Utilizing the Geostationary Lightning Mapper for Lightning Safety

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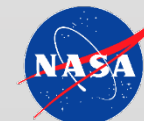
[2]ENSCO, Inc.,

[3]Marshall Space Flight Center, Earth Science Division

[4]Earth System Science Center, University of Alabama in Huntsville

[5]Information Technology and Systems Center, University of Alabama in Huntsville

99th Annual American Meteorological Society Conference

9 January 2019

- Collaborative Partners
- What is the Geostationary Lightning Mapper (GLM)?
- Initial observations (Density Products)
- Lightning safety with GLM
- The 30 minute lightning hazard product
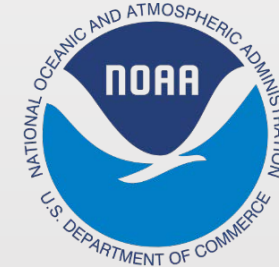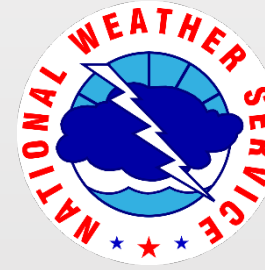- Goal: Basic understanding of and how to use the lightning hazard product
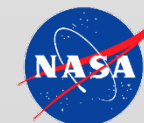
Collaborative Partners

United States

Tennessee

Hamilton County / City of Chattanooga
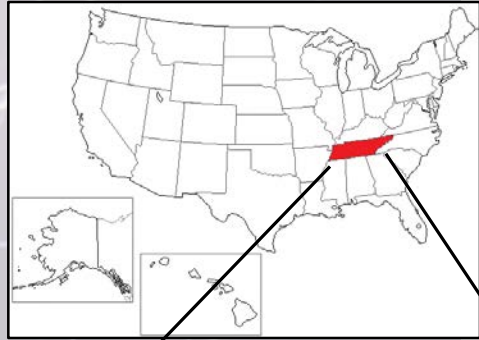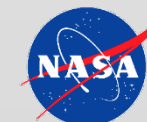
FEMA

National-scale response
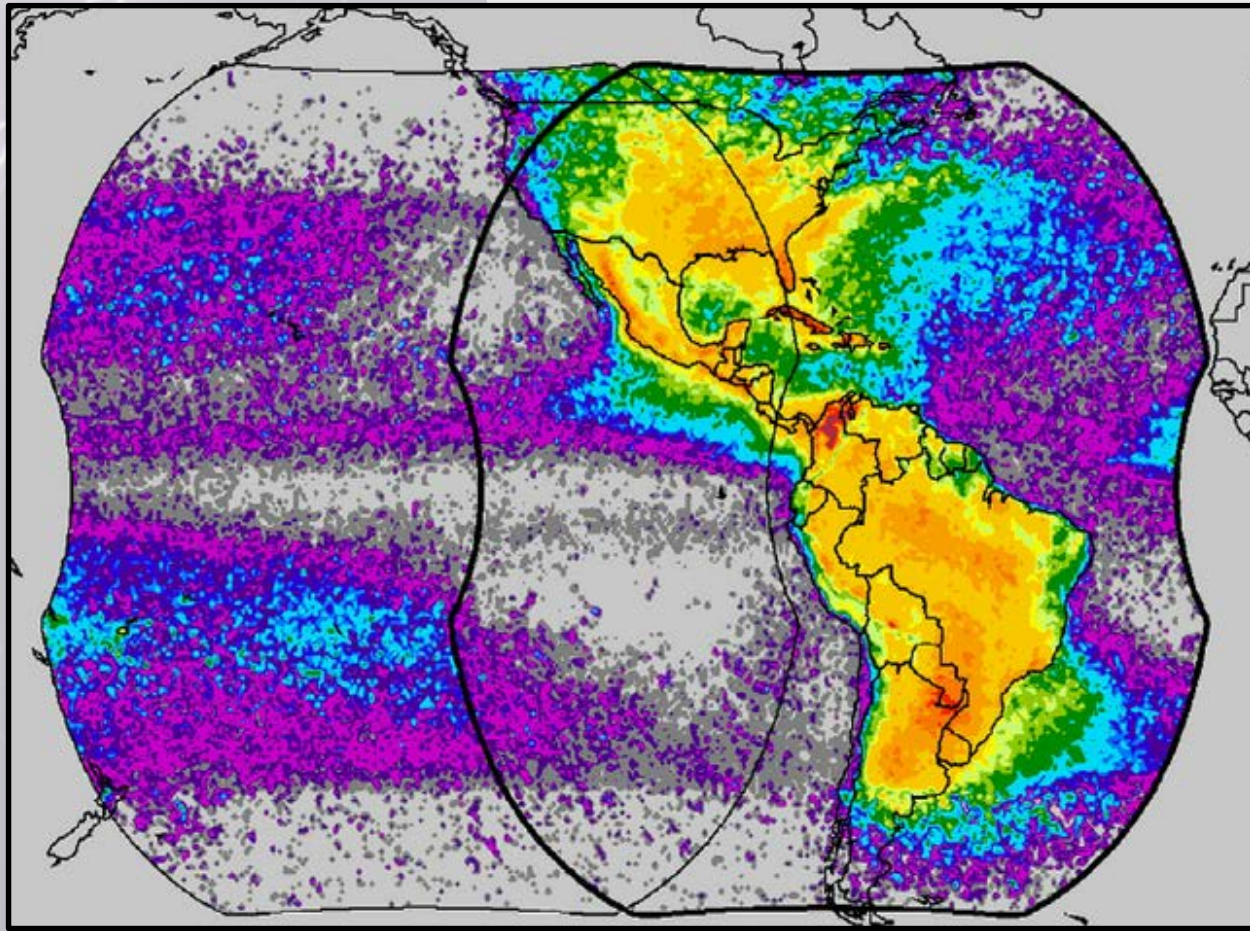
State-scale response

County/City-scale response

- United States National Weather Service coordinates at all levels

- NASA SPoRT partnering with the U.S. National Weather Service, three County/City-scale emergency managers, and Marshall Space Flight Center

- Final goal to work with state and federal emergency managers

Marshall Space Flight Center

SPoRT
Short-term Prediction Research and Transition Center

The Geostationary Lightning Mapper (GLM)

GLM field of view for GOES-16 and -17

- Large digital camera to detect cloud top brightness differences

- Covers 54° N/S

- Observes both intra-cloud and cloud-to-ground lightning – Does not distinguish the difference

- Specifications: >70% detection over the full disk over 24 hours (>90% at night)
  - Initial review exceeding specifications
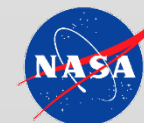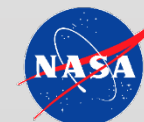
What Does the GLM Observe?

