Understanding the Implications of Merging Existing Lightning Datasets with GLM for Severe Thunderstorm Monitoring

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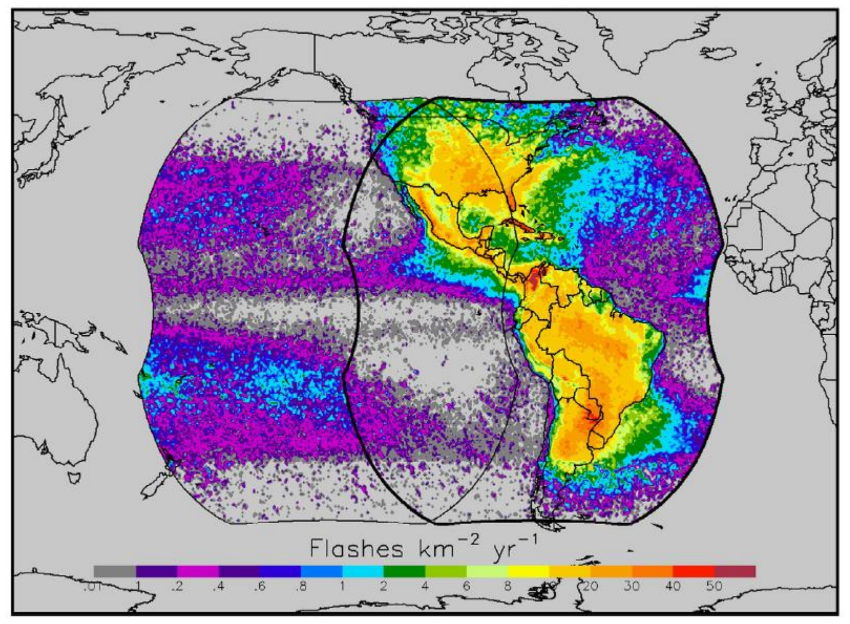
Lightning jumps are the result of rapid increases in updraft strength and size within the mixed phase region of thunderstorms (Schultz et al. 2017). They are well-correlated to severe weather occurrence and have shown utility to nowcast the occurrence of severe weather (Williams et al. 1999, Schultz et al. 2009, 2011, Gatlin and Goodman 2010). Algorithms have been developed to automatically detect these rapid increases in total lightning. These algorithms were developed using lightning mapping array data, which detects 99% of all lightning within 50 km of the center of its network (Rison et al. 1999, Koshak et al. 2004, Fuchs et al. 2016). The limitation to these networks is that they cover very small areas (~40,000 km^2).

The most ideal candidate to observing lightning jumps over large areas is the Geostationary Lightning Mapper (GLM; Goodman et al. 2013). GLM has a large field of view aboard the GOES-16 and future GOES-17 satellites.

