An Analysis of the Lightning Jump Algorithm Using the GOES-16 Geostationary Lightning Mapper

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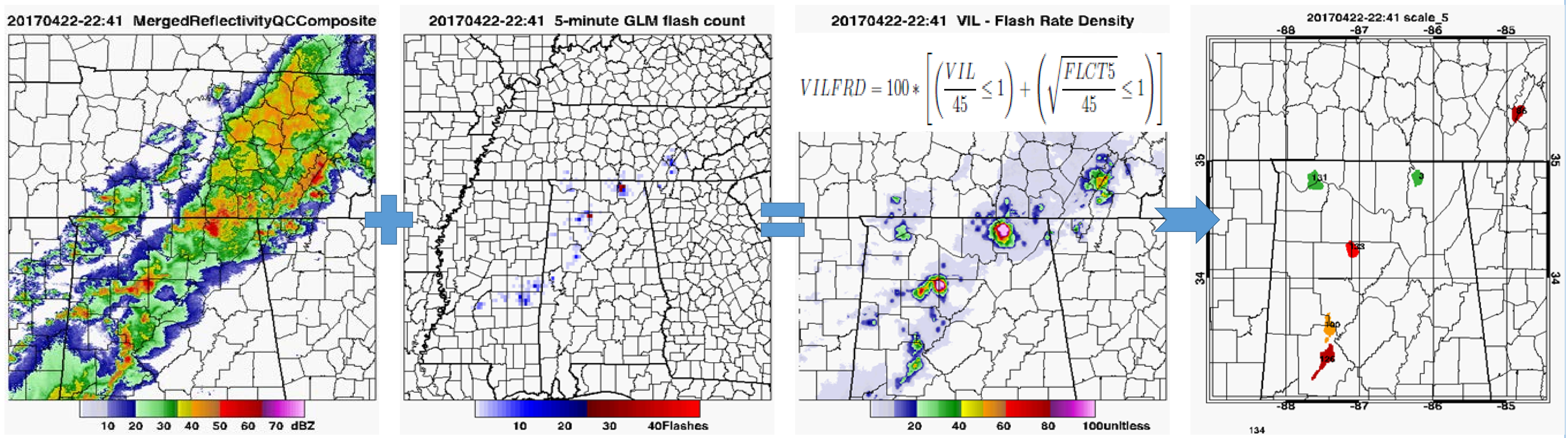
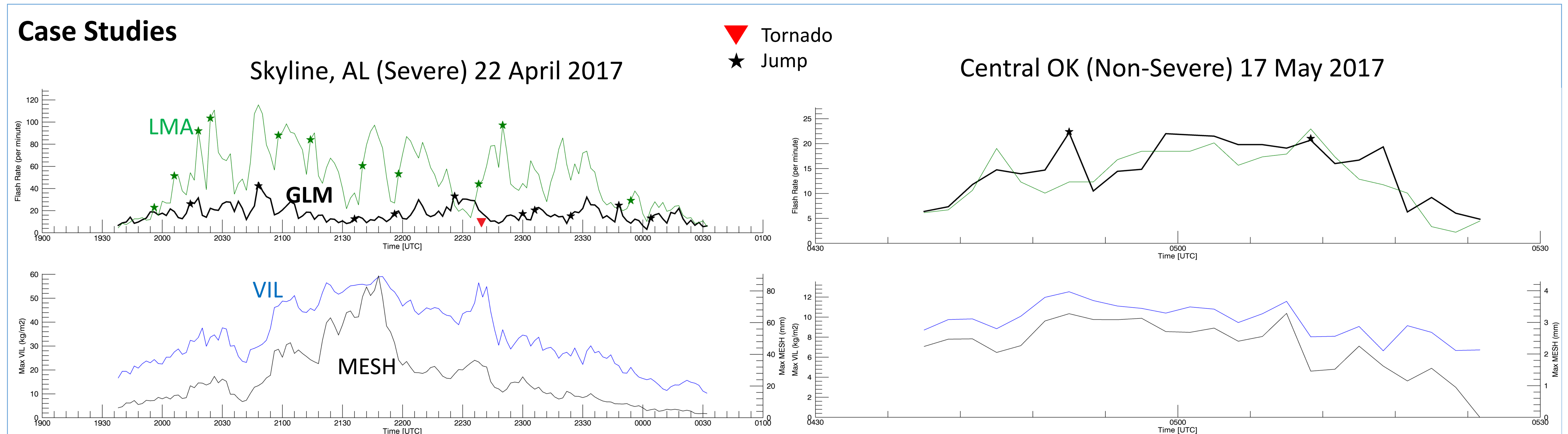
VILFRD and K-means Tracking Method



Reflectivity based VIL is combined with 5 minute flash counts to create VILFRD which is then objectively tracked via a k-means tracking algorithm within the Warning Decision Support System – Integrated Information (WDSS-II).

