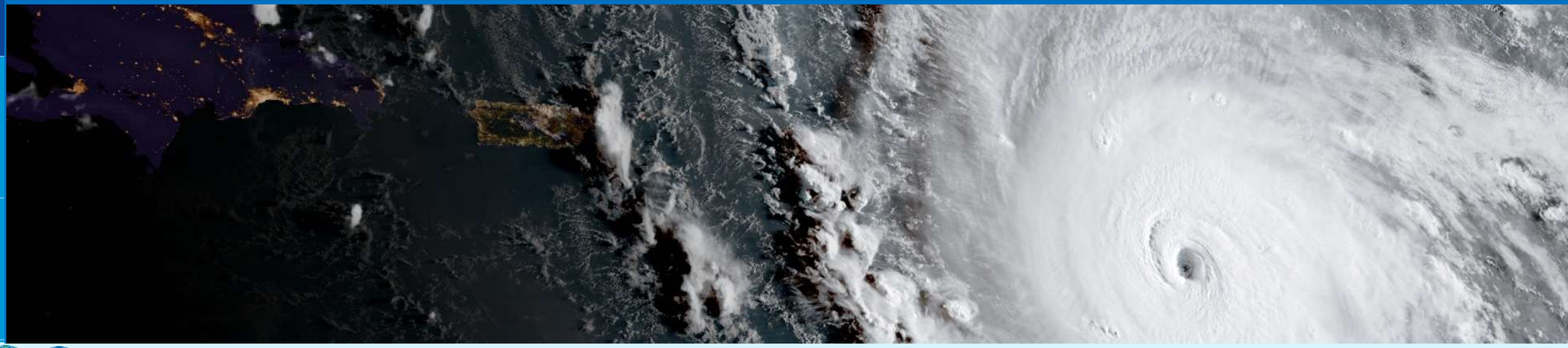
The use of GLM in the tropical cyclone rapid intensification aid

Chris Slocum[1] and Stephanie Stevenson[2]

1. *NOAA Center for Satellite Applications and Research*
2. *NOAA National Hurricane Center*

