

GLM Quick Brief Description

Topic: Definitions and Detection Methods

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Summary: This Geostationary Lightning Mapper (GLM) quick brief describes the GLM detection methods and defines the Level 2 data product. The audience is shown how optical lightning observations are captured, filtered, and combined into a Level 2 product. GLM events, groups, and flashes are defined along with the methods used to locate them. Flash skeletons are shown to demonstrate the value of the rapid temporal updates provided by the GLM. The importance of observing and characterizing the horizontal flash structure is described in the context of quantifying this information to provide insights into convective storm mode and evolution.

Quiz Questions:

- 1) How many images per second does the GLM capture?
 - a) ~100
 - b) ~300
 - c) ~500
 - d) ~1000

- 2) Which Level 2 entities are provided as regularly spaced points on the GLM grid?
 - a) Events
 - b) Groups
 - c) Flashes
 - d) All of the above

- 3) Which of the following statements is not true?
 - a) GLM provides continuous, full disk total lightning measurements
 - b) Flash rates are most closely tied to updraft and storm evolution
 - c) Group locations best depict the spatial lightning extent
 - d) Group/Flash locations are radiance-weighted centroids

Transcript:

Slide 1

Welcome to the Geostationary Lightning Mapper quick brief on GLM Definitions and Detection Methods

Slide 2

the Geostationary Lightning Mapper provides continuous, full disk total lightning measurements with coverage to 54° N/S

by total lightning we mean that the GLM observes both intra-cloud (IC) and cloud-to-ground (CG) lightning, although it does not distinguish between the two

the GLM detects >70% of all flashes when averaged over 24 hours, with better performance at night when the GLM detects approximately 90% of lightning flashes than during the day when the GLM detects approximately 70% of lightning flashes

Shown on the right is a spatial depiction of the eventual footprint of the two GLM's once GOES-17 moves to the west position – the background map illustrates a 17 year climatology from the Tropical Rainfall Measurement Mission Lightning Imaging Sensor – you can see that once both GLMs are in place, we will have total lightning coverage from New Zealand all the way to the west coast of Africa

It is important to note that the GLM is a new instrument and it continues to undergo an extended calibration and validation period

Slide 3

The GLM creates background images every 2 and a half minutes, the GLM then images 500 frames per second to detect changes in brightness relative to the background image

Individual pixels that are illuminated above the background threshold during a 2 ms frame are termed GLM events, filters then determine the likelihood that these events are real lightning

The image on the right depicts an individual GLM flash to demonstrate the detection methods - the GLM events are indicated by brightening of the cloud tops - the green square indicates the location of groups of GLM events that occur during the same 2 ms frame - the white line sequentially connects all groups that comprise this GLM flash - the bottom panel depicts the time evolution of energy and area during this flash, the spatial and temporal evolution of this flash footprint also are indicated on the top and right panels

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A GLM event is the occurrence of a single pixel exceeding the detection threshold during one 2 ms frame, in this image the GLM events are depicted as blue squares on the GLM fixed grid, there were over 1000 GLM events during these two GLM flashes, and since there are only 50 pixels illuminated we know that most of these pixels were illuminated for multiple 2 ms frames

GLM groups represent one or more simultaneous GLM events observed in adjacent pixels, the image illustrates GLM groups as white dots that typically do not occur at the center of a GLM pixel

A GLM flash is 1 or more sequential groups separated by less than 330 ms and 16.5 km, the green X's in this image depict the location of two GLM flashes

It is important to note that GLM Flash rates are most closely tied to updraft and storm evolution, whereas the GLM Event locations best depict the spatial extent

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While GLM events are reported as the center points of GLM pixels, the group and flash locations represent radiance weighted centroids, in this image the red, green, and blue dots represent a lightning mapping array depiction of a lightning flash, the red squares with grey shades indicate GLM events with lighter shades being brighter,

the GLM flash location considers the brightness of all events from both groups to locate the brightest part of the flash, or radiance weighted centroid, indicated by the black X, note that the flash location may not always fall along the lightning channel, but will always fall within the flash footprint

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The GLM maps the extent of the cloud illuminated by individual lightning flashes - despite a relatively coarse spatial resolution of 8 by 8 km at nadir, 13 or 14 km at the limbs, the GLM provides rapid temporal updates, allowing it to map flash structure – Groups within individual flashes are connected to create flash skeletons

This image depicts the evolution of one flash in space and time, the top panel illustrates an important feature of most lightning flashes, this 0.4 second flash produces discrete optical emissions separated by periods of darkness

This is an example of how optical lightning observations provide helpful insights into the flash structure, these insights can in turn be used to make inferences regarding lightning physics and storm structure

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Observing individual flashes clearly illustrates that the GLM is an imager rather than a detector Animating twenty seconds of flash skeletons illustrates the variety of lightning composition and time evolution, which provides important insights into convective mode and storm structure

Forecasters cannot be expected to observe lightning at this frequency during severe storm warning operations, so scientists are working to quantify this information to develop products that aid forecasters, this was the motivation for the gridded GLM products

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This concludes the quick brief on GLM Definitions and Detection Methods, additional GLM information can be found by following these links, and in the other GLM quick briefs