.09 while the directional shift tendency of TC paths shows a increasing trend with p-value of 0.0009.
- Current findings suggest a cooperative effect between TC propagation speed and wind speed with p-value 4.86e-58 and correlation coefficient(r) 0.49.
- Based on our directional propagation speed analysis, we found out hurricanes move the fastest when they turn eastward follow by westward and last poleward.
- Further analysis is needed on the correlation between TC propagation speed and wind speed.

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