2020 GLM Science Meeting | 8 – 10 September 2020

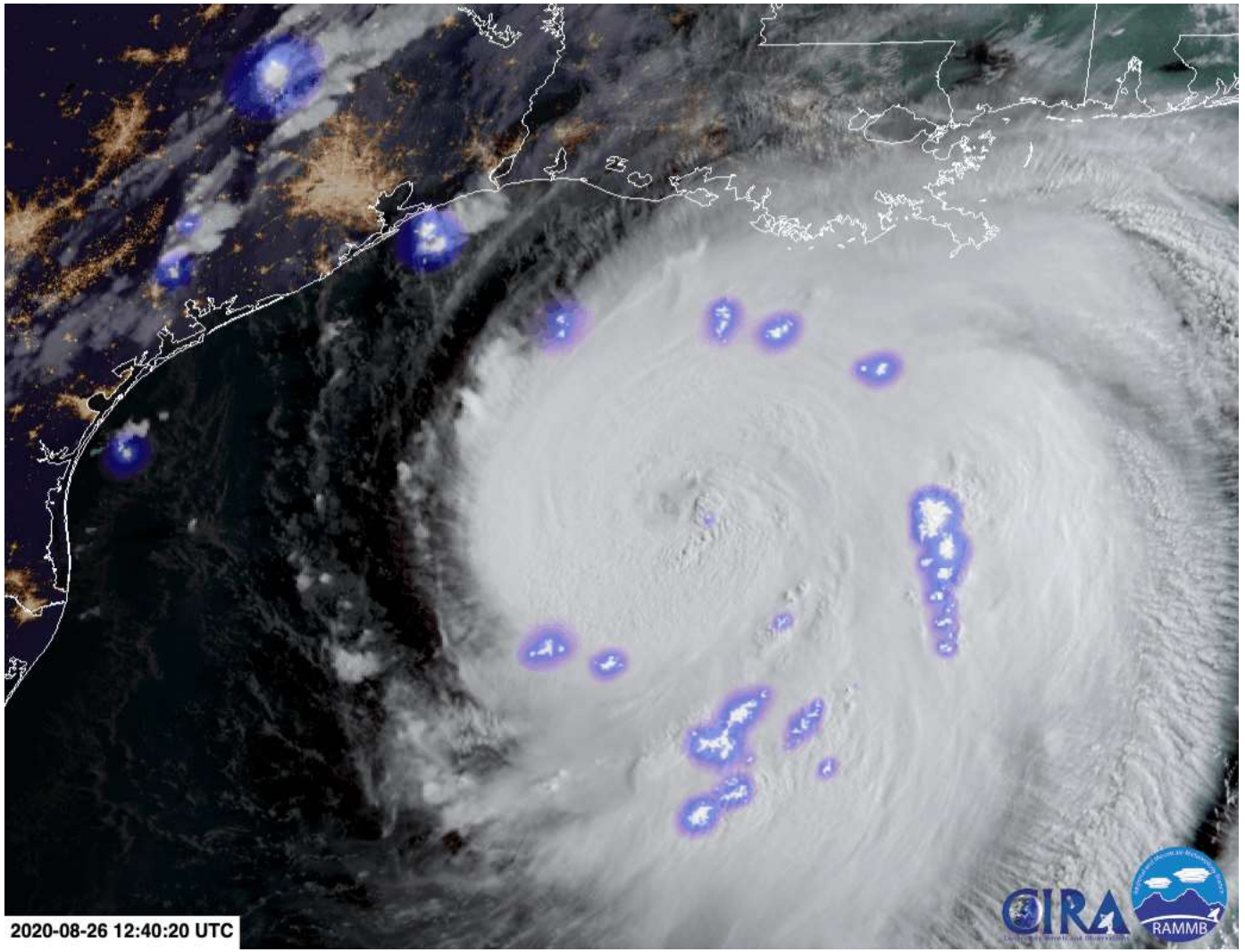


Introduction

Lightning & tropical cyclones
- Relationship to rapid intensification is complicated
- **Goal:** quantitative uses for forecasting

Short-term forecast applications
- Statistical-dynamical aids (e.g., SHIPS RII) convective parameters:
  - Cold pixel count
  - Structure principal components
  - Tropical overshooting tops
  - ***Lightning***

Major Hurricane Laura (2020)



Methods

SHIPS Rapid Intensification Index

- Linear discriminant analysis
