UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL of MARINE & ATMOSPHERIC SCIENCE

Convective Structure of Tropical Cyclones During Extreme Episodes of Rapid Intensification

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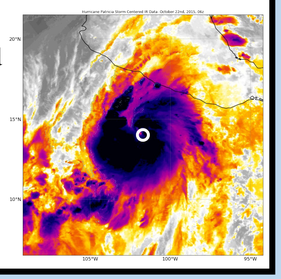
Motivation/ Background

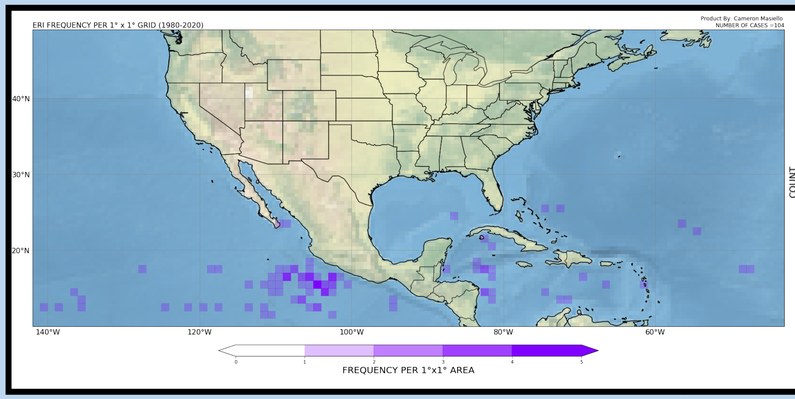
- Extreme Rapid Intensification (ERI) is defined in this study as a 60+ knot increase in maximum surface wind speed over a 24-hour time period
- ERI events supply some of the greatest uncertainties to current intensity forecasts
- Rapid Intensification (RI), defined as an increase in 30+ knots over 24 hours, generally occur in more favorable environments than intensification rates of smaller magnitudes[1]
- It is not well understood how RI or ERI commences, and it is believed to be largely connected to convective-scale and mesoscale processes within the inner core of tropical cyclones (TCs)

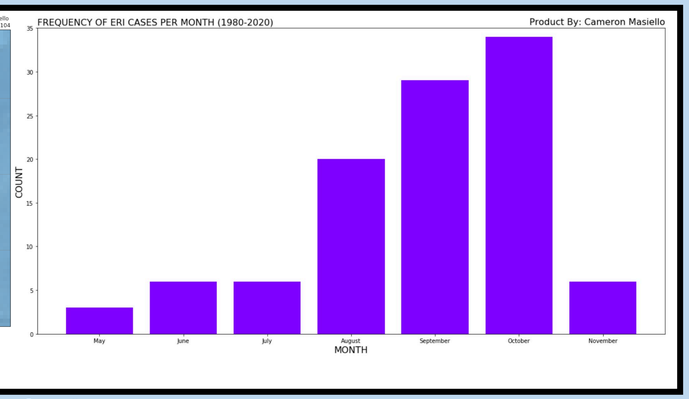
Methods

- Datasets: NASA's GPM_MERGIR, International Best Track (IBTrACS), and the HURDAT dataset
- Temporal and geographical distributions are calculated via binning latitude and longitude data associated with ERI cases.
- NASA's GPM_MERGIR dataset is used to plot TC-centered IR-Brightness plots with the latitude and longitude of the center, which is determined from HURDAT and IBTrACS
- Using the RMW determined from HURDAT, polar coordinates are computed around the TC center. IR-Brightness temperatures are calculated on the resultant circle.



Temporal and Geographical Distribution of ERI

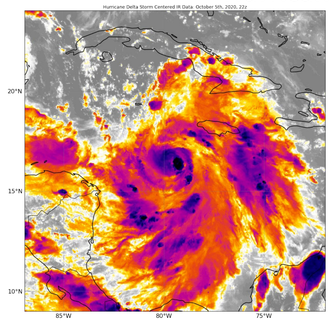


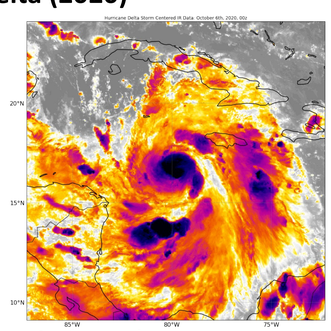


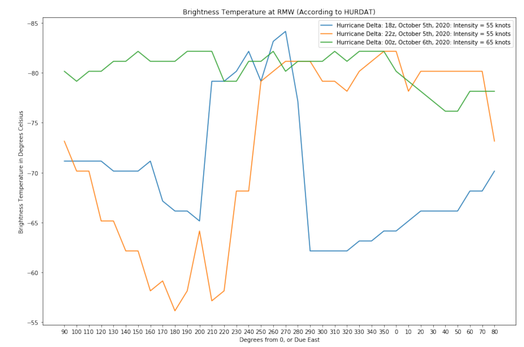
Convective Evolutions

Convective Burst | Immediately After Convective Burst | IR Brightness in Polar Coordinates Around The Center with r = RMW

