Lightning-Based Tropical Cyclone Rapid Intensification Guidance

GLM Science Meeting

National Environmental Satellite, Data, and Information Service

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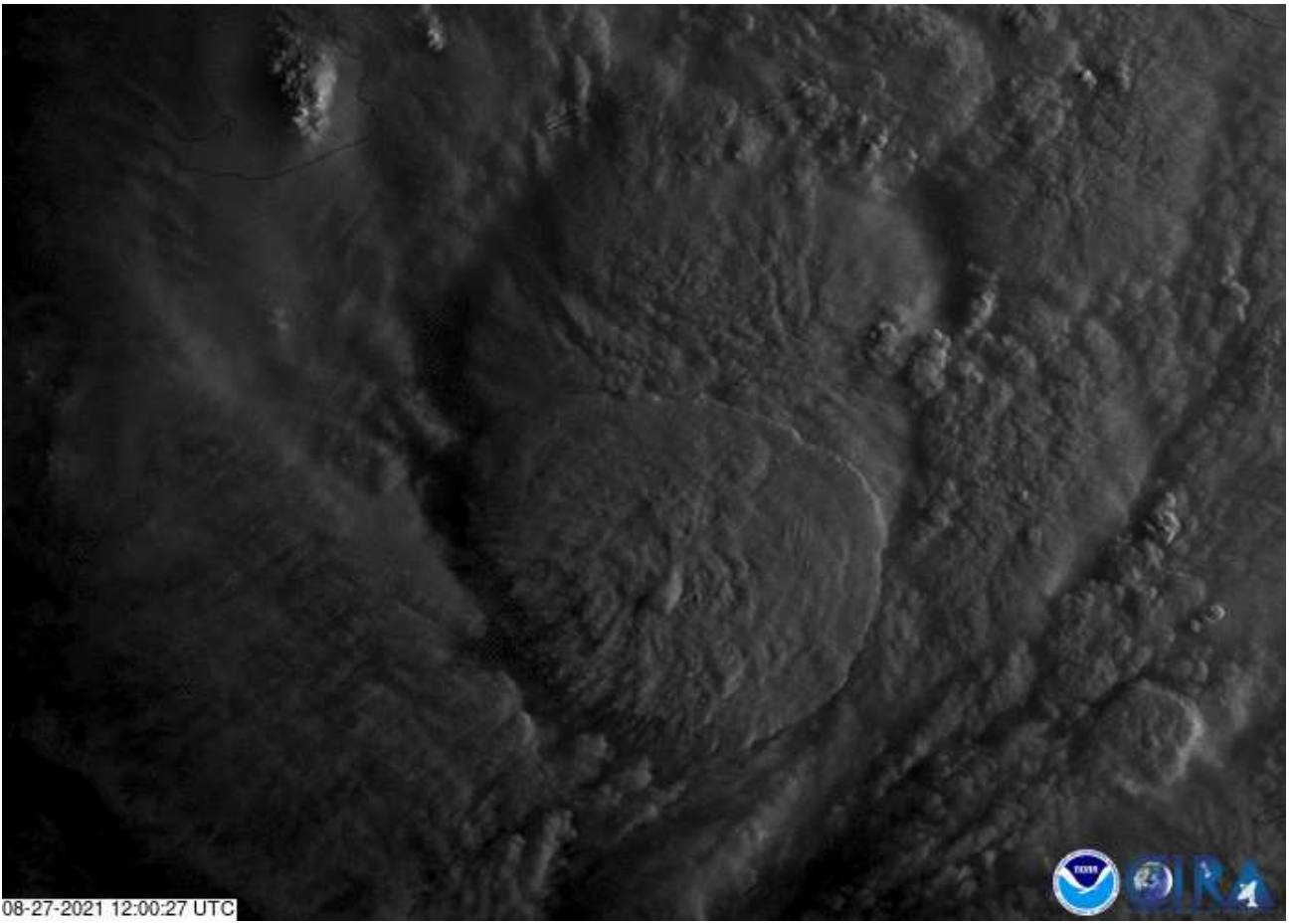
What is GLM showing us? And, how do we use the data for tropical cyclone applications?



Hurricane Ida (2021) on 27 Aug ~12 UTC

Hurricane Zeta (2020) on 28 Oct ~18 UTC

What is rapid intensification?

Traditional definition:

95th percentile of intensity change over the next 24 h period

In operations:

