DERIVING GLM GROUP AND FLASH DETECTION EFFICIENCIES FROM MEASURABLE GLM THRESHOLDS

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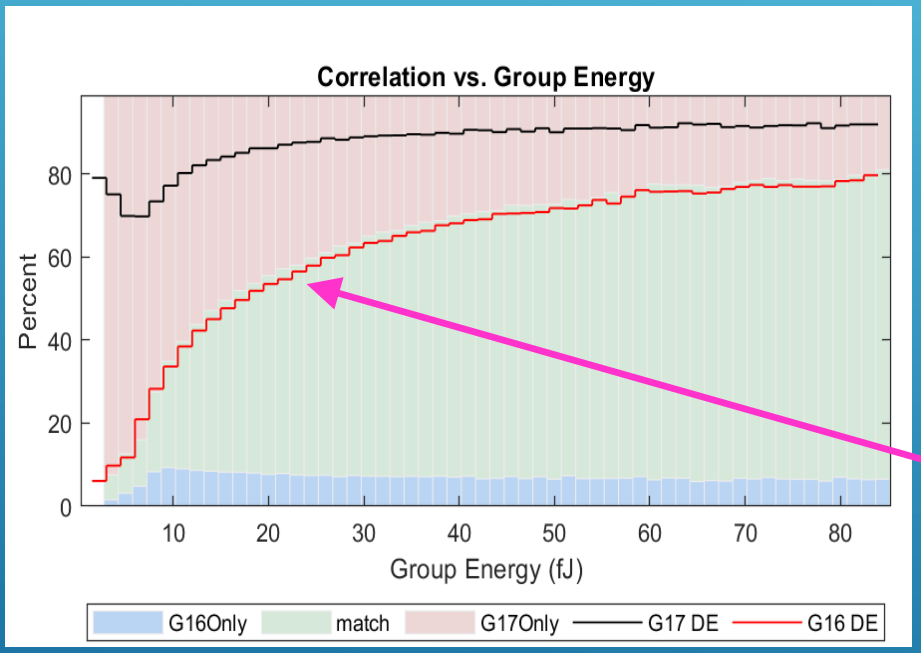
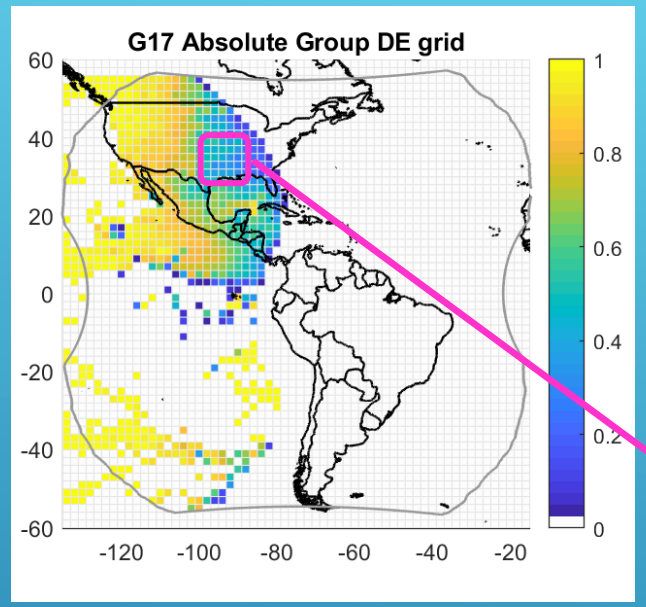
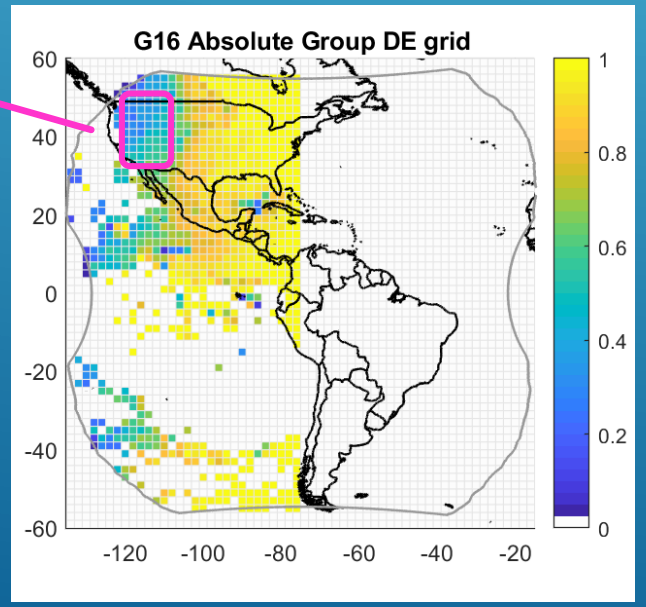
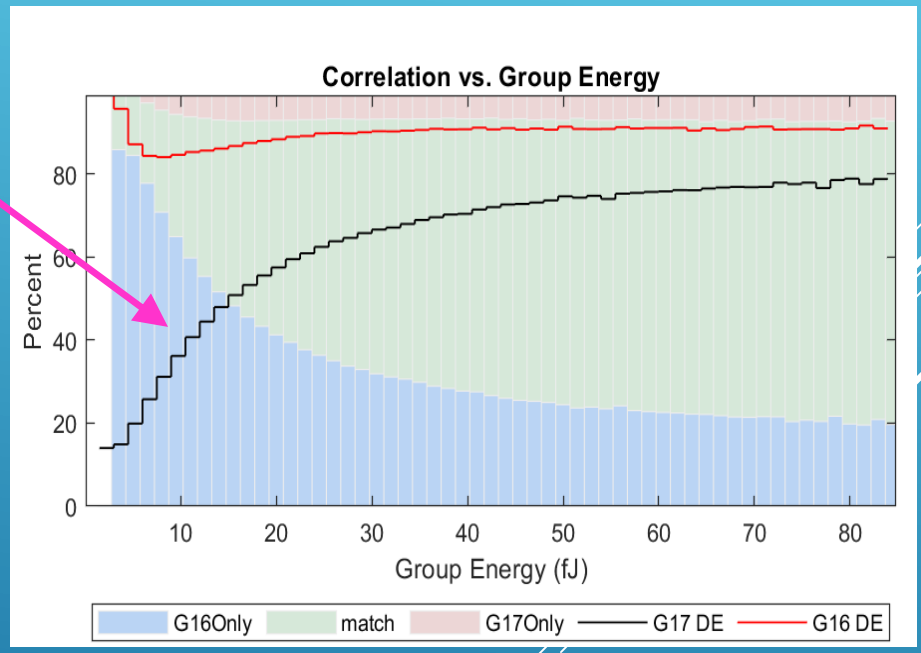
G16:G17 GROUP DE RELATIVE TO EACH OTHER