Overhead view of lightning from the International Space Station

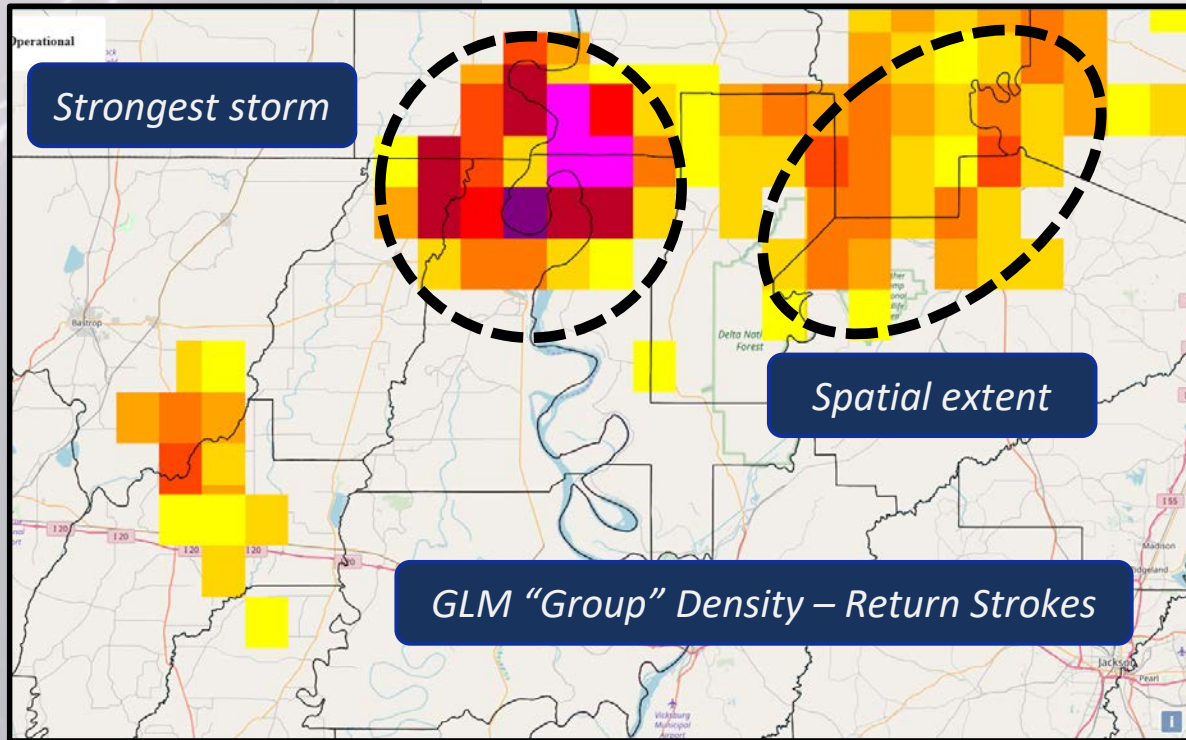*Side view of lightning from the International Space Station*

- GLM very different than ground-based networks
- Observes light emitted through a cloud by a lightning flash
- Results in the lightning flash appearing as a "pool of light" in the cloud
- Shows spatial extent of lightning and not a single point

Examples courtesy of NASA and ESA

Initial Observations: Density Products

Strongest storm

Spatial extent

GLM "Group" Density – Return Strokes
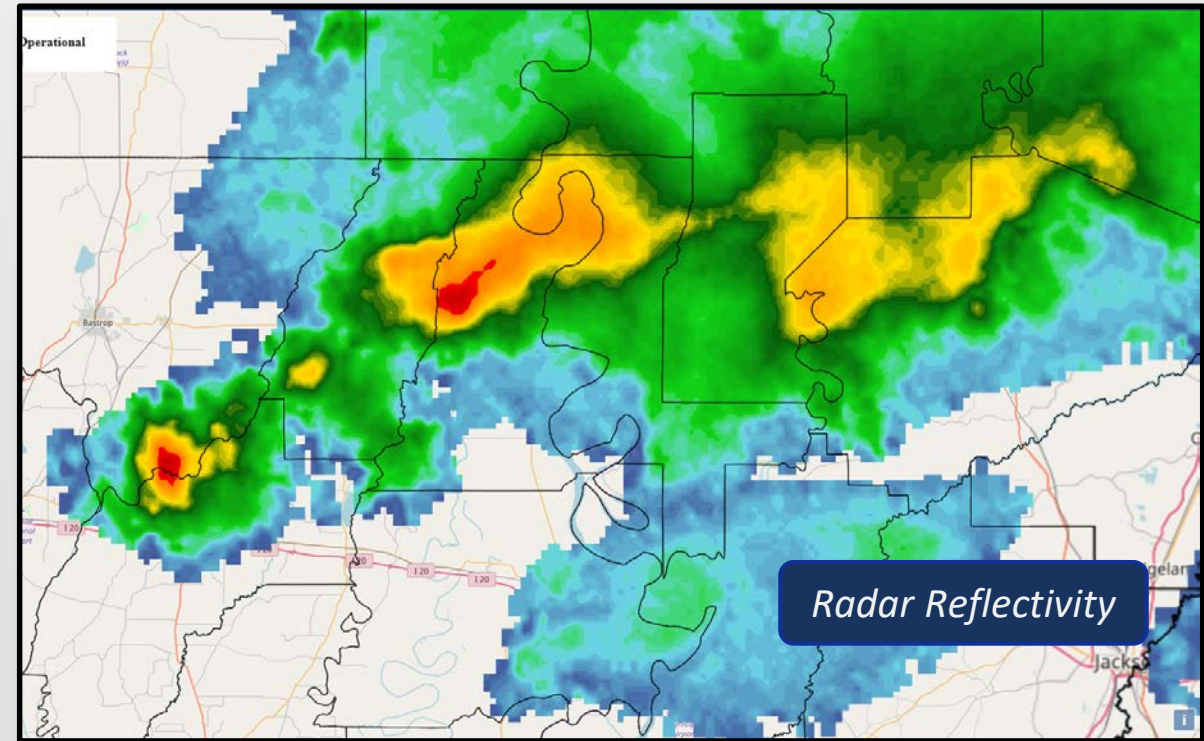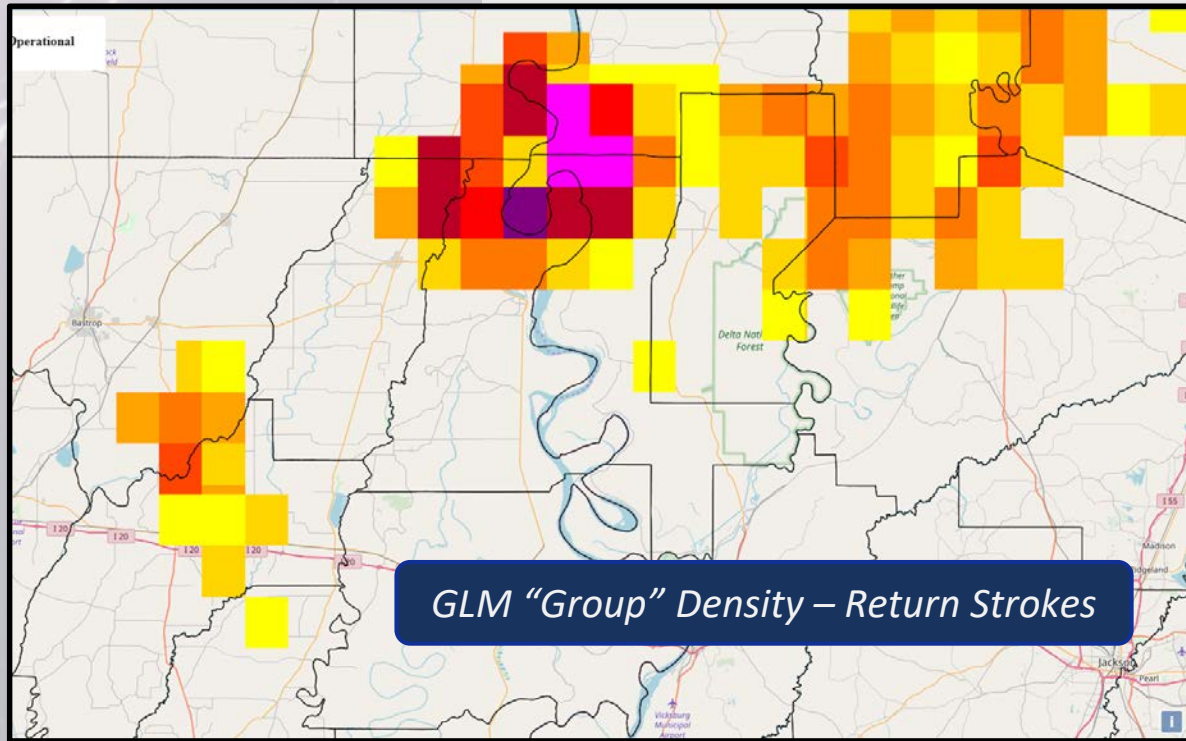
Radar Reflectivity