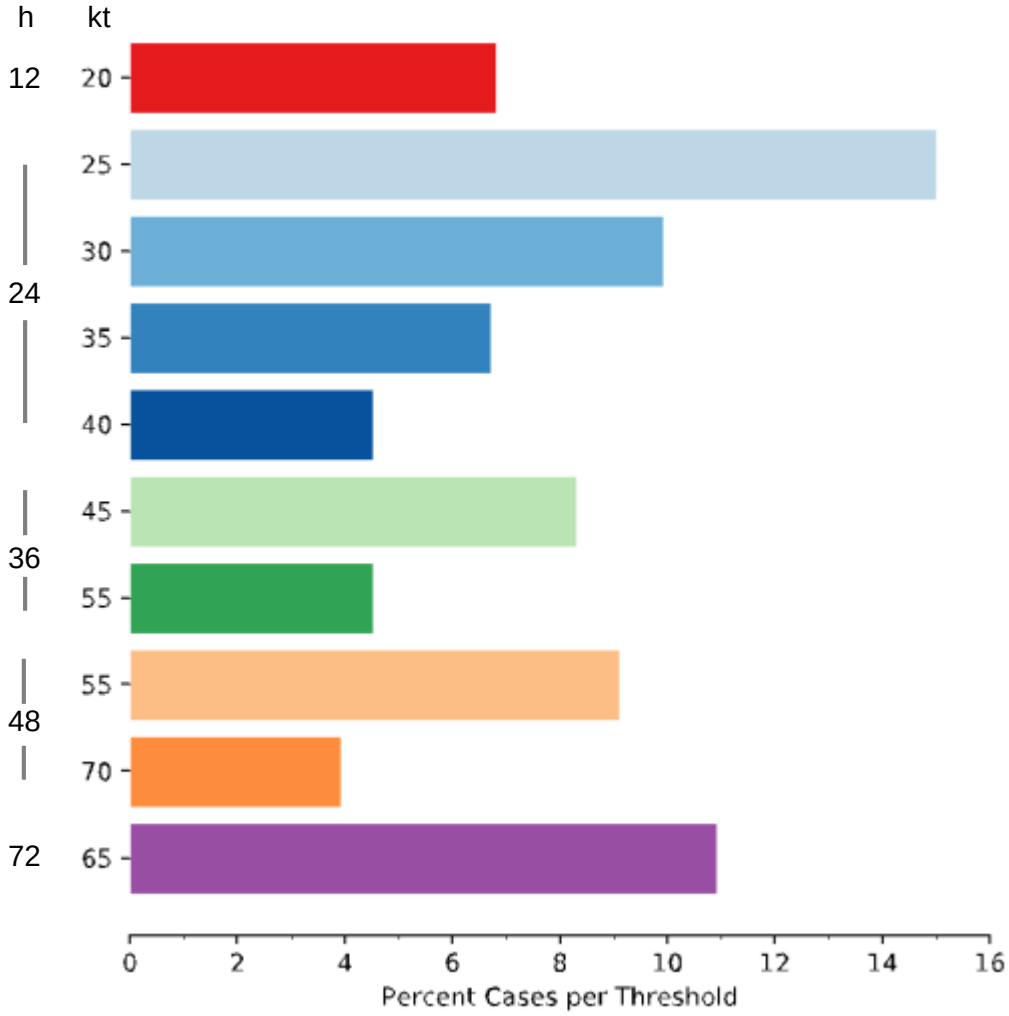
12 h: 20 kt

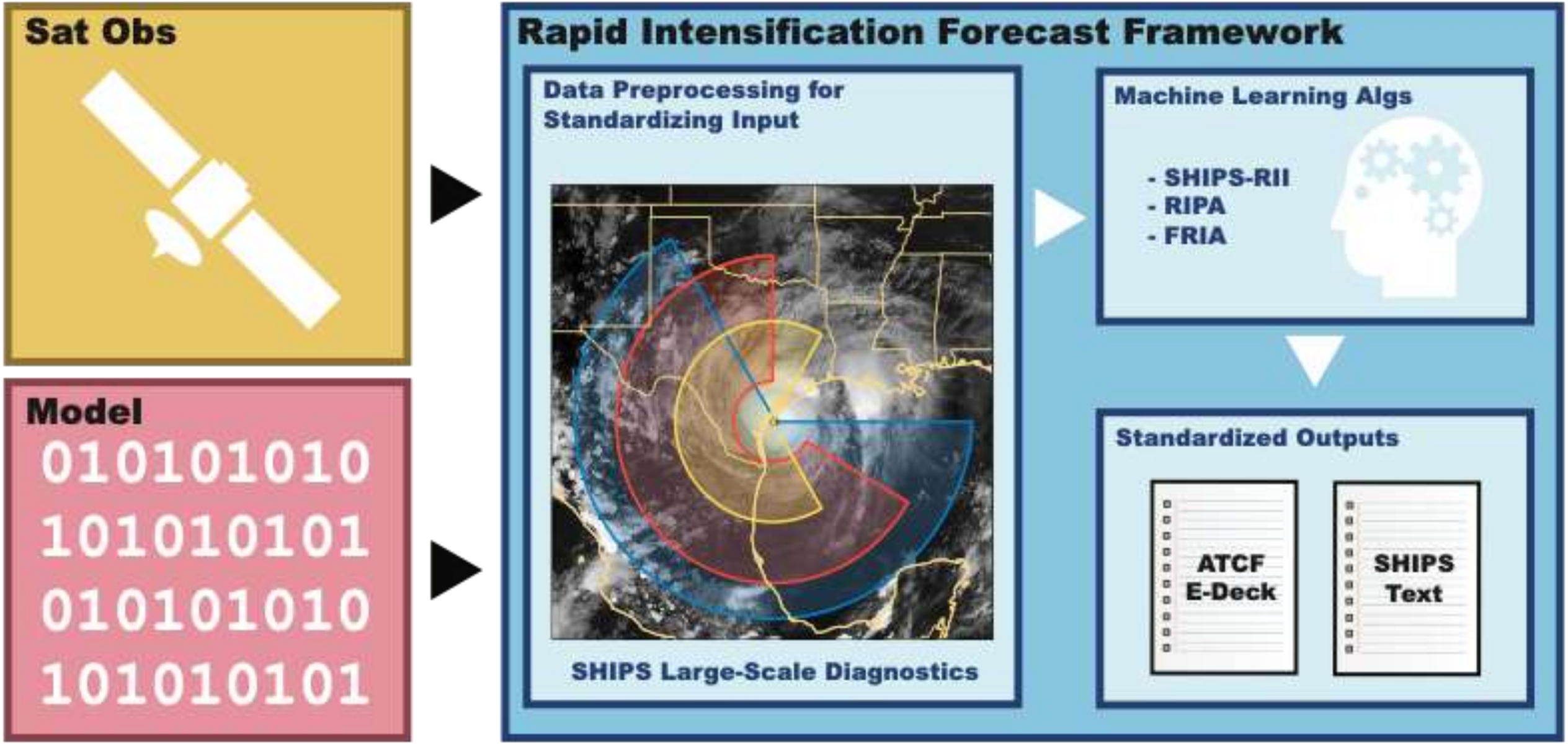
24 h: 25, 30, 35, 40 kt

36 h: 45, 55 kt

48 h: 55, 70 kt

72 h: 65 kt




Sat Obs
Model
010101010
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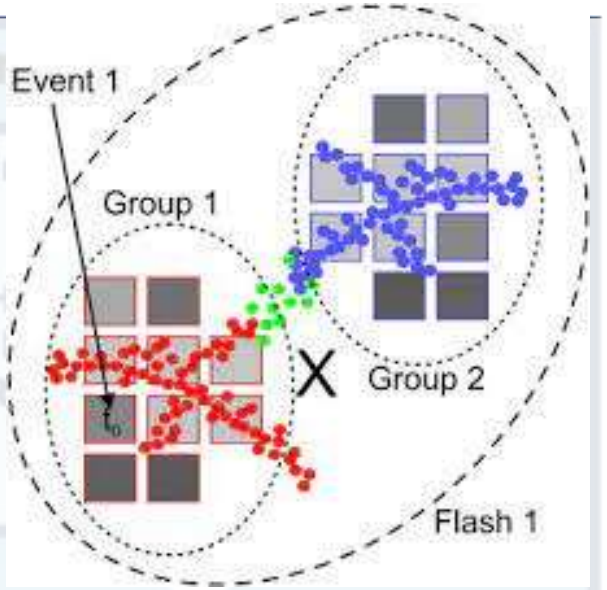
Rapid Intensification Forecast Framework
Data Preprocessing for Standardizing Input
SHIPS Large-Scale Diagnostics
Machine Learning Algs
- SHIPS-RII
- RIPA
- FRIA
Standardized Outputs
ATCF E-Deck
SHIPS Text