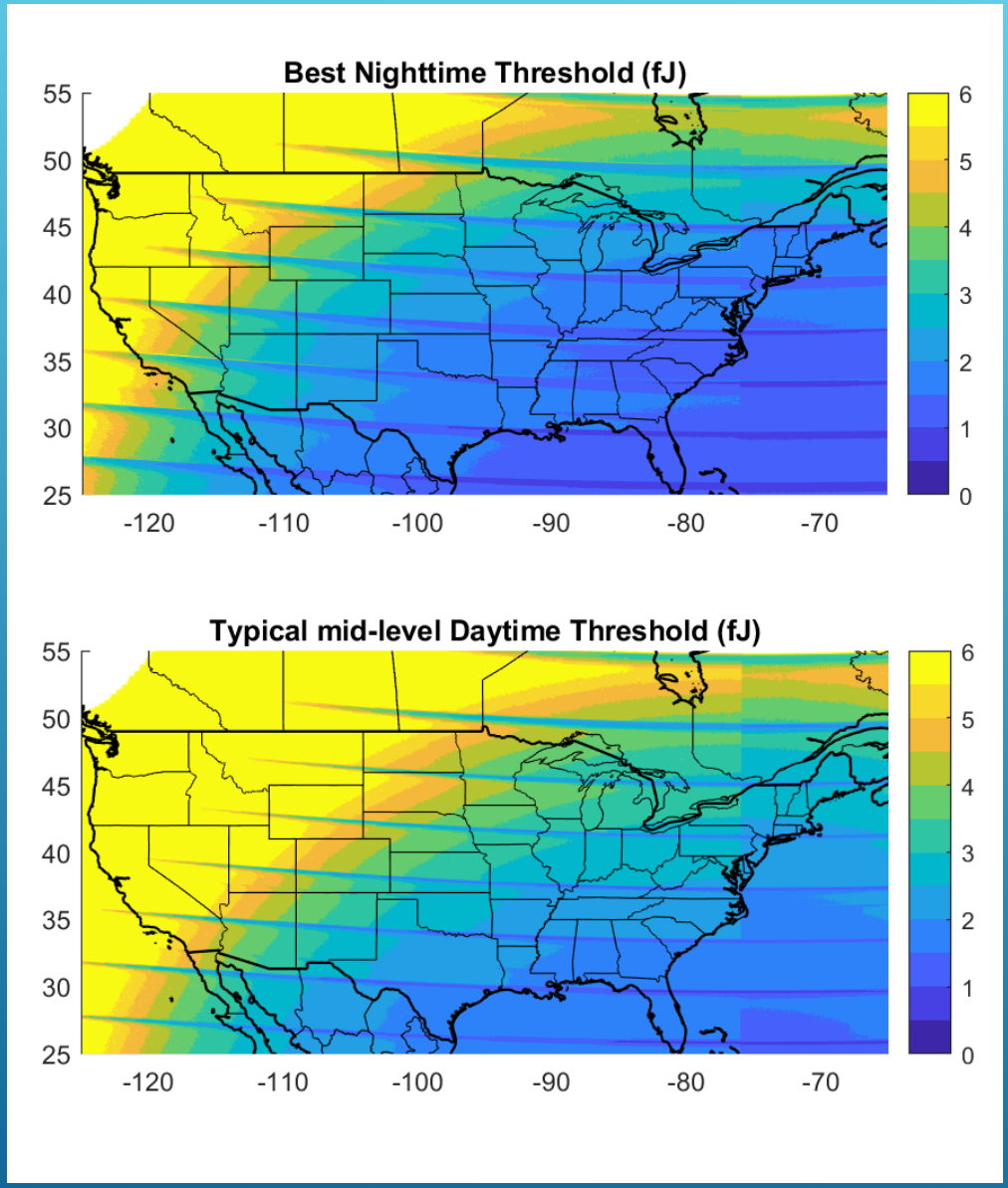






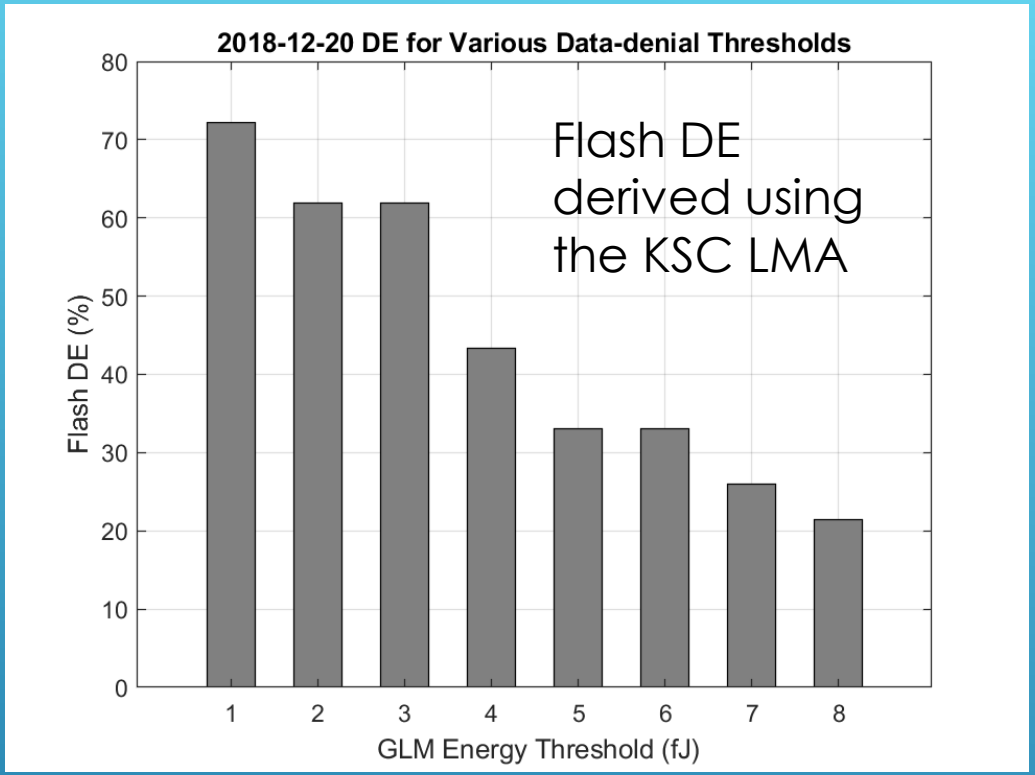


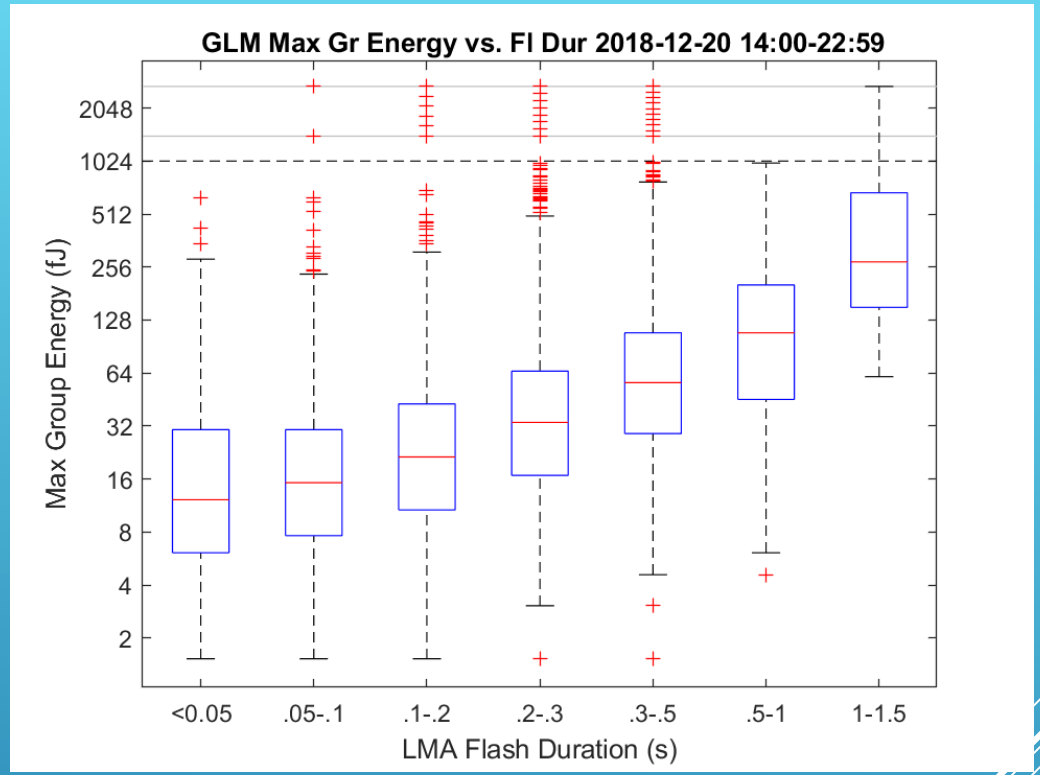
G16 Instrument Thresholds



The DE fall-off towards the edges of the fields-of-view are driven by instrument threshold variations associated with GLM optics and viewing geometry.

This is illustrated in the maps to the left showing best-case (upper map) and mid-level thresholds (likely daytime – lower map) throughout CONUS for G16. The lowest threshold (~1 fJ) is in Florida, and it increases to higher than 6 fJ in the northwest.