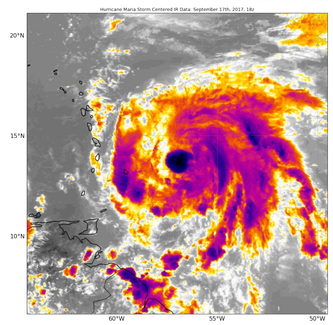
Hurricane Delta (2020)

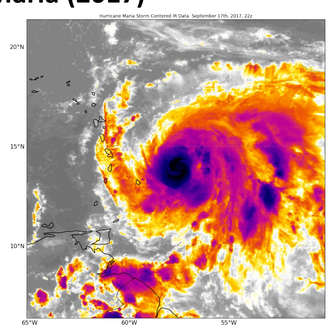


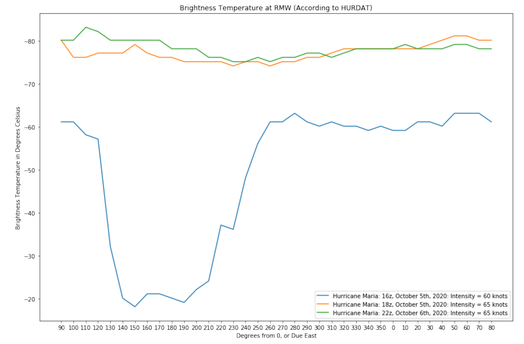




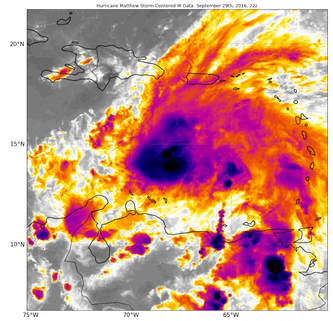
Hurricane Maria (2017)

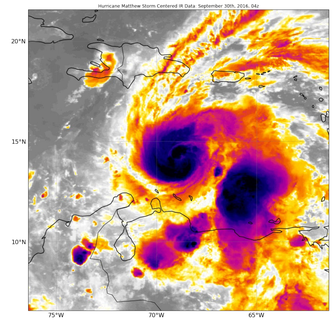


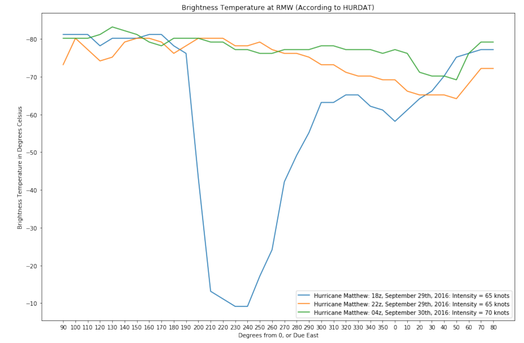


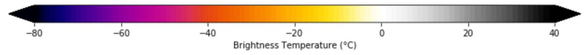


Hurricane Matthew (2016)









Summary of Results

- Geographically, ERI events occur co-located over areas of high oceanic heat content
- Surprisingly, most ERI events occur in October, with an even number of events occurring before and after September 15th in the Atlantic basin.
- The convective bursts (CBs) that commence ERI periods occur consistently at the same time: right before sunset. This extends to cases not shown here.
- ERI-initiating CBs are associated with rapid rates of axisymmetrization.
- Of all the ERI periods observed, the CBs that initiate them occur around an intensity of 60-70 knots. This extends to cases not shown here.

Concluding Remarks

- We hypothesize that the convective bursts that commence episodes of ERI appear to occur during sunset, off the backend of collapsing convection due to reduced instability with daytime absorption of solar radiation

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- Instability is maximized during October, during which the hours of nighttime are greatest.
- Further modeling and analysis of the role of CAPE/Instability induced CB's and their influence on RI and ERI is needed.

References and Acknowledgments

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Accessed From:
https://disc.gsfc.nasa.gov/datasets/GPM_MERGIR_1/summary
https://www.nhc.noaa.gov/data/hurdat/
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References:

[1]Wang, X., & Jiang, H. (2021). Contrasting behaviors between the rapidly intensifying and slowly intensifying tropical cyclones in the North Atlantic and Eastern Pacific Basins. *Journal of Climate*, *34*(3), 987–1003. https://doi.org/10.1175/jcli-d-19-0908.1

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