Case Studies



- Severe: Usually large disagreements in GLM vs LMA flash rates / trends, LMA jumps more during intensification, GLM jumps more during decay.
- Non-severe: Better agreement in GLM vs LMA flash rates / gross trends, GLM tends to jump more, second jump caused by previous little variability.

Case Study Pearson Correlations

Storm:	GLM vs. LMA	GLM vs. VIL	GLM vs. MESH	LMA vs. VIL	LMA vs. MESH
Skyline AL (severe)	0.351	0.127	-0.019	0.507	0.421
Jones AL (severe)	0.569	0.514	0.440	0.643	0.642
N. AL (non-severe)	0.773	0.617	0.650	0.701	0.760
Denver CO (severe)	0.360	0.343	0.178	0.565	0.591
Cen OK (severe)	0.563	-0.211	0.093	0.090	0.266
Cen OK (non-severe)	0.801	0.412	0.517	0.384	0.457
N. TX (severe)	0.439	-0.136	-0.286	0.501	0.351
Average	0.551	0.238	0.225	0.484	0.498

- Overall only moderate correlations between GLM and LMA flashes.
- LMA overall more correlated to radar metrics than GLM
- In the strongest storms (Skyline, N. TX) correlations between GLM and radar/LMA the worst.
- Best agreement in the weakest, two non-severe cases.

Large Scale Study

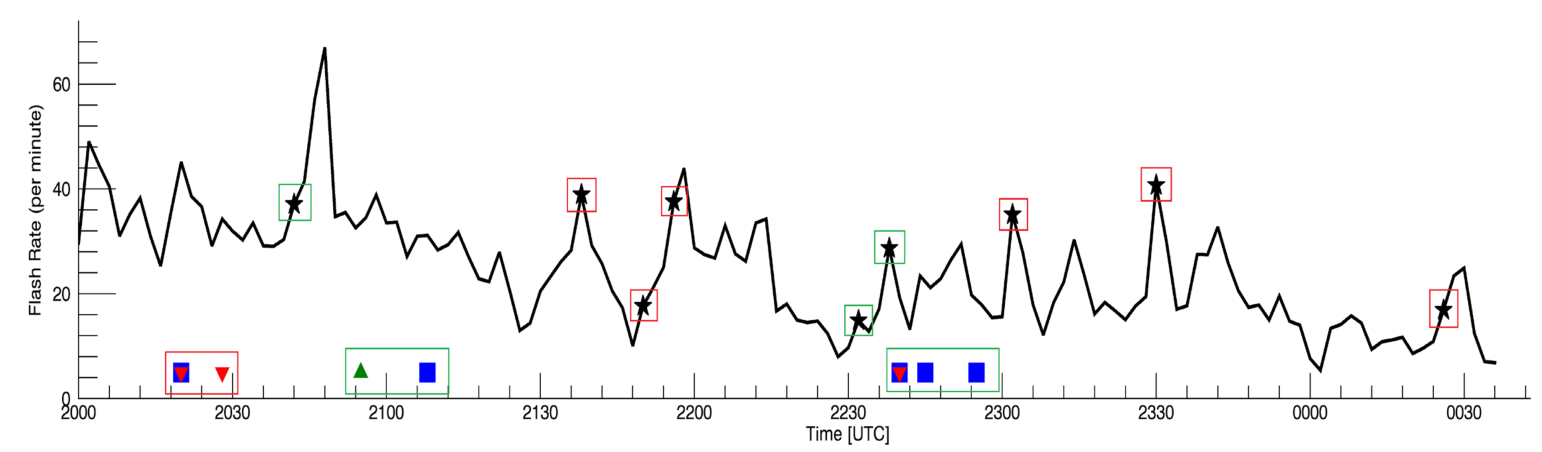
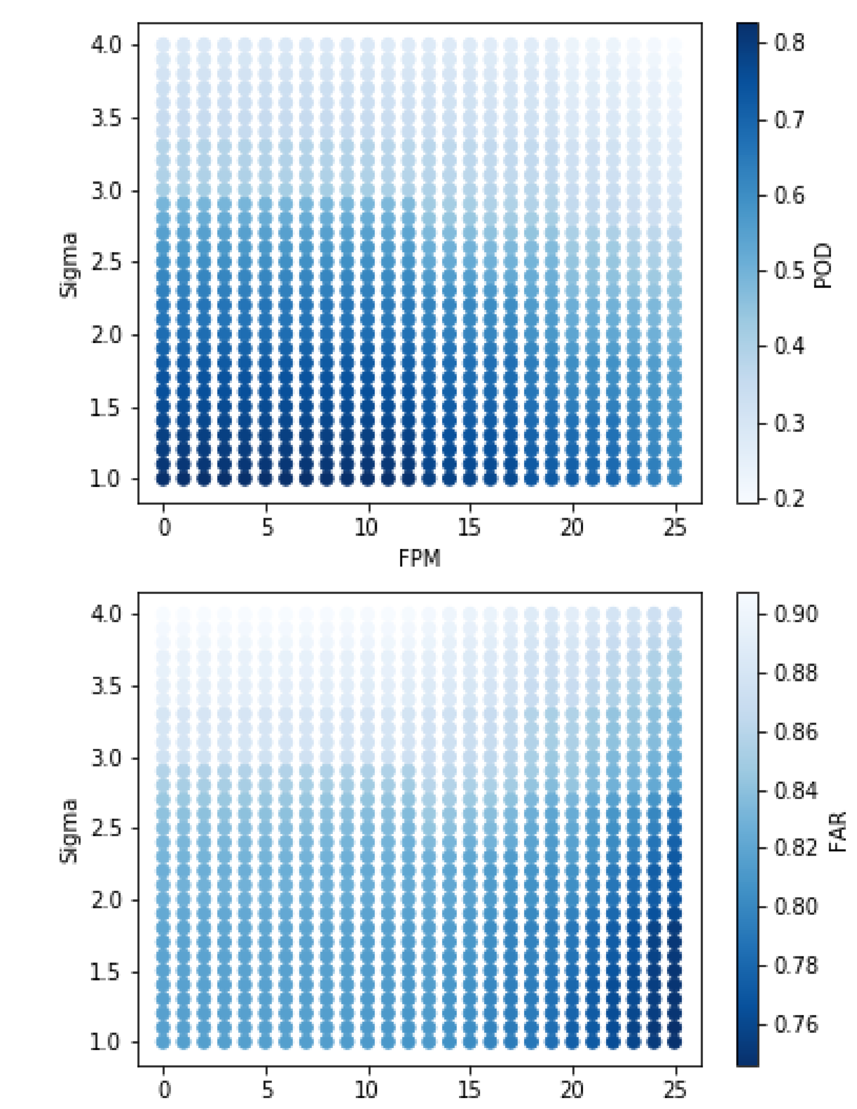