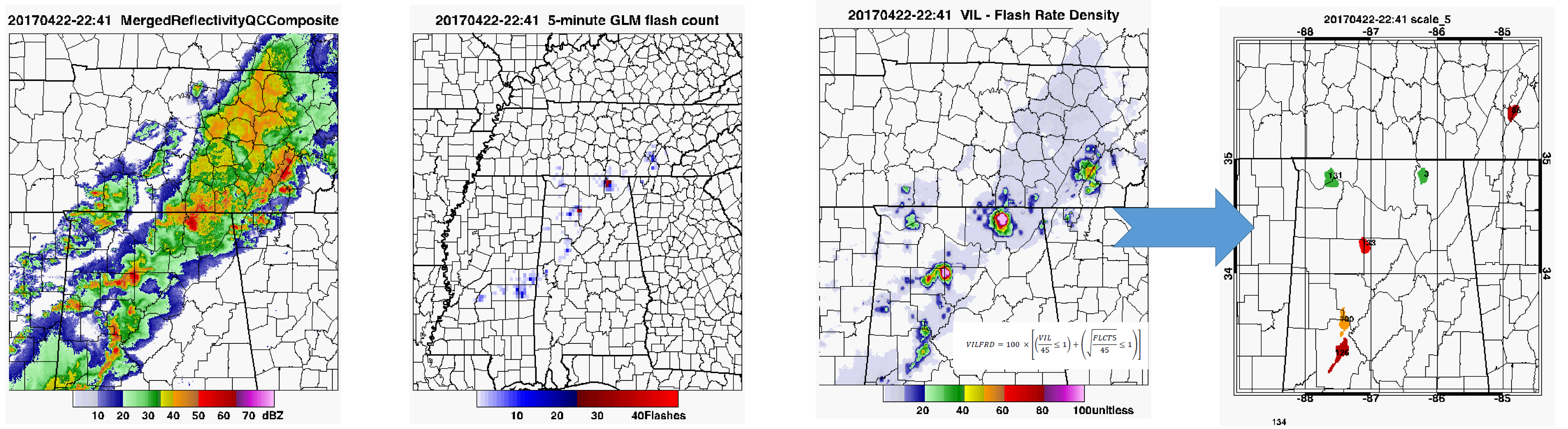


GLM FOV from GOES-E and W positions (image courtesy of www.goes-r.gov)

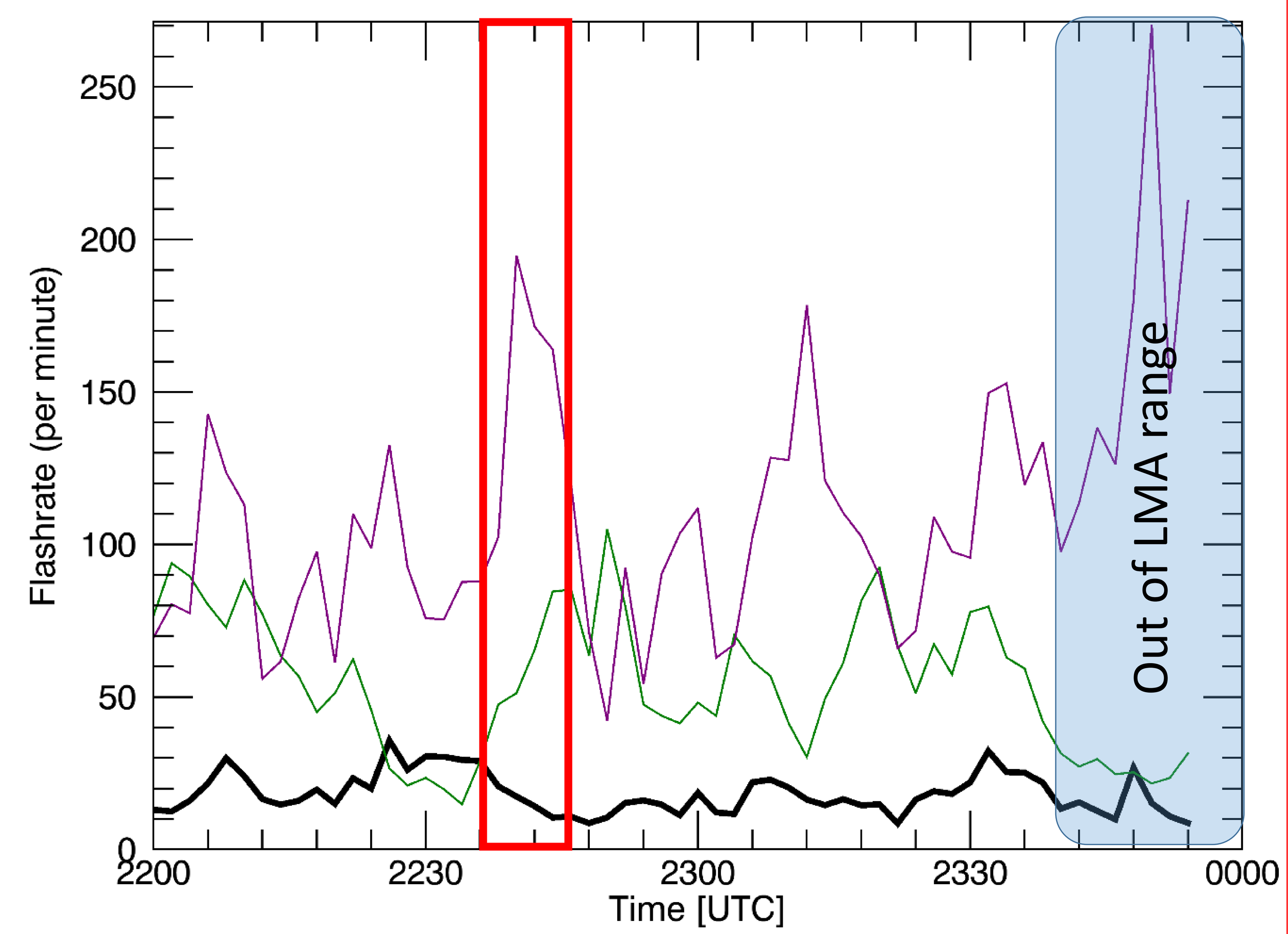
The current challenge is transitioning the lightning jump algorithm from its LMA-based roots to GLM. The LMA and GLM measure different properties of lightning (electrical breakdown vs optical energy), and thus the LMA-based algorithm will need to be adjusted to the GLM data. Furthermore, it is known that the term “flash” is defined by the instrument making the measurement, therefore, simply adjusting the algorithm to the GLM flash rate will not produce similar results. Previous works that took the LMA-based jump algorithm and placed NLDN and Earth Networks data into the algorithm. Often sub-severe storms were identified as severe by the algorithm, leading to high false alarm rates (Chronis et al. 2014, Eck et al. 2017).

