Automated Pipeline for Detecting Gigantic Jets

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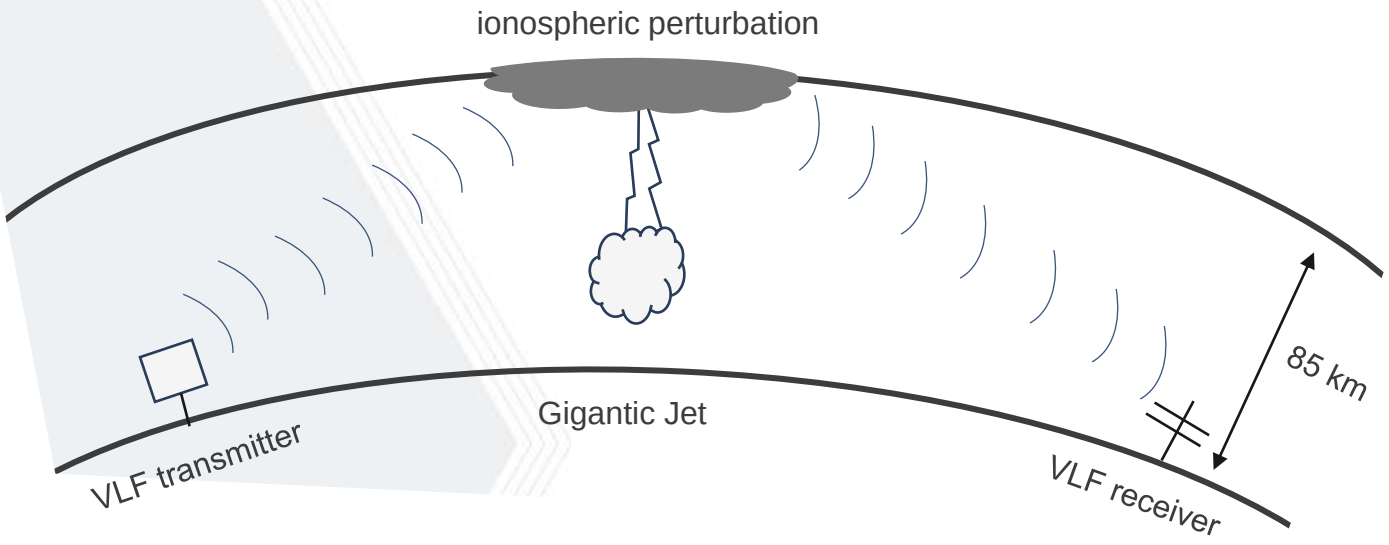
Project Goals



- VLF remote sensing: probing the lower ionosphere (D region)
- Perturbations can be detected by monitoring the amplitude and phase of the VLF signals

- Detect GJs using GLM in combination with ground based networks
- Goal: significantly increase detections over current methods (i.e. camera)
- GJs directly exchange charge with the ionosphere
- Long continuing current and charge transfer
- **How does this affect the ionosphere and the Global Electric Circuit?**

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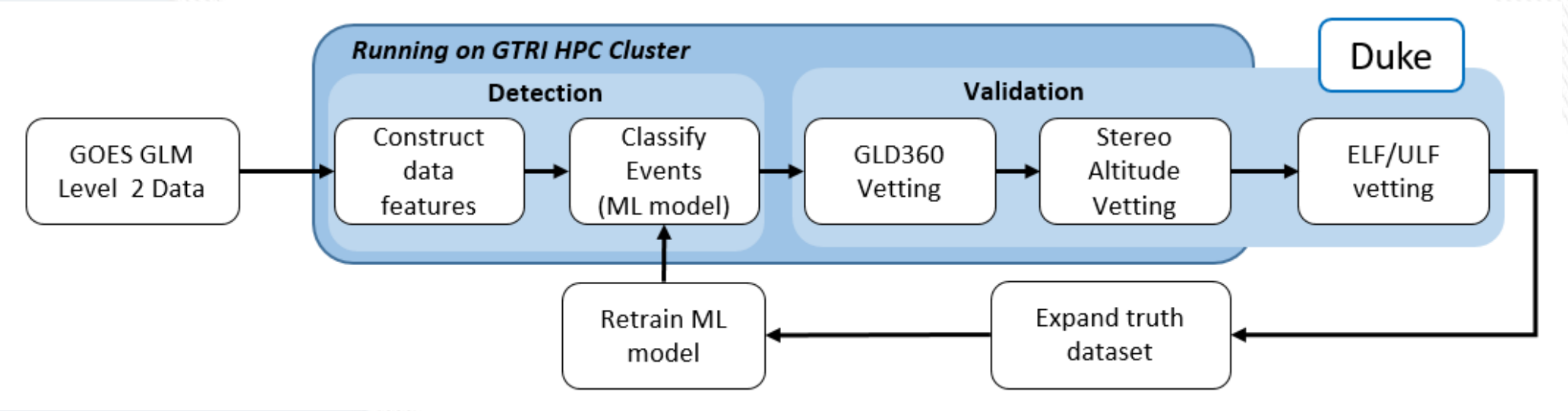
Detection Pipeline



