Cross Comparison Analysis on Geostationary Lightning Mapper, High speed Video and Electric Field Data

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Introduction

The Geostationary Lightning Mapper (GLM) is a sensor placed on the GOES -16 and GOES-17 satellites used to continuously observe lightning over the western hemisphere and to support expanded detection of environmental phenomena. To verify GLM observations, high speed videos (HSV) taken at Langmuir Lightning Laboratory and their corresponding electric field data were analyzed to isolate discrepancies between GLM, HSV and electric field data when compared. HSV taken in Brazil were also compared.

Fostering scientific advancements on an international scale

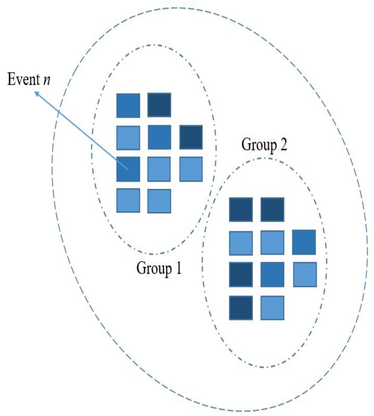

Figure 1
Lightning detection and terminology

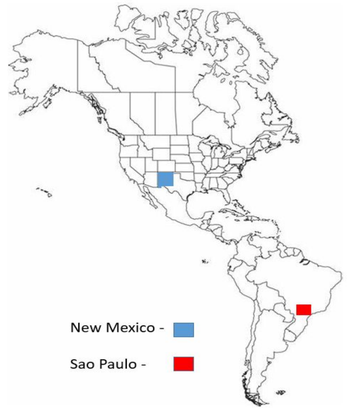

Figure 2
Locations of data collection sites

Methods

HSV's taken in 2019 were analyzed visually and data such as the number of return strokes were counted and compared to GLM and electric field data down to a millisecond timescale. GLM data is retrieved directly from the NASA repository and electric field data is retrieved from Langmuir Electric Field Array (LEFA). Luminosity vs. Time plots were composed to aid in the visual identification process in regards to counting the number of return strokes in HSV. The Luminosity vs. Time plots were rendered using Python on Visual Studio Code software.

Analysis/Models

Electric Field, GLM and HSV Luminosity vs. Time data were plotted together to illustrate return stroke occurrences on the same time-scale.

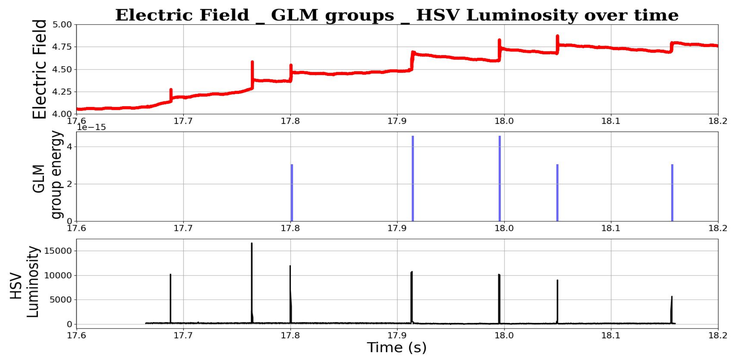

Figure 3
Illustration of all return stroke data collection types that occur at Langmuir

To optimize the data collection process in regards to recording return strokes in HSV, a program in Python was written to record flux in brightness indicating a return stroke.

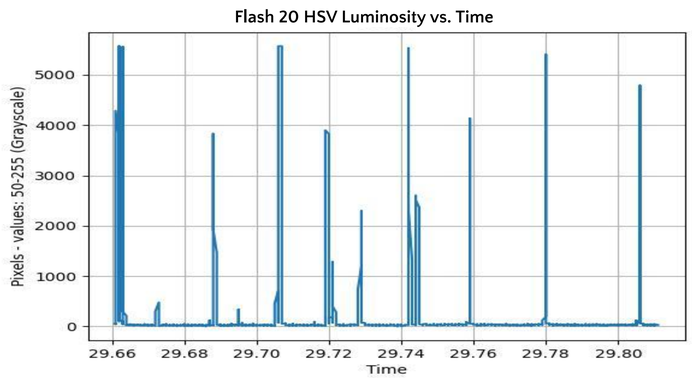

Figure 4
Flash 20 HSV Luminosity vs. Time plot illustrating data collection efficiency

Results

From eleven lightning flashes recorded in July 2019, it was noted that GLM was able to observe ~40% of the return strokes recorded in HSV and ~38% of the return strokes recorded in electric field data. For 6 flashes recorded in Brazil, GLM observed 68% of the return strokes recorded in HSV.

We understand that GLM algorithms have improved since 2019, however these statistics can be used to pinpoint GLM data fragility and how it can be improved in the future resulting in more timely and accurate forecasts and warnings.

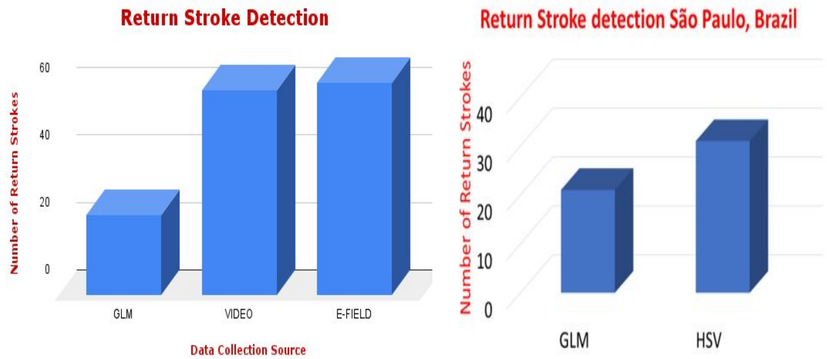

Figure 5
Visual comparison between data collection methods and accuracy for Langmuir and Sao Paulo data

Discussion

After various tests and comparisons alongside the optimization of data collection techniques, it was concluded that Electric Field Data most accurately records return strokes that occur in thunderstorms. With this knowledge, the GLM can further be augmented to improve it's data collection abilities over the western hemisphere.

Acknowledgements

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