GLM Quick Brief Description

Topic: Gridded Products: AFA and TOE

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Summary: This Geostationary Lightning Mapper (GLM) quick brief defines GLM average flash area (AFA) and total optical energy (TOE) and illustrates how these products complement flash extent density (FED) to enhance the GLM insights. These guides illustrate how the AFA and TOE help diagnose convective initiation and subsequent storm growth, and document their value for characterizing the convective scene. The AFA and TOE also help diagnose and understand how the optical lightning signals interact with the cloud scene.

Quiz Questions:

1) Which product often reveals the lightning channels in extensive anvil/stratiform flashes?
   a) Flash Event Density (FED)
   b) Average Flash Area (AFA)
   c) Total Optical Energy (TOE)
   d) None of the above

2) Which of the following is not an application of the AFA product?
   a) Diagnosing convective initiation and subsequent storm growth
   b) Observing the areal lightning extent
   c) Monitoring convective mode and storm evolution
   d) Identifying lightning jumps

3) Which of the gridded GLM products is the best?
   a) Flash Event Density (FED)
   b) Average Flash Area (AFA)
   c) Total Optical Energy (TOE)
   d) Depends on the application

Transcript:

Slide 1

Welcome to the Geostationary Lightning Mapper quick brief on GLM average flash area and total optical energy

Slide 2

This training module defines two new gridded GLM products, the average flash area and total optical energy, and illustrates how these products complement flash extent density to enhance the insights provided by the GLM

As with all lightning datasets, each of the gridded GLM products can be applied to similar forecast challenges, with certain products better suited to certain applications

The A-F-A and T-O-E also provide context for understanding GLM data quality and the subtleties of space-based optical lightning observations

This animation depicts all three gridded products illustrating the evolution of a nocturnal line of convection

Slide 3

The A-F-A reports the average area of all flashes spatially coincident with each 2 by 2 km grid cell during a specified time period – it has units of square kilometers, with values ranging from a minimum of 1 pixel or roughly 64 square kilometers to several thousand square kilometers for regions with extensive stratiform flashes

The T-O-E is the sum of all optical energy observed within each grid cell during a specified time period, with units of femptojoules (or 10 to the minus 15 Joules), ranging from decimal values for the dimmest flashes to more than a thousand for regions with frequent, bright flashes

This image reveals contrast both within and between the gridded fields – for example, regions that appear bright in the T-O-E do not always coincide with the greatest flash extent densities

Slide 4

Bright regions in the T-O-E indicate the most energetic convective cores – and this product often provides the clearest insights during the earliest stages of pulse convection

Lightning channels within extensive flashes often appear very bright due in part to the thinner cloud between the lightning and satellite – knowing the location of the lightning channels is crucial since cloud-to-ground strikes can occur at any point along these paths – the lightning channels also help identify which distant storm cells are “communicating”

The A-F-A reveals small flashes in newly developing storms, intense deep convection, and along the leading convective line - Larger flashes are most common in the stratiform and anvil regions as well as decaying storms

Slide 5

The T-O-E directly represents the optical observations providing the most intuitive GLM depiction

Much like the F-E-D, the T-O-E can help identify strengthening and weakening storms, forecasters have likened this to watching a lightning bulb brighten and dim as the storms grow and decay

Lightning often illuminates large cloud areas with relatively uniform F-E-D values, since the T-O-E depicts the actual extent of the lightning channels, this product is well suited for analyzing the cloud-to-ground lightning threat associated with large anvil or stratiform flashes

The next slide illustrates the usefulness of the A-F-A for diagnosing convective initiation and the ensuing storm growth, and the subsequent slide describes how both products can help characterize the convective scene

Slide 6

The A-F-A color map accentuates small flashes to highlight the newest convection; the A-F-A then provides a visual que to help quantify the growth of individual storm cells

These images clearly indicate the earliest flashes in yellow which transition to shades of blue and purple as the storms grow

Slide 7

Perhaps the greatest benefit of the additional gridded products is the context they provide for the flash extent density when characterizing active convective scenes

The A-F-A helps differentiate anvil and stratiform flashes from newly developing convection, long flashes often connect to the remnants of earlier convection or new convection, so knowing the source, path, and size helps differentiate between the two

New storm cores are often most apparent in the A-F-A and T-O-E products as evidenced off the coast of Texas in this animation – and in this multi-panel image

The bottom panels illustrate the F-E-D and A-F-A during the early and later stages of a severe MCS, while the F-E-D values are comparable between frames, the A-F-A clearly depicts the contrast in convective mode and evolution between these two times

This slide demonstrates that all three gridded products provide distinct value for monitoring storm mode and evolution

Slide 8

The optical lightning observations differ from the ground based networks most familiar to forecasters – the A-F-A and T-O-E help diagnose and understand how the optical lightning signals interact with the convective scene

The first animation depicts false events along a subarray boundary to illustrate that the A-F-A makes the false events very apparent, note that a fix has been developed for these false returns which should be implemented by the end of 2018

The second animation reveals that other artifacts should be viewed as features rather than flaws – In this case, nocturnal convection results in the illumination of the surrounding low level clouds making it appear as though lightning is occurring outside of the convective turret - the T-O-E product helps confirm that these dim areas are illuminated low-level clouds rather than lightning channels connecting separate storm cores

Slide 9

This concludes the quick brief on GLM average flash area and total optical energy, additional GLM information can be found by following these links, and in the other GLM quick briefs