

# GLM TRAINING UPDATE



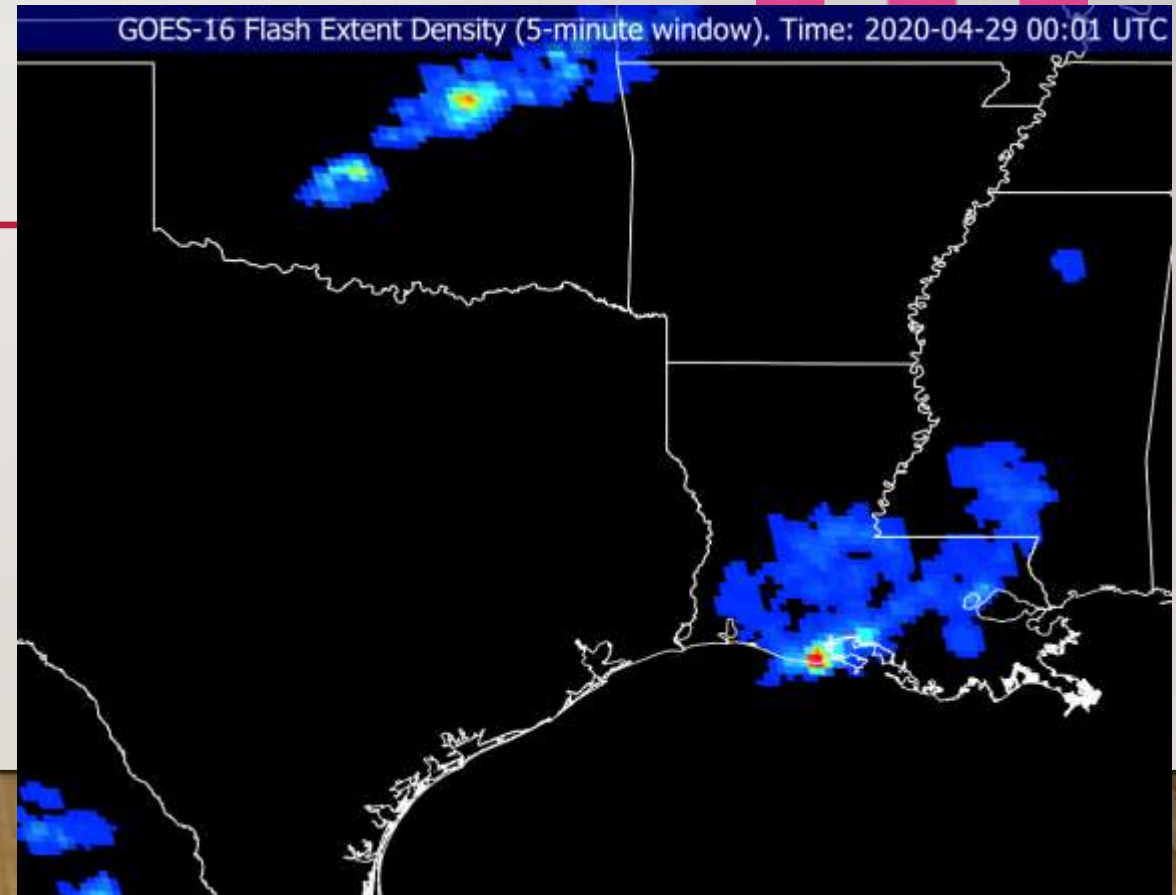
JOSEPH PATTON, UMD/ESSIC/CISS

14 NOVEMBER 2023

GLM SCIENCE MEETING



UNIVERSITY OF  
MARYLAND



# QUICK RECAP FROM LAST YEAR

- Presented on this topic last year at 2022 GLM Science Meeting
- Focused on new GLM training webinars, Hazardous Weather Testbed work, Quick Guides, COMET modules, and NWS resources such as the WOC Severe training course



**GLM Training Resources Revisited: Modules, Presentations, and Forecaster Development**

Joseph Patton  
(UMD/ESSIC/CISS)



