FDL

FDL 2020 EARTH SCIENCE

LIGHTNING AND EXTREME WEATHER

POSTER TITLE AND RESEARCHERS

SEVERE WEATHER PREDICTION USING LIGHTNING DATA

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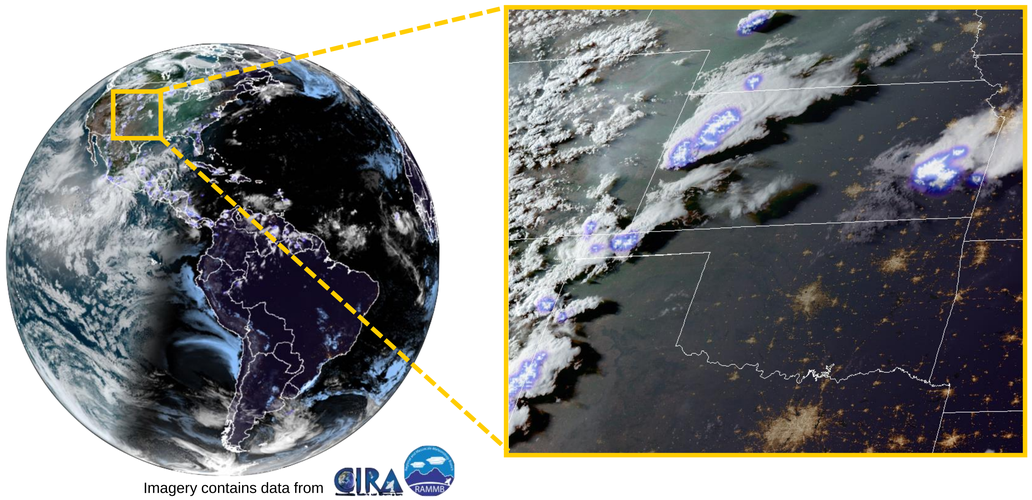
Project Pikajoule

CHALLENGE & OPPORTUNITY

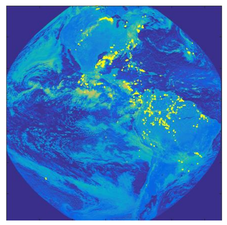
PROBLEM: Can we use lightning observations from GOES satellite to improve predictions of severe thunderstorms and help forecasters keep the public safe?



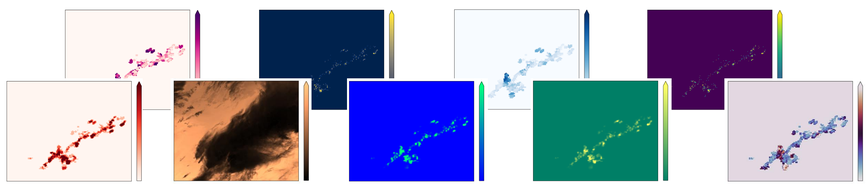
Imagery contains data from CIRA RAMMB

Data from the Geostationary Lightning Mapper (GLM) and Advanced Baseline Imager (ABI) instruments aboard GOES can be used to create proxies for convection intensity that can then be used to identify possible severe weather.

OPPORTUNITY: Use high temporal resolution and large spatial coverage of GLM and ABI data aboard GOES to improve predictions of severe thunderstorms.



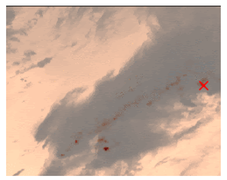
8 variables from GLM (e.g., flash extent density, group centroid density) and 1 variable from ABI (channel 13).



Google Cloud

Requires **significant** computational resources.

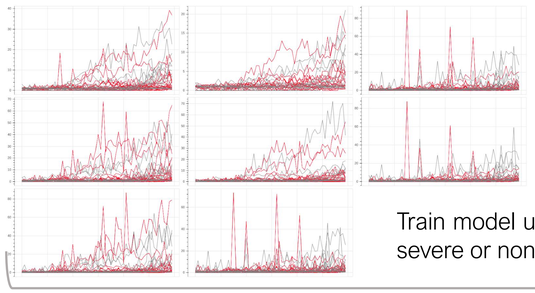
- 240 CPUs
- 9 input channels, 1 min cadence
- 10 GPUs
- 3,000,000+ GLM files processed



OUTCOME

Our time series convolutional-kernels model suggests GLM + AI can improve forecasting of severe weather events with a 15 min lead time.

- **15 min nowcasting lead time**
- **8 GLM lightning time series derived quantities**
- **1/2** Reduced false alarms for warned thunderstorms
- **8/10** Correctly classified tornadoes and severe hail reports



Non-severe: Warning with no confirmed report in a 24-hour period.

Severe: Confirmed tornado or severe hail report.

Train model using 8 GLM quantities 60 minutes prior to events to classify as severe or non-severe.

ROCKET
RandOm Convolution Kernel Transform
(Dempster et al. 2020)

10,000 convolutions

Classifier → **15 min lead time**

Severe

Non-severe

	Miss	Correct Rejection
Hit		False Alarm

83 Hit	26 Miss
59 False alarms	**53** Correct rejection

Critical Success Index (CSI) [Higher is better]

False Alarm Ratio (FAR) [Lower is better]

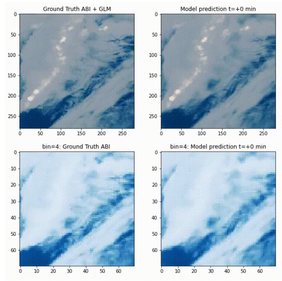
	Project Pikajoule	State of the Art
Lead time	15 min	> 15 min
Coverage	Central US (1,000 x 800 km)	CONUS
Period	Mar-Jun 2019	May-Jul 2014, Mar-Dec 2016
CSI	0.49*	~0.35
FAR	0.41*	~0.55

* Mean of 100 trained models in test dataset.

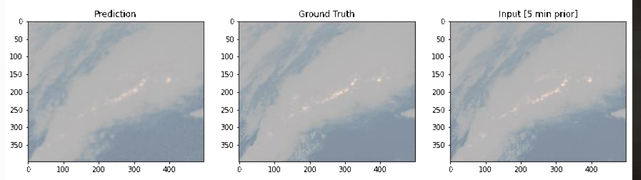
National Weather Service, (Cintineo et al. 2018)

NEXT STEPS

- ML explainability.
- Video frame prediction.
- Geographic and seasonal extension.
- Increased lead time.



U-Net model (GLM, ABI).



Recurrent model (GLM, ABI, severe mask).