NOAA ROSES Semi-Annual Report

Reporting Period: March 2021 – August 2021 (2nd report)

PI: Daile Zhang
Co-PI(s):

Project Title: Downscaling of GLM Lightning Observations Using ISS-LIS Data

Executive Summary (1 paragraph max)

This report summarizes progress on three main project components: 1) using the Tropical Rainfall Measuring Mission Lightning Imaging Sensor (TRMM-LIS) data to evaluate the performance characteristics of the International Space Station Lightning Imaging Sensor (ISS-LIS); 2) building GLM and ISS-LIS coincidence datasets and conducting intercomparison analysis; and 3) website design and development for data storage, data visualization, data query and other resources. In the following, we provide a summary of the work performed to date, including analysis results, data development, website design and development, as well as future work.

Progress toward FY20 Milestones and Relevant Findings (with any Figs)

1. ISS-LIS Evaluation Study

The full characteristics and performance evaluation study of the ISS-LIS was conducted and completed. The manuscript is finished and ready for submission. Part of the results were presented at the 2020 AGU conference as well as the 2021 GLM Science Meeting during September 21-23. The work was also invited to be presented as an educational resource at an international lightning safety meeting – Preparing for International Lightning Safety Day 2021: Raising Awareness and Saving Lives on May 27th, 2021. The work has been getting international attention, especially from south Asia and Africa, where ground-based lightning detection networks are generally not available and satellite-based sensors are a better or the only option for their lightning research, education and safety. In addition, the work was invited to be presented at the 2021 AGU conference in December and will be presented as part of an invited talk for the Arizona State undergraduate weather club monthly meeting on October 29th.

This study used nearly four years (March 2017 - September 2020) of Quality Controlled ISS-LIS data, hosted by the GHRC, to intercompare with the well-documented TRMM-LIS. Probability distribution functions and statistics of the optical lightning signatures including radiance amplitudes (energy density), illuminated cloud-top area, and geometric parameters for events, groups and flashes, and the temporal and spatial characteristics of groups within the flashes for both LIS sensors were examined. Although ISS-LIS is a spare flight model for TRMM-LIS, the individual instrument specifications including pixel resolution, sensitivity, and viewing angle are different. Our main conclusions are that the overall ISS-LIS detection performance is similar to that of TRMM-LIS (i.e. the probability distribution of the optical signatures), though differences remain.

2. GLM and ISS-LIS Coincidence Intercomparison and Dataset

The GLM/LIS coincidence data is processed and stored as the MAT format on our local server. A 6-month (March – August 2020) of the coincidence dataset is analyzed so far. We are in the process of analyzing the rest for the available period (March 2017 – February 2020). The GHRC DAAC started processing version 2 near real-time (NRT) and non-quality controlled (NQC) ISS LIS data starting on 9/28/2021 and is still in the process of updating the web pages to reflect version 2. Once the version 2 ISS-LIS data are available, we will start processing the newer GLM/LIS coincidence dataset and storing them on our server. The coincidence dataset will be first converted to netCDF and/or NC formats and then uploaded once our new AERT website is operational (see details in Section 3). Some of the results from this work were presented at the 2021 AMS Annual Meeting and the 2021 GLM Science Meeting.

The LIS group radiances (more precisely, energy densities) were converted to GLM equivalent energy. Coincidence GLM groups and LIS groups or "supergroups" energy were intercompared. Overall, more than 50% of the coincidence GLM and ISS-LIS energy correlate well, although differences exist. There is not much latitudinal variations in the GLM:LIS energy ratio, except for higher latitudes where there is parallax in the GLM data. GLM tend to miss observation during the first series of LIS groups and/or the very last ones when the energy of these groups were not high enough.

3. New AERT Website and GLM Status Page

A newly designed Atmospheric Electricity Research and Training (AERT) website is currently under development and testing, and will complement our existing GLM website at https://lightning.umd.edu/glm/ once live. The new AERT website will have a few main functions/pages: 1) a Main GLM page for training materials and resources with pdf documents downloadable (see Fig. 1); 2) a Status page that shows the daily and hourly time series of GLM data products and statistics, generated by the GLM L2 files (see Figs. 3-5); 3) a Query page (see Fig. 2) that allows users to explore the recent and archived GLM gridded data products including Flash Extent Density (FED), Minimum Flash Area (MFA), and Total Optical Energy (TOE), and submit a request to download the selected data; 4) a Blog page that updates AERT team news and other GLM and related news; and 5) a Project page that links to our other side projects such as the D.C. Lightning Mapping Array (DLMA) and Virtual Reality (VR) project for exploring the GOES satellite data. Currently, the website is implemented and being tested on a virtual workstation. We are closely working with our IT engineer to transfer the PHP code and some JavaScript libraries.