- **Detection**: supervised machine learning classifier that operates on GLM group data
- **Validation**: vet GJ candidates with GLD360 model, ABI model, stereo altitude model, and finally with ELF/ULF model.

Truth Database

- We have collected ground-based video from several sources, mostly citizen scientists
- Captures come from cameras located in Puerto Rico, Colombia, Hawaii, Oklahoma, and Brazil
- Currently have 65 ‘truth’ GJ events
- Find matching GLM flashes
  - Note: we only find clear, unambiguous GJ signatures for 50% of ground-based video captures

Photographer credit: Chaim Scowcroft

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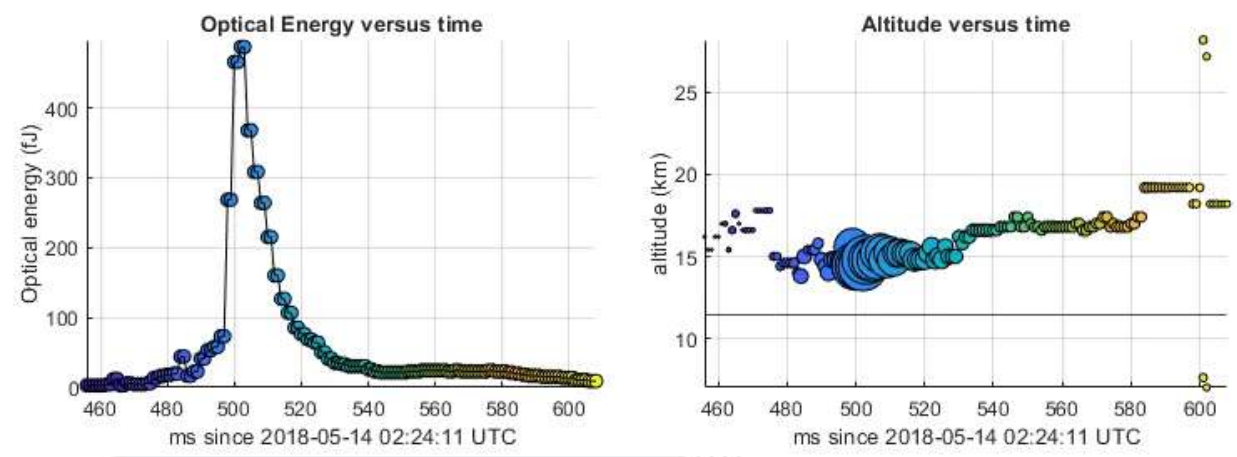
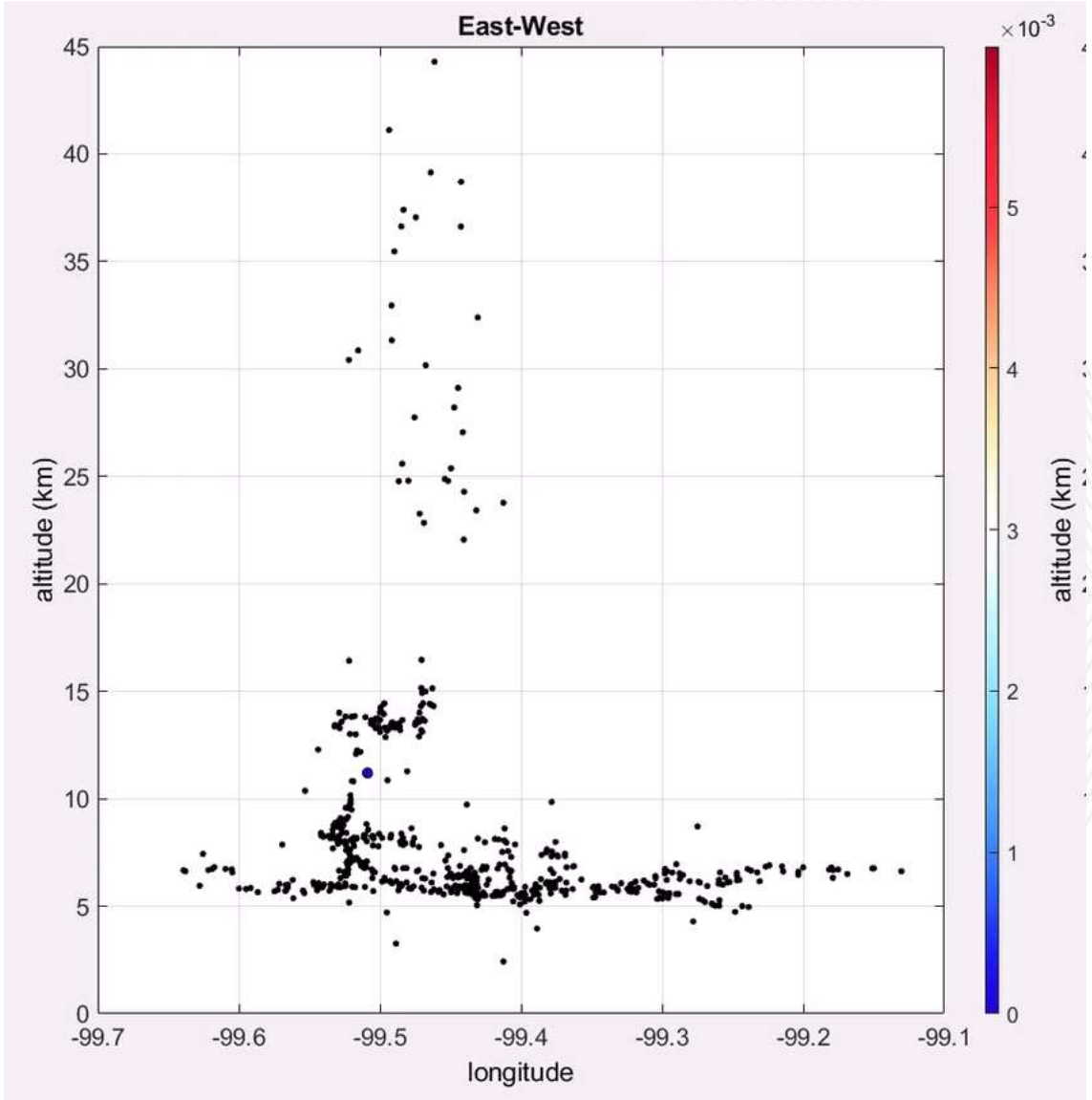
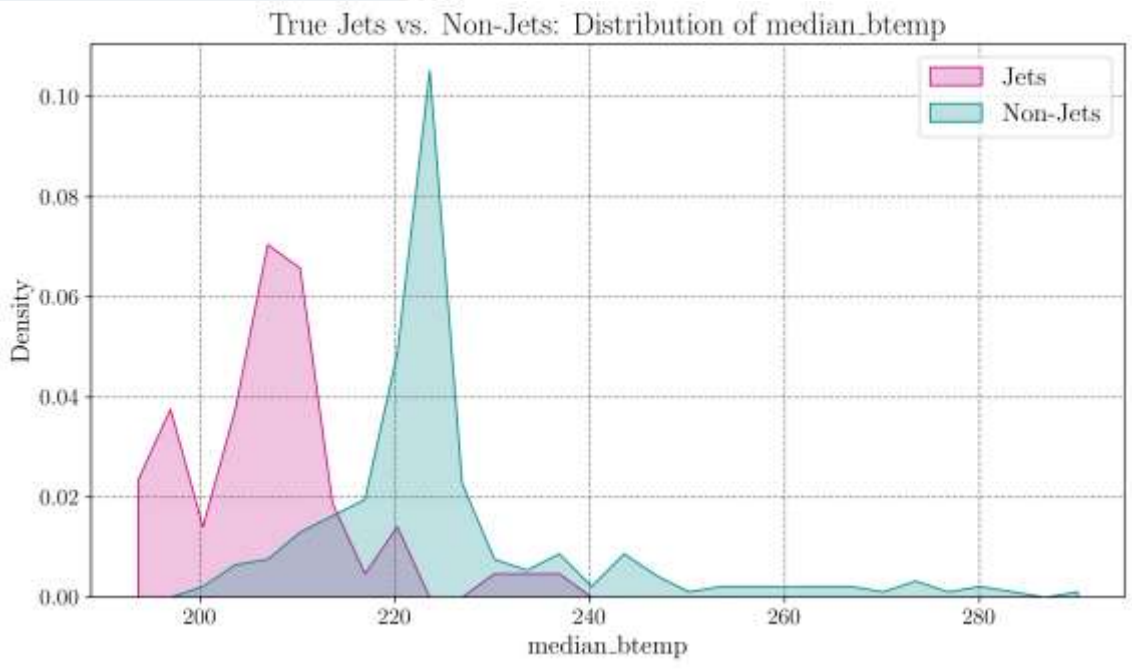
Gigantic Jet Signatures - GLM

