AFA and TOE Background

- Average flash area (AFA) is the average area of all GLM flashes spatially coincident with each 2×2 km grid cell during a specified time period

- AFA has units of km^2, with values ranging from a minimum of 1 pixel or ~64 km^2 to several thousand km^2 for regions with extensive stratiform flashes

- Total optical energy (TOE) is the sum of all optical energy that the GLM observes within each grid cell during a specified time period

- TOE has units of femtojoules (fJ; 10^{-15} J), with values on the order of decimals for the dimmest flashes to over 1000 fJ for regions with many bright flashes

- <u>AFA and TOE complement flash extent density (FED) to maximize the insights provided by the GLM</u>

- <u>AFA and TOE also provide context for understanding GLM data quality and the subtleties of space-based optical lightning observations</u>
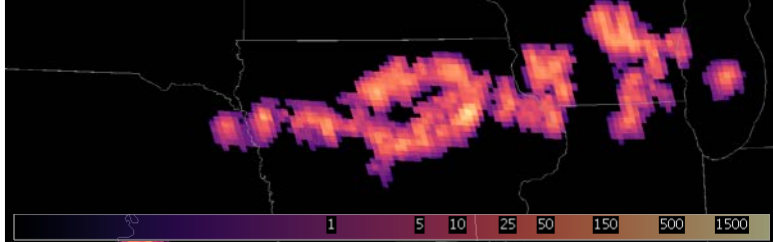
Flash Extent Density
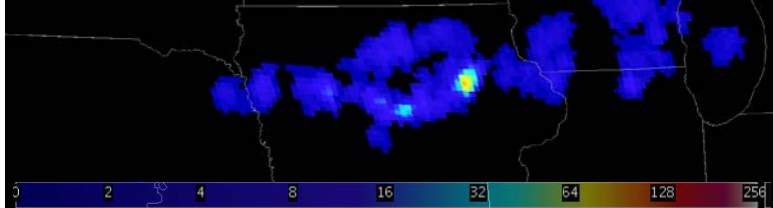
Average Flash Area
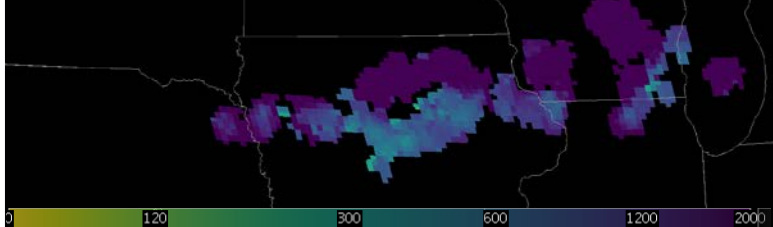
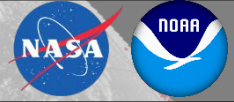Total Optical Energy

Primary AFA Applications

- <u>Detect/Monitor Thunderstorm Growth</u> – the AFA color map accentuates small flashes to highlight the earliest flashes, AFA also provides a visual que to help quantify subsequent storm growth

- <u>Observe the areal lightning extent</u> – the AFA indicates the occurrence of large/long flashes and helps differentiate anvil/stratiform flashes from embedded, newly-developing convection

- <u>Monitor convective mode and storm evolution</u> – the AFA trends are indicative of storm life cycles [e.g., frequent small flashes within the most intense convection (< 300 km^2) and a tendency for larger flashes as storms weaken (> 600 km^2)]

Primary TOE Applications

- <u>TOE directly depicts optical lightning observations</u> – provides the most intuitive GLM portrayal

- <u>Identify strengthening and weakening storms</u> – forecasters have likened the use of TOE to watching a light bulb brighten/dim as the storms grow/decay

- <u>Characterize convective scenes</u> – the TOE helps make inferences regarding the surrounding cloud scene [e.g., the TOE helps distinguish between deep convection and the dimmer low level clouds it often illuminates (most common at night)]

- <u>Analyze the cloud-to-ground lightning threat</u> - TOE indicates lightning channel locations within extensive stratiform flashes, along which these flashes commonly strike ground [e.g., FED often illuminates large cloud areas (especially at night), TOE illustrates the actual lightning channel extent
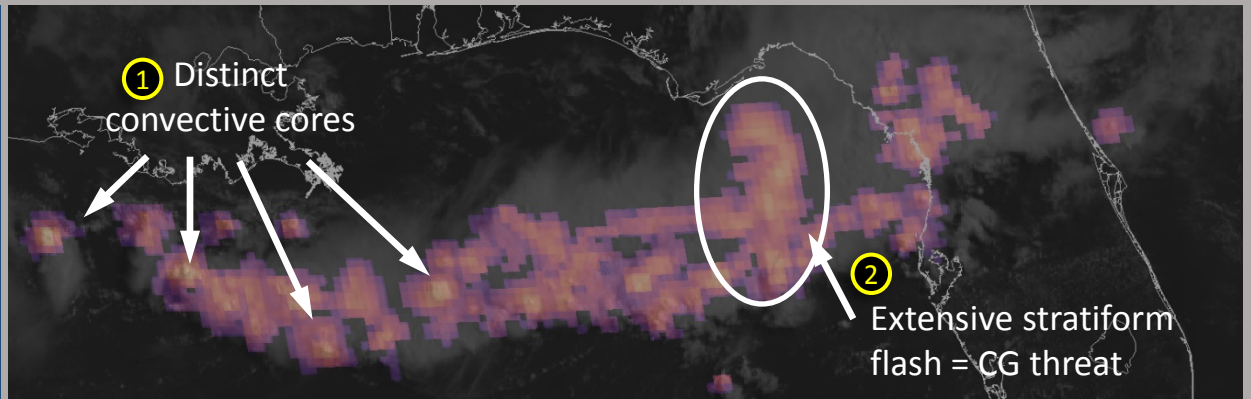
Author: Scott Rudlosky, Ph.D.
NOAA/NESDIS/STAR (CICS-MD)