- Available every minute

- Highlights strongest storms

- Also shows spatial extent
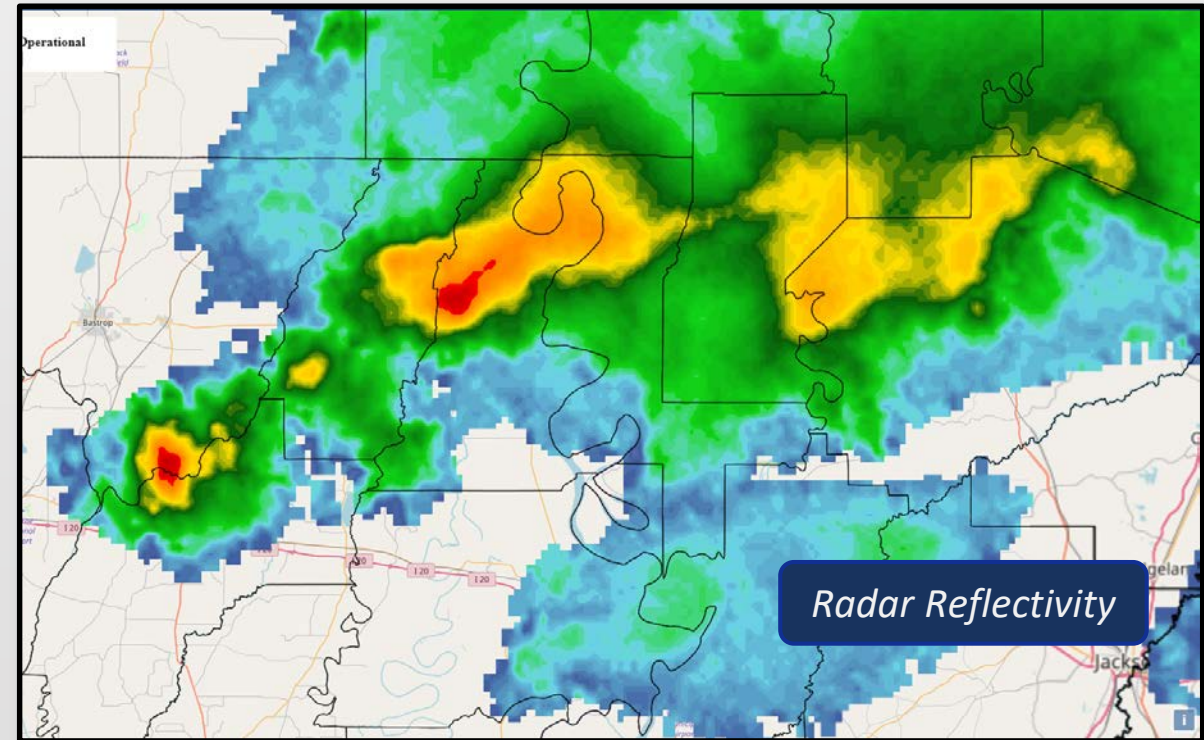
- GLM and radar excellent to use in combination with one another