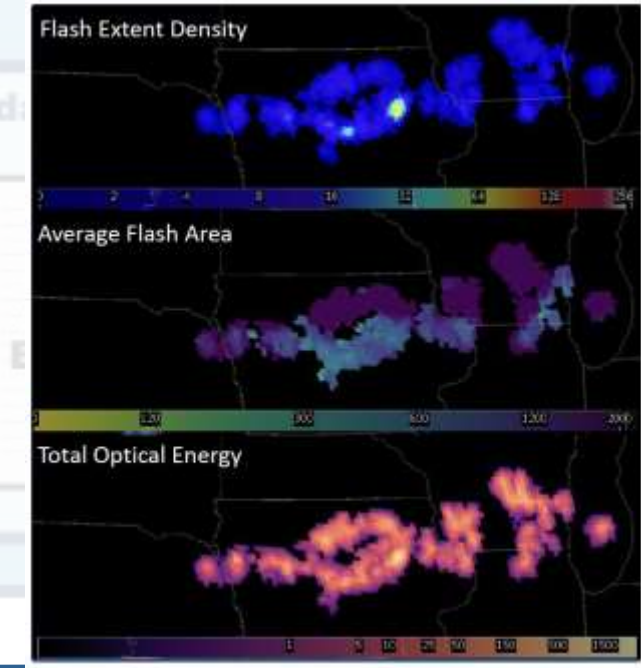
GLM Products

- Events, groups, flashes
- Gridded products

Goal

- Use GLM in real time
- Incorporate into rapid intensification forecasts



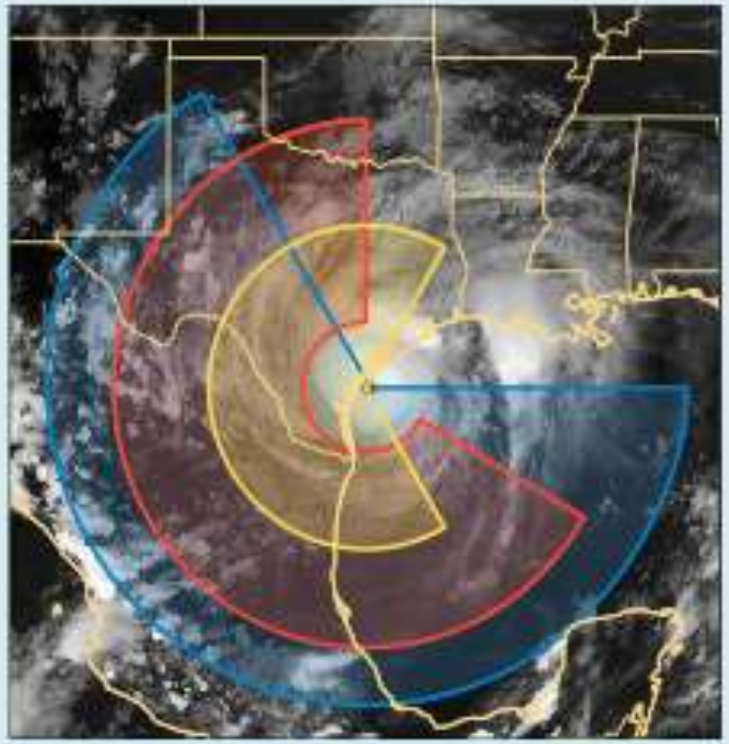


Sat Obs

Model

Rapid Intensification Forecast Framework

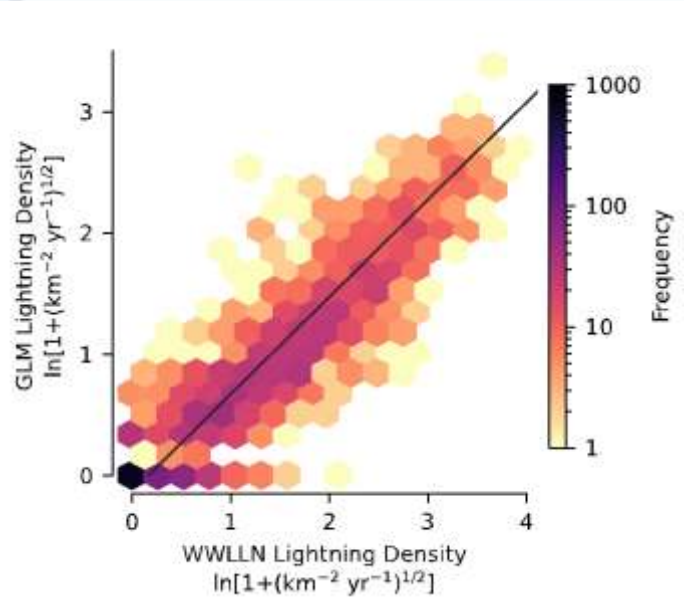
Data Preprocessing for Standardizing Input



SHIPS Large-Scale Diagnostics

Issue

- GLM has a short record
- Calculate a lightning density metric
- GLM & WWLLN correlate



