



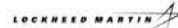
# Predicting Severe Storms with ML and GLM

September 9, 2020





- AI accelerator lab
- SETI institute and NASA
- 8 week research sprint
- Unites Machine Learning Engineers with Domain Specialists





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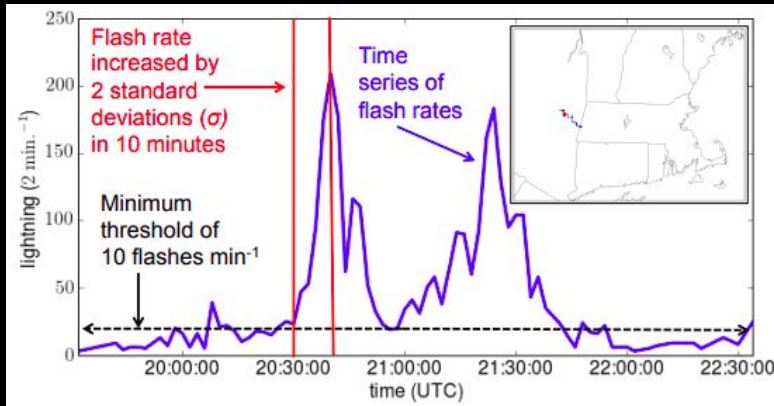


**PROBLEM:** Can we use GLM observations and machine learning to improve predictions of severe thunderstorms?

**APPROACH:**

1. Time-series convolutional-kernel model using gridded GLM quantities.

2. Recurrent spatial-temporal model using GLM and ABI (Channel 13)



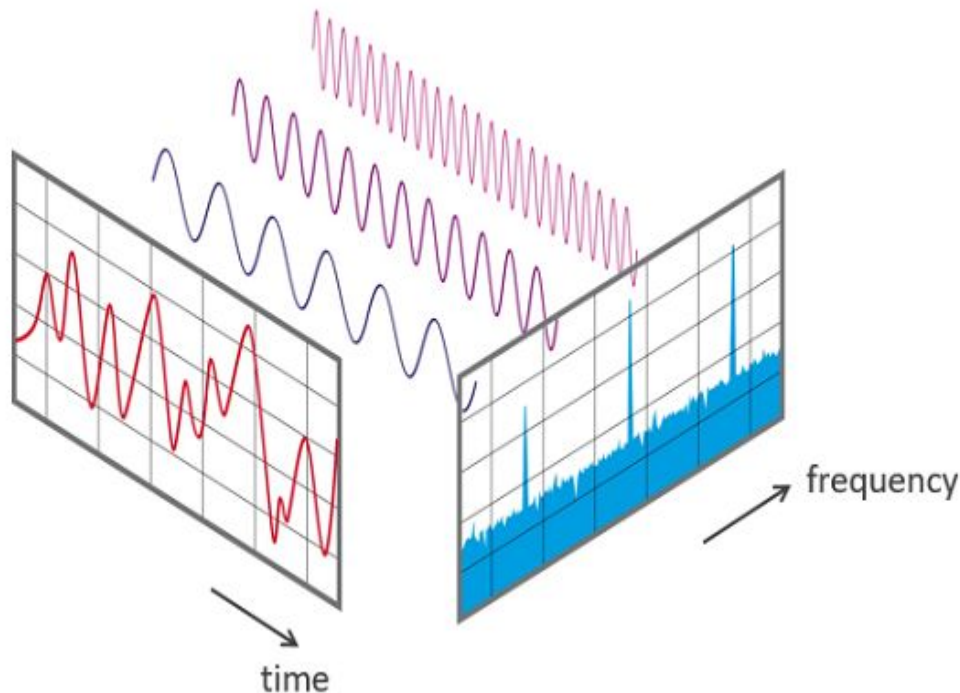
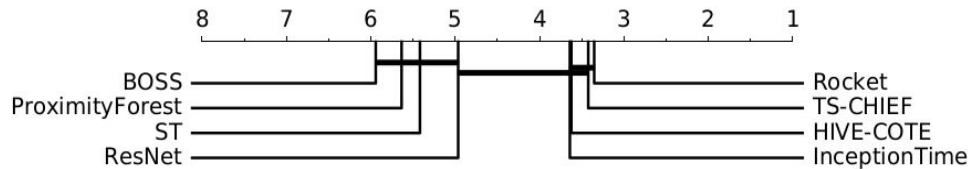
Eck (2017)