Utility of the Density Product

GLM "Group" Density – Return Strokes

Radar Reflectivity

- Density product very good at monitoring storm intensity
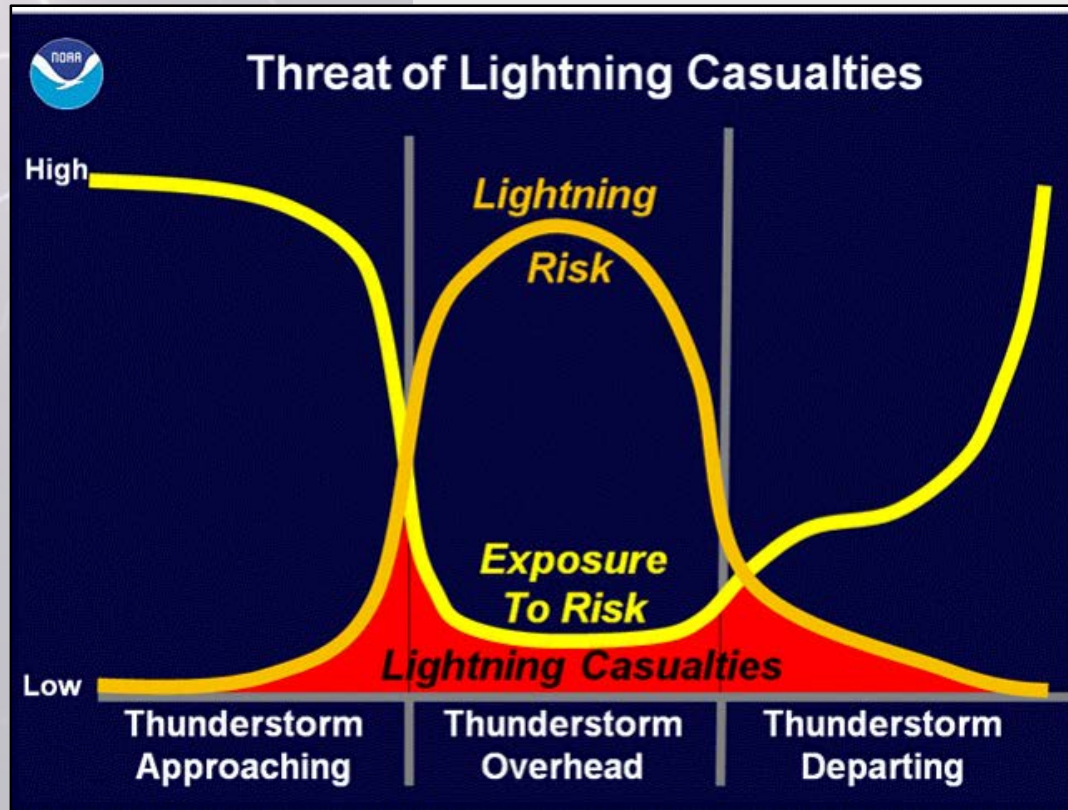
- See where storm may be growing or weakening

- Provides spatial extent, but need an animation to see extent over time
  - Loops could be difficult with limited data availability in the field
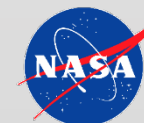
Density Product Animation

35.9703, -88.1794   06/22/2018 19:00:00Z
GLM are Preliminary, Non-Operational
☑ Animate Mode   60

*GLM density animation
1900-1950 UTC
22 June 2018*
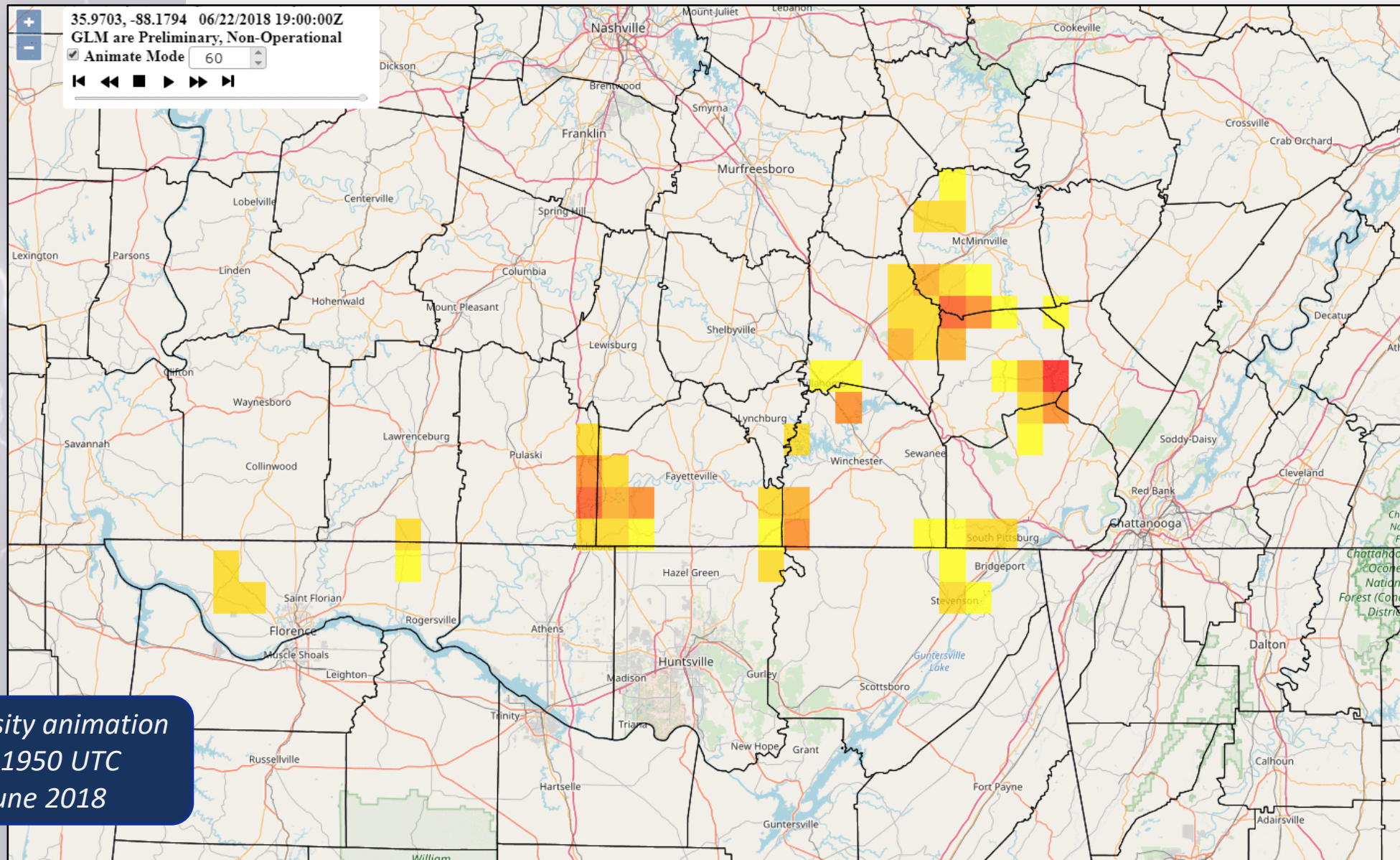
Lightning Safety Information