GLM Science Meeting  
September 2022

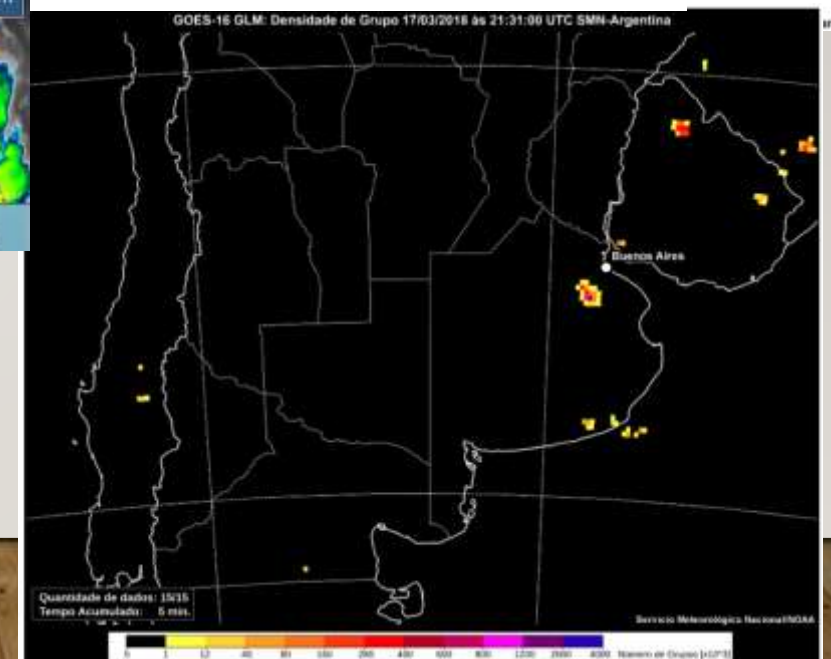
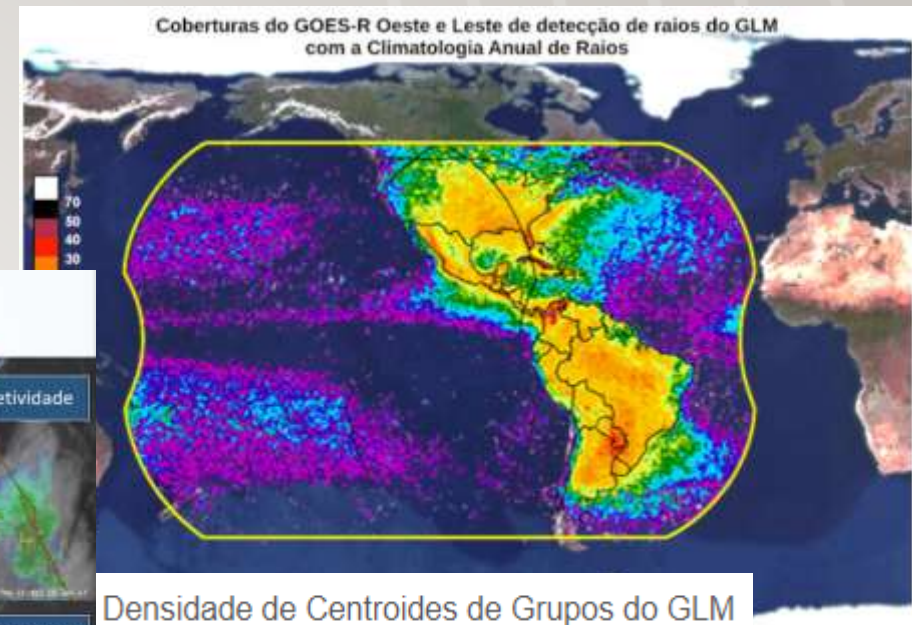
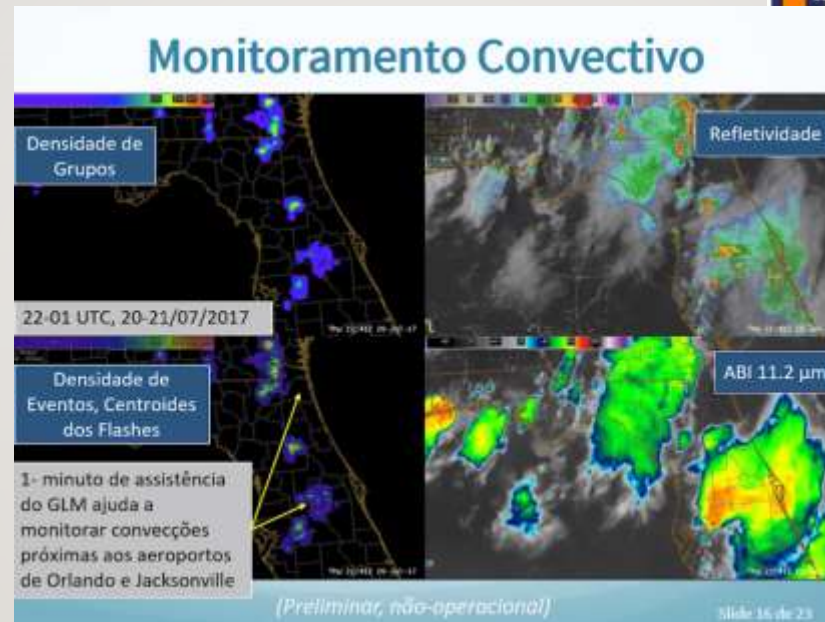


Huntsville, Alabama



# COMET/METED COURSES

- Portuguese language GLM training modules were recently added to COMET modules in Feb. and March 2023
- One of these was adapted from an early training module given by Scott Rudlosky and Steve Goodman, and another was a case study for Buenos Aires, Argentina





# ASMET WORKSHOP

- Workshop given to forecasters across Africa about GLM imagery and forecasting to prepare them for upcoming MTG-LI imagery
- Focused on applying GLM gridded products to different severe weather scenarios with interactive case studies

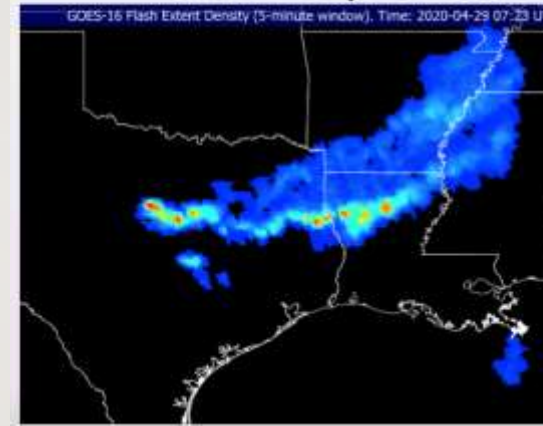
## Geostationary Lightning Mapper (GLM) Gridded Products Applications and Operational Case Studies