Figure: GLM Flash rates (black), lightning jumps (black stars), wind (blue squares), hail (green triangles), tornado (red triangle). Green (red) boxes on jumps indicate hits (false alarms). Green (red) boxes on reports indicate hits (misses).

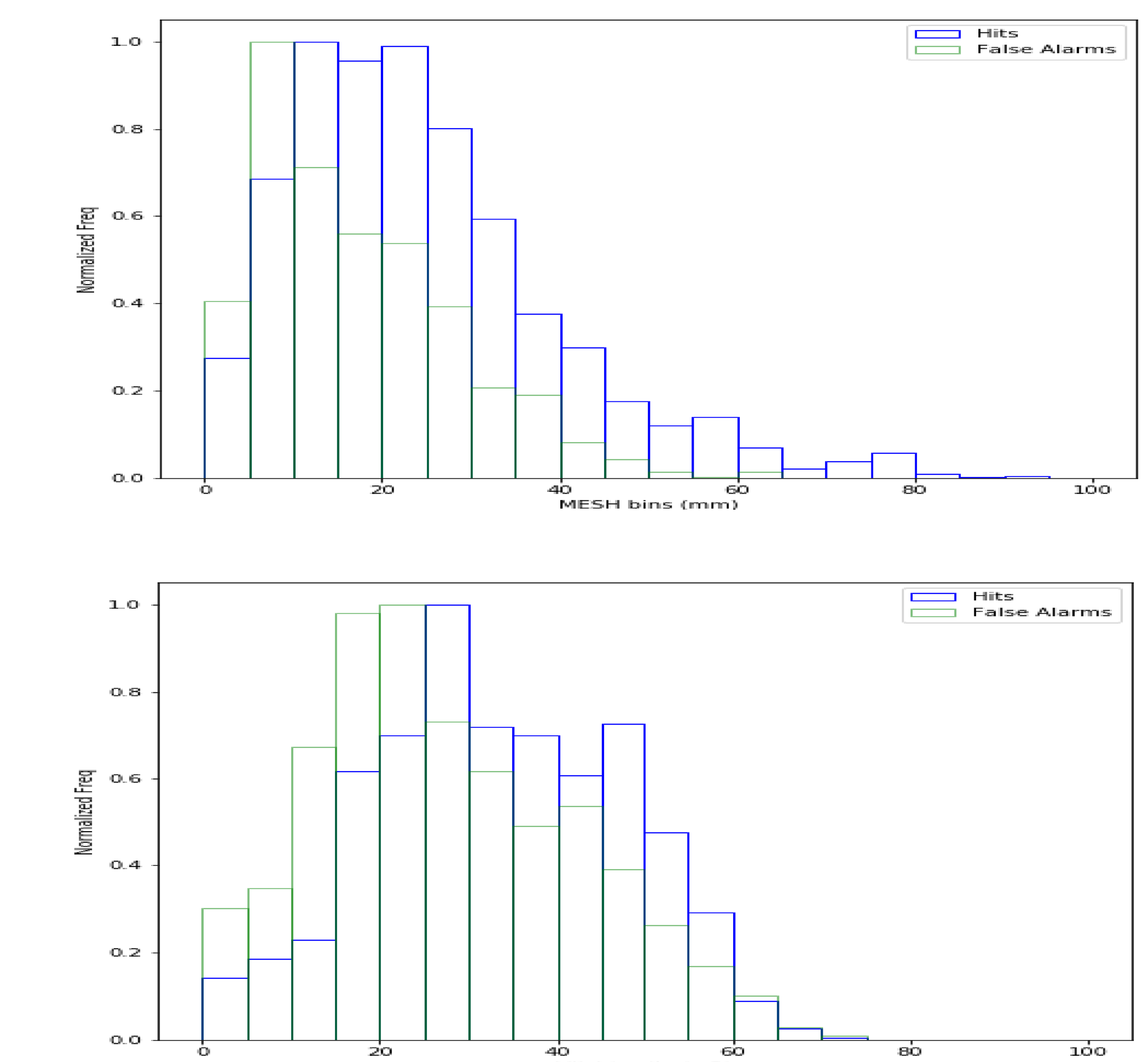
- Large scale study using Lockheed Martin reprocessed GLM flashes from 2017 GOES-R CAL/VAL campaign.
- Used 10 of 11 days from the campaign (excluded March case).
- Total of 930 storms objectively sampled using VILFRD and k-means tracking within WDSS-II.
- Storm report verification using 45 minute warning after a jump, reports binned in 6 minute increments, only counting first jump if two occurred within 6 minutes, and one report can verify multiple jumps.
- 273 hits, 129 misses, 1265 false alarms
- 67.9% POD, 82.2% FAR, and 0.16 CSI
- Comparable POD but very high FAR compared to most recent LJA study using VILFRD that found 69% POD and 63% FAR (Schultz et al. 2016).

Threshold Sensitivity



- POD (FAR) optimized at low (low) sigma and low (high) min flash per minute.
- Highest skill score at 1.1 sigma and 25 fpm with CSI of 0.22.
  - POD 61.2%, FAR 74.5%

Radar Verification



- Calculated MESH and VIL values for 15 minutes centered on each jump and split into hits and false alarms.
- False alarms generally occur with weaker MESH and VIL values despite some overlap in distributions.

Potential Improvements Moving Forward

- In order to reliably use the LJA on the GLM some improvements will need to be made to either or both of the GLM LJA system and GLM flash measurements for better LJA optimization