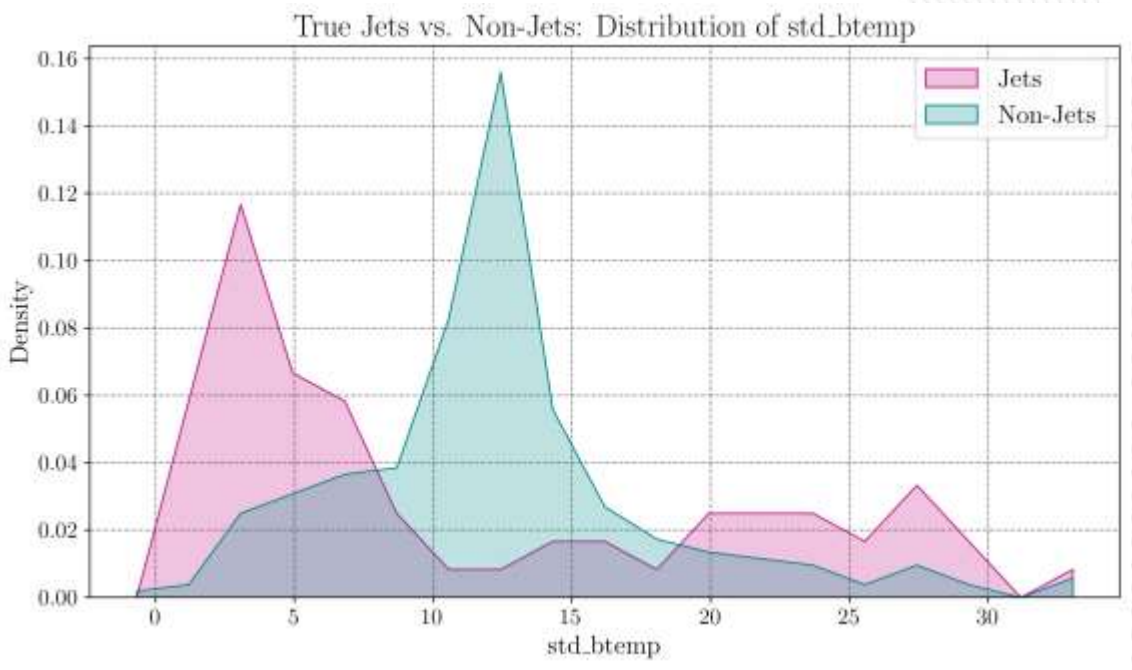




- Long continuing current
- Impulsive lightcurve
- Stereo altitudes increase over time
- GLM primarily detects the leader above the cloud top

Gigantic Jet Signatures – ABI brightness temperature





- GJs – colder cloud tops, less variation in brightness temperature near the jet location