The new website highlights a user-interactive GLM Status Page. It displays recent hourly and daily time series of GLM data products and related statistics such as the data count (Fig. 3), group and flash areas (Fig. 4), GLM instrument status (Fig. 5) and so on. Users can hover over the plots and obtain the information at a certain time. For instance, the users can see the minimum, mean, maximum and standard deviation values of the selected parameter (Group Area in Fig. 4). The plots are also downloadable as PNG format. The statistics are updated daily and currently stored on our local server and being implemented and tested. In the future, we plan to add two other components: a) time series plots and statistics of the downscaled datasets when they are available; and b) GLM and ISS-LIS coincidence data including events, groups, and flashes (see details in Section 2).

The project, along with an NOAA grant NA19NES4320002 (Cooperative Institute for Satellite Earth System Studies -CISESS) at the University of Maryland/ESSIC, has supported a

senior high school student for his summer internship at CISESS and extension of the internship for his graduation research project. The student was involved in AERT website design and development including adding more webpages, increasing functionality, and transitioning into a dynamic website. He was also involved in other projects including D.C. LMA maintenance and our newly developed and proposed Raspberry Pi camera network.
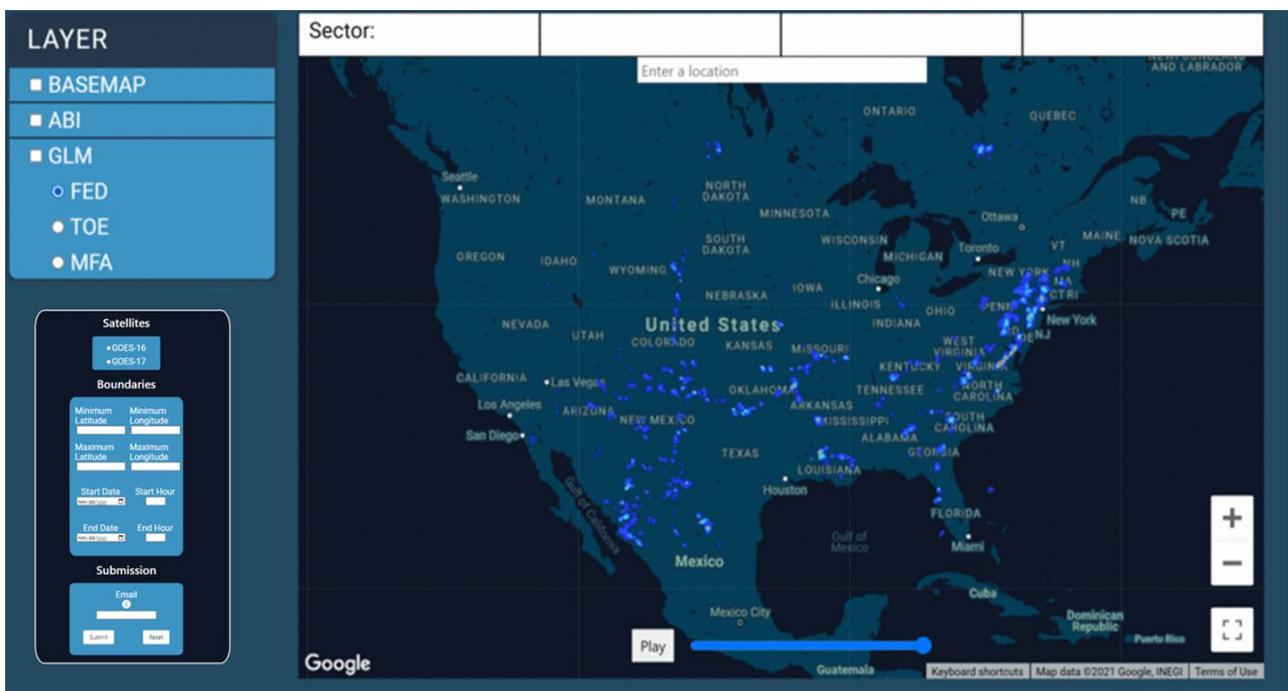