Threat of Lightning Casualties

High — Low

Lightning Risk

Exposure To Risk

Lightning Casualties

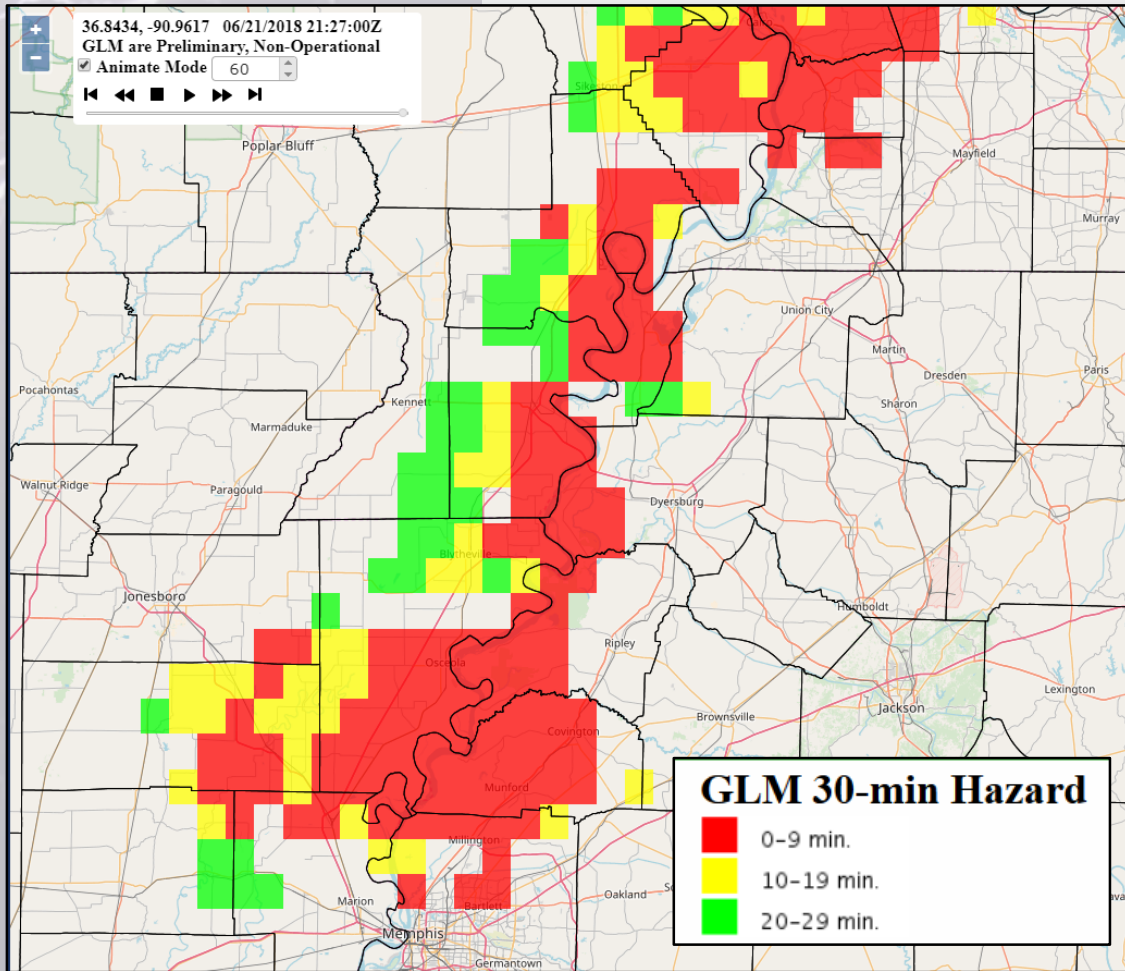Thunderstorm Approaching | Thunderstorm Overhead | Thunderstorm Departing

Courtesy of NOAA's lightning safety page
www.lightningsafety.noaa.gov/safety-overview.shtlm

- Graphic of lightning casualty occurrence versus
  - Location relative to thunderstorm
  - Risk of lightning
  - Exposure to risk (i.e., are people indoors?)
- Key point:
  - People are in shelter when lightning risk obvious
  - Many casualties occur when threat of lightning is low, but individuals' exposure is high
- Emergency managers have asked for a visualization tool to show location, extent, and time of lightning
- SPoRT created the 30 minute hazard or "stoplight" product
 - Uses 30 min rule (stay indoors for 30 minutes after last lightning)

The GLM Stoplight Product

36.8434, -90.9617 06/21/2018 21:27:00Z
GLM are Preliminary, Non-Operational
☑ Animate Mode 60

GLM 30-min Hazard
- 🔴 0-9 min.
- 🟡 10-19 min.
- 🟢 20-29 min.

Example of the 30 minute lightning hazard product in western Tennessee (21 June 2018)

- Uses space-based Geostationary Lightning Mapper (GLM)
  - Public data – Can share on social media
- Resolution of ~10 km^2
- Uses 30 minutes of GLM observations and updates every minute
- Any grid box with GLM observations is marked based on most recent flash
  - 0-9 minutes – Red
  - 10-19 minutes – Yellow
  - 20-29 minutes – Green
- Initial response indicates green should be changed as it suggests "all clear"