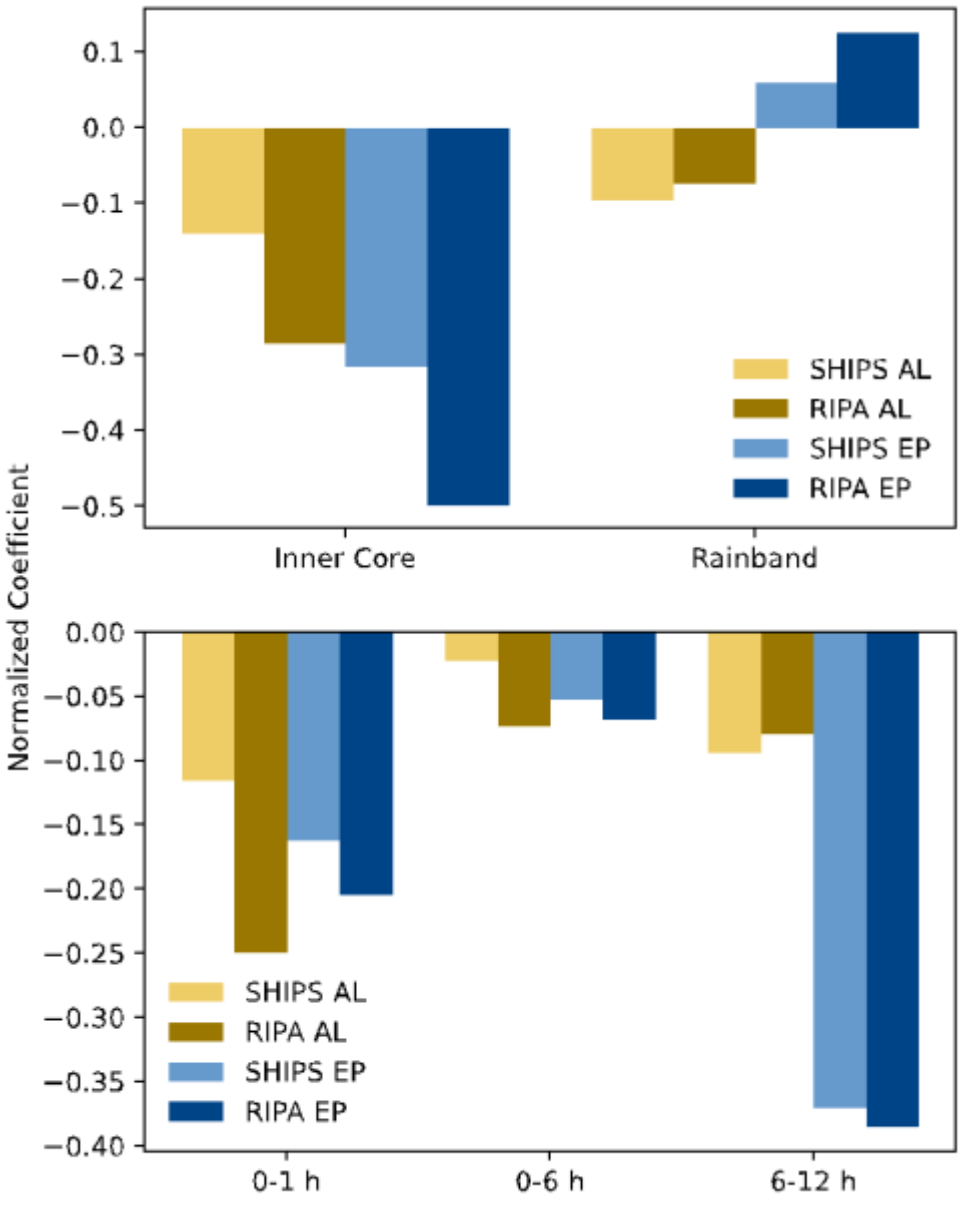
Slocum, C. J., J. A. Knaff, and S. N. Stevenson, 2023: Lightning-Based Tropical Cyclone Rapid Intensification Guidance. Wea. Forecasting, 38, 1209–1227, https://doi.org/10.1175/WAF-D-22-0157.1.