Fig. 1 The Main Page for the new AERT website
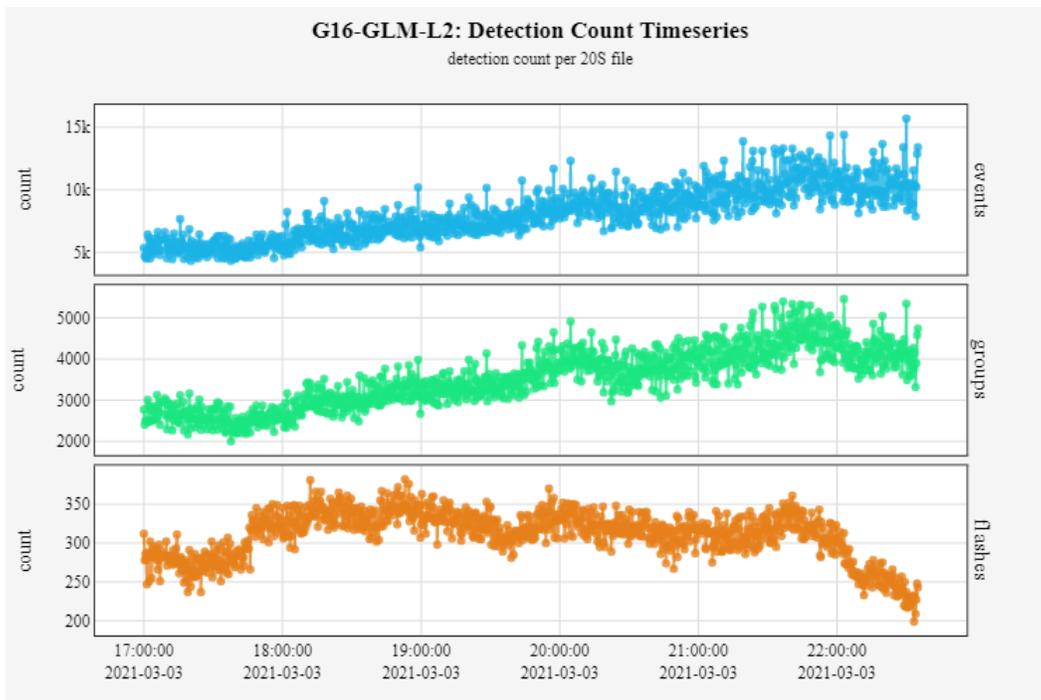

Fig. 2 The Query Page displaying tool

Fig. 3 Time series of GLM L2 data products count including events (top), groups (middle), and flashes (bottom)
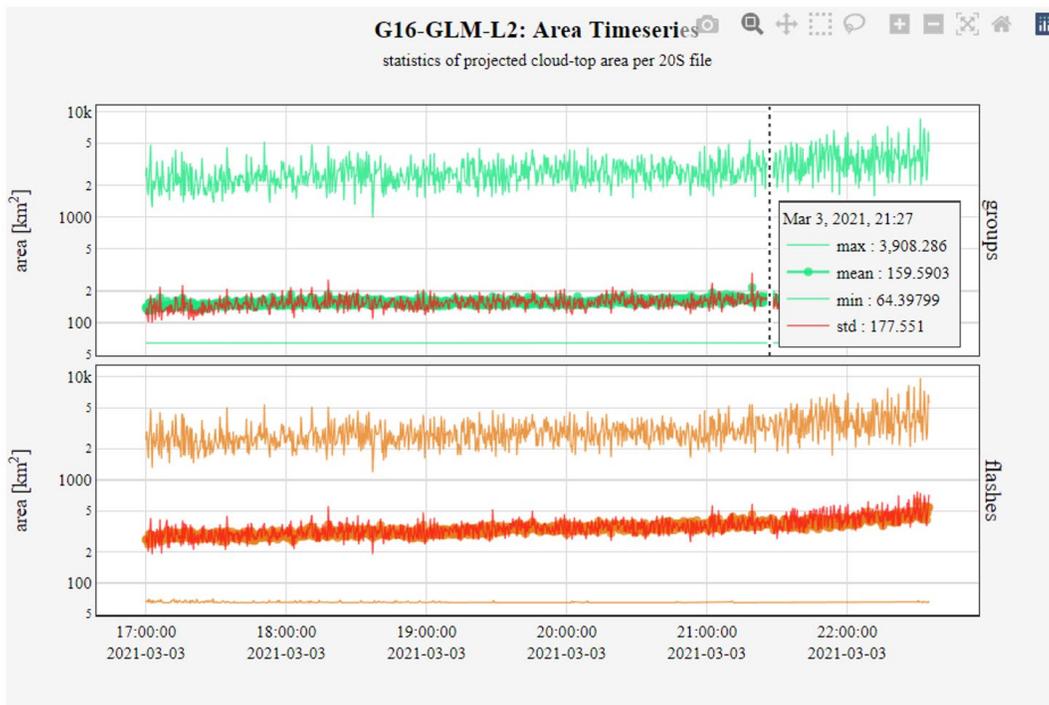