NASA

SPORT
Short-term Prediction Research and Transition Center
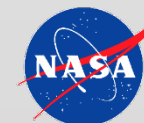
Using the GLM Stoplight for Lightning Safety
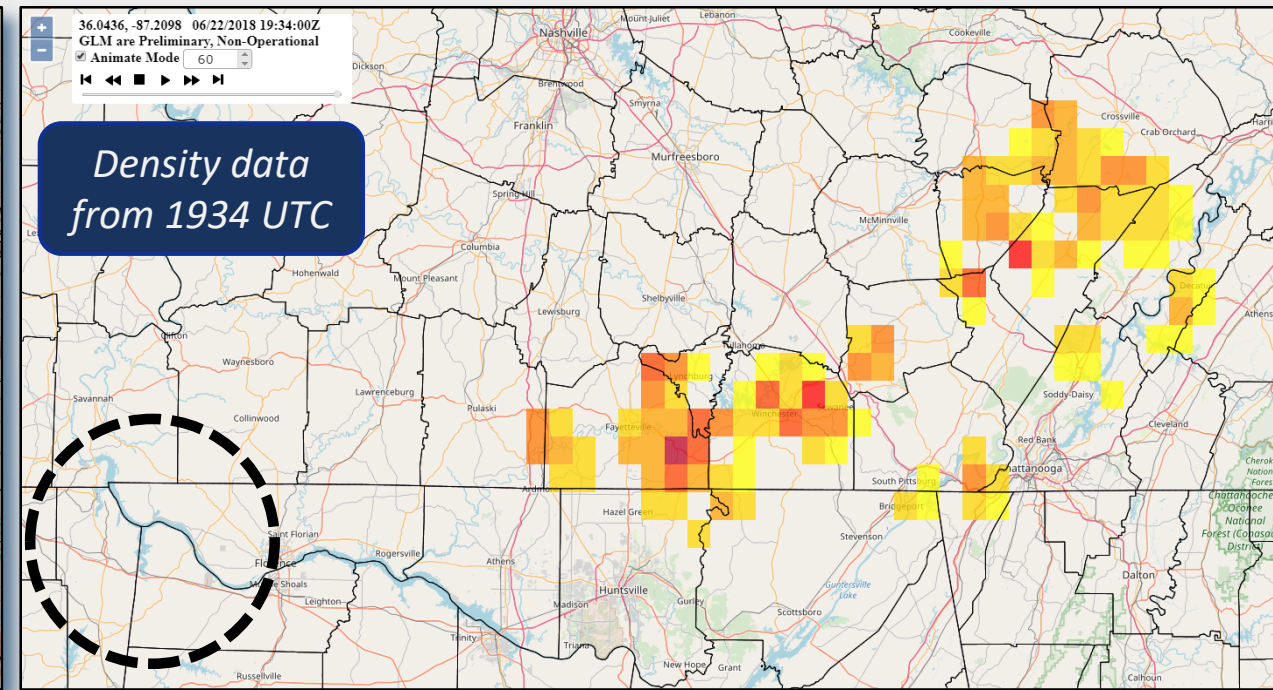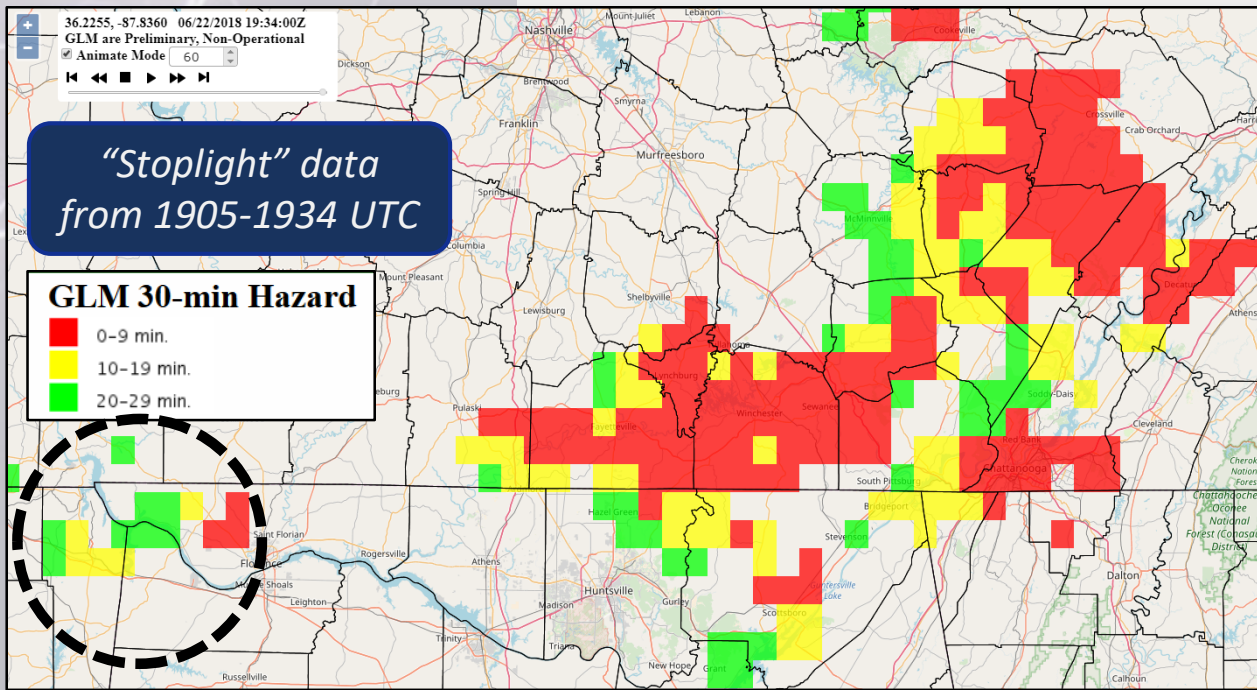
- Density product (every minute) highlights strongest storms and current spatial extent
- Hazard display shows where lightning has been for the past 30 minutes
  - Note activity seen in NW Alabama, but not with density – Red indicates developing storm
  - General motion can be inferred (green to red) – Slow moving in Tennessee
  - Green next to red starkly illustrates threat of lightning over 30 minutes
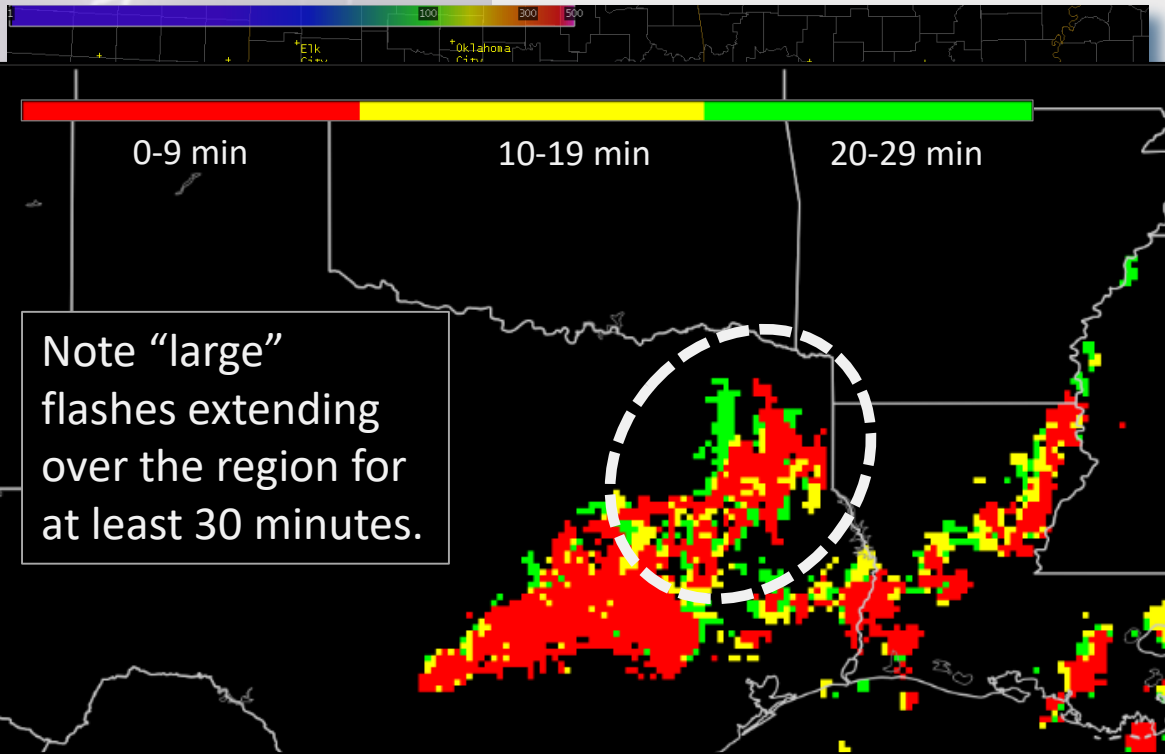 - Single large flashes will remain on display for 30 minutes