Therefore, the goal of the present work is to understand how the GLM, LMA, and ground based networks like the NLDN observe lightning. Additionally, GLM provides new measurements of flash size and flash radiance that are more physically connected to the kinematics and microphysics of the parent storm. Therefore, the authors are working to characterize how the trend in these measurements align temporally with the LMA-based lightning jump algorithm.

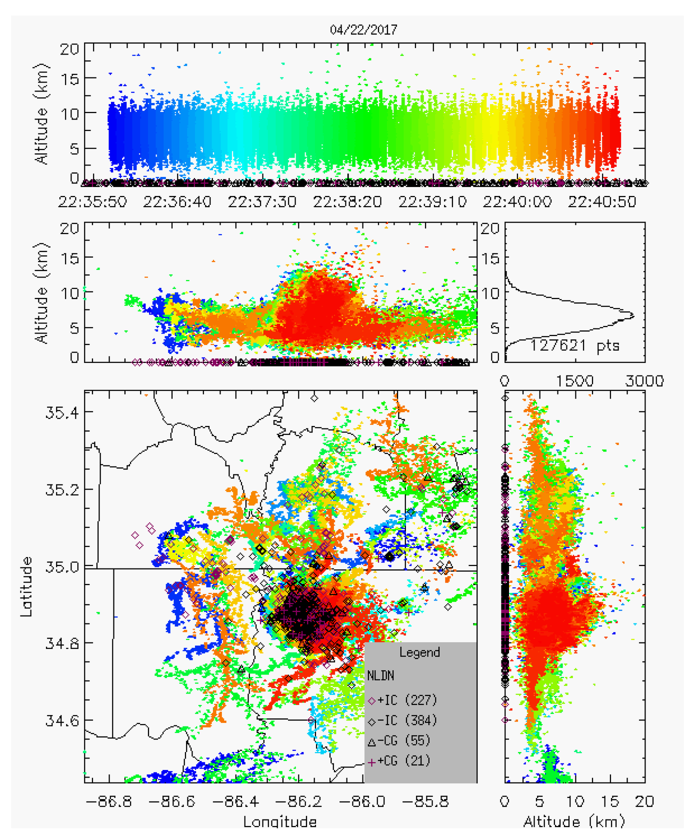
The GLM/Radar fused tracking algorithm used to assign characteristics to storms (the VILFRD Method; Schultz et al. 2016).



Reflectivity based VIL is coupled with the 5 minute flash count from the GLM to produced tracked features that assign flashes to specific storms. This tracking method works anywhere within the GLM field of view.



GLM flash rates (black), GLM group rates (purple), and LMA flash rates for a tornadic storm on 22 April 2017 during the GLM validation campaign. The red box shows the period of interest near the time of a tornado at 2040 UTC.

