

GOESR3 Final Report

Reporting Period: July 2017 – June 2020 (full 3-year period)

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Project Title: Integration of the Geostationary Lightning Mapper with Ground-Based Lightning Detection Systems for National Weather Service Operations

Project Number: 477

Executive Summary

Spatially gridded imagery of Geostationary Lightning Mapper (GLM) data were co-developed with academic and federal partners to demonstrate the utility of the data in an operational environment. This gridded GLM imagery provides details on both the spatial coverage and density of the lightning activity as seen from space. Within the NWS operational environment and software (the Advanced Weather Interactive Processing System - AWIPS), forecasters are now able to view the GLM data in conjunction with lightning location detections made by ground-based systems from industrial partners.

Unfortunately, the initial implementation of the GLM data for NWS forecasters within AWIPS was not appropriate for comparison with both other lightning detection systems and other meteorological data. As part of this grant, the PI and co-investigators helped develop real-time programs to run GLM gridding algorithms and convert the gridded products into a format capable of display within AWIPS. The programs were used to produce GLM products at 1-minute intervals with variable product summations of 1, 2, and 5 minutes. The exposure of the variable summations in the HWT helped to define the GLM products shipped to forecast offices later in the year. Configurations created in the HWT were transferred to both other developers and other operational partners for access to the data during active weather. Additional code was created to translate the GLM data to a latitude/longitude grid for processing outside of AWIPS, such as for blending and tracking within the Multi-Radar Multi-Sensor (MRMS) framework, and then to translate the results back to the ABI grid.

Examinations by National Weather Service forecasters in the NOAA Hazardous Weather Testbed (HWT) showed that viewing the GLM data in combination with data from the ground-based networks provides a holistic view of the lightning activity associated with storms, providing both high temporal and increased spatial knowledge. The first year of evaluations in the HWT highlighted areas of needed improvement in the GLM products, with forecasters providing guidance for both best practices and new development. Based on this feedback, new products such Minimum Flash Area were developed, tested, and implemented within the real-time system for the HWT. Throughout this process many improvements were made locally to the stability and flexibility of the programs; these were later integrated into source code control for the team finalizing the operational implementation of the products.

As of 2020, NWS forecasters are now using these products to make severe weather warning decisions (see: "Utilizing GLM in the Warning Decision Process", White and Ravenscraft, 2020, https://www.youtube.com/watch?v=i0_kfvt0Wck) and to communicate risks of lightning hazards to Emergency Managers and other partners for decision support services (see: "Using the Geostationary Lightning Mapper Long-Flash Detection Capability for National Weather Service Decision Support Services", Gravelle, 2019, <https://nwas.org/annual-meeting-events/annual-meeting/meeting-agenda/>).

Final Year Milestones (FY19) and Project Deliverables

***Integrate modifications based on forecaster feedback during HWT operations.**

[Changes from 2018 and 2019 evaluations included the development of a Minimum Flash Area product to replace the Average Flash Area product. This new product was requested by NWS forecasters to capture the changes in small flashes around the main updraft area of storms].

***Share updated version with NWS co-investigators for evaluation and feedback.**

[The updated code, color tables, and other local HWT configurations were included into the source code control via github and shared with TOWR-S team for inclusion in the operational NWS implementation. Additionally, shared AWIPS EDEX configurations, style rules, and procedures with the COMET program for education/outreach.]

***Complete NWS local forecast office visits working with co-investigators, science officers and lightning focal points.**

[Completed virtually due to COVID-19 restrictions; presentations given to both NWS Western and NWS Central Regions via Google Meet and GoToMeeting with more than 100+ attendees at each presentation.]

***Complete integration of final product into HWT operational data feed. [done]**

***Develop training for final HWT evaluation. [done]**

***Complete final HWT evaluation prior to operational transfer.** [HWT activities for the NOAA Experimental Warning Program did not take place in 2020 due to COVID-19 travel restrictions. However, worked with individual offices and forecasters getting the data over LDM feeds for operational testing and continuing to evaluate new GLM visualizations via AWIPS cloud demonstrations.]

***Provide new WMO product codes through MRMS for AWIPS implementation & complete necessary adjustments following final HWT evaluation and transfer operations to NCEP.** [Unnecessary, due to implementation through NESDIS/NWS and not through MRMS product stream.]

***Complete training packages based on forecaster use and best practices from the HWT with the WDTD and FDTD.** [Worked with Katy Christian at NWS WDTD to implement best practices and guidance regarding GLM use by forecasters.]

Discussion of operational transition readiness for any project outcomes

Based on feedback from forecasters at the NOAA HWT and local offices, the GLM Flash Extent Density product is set to become the first GLM gridded operational product. The GLM technical reports (links in the following section) highlight the findings and recommendations for operational implementation by the NWS of the gridded data.

Additional Information

1. Interaction with operational partners –

Calhoun participates in weekly telecons with NWS Lightning Group, providing feedback and details regarding GLM product and gridded development.

Participated as a subject matter expert for 6 weeks in both 2018/2019 Hazardous Weather Testbed and NOAA GOES Proving Ground experiments. (Note: The 2020 Warning Experiment did not occur due to COVID-related travel restrictions).