GLM Stoplight Animation
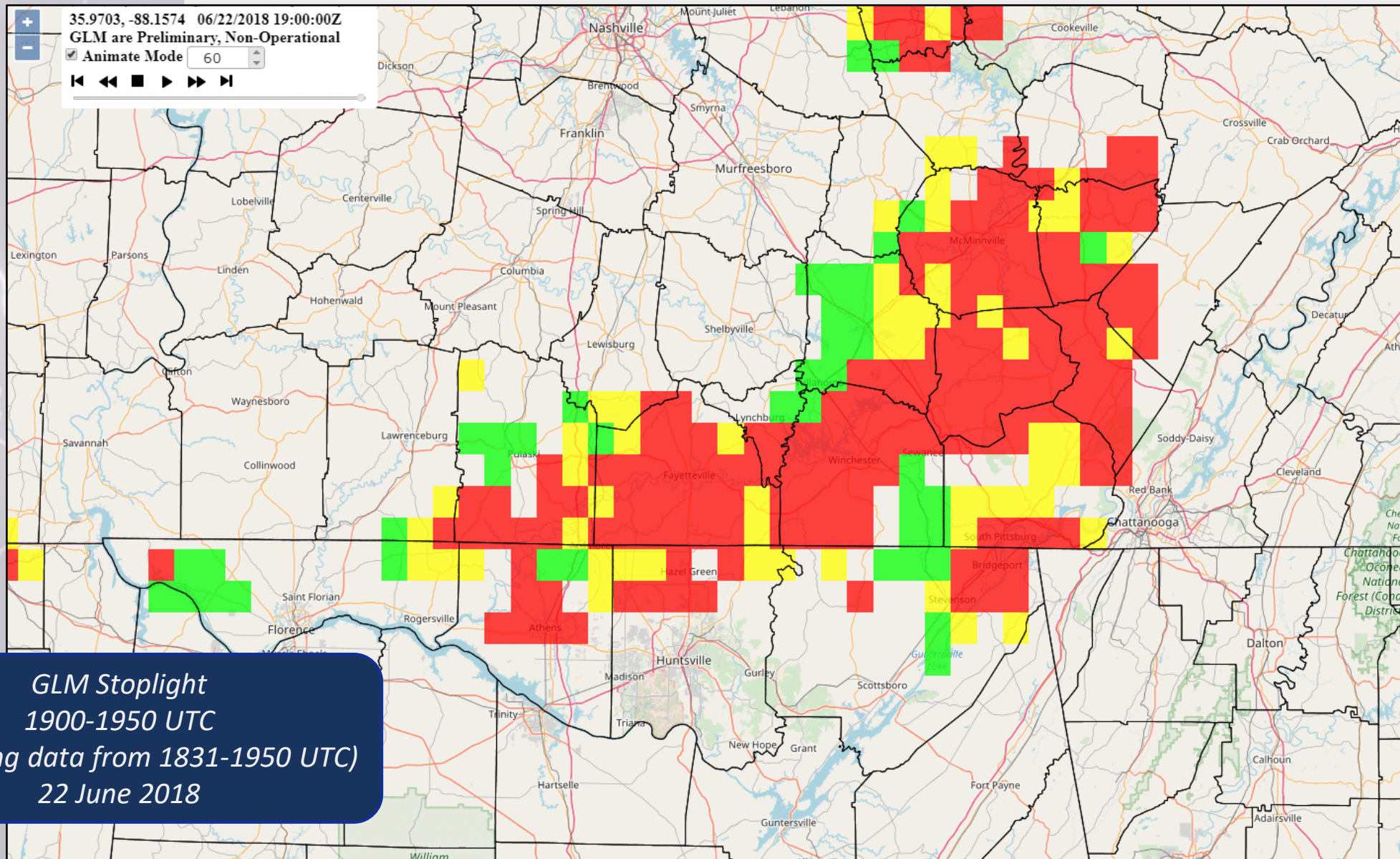
GLM Stoplight
1900-1950 UTC
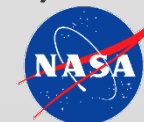(containing data from 1831-1950 UTC)
22 June 2018

Importance of 30 Minutes and Spatial Extent

0-9 min   10-19 min   20-29 min

Note "large" flashes extending over the region for at least 30 minutes.

GLM Stoplight product from 1208-1237 UTC.

Lightning flash in Texas observed by GLM extending 160+ km. (1 minute of observations at 1237 UTC.)

- Timing very critical with lightning safety

- Threat exists before and after storm's passage

- Balance safety with impacts of being shut down

- Upcoming publication information: Delay between two lightning flashes in the same area
  - ~7.4 million pairs of flashes with 1-45 min differences
  - 9.5% > 10 minutes (708.919)
  - 3.5% > 20 minutes (262.264)
  - 1.4% > 30 minutes (107.018)
  - 0.4% > 40 minutes (and up to 45 minutes) (27.332)