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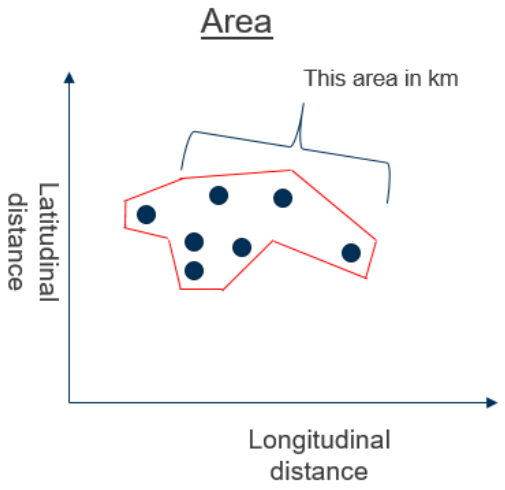
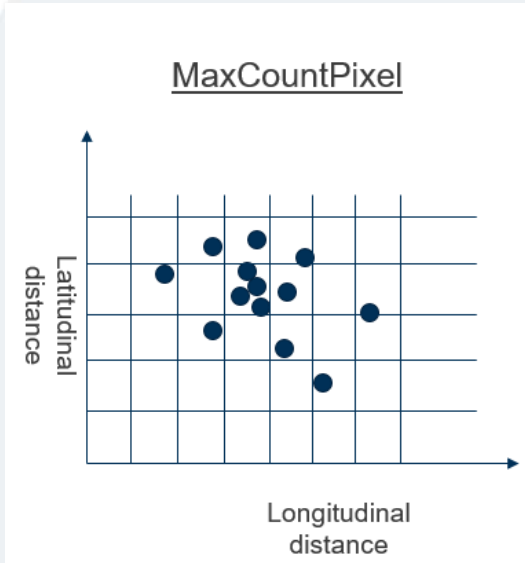
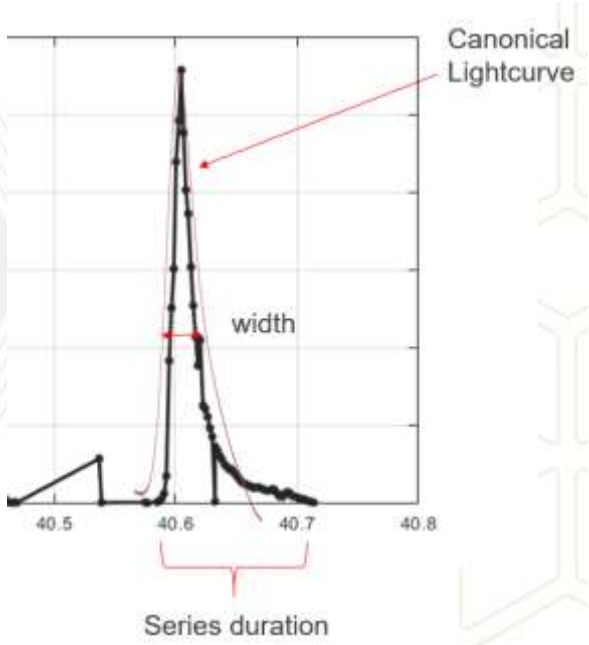
GLM Machine Learning Model