- **Thresholds:** 12 h (20 kt); 24 h (25, 30, 35, 40 kt)
- **Parameters:** persistence, potential intensity, shear, 200 mb divergence, ocean heat content, low-level RH, -30C pixel count

Lightning Data

- GLM 2018 to 2020
- WWLLN 2005 to 2020
- GLD360 strokes 2012 to 2020
- Split into testing ('18 & '19) & training (thru '17)

Lightning density for SHIPS RII

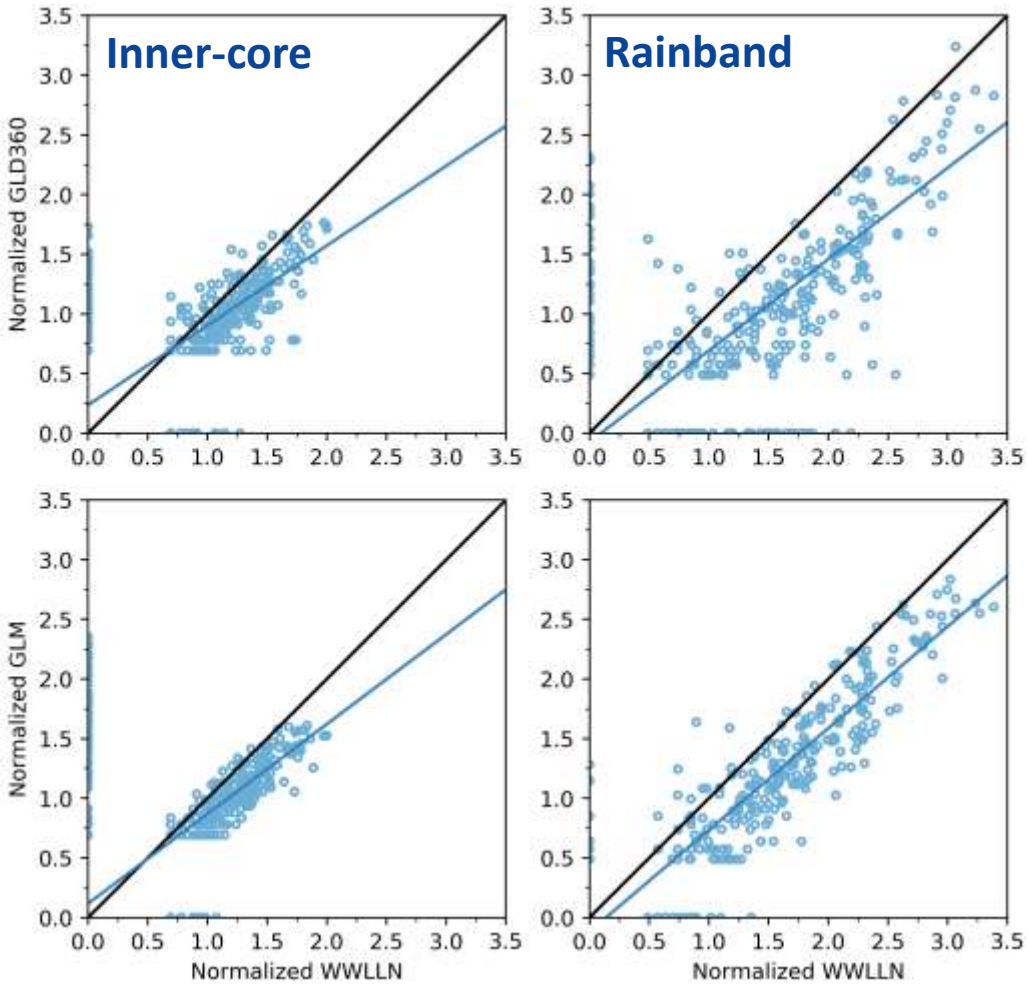
- LD = flashes per km^2 per year
- 6-hour, 100-km bins from 0 to 1000 km
- "Inner-core": 0 to 200 km (AL) / 100 km (EP)
- "Rainband": 200 to 300 km