Configurations

RIPA & SHIPS-RII

1. DeMaria et al. (2012) with
   inner (0-100 km) and
   rainband (200-300 km)

2. Inner core only and time lag
   (0-1, 0-6, 6-12 h)



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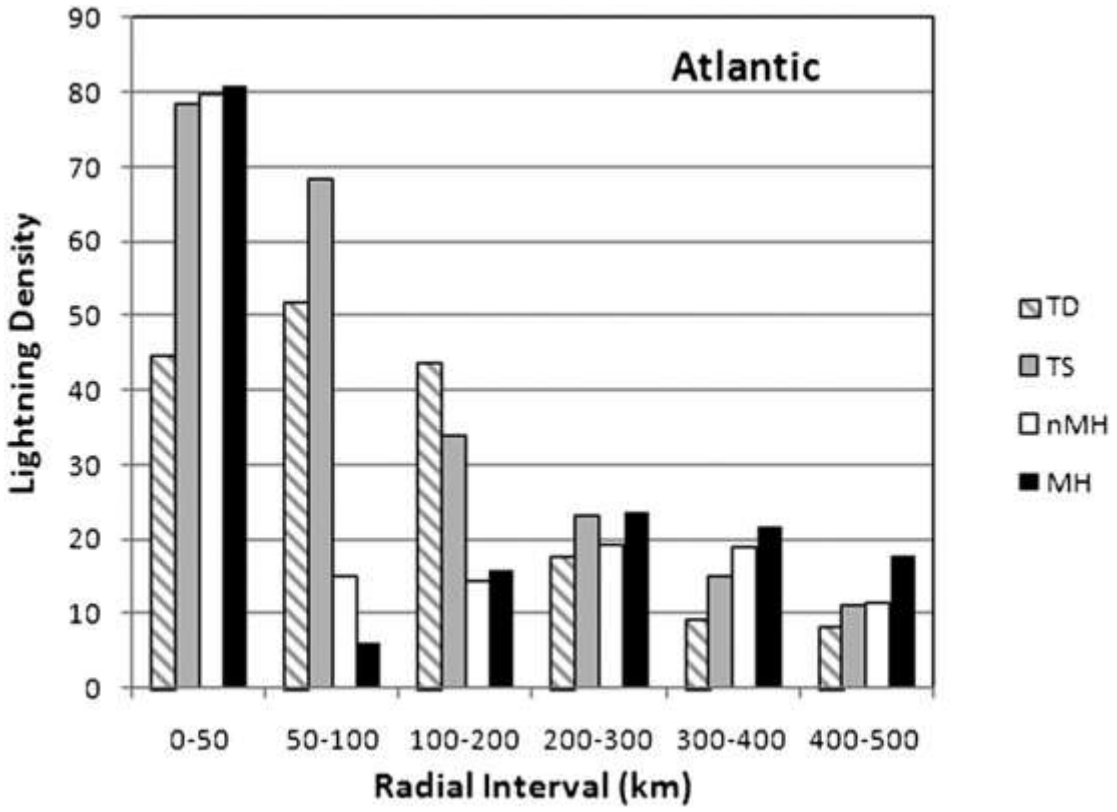
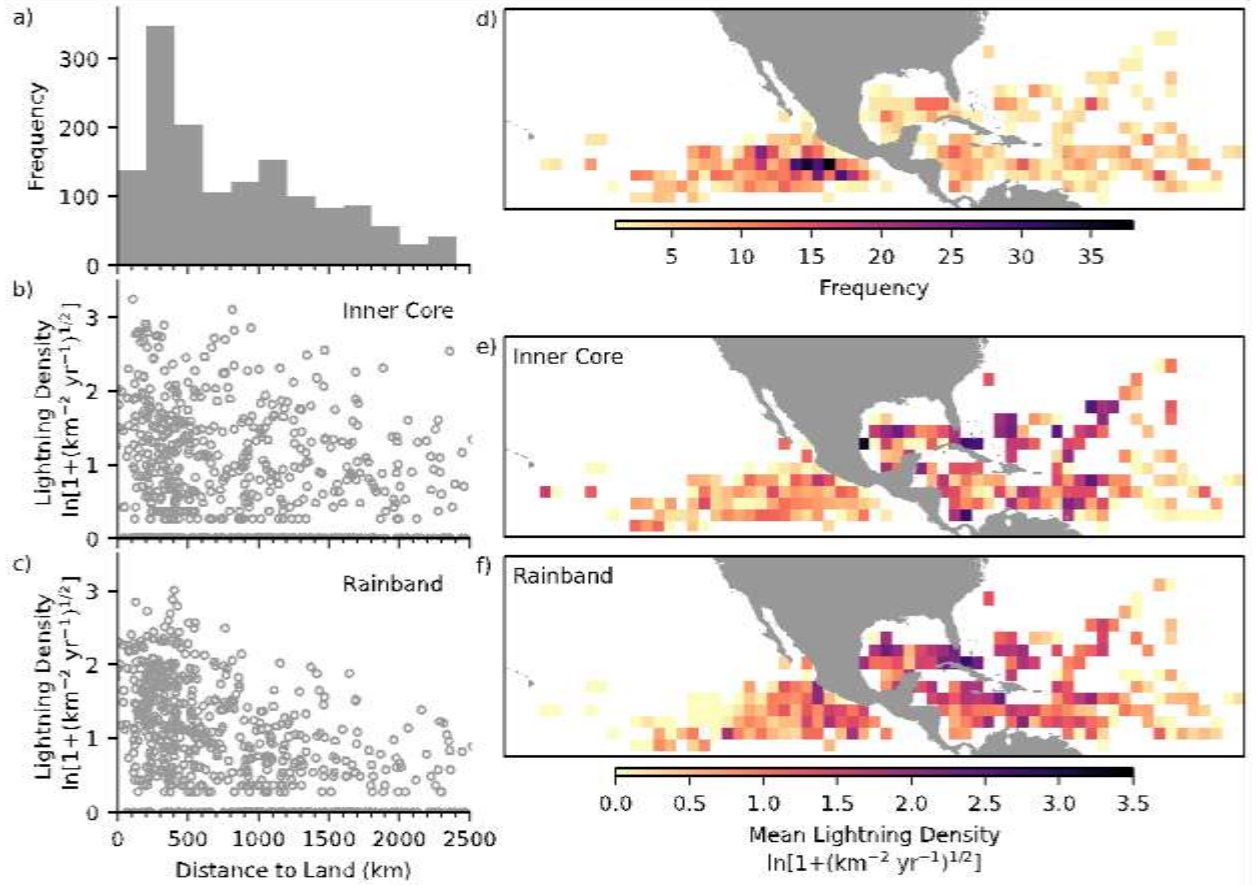
Lightning in tropical cyclones & impact of land



DeMaria et al. (2012)