Joseph Patton, UMD/CISESS

Lee-ann Simpson, UCAR/COMET

ASMET Workshop

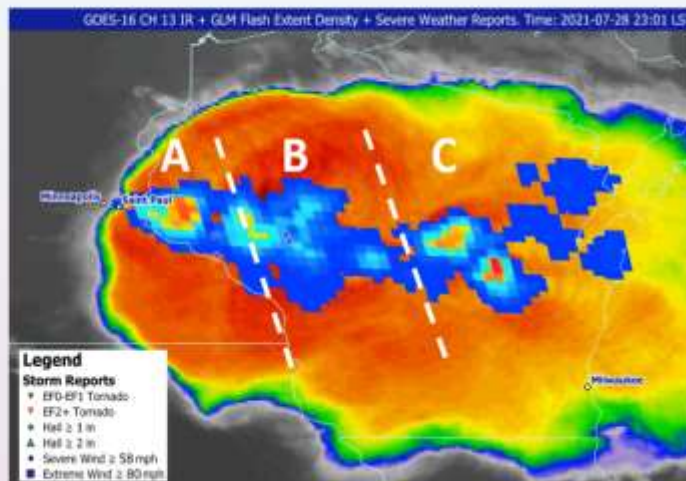
October 27<sup>th</sup>, 2022



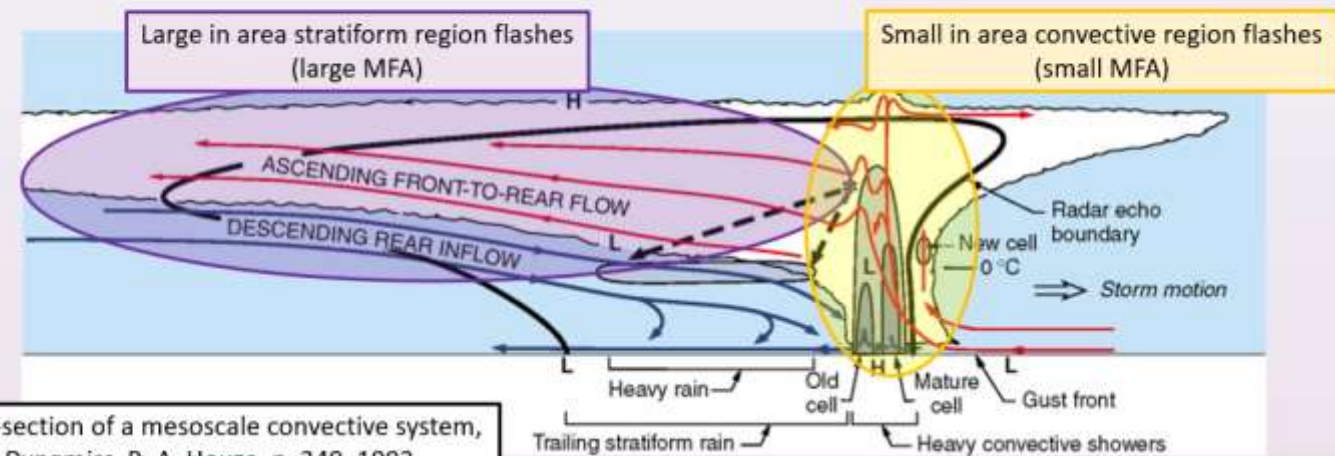
### Case Study 3: Infrared Satellite

24

- Finally, Flash Extent Density (FED) shows flash counts (more flashes -> higher chances for severe weather)
- Which region now – A, B, and/or C?
- Most wind reports and tornado in region C



- Larger (smaller) horizontal area flashes are more likely to be associated with stratiform (convective) precipitation



Cross-section of a mesoscale convective system, *Cloud Dynamics*, R. A. Houze, p. 349, 1993



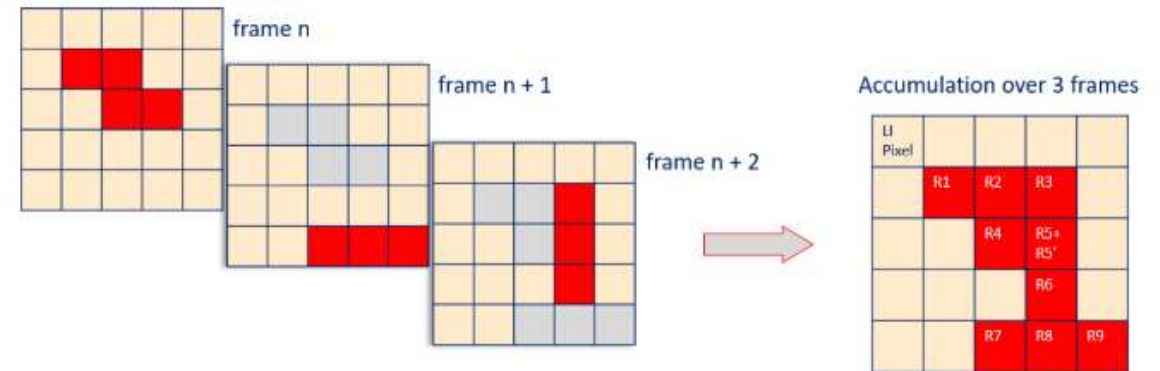
# EXPERT WORKSHOP ON GLM & MTG-LI

- Workshop between scientists and forecasters working with the GLM and MTG-LI instruments
- Discussed the nuances of using a lightning mapper in operations, including the specific products from the MTG-LI and their GLM equivalents



Participants at the Expert Workshop on GOES-GLM and MTG-LI in early spring 2023 (photo: Alois M. Holzer)

- The LI-L2-AFR Accumulated Flash Radiance product represents the **total radiance** detected within a certain pixel from multiple events. Provided every 30 s.



As from US experience after the first years of GOES GLM exploitation, gridded accumulated data is of most value for operational forecasters, while point data is rarely used.