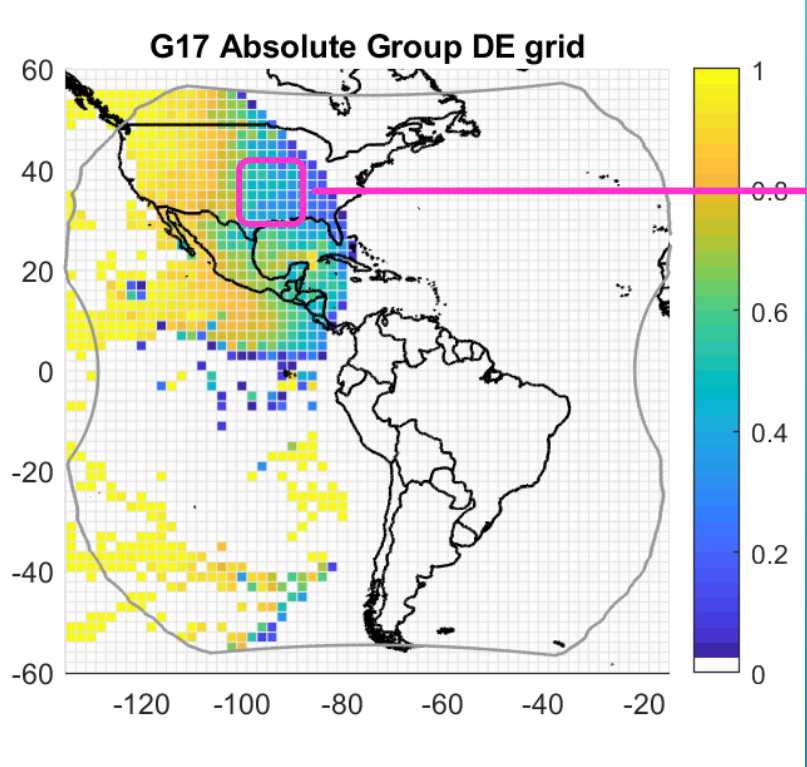


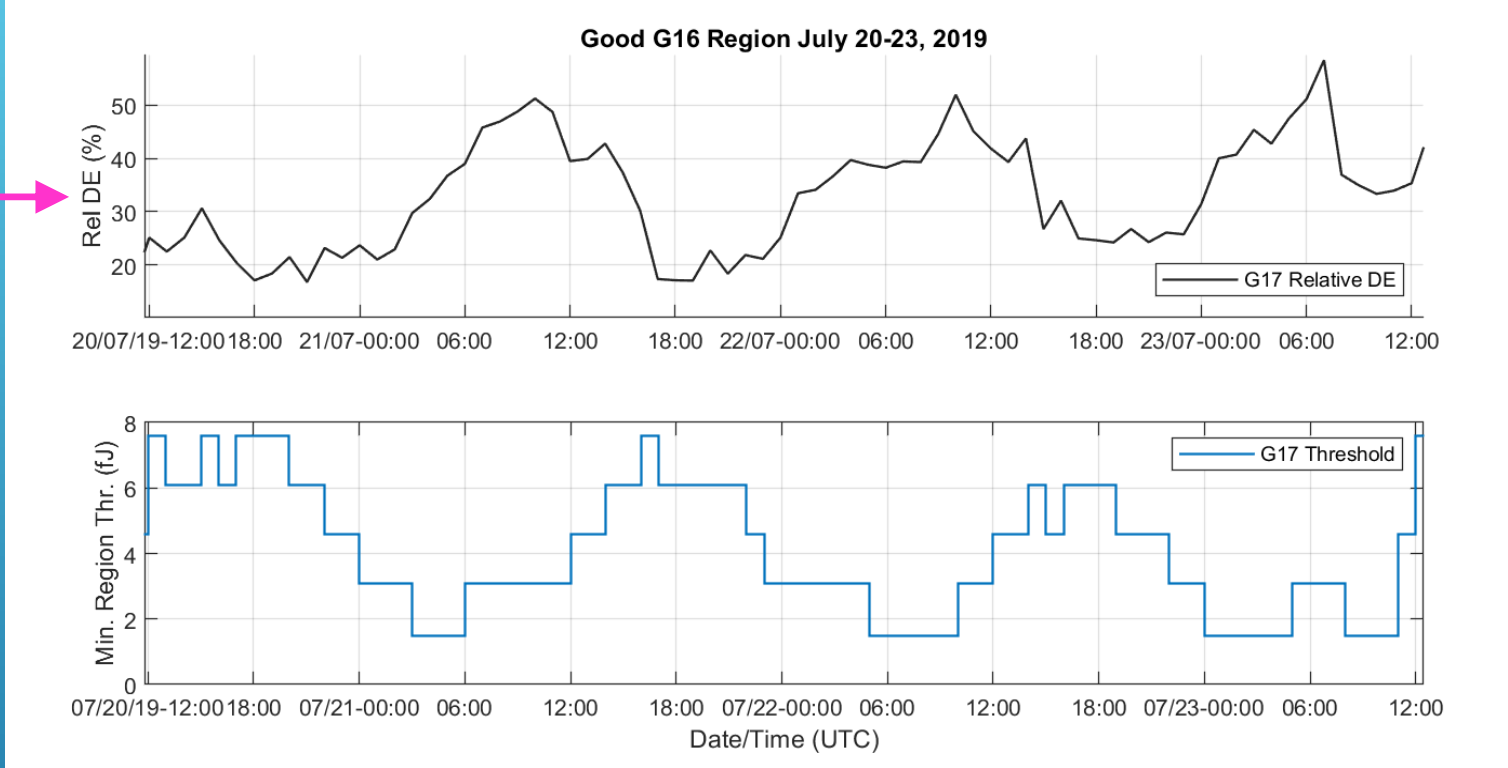
Since the instrument threshold in Florida is quite low, we can assess overall flash DE vs. threshold by re-processing the GLM data with artificially elevated event threshold values (see results above)

The Box plot (above) shows that short-duration flashes have the smallest "maximum group energy in the flash" values. Therefore they will be lost first when instrument thresholds increases

Boxes are25th – 75th percentiles. Red +'s are extreme values. Note log scale for energy.