Details on the GLM gridded products were presented to both the NWS Western Region and NWS Central Region via virtual presentations by K. Calhoun on 24 Jun 2020 and 22 July 2020.

2. Conference/workshop participation –

Calhoun, K. M., 2019: GLM Use, Feedback, and Development in the HWT. GLM Science Team Meeting. 10-12 Sept 2019. Huntsville, AL. <https://goes-r.nsstc.nasa.gov/home/meeting-agenda-2019>

Calhoun, K. M., 2020: GLM Use, Feedback, and Development in the HWT. AMS Annual Meeting. 14 Jan 2020. Boston, MA. 16th Annual Symp. on New Generation Operational Environmental Satellite Systems. <https://ams.confex.com/ams/2020Annual/webprogram/Paper368168.html>

3. Outside project publicity –

4. Journal articles –

Bruning, E. C., and Coauthors, 2019: Meteorological Imagery for the Geostationary Lightning Mapper. *Journal of Geophysical Research: Atmospheres*, 124 (24), 14 285–14 309, doi:10.1029/2019JD030874, URL <https://onlinelibrary.wiley.com/doi/abs/10.1029/2019JD030874>.

NOAA technical reports:

Calhoun, K. M., 2018: Feedback and Recommendations for the Geostationary Lightning Mapper (GLM) in Severe and Hazardous Weather Forecasting and Warning Operations https://hwt.nssl.noaa.gov/ewp/projects/GLM-HWT-report_2018.pdf Published on 14 Aug 2018.

Calhoun, K. M., 2019: Feedback and Recommendations for the Geostationary Lightning Mapper (GLM) in Severe and Hazardous Weather Forecasting and Warning Operations https://hwt.nssl.noaa.gov/ewp/projects/GLM-HWT-report_2019.pdf Published on 31 July 2019.

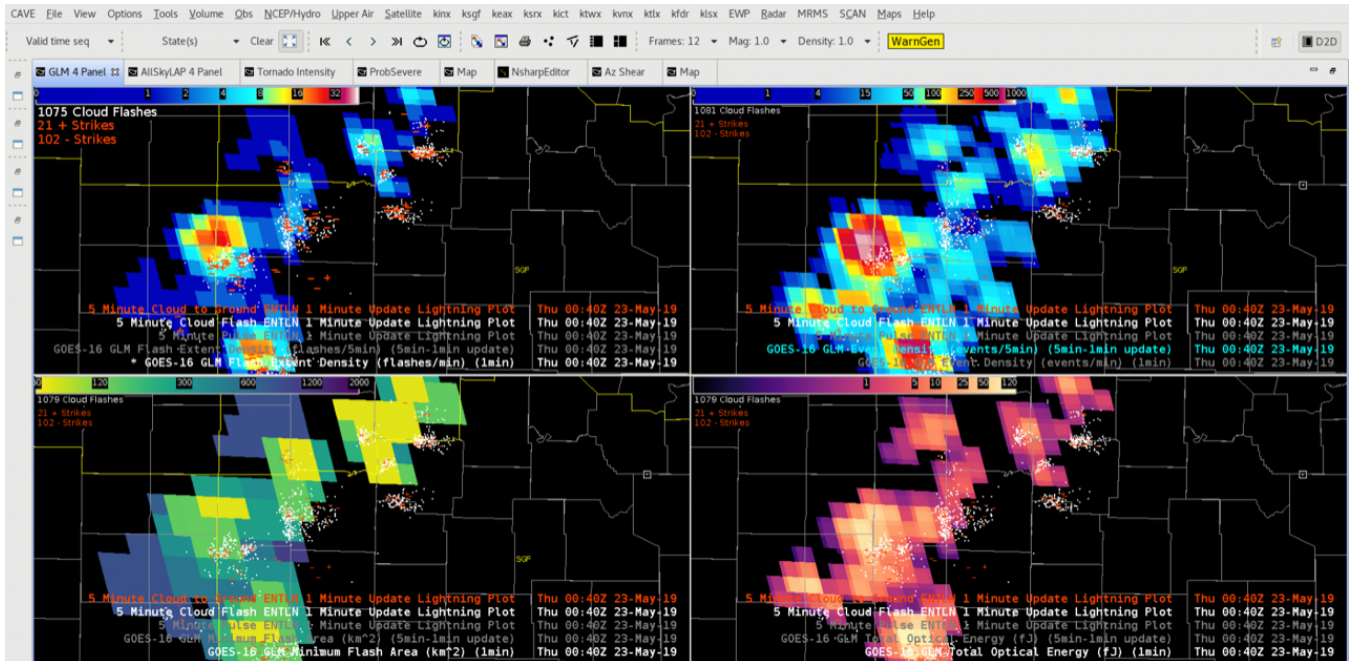


Fig. 1: Screenshot of NWS forecaster display in the NOAA Hazardous Weather Testbed on 23 May 2019 of both GLM and Earth Networks' Total Lightning Network measured lightning activity. Top Left: GLM Flash Extent Density (gridded) and Earth Networks' Cloud Flashes (white points) and Cloud-to-ground flashes (red +/-). Top right: GLM Event Density and Earth Networks detection locations. Bottom Left: GLM Minimum Flash Area (km²). Bottom Right: GLM Total Optical Energy (fJ).