## Comparison between MTG-LI and GOES-GLM baseline products

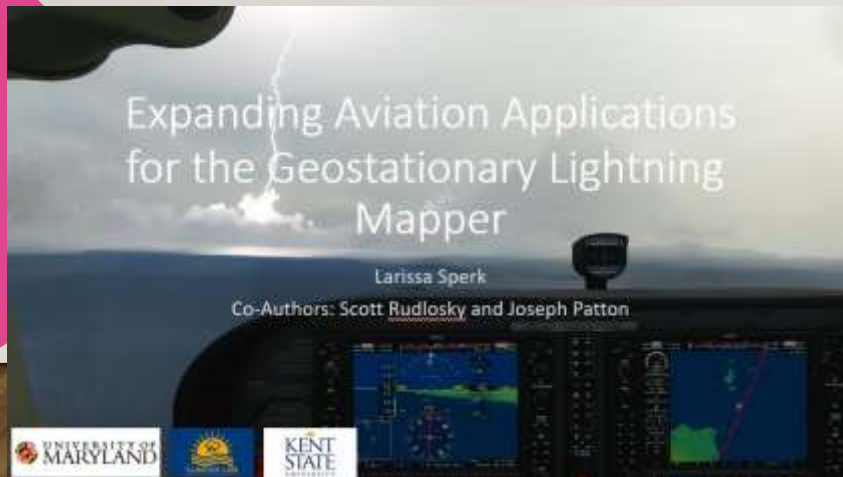
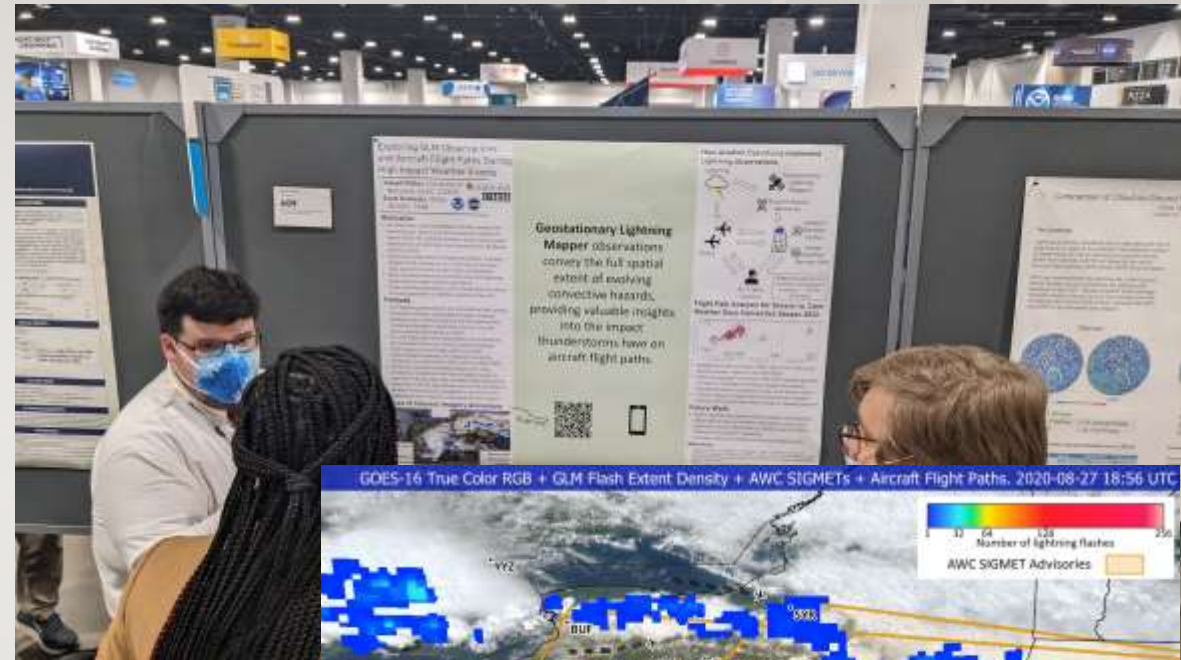
MTG-LI baseline product	GOES-GLM equivalent
Group	Group
Flash	Flash
(accumulated flash area) AFA	FED (flash extent density)
(accumulated flash radiance) AFR	TOE (total optical energy)
(accumulated flash) AF	No equivalent
No equivalent	MFA (minimum flash area)

Compiled from (Le Moal, 2023), (Bojinski, 2023), and (Bruning E., 2023).



# GLM IN AVIATION

- Jan. 2023: Presented poster on using GLM observations in aircraft operations at AMS showing animations showing aircraft flight paths overlaid with GLM lightning and Aviation Weather Center advisories
- Interviews conducted with ARTCC controller and CWSU MIC
- Larissa Sperk (Kent St.) is working on expanding GLM applications to aviation



## Project Overview

- Goal: Display a map with air traffic, airspaces, GLM lightning observations, and proximity indicators to airports and aircraft
- Example image illustrates:
  - GLM lightning with the flash intensity
  - Flight paths for the time frame (pink lines)
  - Air Traffic Service (ATS) routes (green lines)
  - Airspace rings (yellow lines)
  - Flight traffic with transponder information
  - Turbulence detection in progress
- Create a tool for pilots, ATC, researchers, and weather briefers to use to expand the knowledge of storms effects on aviation