# ROCKET

- **RandOm Convolution KErnel Transform (Dempster et al. 2020)**
- **Fast Time Series Classification**
- **Convolutional kernel as a transform**
  - **Random length**
  - **Dilation**
  - **Padding**
  - **Bias**
- **Transformation input to classifier**
- **Single layer**



# Project Pikajoule

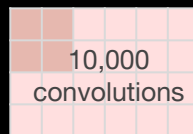
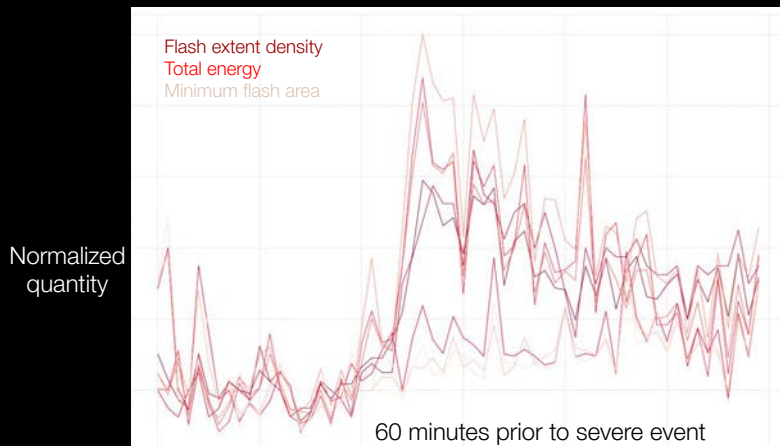


Using ROCKET, we create features from convolutions of GLM time series data and train a classifier to predict if a severe event occurred.

Data: Spring 2019, central plains

Null: Warning issued, but no severe event within 24 hours

**Severe:** Reported tornado or hail event.



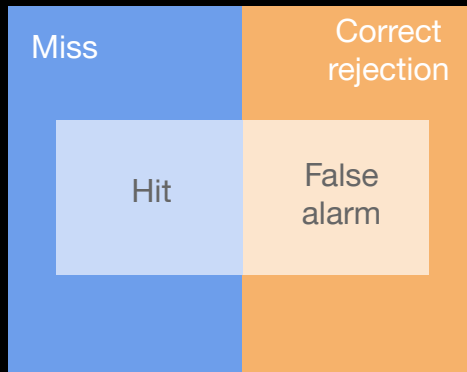
Classifier



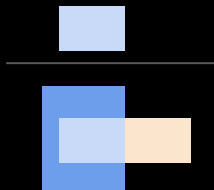
15 min lead time

Severe  
Non-severe

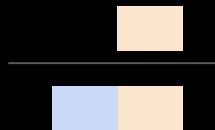
# Results



**Critical Success Index (CSI)**  
[Higher is better]



**False Alarm Ratio (FAR)**  
[Lower is better]



## Project Pikajoule

**State of the Art**  
(National Weather Service, Cintineo et al. 2018)

<i>Lead time</i>	15 min	> 15 min
<i>Coverage</i>	Central US (1,000 km x 800 km)	CONUS
<i>Period</i>	Mar-Jun 2019	May-Jul 2014, Mar-Dec 2016
<b>CSI</b>	0.49*	~0.35
<b>FAR</b>	0.41*	~0.55

\*Mean of 100 trained models



**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**

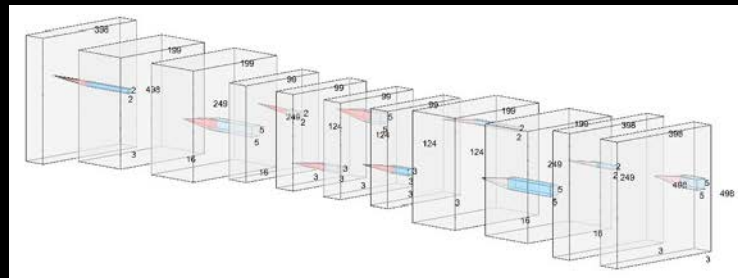
***These results suggest we can enhance and refine this work to aid in forecasting severe events***





## Video Frame Prediction

- **Encoder ConvGRU Decoder**
  - Encoder - feature extraction
  - ConvGRU - temporal context
  - Decoder - original image
- **Examine 30min before and after severe event**
- **Train 100 video segments**
- **Test 15**



Predicted  
Frame



Ground Truth



Prior (5min)

Convolutional Neural Network using lightning observations, cloud-top temperatures, and severe weather reports



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# Google Cloud



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