Regress GLM LD to WWLLN LD

$$LD_w = \{\exp[w_0 + w_1 \ln(1 + LD_g^{0.5}) + w_2 V_m + w_3 \cos(lat)] - 1\}^2$$

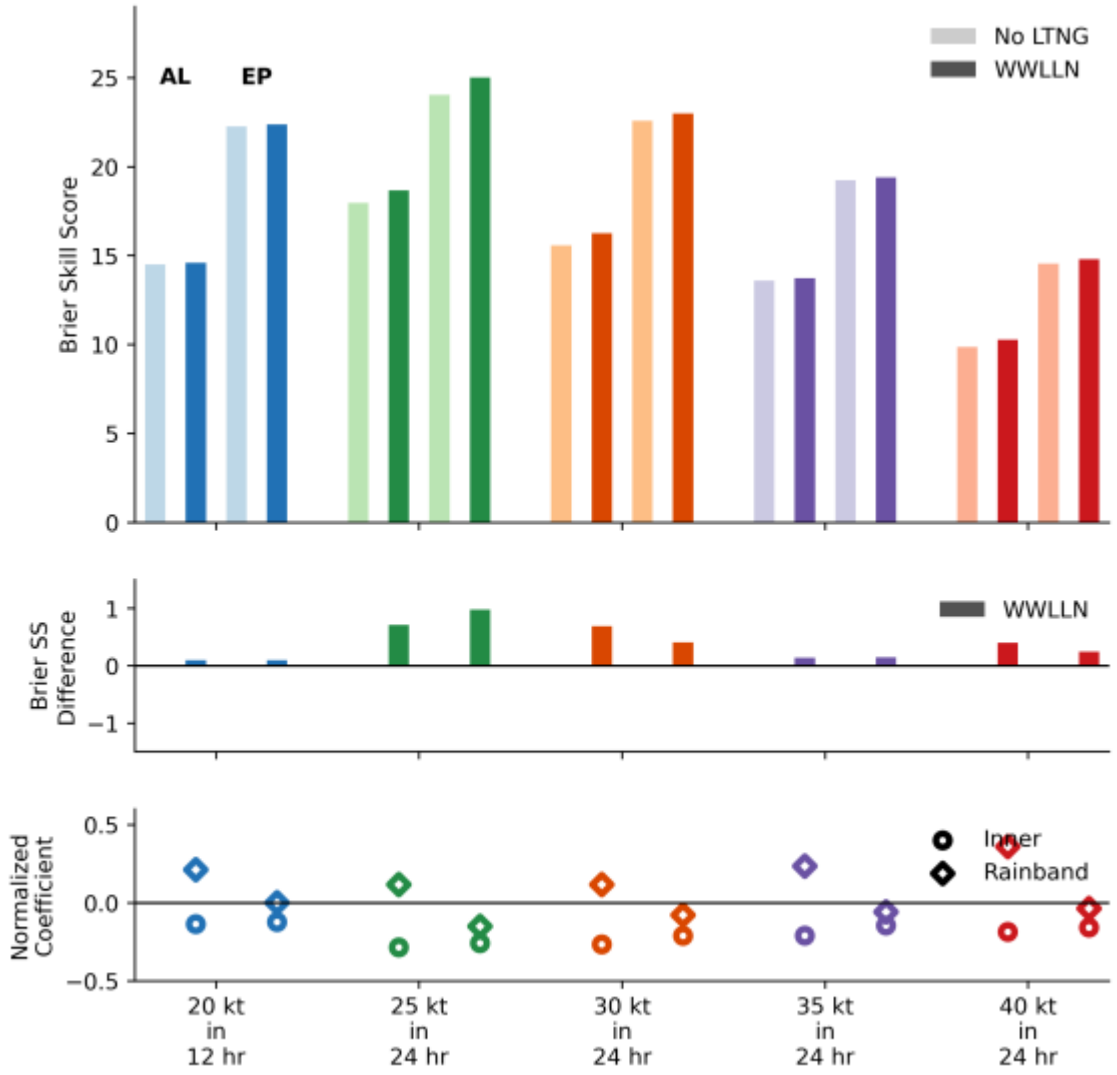
2018 – 2019 Atlantic Spearman's Rank Correlation