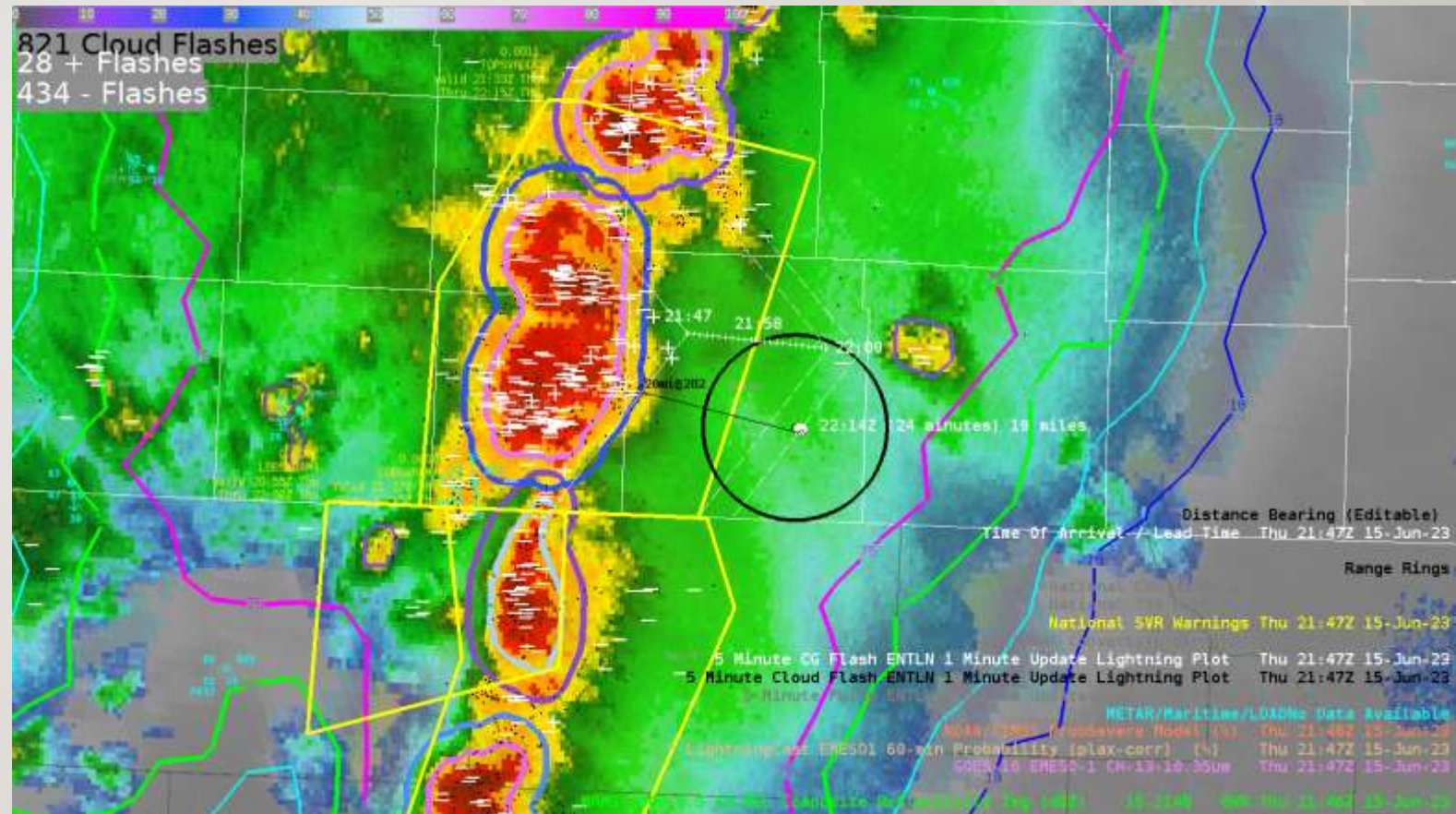


Imagery available via MADIS/NCEP/NOAA. Archived AWC SIGMETs courtesy of EM/Town State, NCEP/NOAA and CSPP-Geo/UW. Imagery created by Joseph Patton (UMD/ESSIC/CISSS).



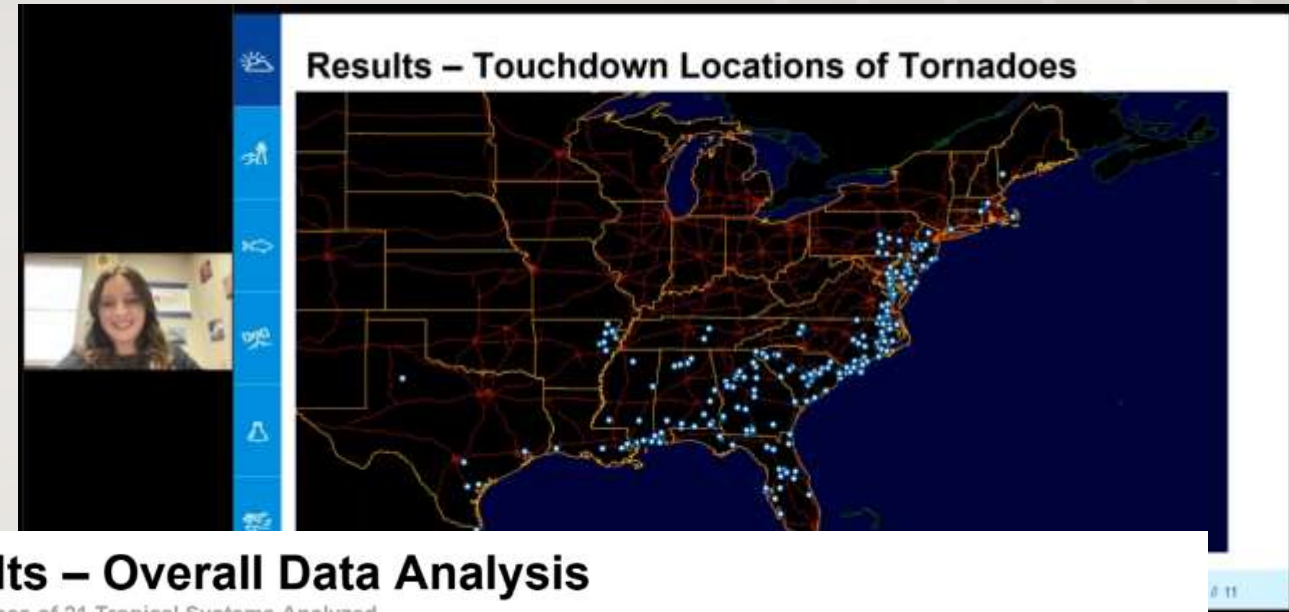
# NWS – HAZARDOUS WEATHER TESTBED

- June 2023: Kevin Thiel worked with forecasters on the use of the ProbSevere LightningCast probabilities (based on GLM/ABI) for the Experimental Warning Program within HWT
- In this example, relatively low LC probabilities were displayed despite the ground-based networks showing ongoing lightning in the trailing stratiform region