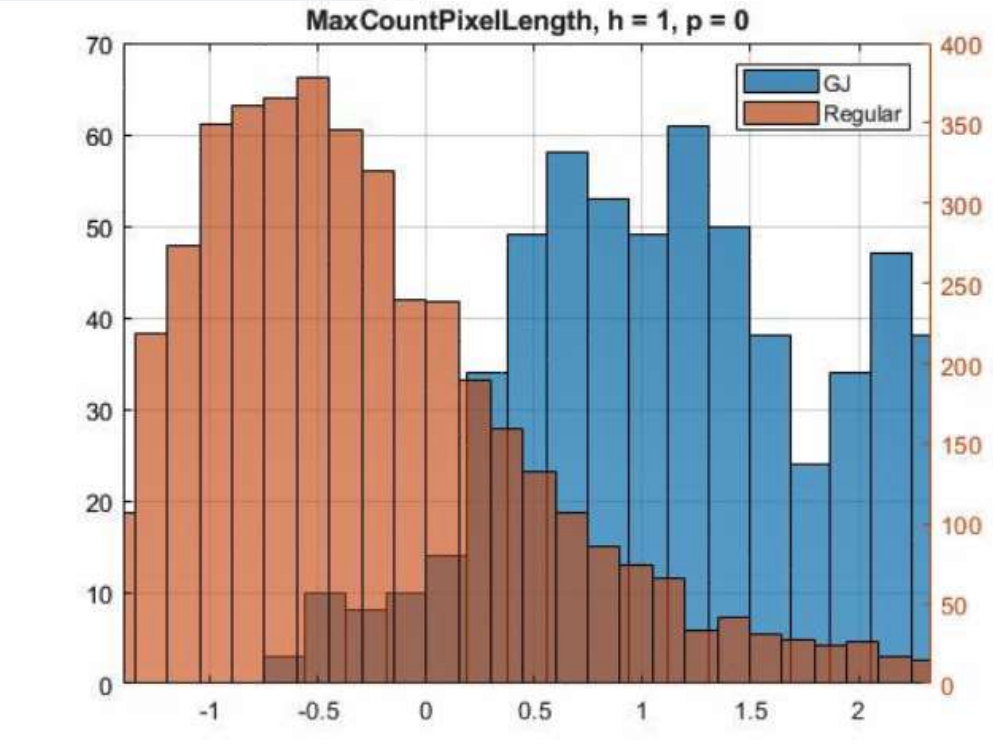




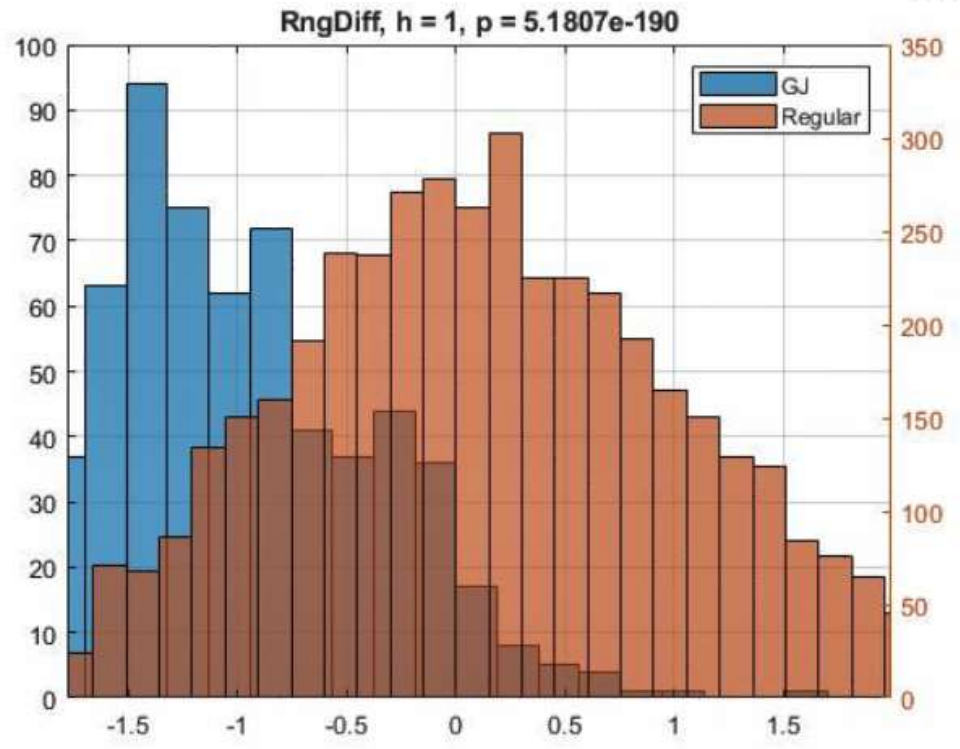
- Many different features capturing spatial and temporal differences between GJ and nonGJ flashes

- Spatial:
  - features that calculate things like flash size, distance traveled, and energy flux
- Temporal:
  - features that calculate properties from the lightcurve, such as FWHM, continuous duration, correlation with canonical jet lightcurve

GLM Machine Learning Model



Example of a spatial feature



Example of a temporal feature

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Current Status and Next Steps

- We have deployed a preliminary ML model (random forest) to ~6 months of data
- Currently vetting the data: stereo altitudes, ABI and GLD model, and finally ELF/ULF model
- Continually expanding our ‘truth’ dataset with new vetted events
- Precision is low as expected (~1%), but **goal at this stage is to get more truth data**
- Next two years: begin correlating our GJ detections to VLF remote sensing data, in addition to other lightning physics data (LMAs, ASIM, RF SENSER).

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