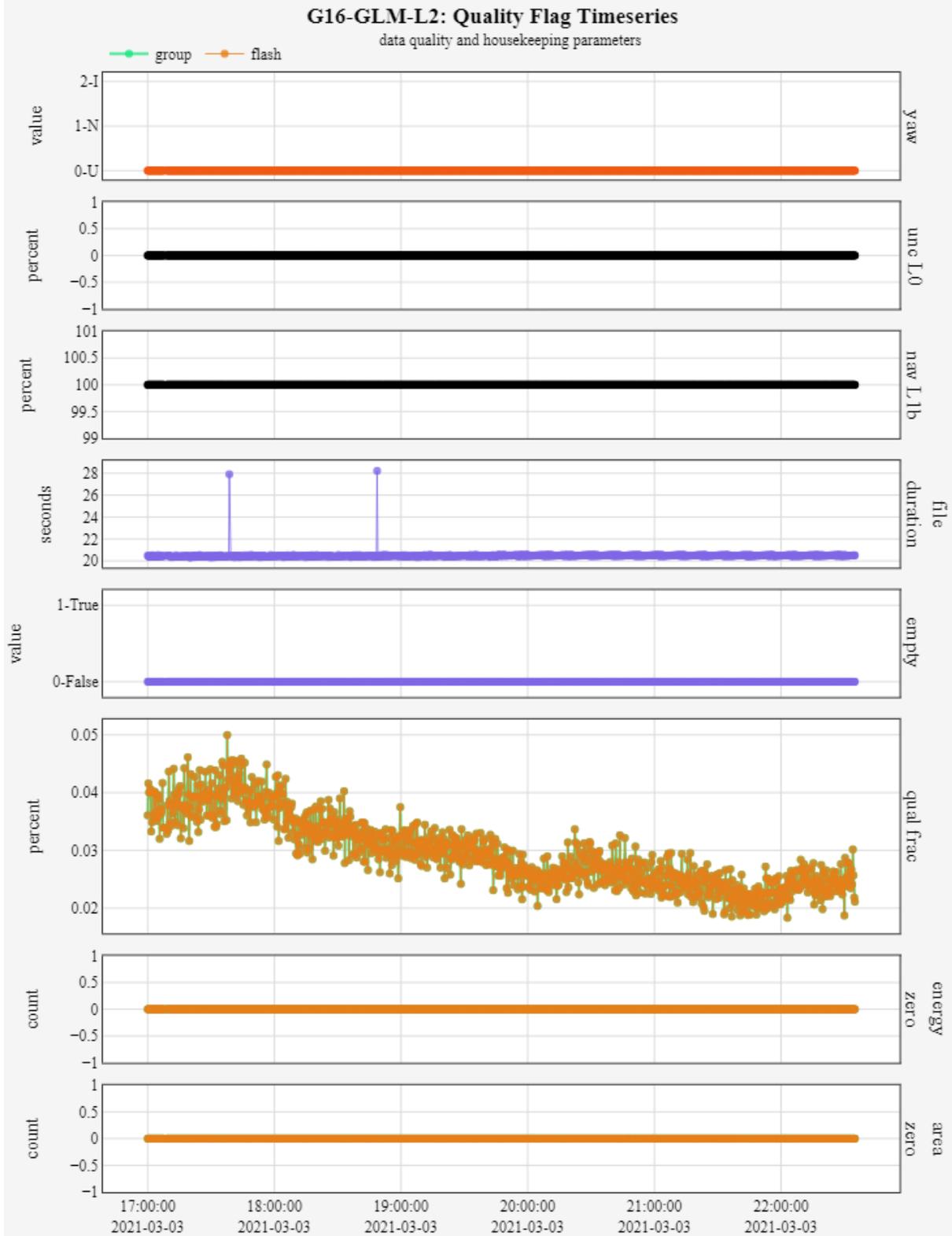Fig. 4 Time series of statistics of Group areas (top) and Flash areas (bottom)

Fig. 5 Time series of GLM L2 files quality flags and other statistics

Plans for Next Reporting Period

- Finish the analysis of the GLM-LIS cloud-top optical products empirical relationships
- Develop the light source illumination deconvolution model for the coincidence GLM and ISS-LIS, based on our former model for intercomparing GLM and TRMM-LIS.
- Convert and update the coincidence datasets in the netCDF format and transfer them to the University of Maryland GLM website once it is live
- Develop a machine learning model for cloud-top optical products pattern