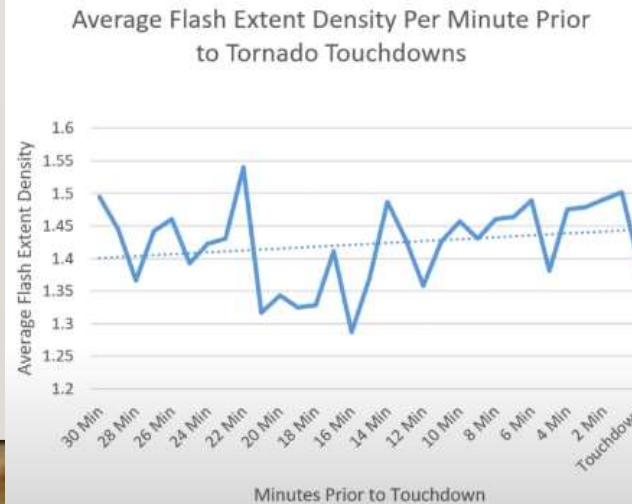
# NWS – SATELLITE BOOK CLUB PRESENTATIONS

- Aug. 2022: Gabrielle Brown (NVU-Lyndon) presented on GLM trends prior to tornadoes in US landfalling tropical cyclones
- Identified 21 landfalling tropical cyclones and 265 associated tornadoes
- Found that on average, FED and MFA increased prior to tornadogenesis
- Hurricanes along Gulf Coast had significantly higher over FED than those along the East Coast



## Results – Overall Data Analysis

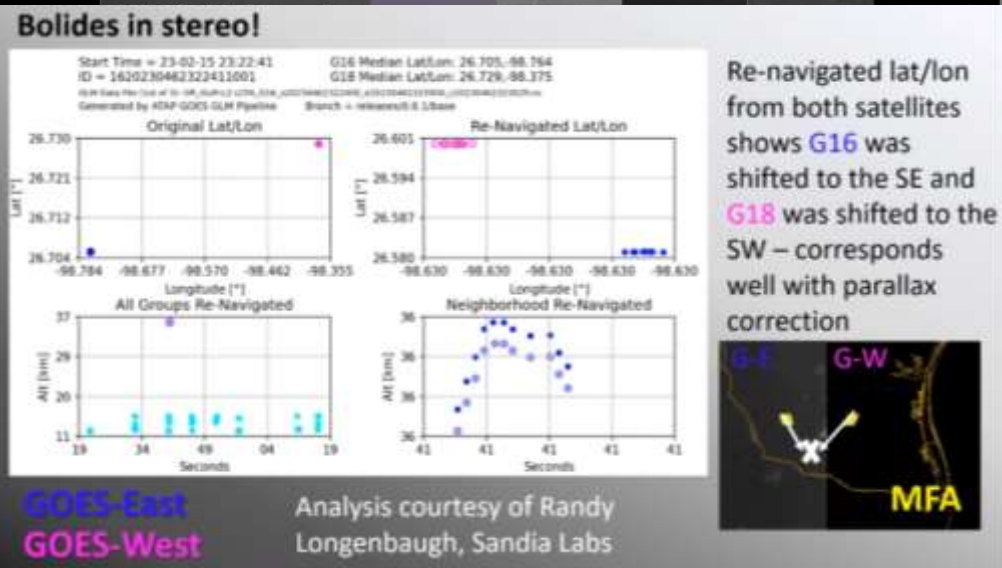
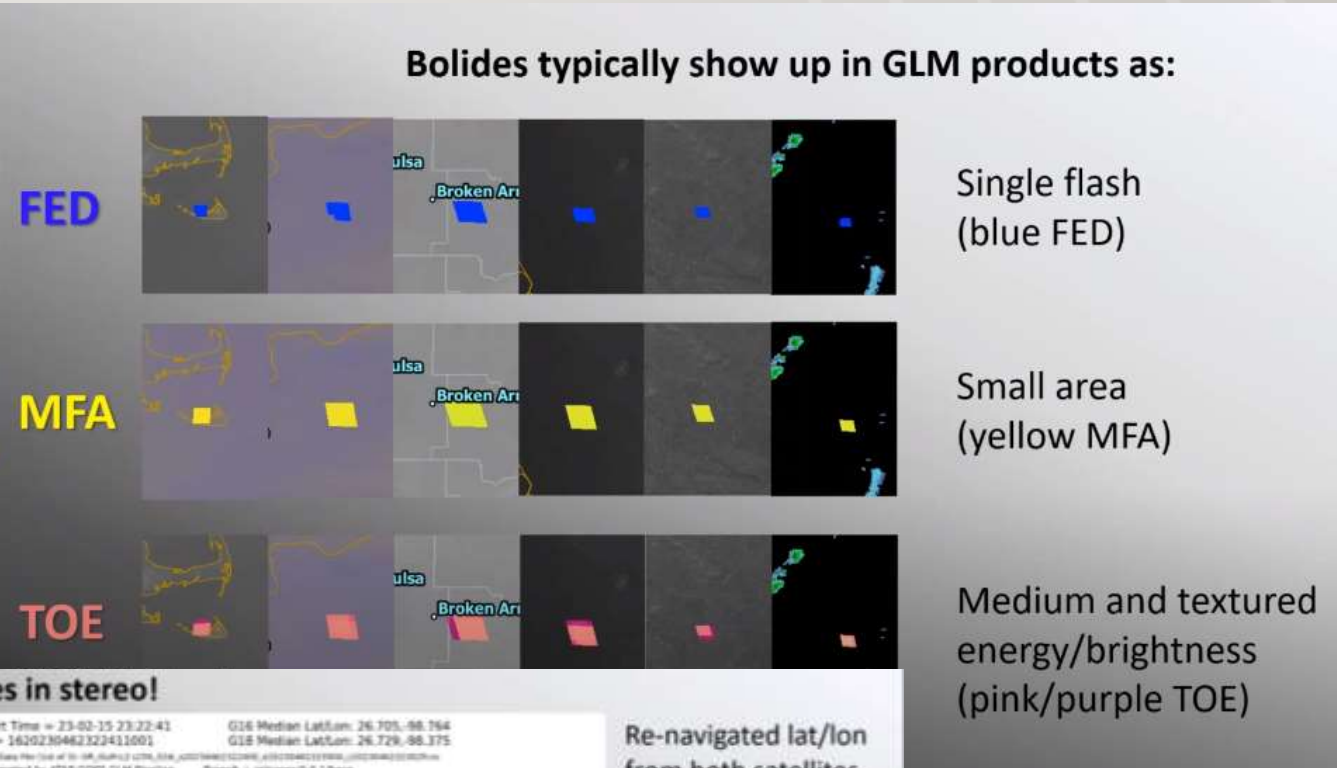
265 Tornadoes of 21 Tropical Systems Analyzed