- GLM flash measurements measure at times 2-5 less than LMAs, especially in the more severe storms. Noted potential causes of this are GLM not detecting small flashes and potential optical extinction processes. Increases in DE of the GLM should impact the operational skill of the LJA. There also exists an issue of GLM splitting up large flashes into many small flashes which may cause increased jumps in weak or decaying convection. Currently ongoing CAL/VAL activities working to potentially alleviate some of these issues.
- The tracking algorithm tended to be more biased towards VIL even when flash counts were high. This led to GLM flashes likely associated with the storm falling outside of the tracked feature and not counted. Also, changing how the flashes were gridded had direct impacts on skill scores given similar features. Could move to GLM only tracking using fixed GLM grid.
- Extended periods of little variability in GLM flash rates not usually seen in LMA caused minimal increases in flash rates to trigger a jump. May need to revisit the actual LJA for its use on GLM.

References/Acknowledgement

- This project was supported by the NOAA GOES-R Series Risk Reduction Research (R3) program and NASA MSFC through the NASA MSFC and UAH Cooperative Agreement (NNM11AA01A).
- Schultz, E. V., C. J. Schultz, L. D. Carey, D. J. Cecil, and M. Bateman, 2016: Automated storm tracking and the lightning jump algorithm using goes-r geostationary lightning mapper (glm) proxy data. Journal of Operational Meteorology, 4 (7), 92-107, doi:10.15191/nwajom.2016.0407.