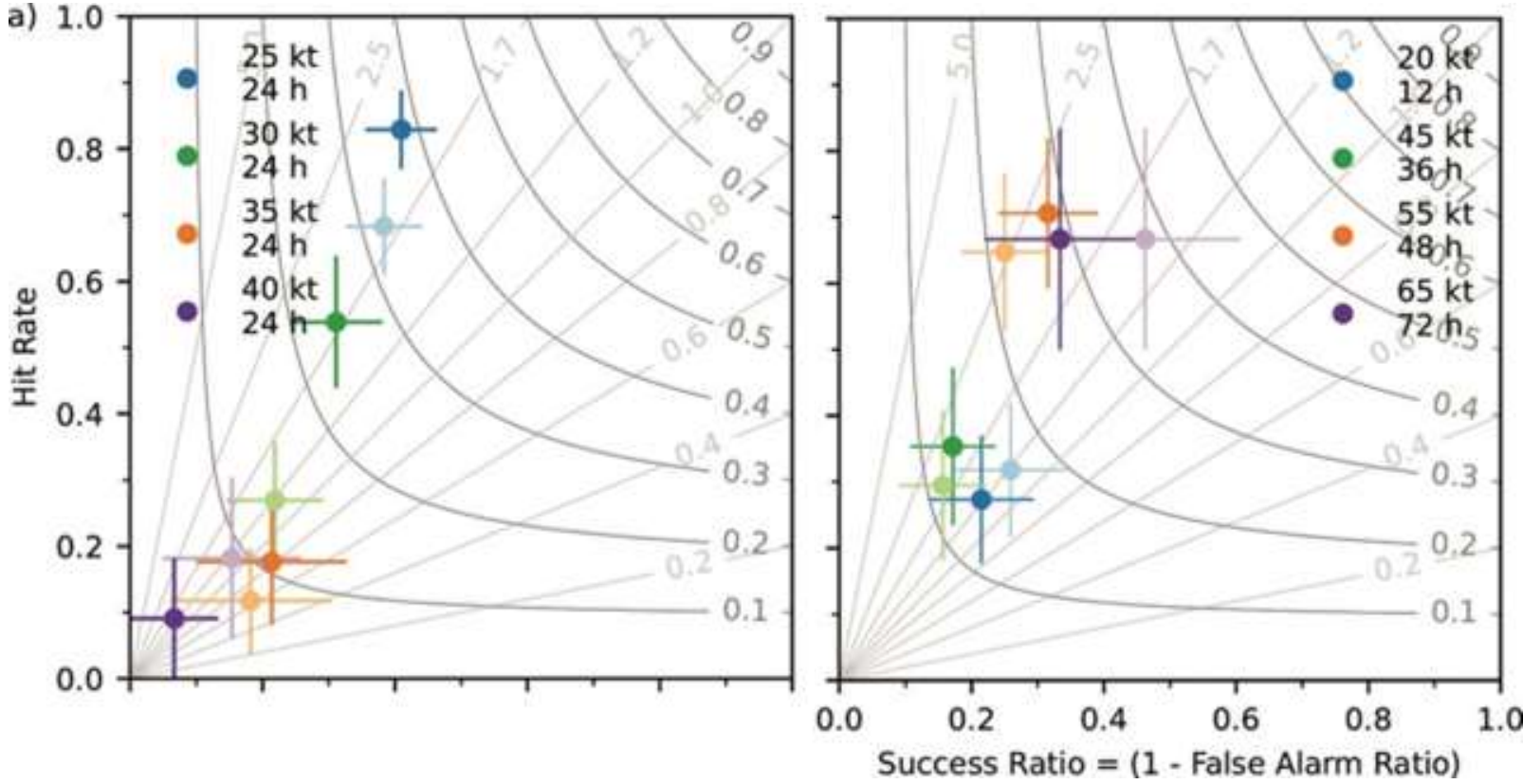


Slocum et al. (2022)

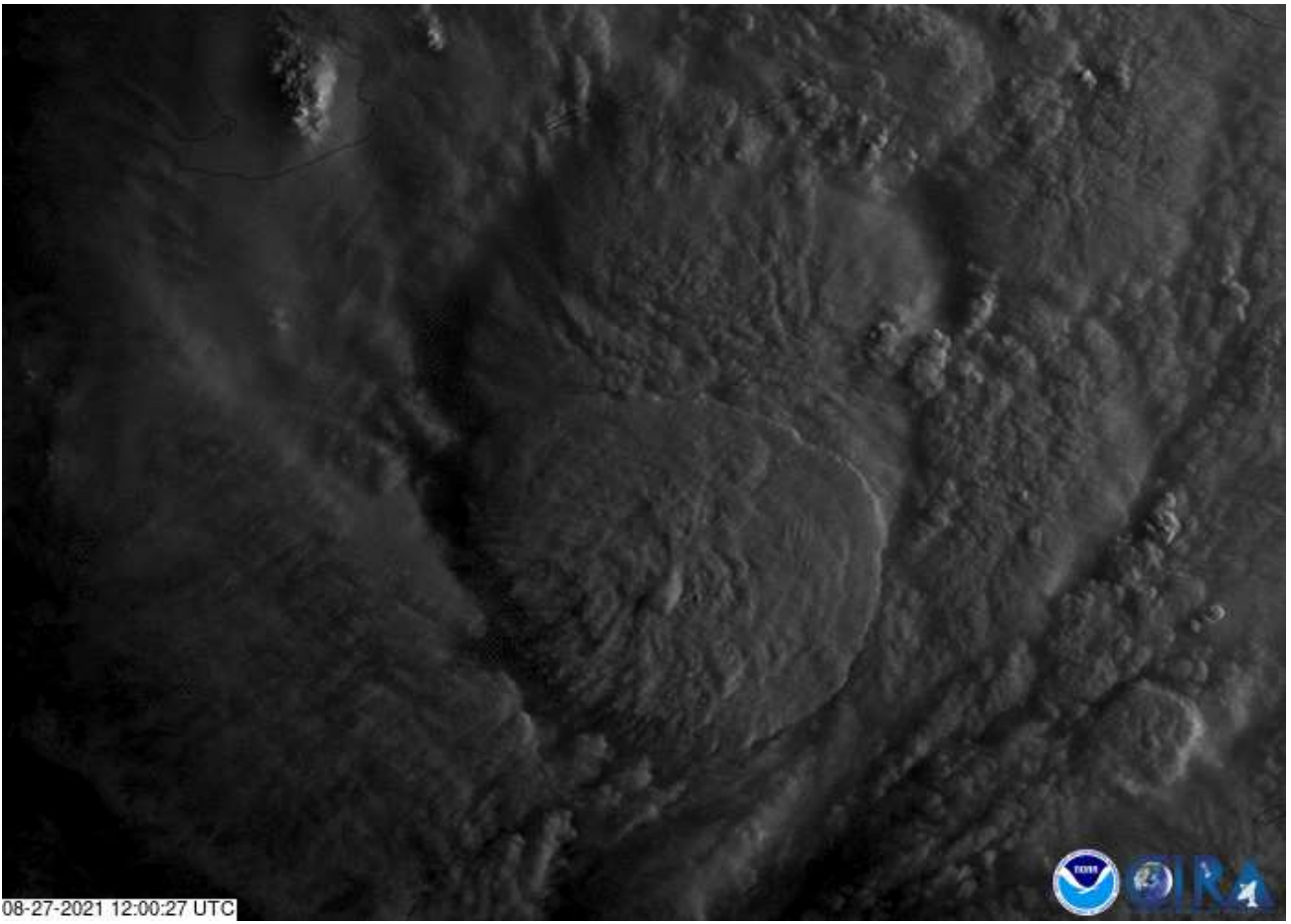
What is the operational performance?

1. For short lead times in the 25-30 kt in 24 h, lightning predictors improve hit rate and Peirce skill score

2. At long lead times (36 to 48 h) and rare RI thresholds



Back to: What is GLM showing us?