- Public 30 minute rule of thumb good, but non-zero threat beyond 30 minutes

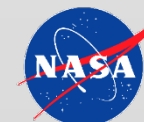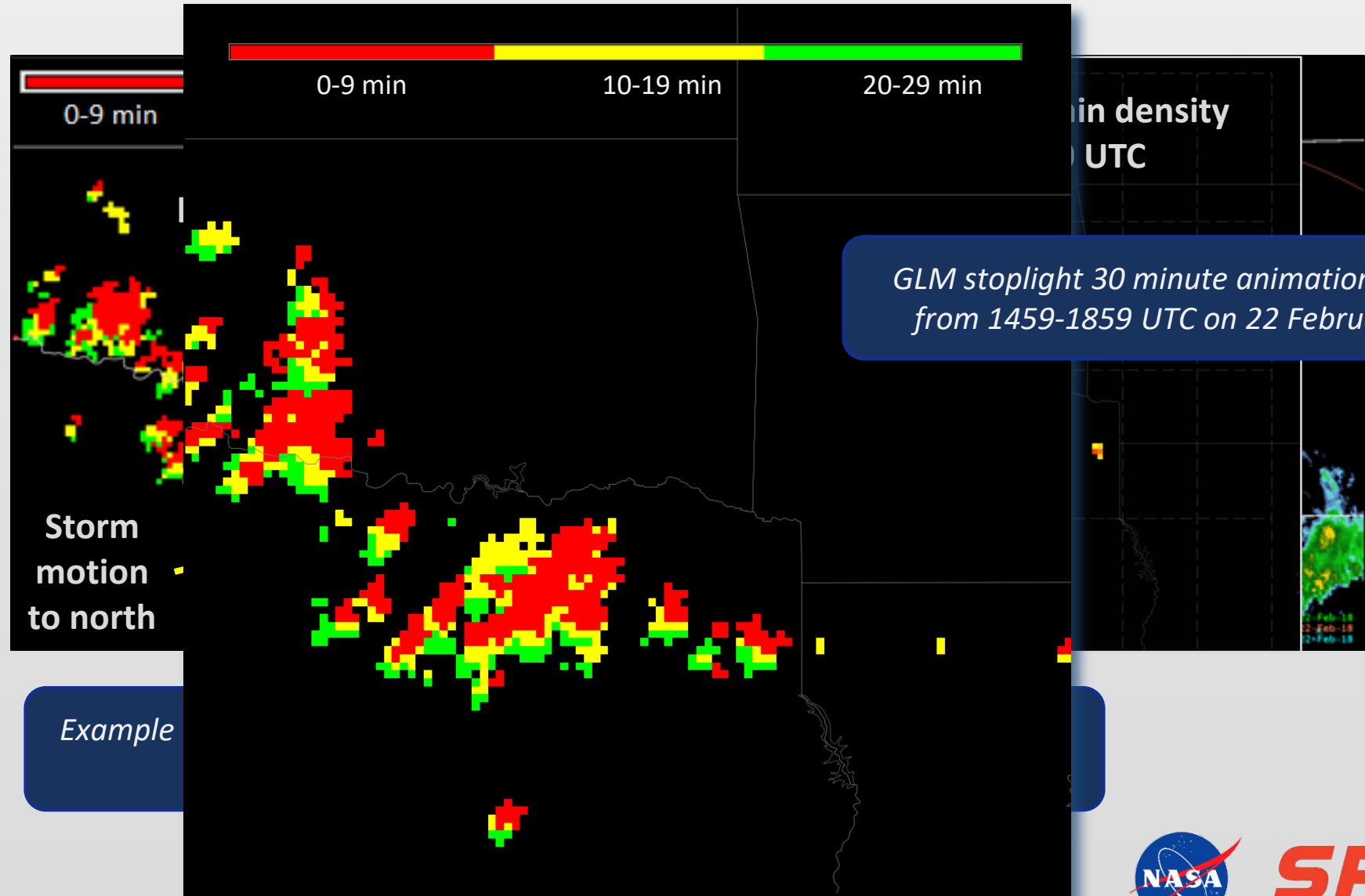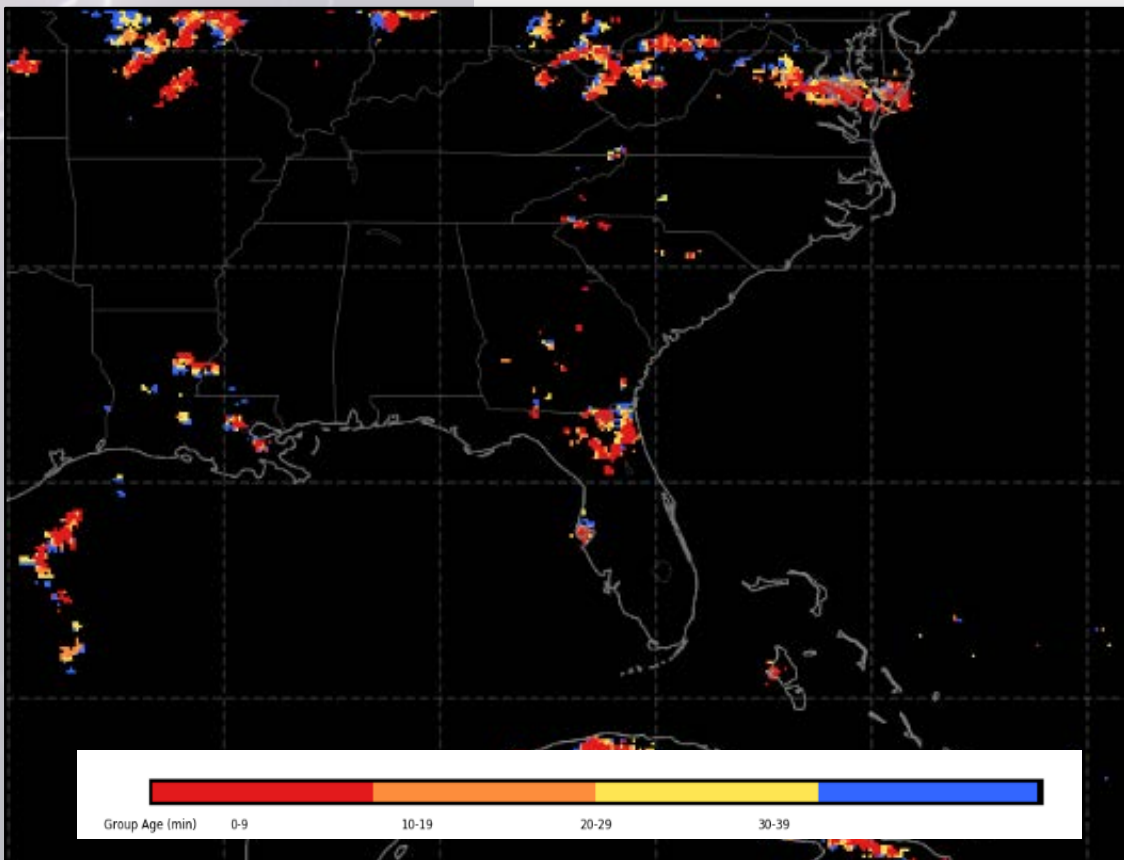- Long flashes (spatial extent) could account for some of these

Additional Example

Upcoming National Weather Association Journal of Operational Meteorology Stano et al. (2018)

GLM stoplight 30 minute animation with data from 1459-1859 UTC on 22 February 2018.

0-9 min · 10-19 min · 20-29 min
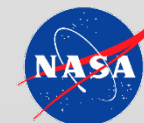
Storm motion to north

Example

Summary

Updated GLM Stoplight product "quick look" example.
Adds 30-39 min range (blue) and changed color brackets

- Lightning Hazard Product shows age and extent of all lightning for the past 30 minutes
  - Uses 10 minute bins (0-9, 10-19, 20-29)
  - Based on 30 minute safety rule
  - Developed from emergency manager requests
- Shows 30 minutes of data and updates every minute
- "At a glance" ability to determine age and coverage
- Future options (example to left):
  - Remove green as the 20-29 minute age
  - Add a 30-39 minute age band?

Questions and Web Links

- Dr. Geoffrey Stano: geoffrey.stano@nasa.gov

- More details to come in the National Weather Association's Journal of Operational Meteorology Stano et al. (2018 – Submitted)

- "Quick Look" web pages:

  - Density: https://weather.msfc.nasa.gov/cgi-bin/sportPublishData.pl?dataset=goeseastglm&product=group&loc=conus

  - GLM Stoplight: https://weather.msfc.nasa.gov/cgi-bin/sportPublishData.pl?dataset=goeseastglmstoplight&product=group

- Web mapping server

  - NASA-safety: https://weather.msfc.nasa.gov/viewer/viewer.html?config=nasa-safety

  - EMA-safety: https://weather.msfc.nasa.gov/viewer/viewer.html?config=ema-safety