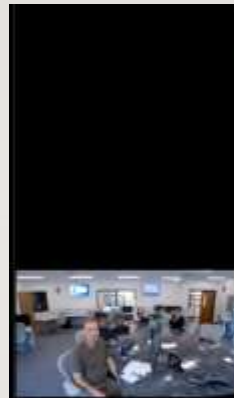
# NWS – SATELLITE BOOK CLUB PRESENTATIONS

- May 2023: Presented on recent GLM observations of bolides (bright meteors exploding in the atmosphere which emit light at a similar wavelength to lightning)
- Discussed several cases of bolide detection, including comparing gridded product values and energies detected by G16/G18 GLMs



# NWS – SATELLITE BOOK CLUB PRESENTATIONS

- Sept. 2023: Sean Campbell presented on useful satellite products for convective SIGMET operations at Aviation Weather Center
- Noted how spatial lightning extent from the GLM is important for their products warning of convection
- Also use ProbSevere LightningCast (based on GLM/ABI data) for short-term nowcasting of incipient electrified convection



**GLM**

- Helps distinguish between strong, organized thunderstorms and isolated thunderstorms; early GLM lightning detection helps identify where charge separation is occurring
- Horizontal extent of lightning aloft can be quite expansive, which the GLM picks up on; better for aircraft safety
- Value added when GLM products are overlaid with ground-based lightning systems and when GLM is overlaid on other satellite and radar products (IR, water vapor, composite reflectivity)

**NOAA/CIMSS ProbSevere LightningCast**

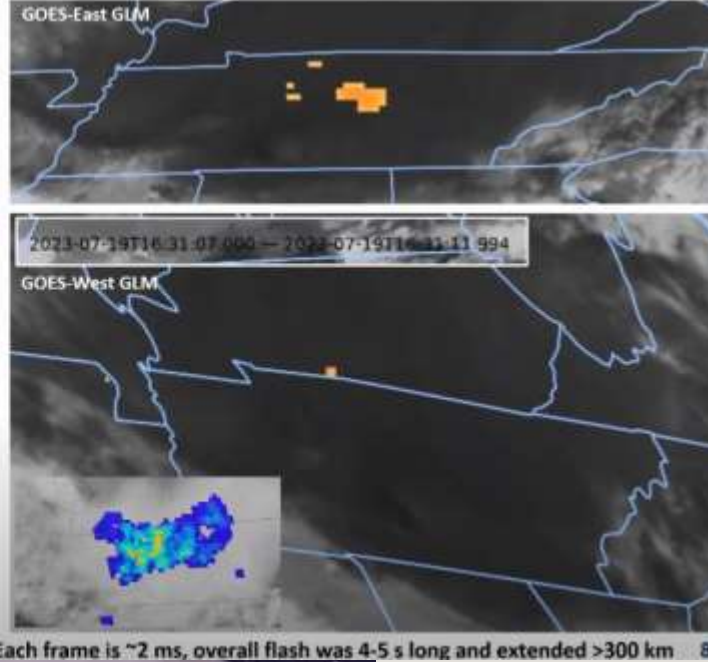
- ABI-based machine learning model that predicts where gridded GLM will observe lightning up to 60 mins in the future, based in evolution of ABI cloud imagery (per the LightningCast training slides); available in AWIPS at AWC
- Generally, the > 50% threshold provides 5-20 min+ of lead time for GLM-detected lightning, which is helpful when determining where/how large to draw C-SIG polygons
- Watching trends (loop capability) is useful – indicates strengthening/weakening of convective activity



# NWS – SATELLITE BOOK CLUB PRESENTATIONS

## Lovely Lightning

- Frame-by-frame loop showing the energy of each event in flash #1
- Discharge develops to progressively larger distances with time
- Extensive, quite bright illuminations of longer channel segments, probably coincident with ground strikes



- Aug. 2023: Scott Rudlosky (NOAA) and Matt Miller (TTU) presented on an unusually large series of flashes over Tennessee
- Size of flash led to parts being broken up into smaller flashes due to data processing restrictions for the GLM
- Large, seemingly numerous flashes caught the attention of forecasters on shift and the TOWR-S team in NWS