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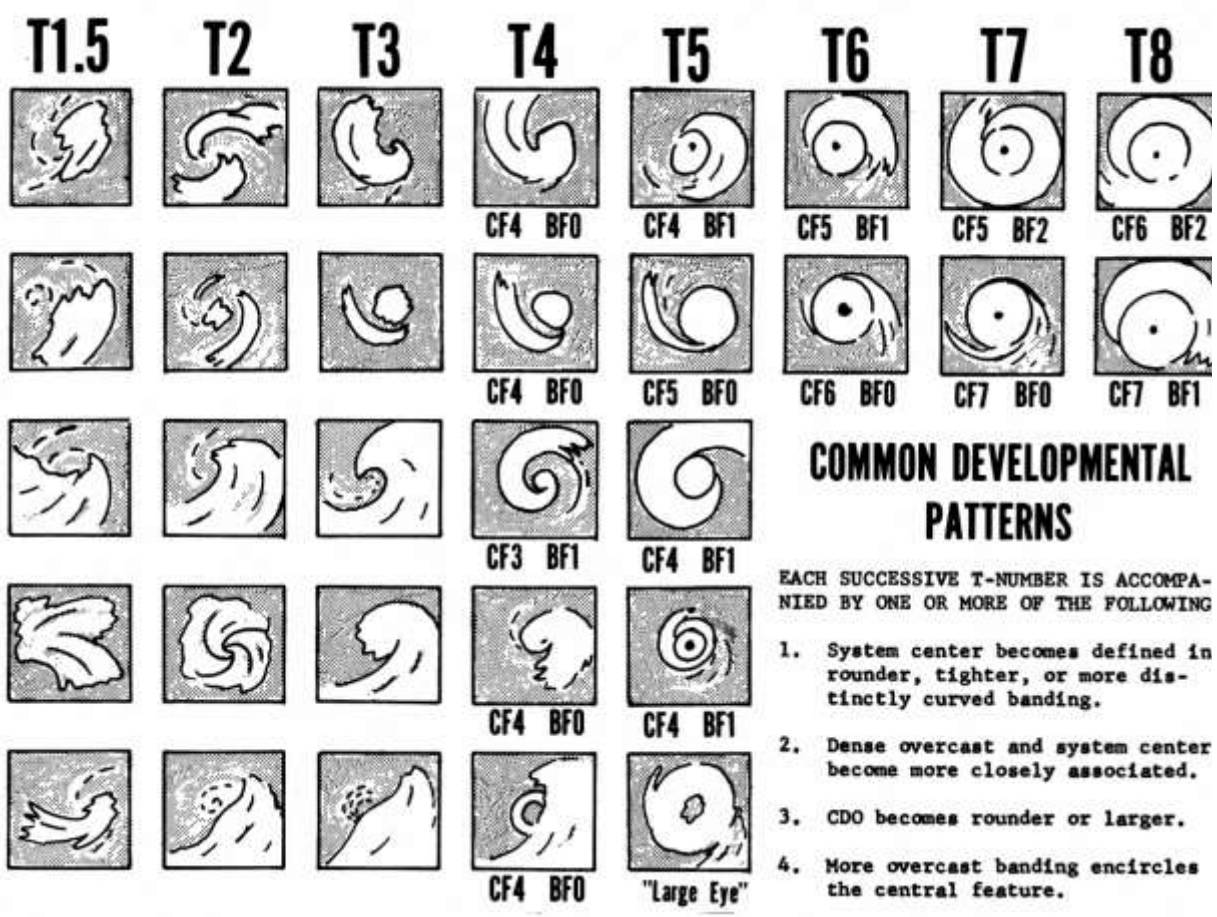
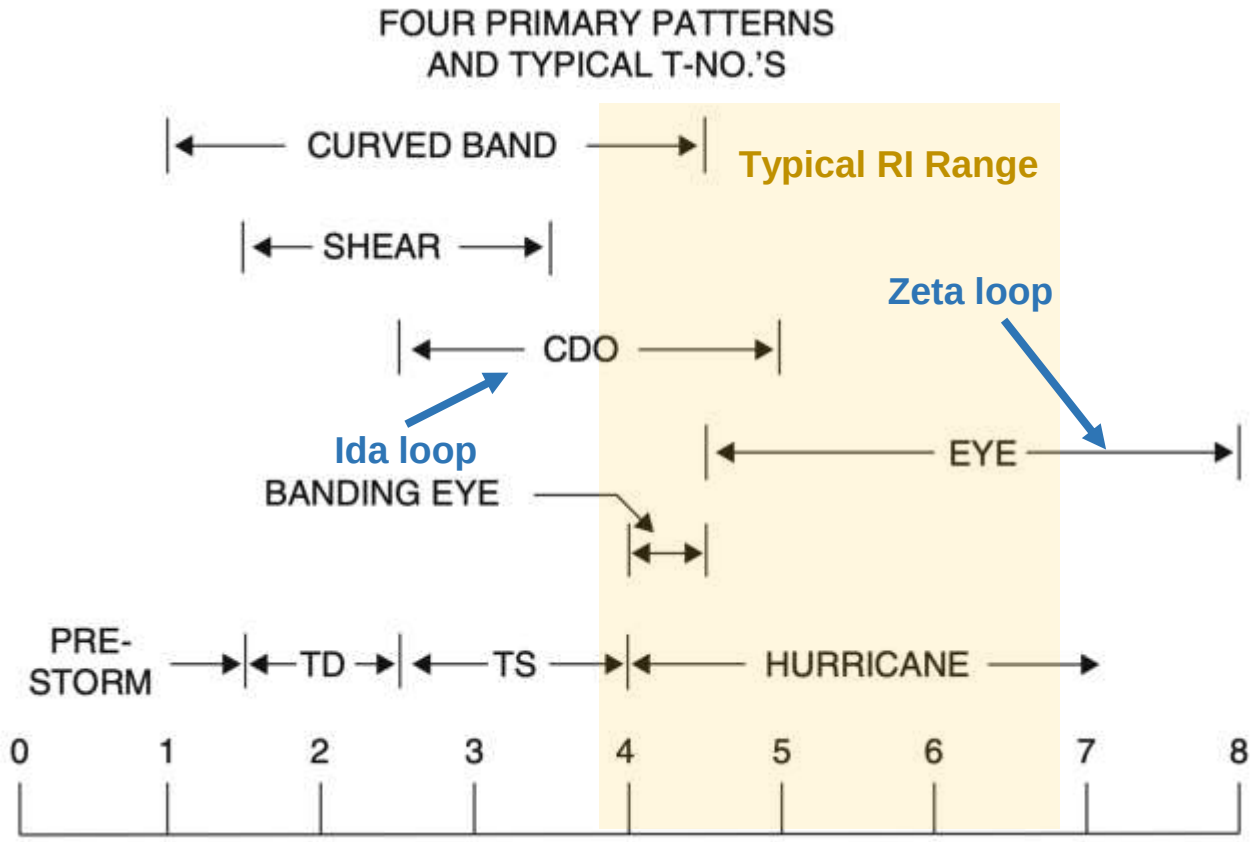
Subjective Dvorak Technique