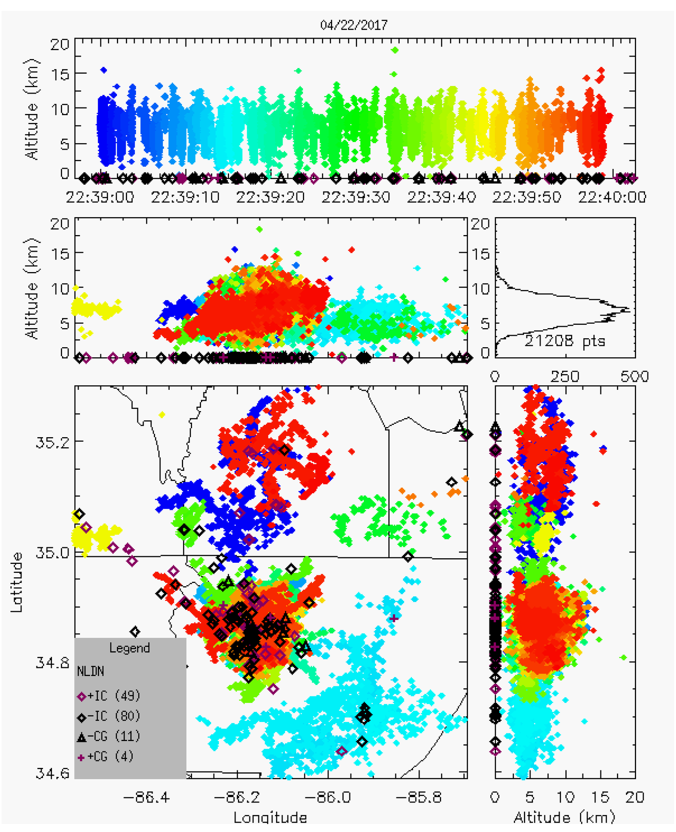


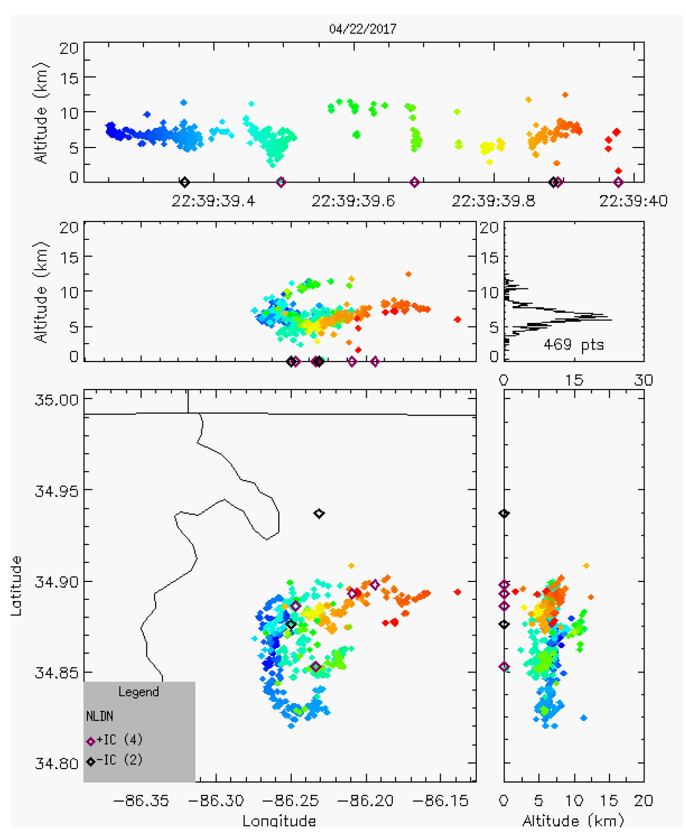
Flash rate comparison for GLM, LMA, and NLDN on 22 April 2017 between 2236 and 2241 UTC.

GLM flashes: 171
GLM groups: 2279
LMA flashes: 385
NLDN flashes: 687

Flash rate comparison for GLM, LMA, and NLDN on 22 April 2017 between 2239 and 2240 UTC.

GLM flashes: 31
GLM groups: 579
LMA flashes: 86
NLDN flashes: 152





Flash comparison for a single LMA-flash on 22 April 2017 at 22:39:39.3 UTC.

GLM flashes: 1
GLM groups: 27
LMA flashes: 1
NLDN flashes: 6

Early Observations

1) At times, inverse trends in flash rate are observed between the LMA flash rate and the GLM flash rate This is likely due to GLM’s lightning cluster filter algorithm merging smaller flashes that occur in the same GLM pixel or splitting very large flashes.
2) Monitoring GLM group/event rates should be the more intuitive way to monitor lightning from thunderstorms for severe weather potential versus GLM flash rate.
3) Multiple NLDN flashes continue to be associated with single LMA or GLM flashes. This is due to the lack of areal information from these types of networks to combine multiple detections that are part of the same lightning event.
4) GLM flash areas and radiance values are still to be explored. This will occur after the release of level 2 GLM data in January 2018. .

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