3-DAY TIME VARIATION OF GROUP DE



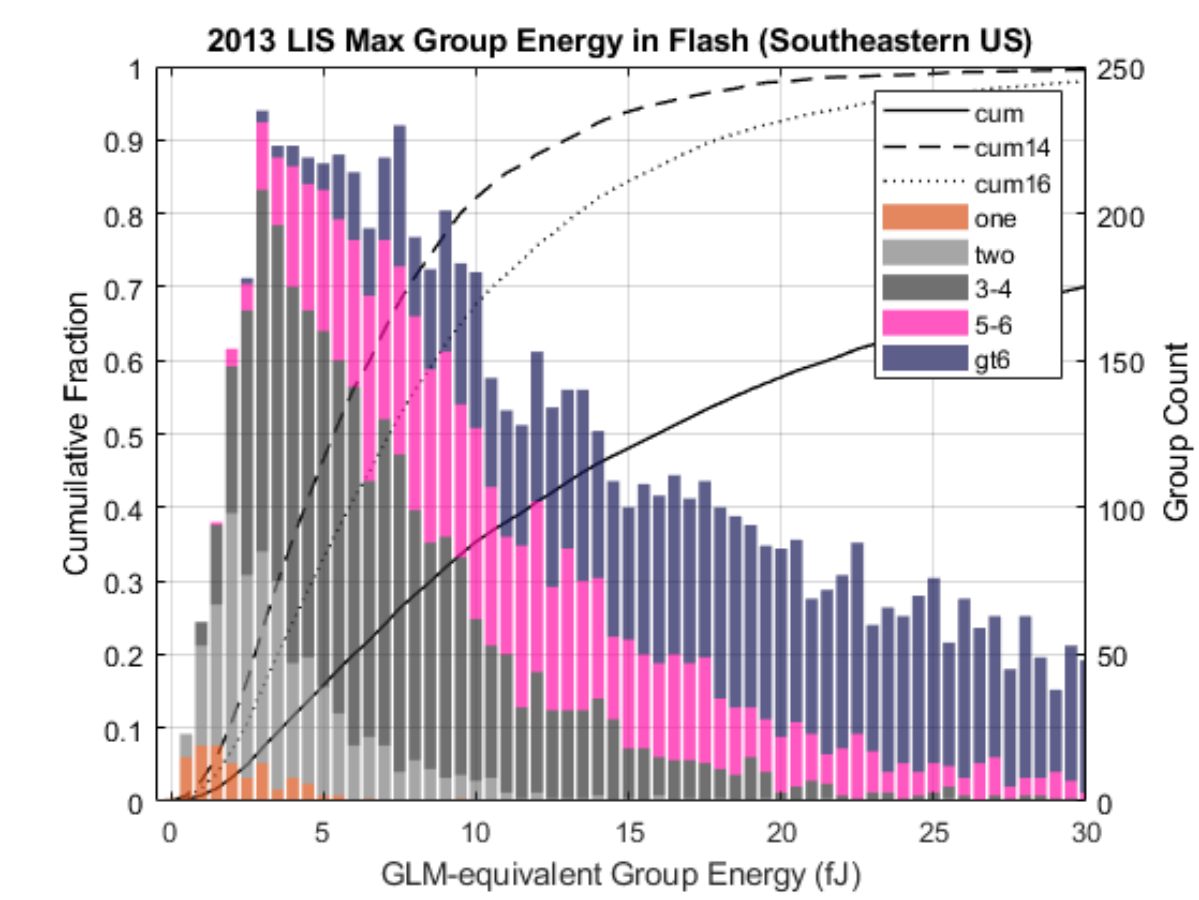


Note the overall low values of G17 Relative DE (compared to G17; upper right plot), with the mid-day minima around 20%. These minima occur when the overall region minimum threshold is between 6 and 8 fJ (lower right plot).

These thresholds are computed directly from the hourly group minimums, which are implicitly determined from single-event groups. A better calculation would be event minima.