Version 1 – August 7, 2018

NESDIS
National Environmental Satellite, Data and Information Service

cics-md

Geostationary Lightning Mapper: Gridded Products (FED)
# Quick Guide

Bright TOE regions indicate

1. **The most energetic convective cores**
2. **Lightning channels within extensive flashes**

AFA reveals

3. **Large flashes in the stratiform / anvil regions and decaying storms**
4. **Small flashes in new convection (see below) and along the leading line**

1 Distinct convective cores

2 Extensive stratiform flash = CG threat

3 Trailing stratiform region

4 Leading convective line
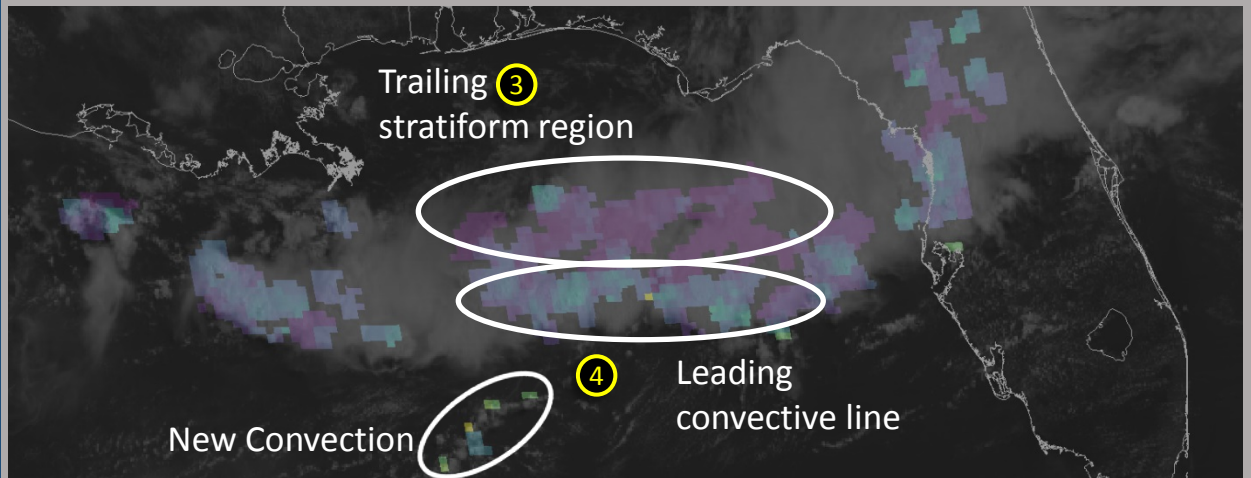
New Convection

Detect and Monitor Storm Growth

5. **AFA accentuates small flashes to highlight earliest convection, also provides a visual que to help quantify storm growth**

5 1953 UTC   2018 UTC   2112 UTC

AFA
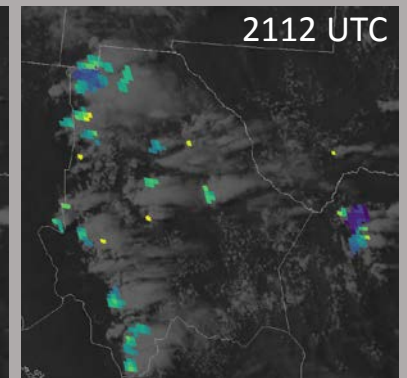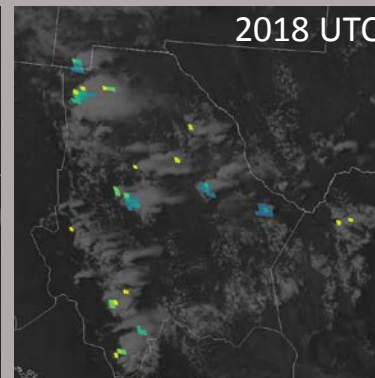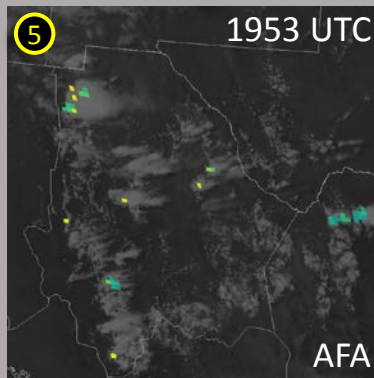
Understanding Optical Observations

- AFA and TOE help understand how the optical lightning signals interact with the convective scene
- AFA makes false events along subarray boundaries very apparent (issue should be fixed during 2018)
- TOE helps confirms when dim areas in nocturnal scenes represent illuminated low-level clouds rather than lightning channels ahead of the storm
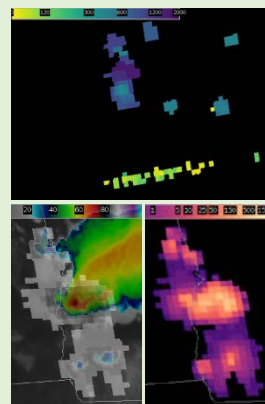
Additional Resources

GLM VLab Community:
https://go.usa.gov/xU5MF

GLM Faculty Virtual Course

NESDIS/STAR - CICS-MD

NASA SPoRT Home Page

Hyperlinks not available when viewing material in AIR Tool