## Giant GLM Flashes over Tennessee

Scott Rudlosky (NOAA/NESDIS) and Matt Miller (TTU)

Satellite Book Club

10 August 2023

<https://lightning.umd.edu/gim/>

<https://vlab.ncep.noaa.gov/web/geostationary-lightning-mapper/>



# NWS – WDTD/WOC SEVERE

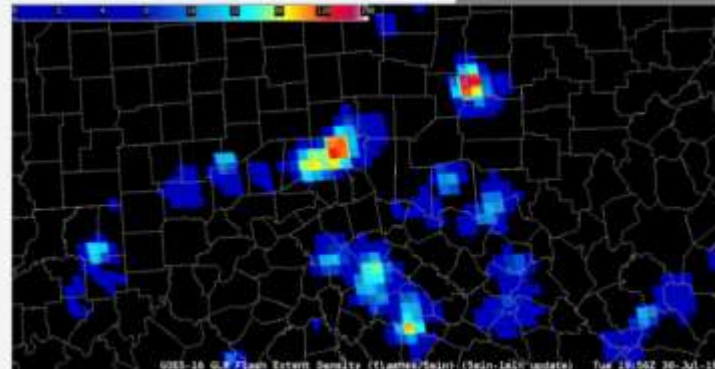
- Katy Christian/Dan Bikos: New data fusion training module with radar outage and GLM imagery
- Overall update to NWS WOC Severe training course that includes new lightning training, which has been reviewed by members of the scientific community

## Flash Extent Density (FED)

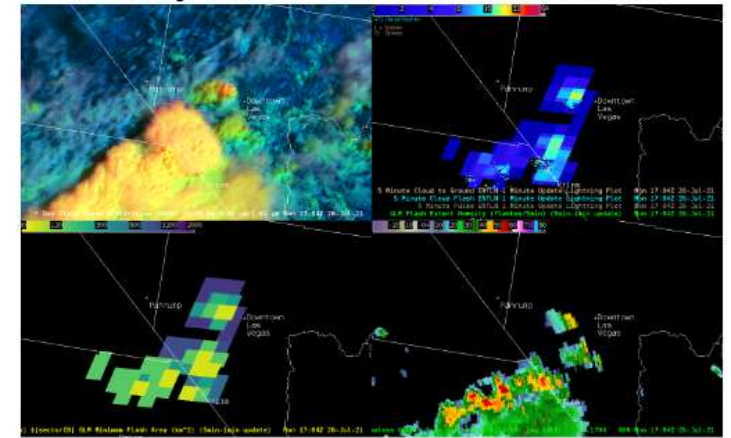
What is FED? The total number of flashes in a GLM pixel over a given time period.

### ❖ How is FED useful?

- Shows quantity of total lightning
- Highlights locations of strongest convection
- Distinguishes between separate updrafts
- Signals lightning jumps



## Data Fusion Exercise for Flash Flood Warnings: 26 July 2021 Flash Flood Event



Dan Bikos, Katy Christian and Jim LaDue



# UPCOMING: GLM QUICK GUIDES/BRIEFS



Fig. 1. GLM gridded products for squall line with large stratiform flash circled



## GLM Gridded Products

- GLM gridded products help differentiate large anvil/stratiform flashes from nearby mature convective (Fig. 1), indicated by
  - Small Flash Extent Density (FED) (not always, see page 2)
  - Large Minimum Flash Area (MFA)
  - Bright Total Optical Energy (TOE)
- Large TOE values result from both thinner clouds (fewer hydrometeors and lightning nearer cloud top) and energetic (optically bright) cloud-to-ground (CG) flashes often located in the stratiform region

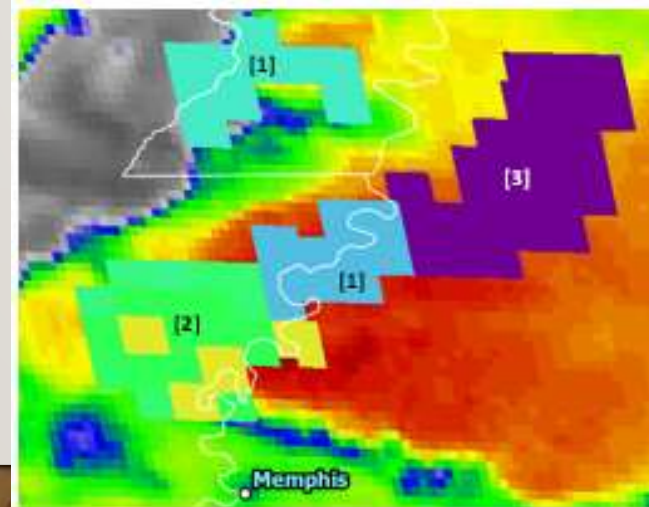


Fig. 2. Depiction of small [1], medium [2], and large [3] GLM flashes illustrating a large anvil flash which likely struck ground multiple places well ahead of a supercell thunderstorm

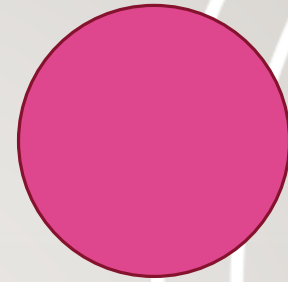
- New GLM Quick Guides are being developed on large stratiform flashes and regional GLM applications
- GLM offers unique capability to map the spatial extent of lightning flashes
- MFA highlights the exceptionally large flashes trailing/leading convection
- Forecasters can anticipate hazards by location of stratiform flashes (e.g., wind threat for trailing flashes)

MD

Version 1 – October 2023



# THANK YOU FOR ATTENDING



Contact me at [jpatton4@umd.edu](mailto:jpatton4@umd.edu) to talk more about GLM training and outreach!