	GLM	GLD360
Inner-core	0.48 *(0.88)*	0.67
Rainband	0.93 (0.94)	0.65

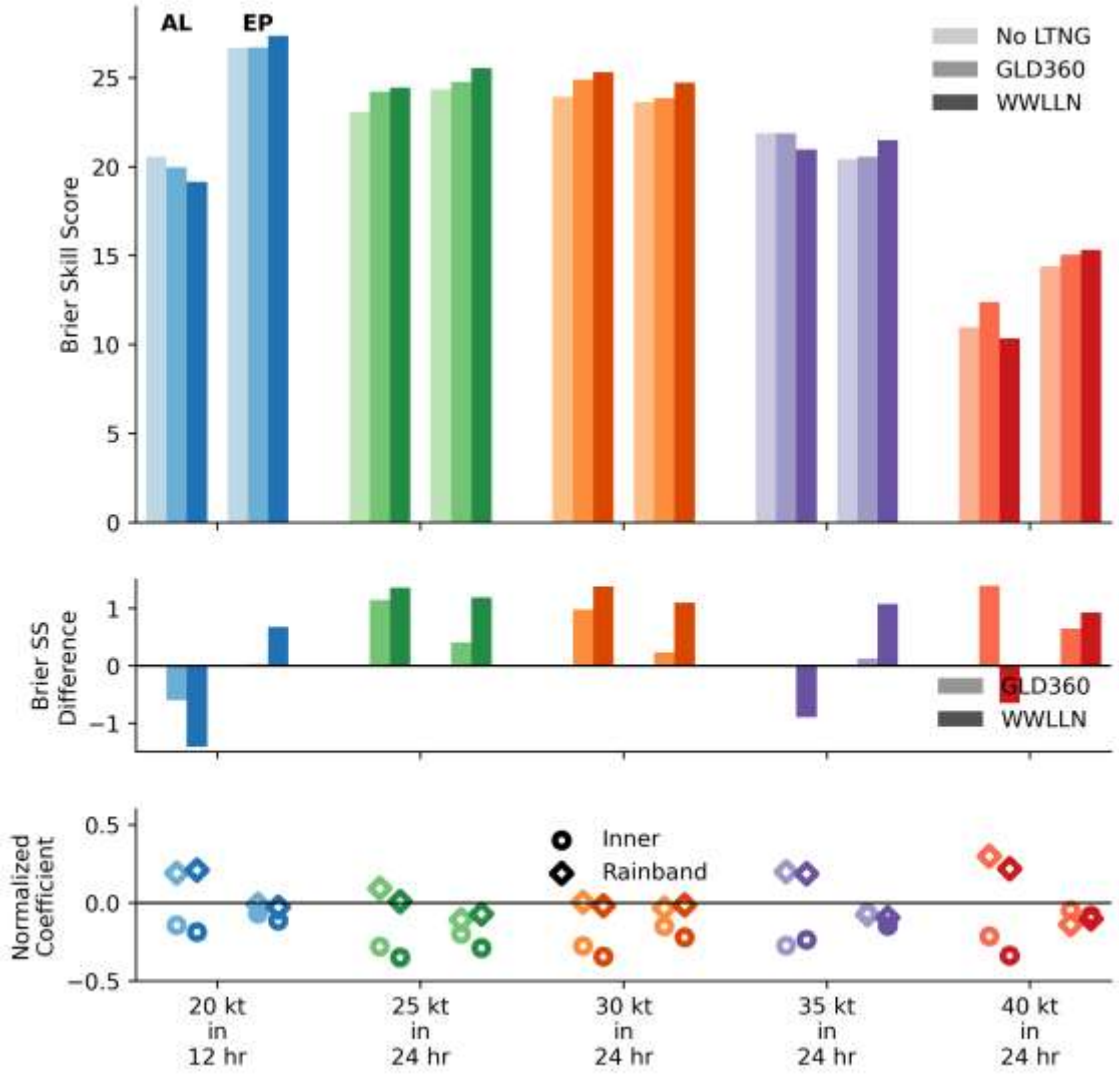


Results – model performance

WWLLN 2005 to 2017



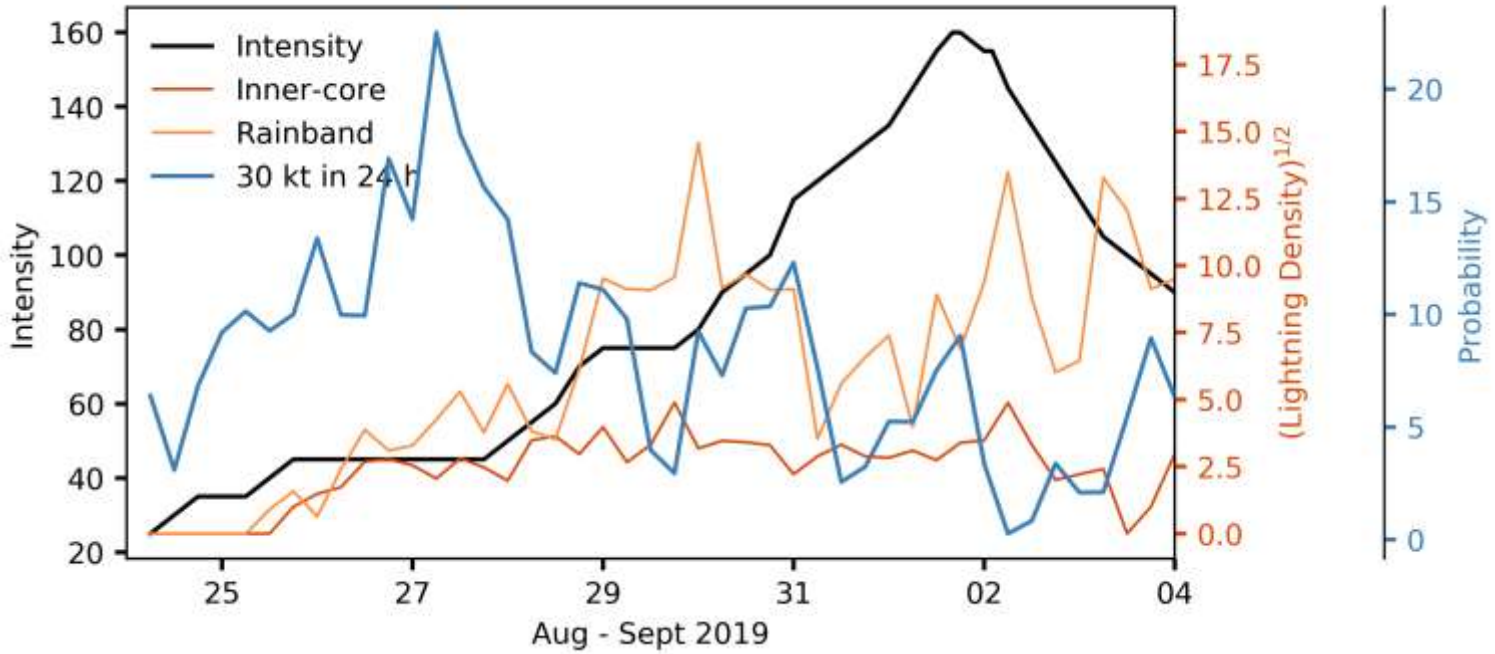
GLD360 & WWLLN 2012 to 2017



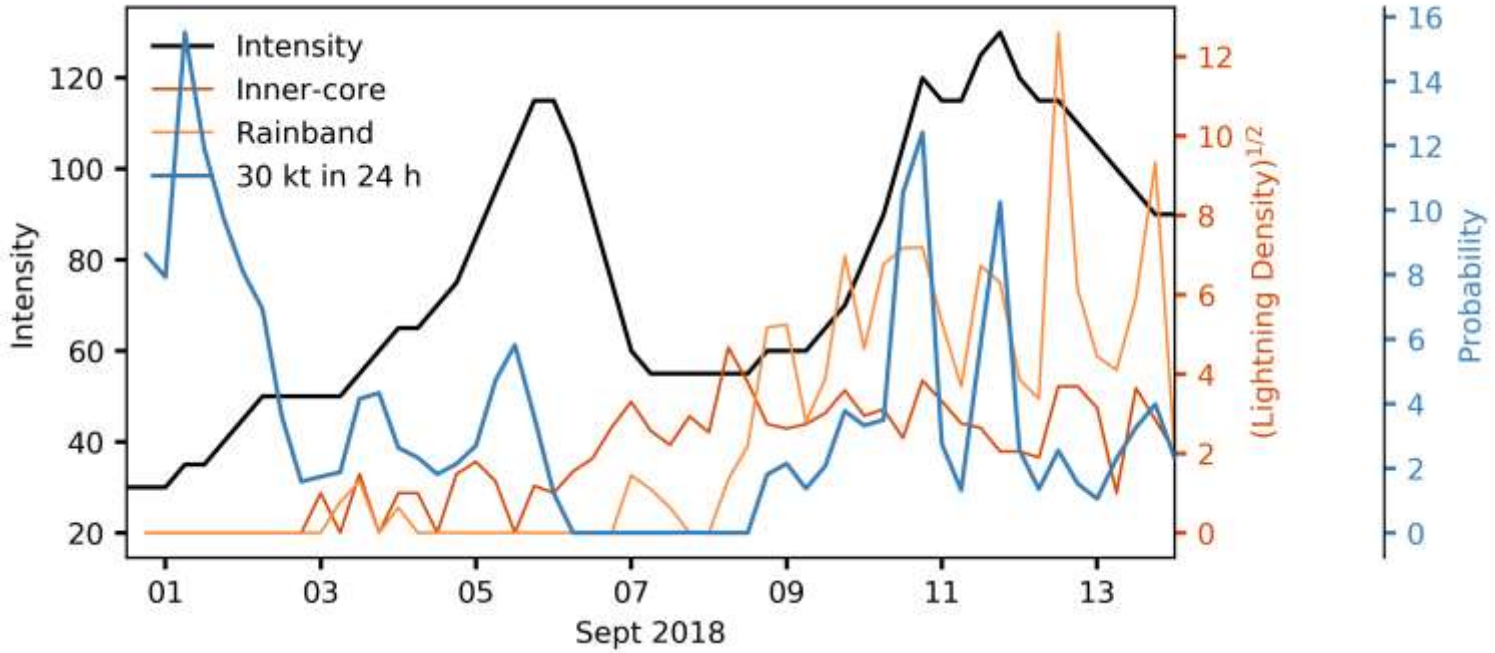
Results – independent test case examples

- Regressed GLM input values in WWLLN trained model
- Threshold: 30 kt in 24 h
- Probabilities spike in both cases before the onset of the first RI period

Hurricane Dorian (2019)



Hurricane Florence (2018)



Summary

- Adding lightning improves skill of SHIPS RII
- Inner-core lightning is negatively correlated with the onset of RI using 6-hour, 100-km bins
- Rainband positively correlated with RI in AL but not EP (consistent with DeMaria et al. 2012)
- This work provides a baseline for using lightning in operations
- Higher temporal fidelity data (1-hour bins) could add information about sudden changes (would require a nonlinear ML algorithm to leverage this input)

Major Hurricane Dorian (2019)