LIS Group Parameters Related to Flash Detection

Broken-down by the number of events in the group



See Zhang and Cummins (JGR, 2020) for conversion of LIS Radiance to GLM-equivalent Energy

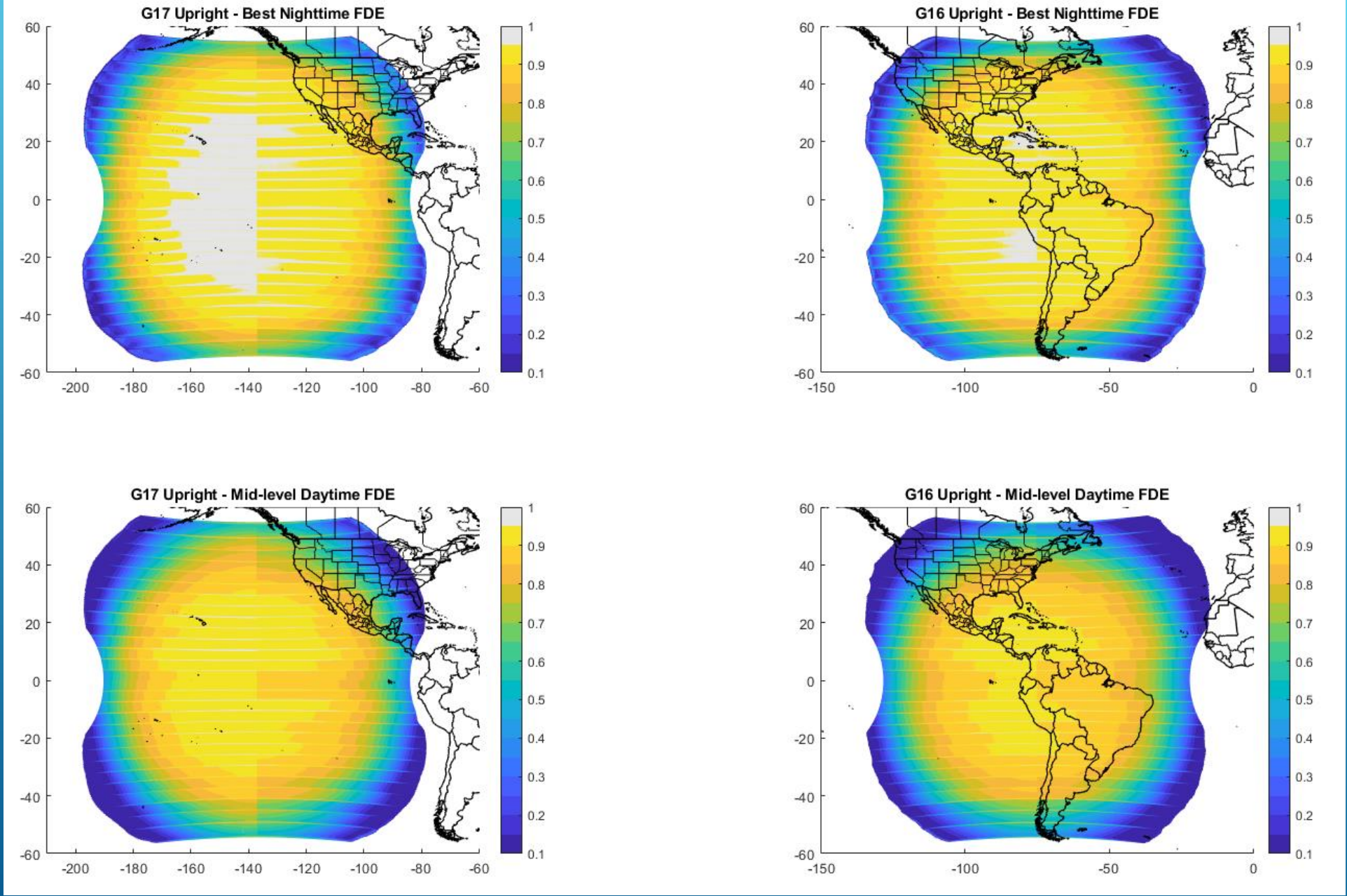
A flash will be reported by GLM or LI ***IFF*** at least one group is reported, meaning that at least one of its events has optical energy above threshold