Dvorak (1973)



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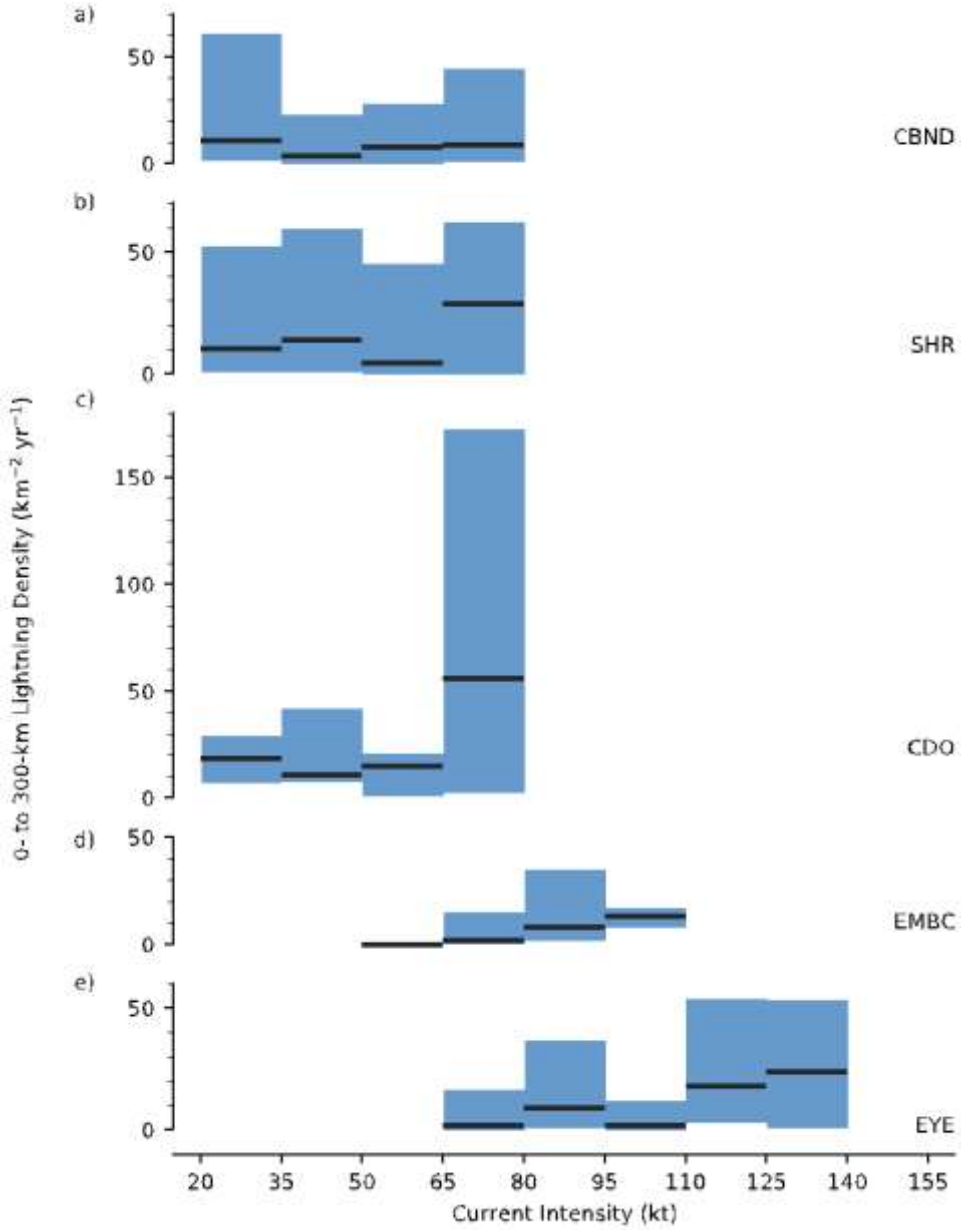
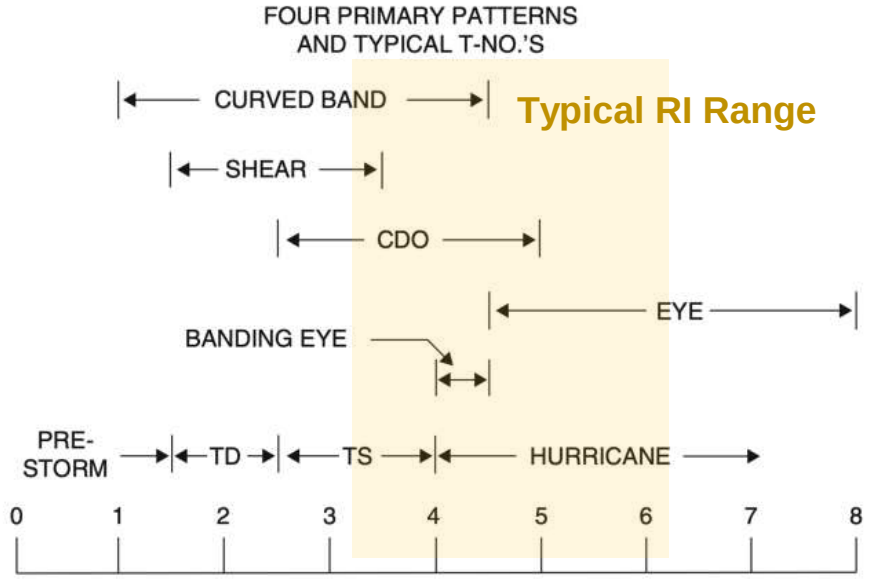


- 0 to 300 km GLM lightning density
- 2018 to 2021 Atlantic and eastern North Pacific



Summary

- Goal is to use GLM operationally for tropical cyclone algorithms (e.g., rapid intensification forecast aids)
- With GLM and WWLLN correlating, we can create training datasets
- Lightning in tropical cyclones is complex
  - Loosely related to intensity
  - Not well correlated to environmental parameters like shear
  - Contaminated by land
- GLM from GOES-16/-17/-18 from 2018 to present shows relationship between convective organization which can be exploited
- GLM gridded products assist in convective structure detection