Therefore, the distribution of the maximum pixel-sized event energy in flash can be used to produce a direct estimate of group and flash DE, given local thresholds

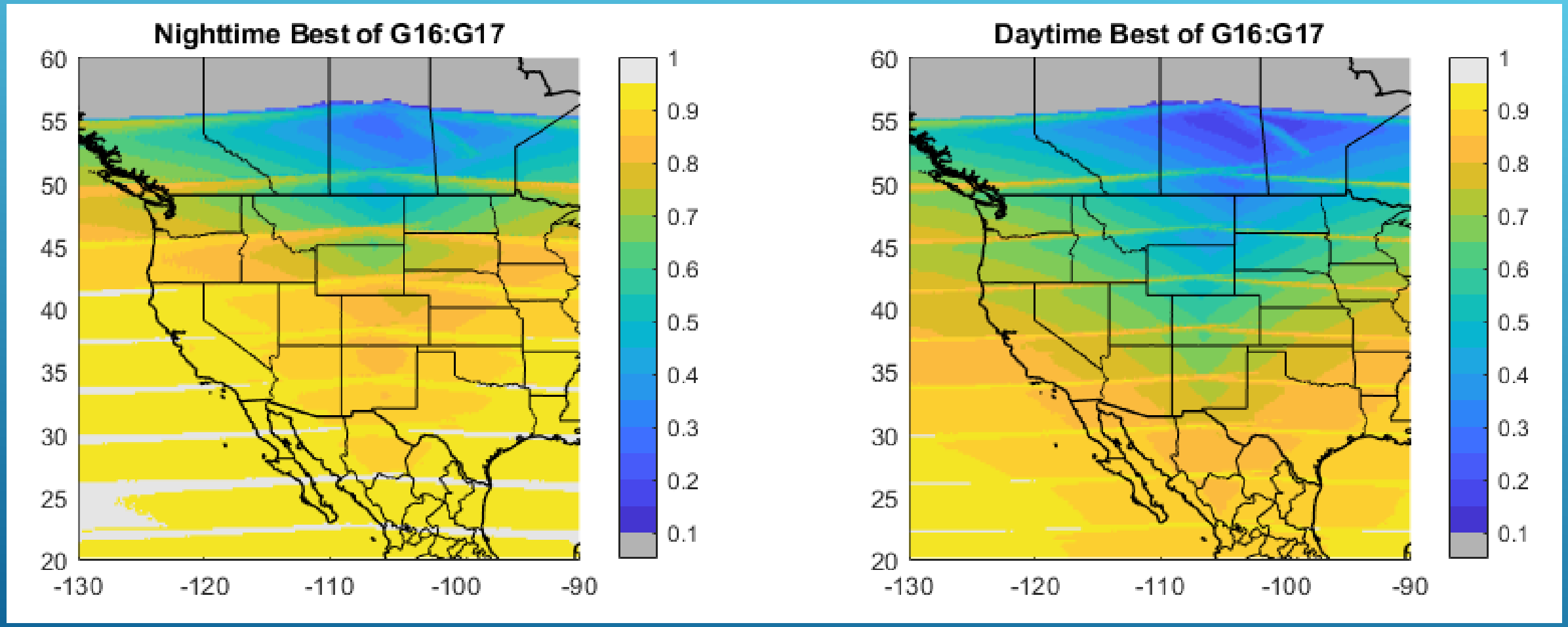
The associated cumulative distributions are approximately

(1 – fractional DE)

FINAL RESULT: DAY AND NIGHT GLM FLASH DE ESTIMATES

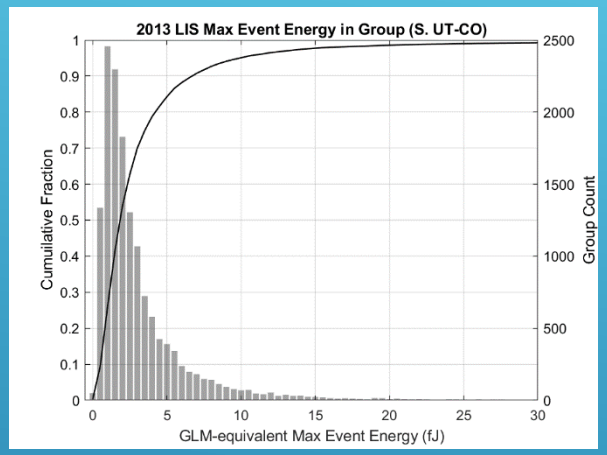
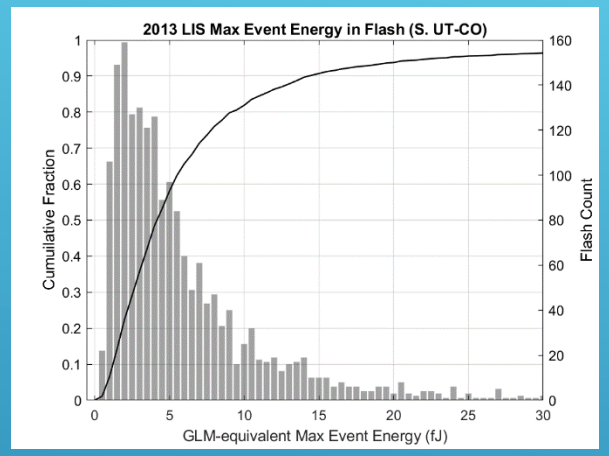
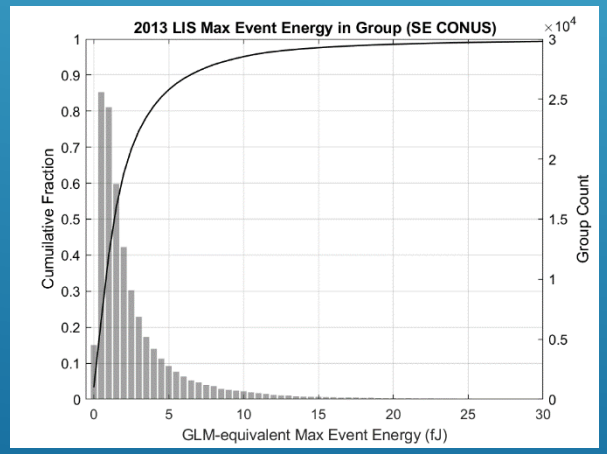
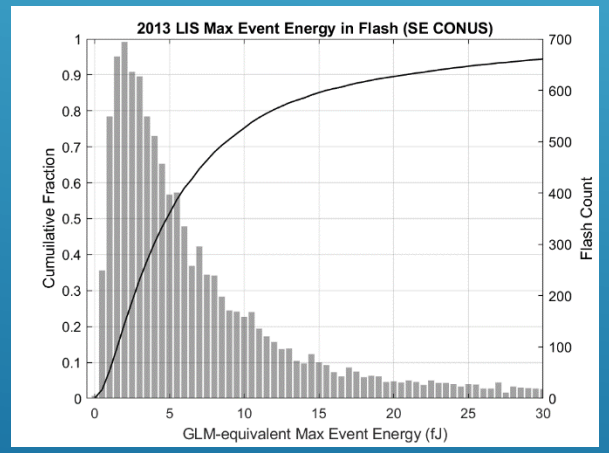


WHAT FLASH DE (RELATIVE TO LIS) CAN WE GET WITH THE BEST OF GOES-EAST AND WEST?



SUPPORTING SLIDES

Highest LIS Energy Event in:

	Group	Flash
Utah - Colorado		
S.E. CONUS		

Reminder: Typical daytime GLM thresholds in Colorado are 4-5 fJ

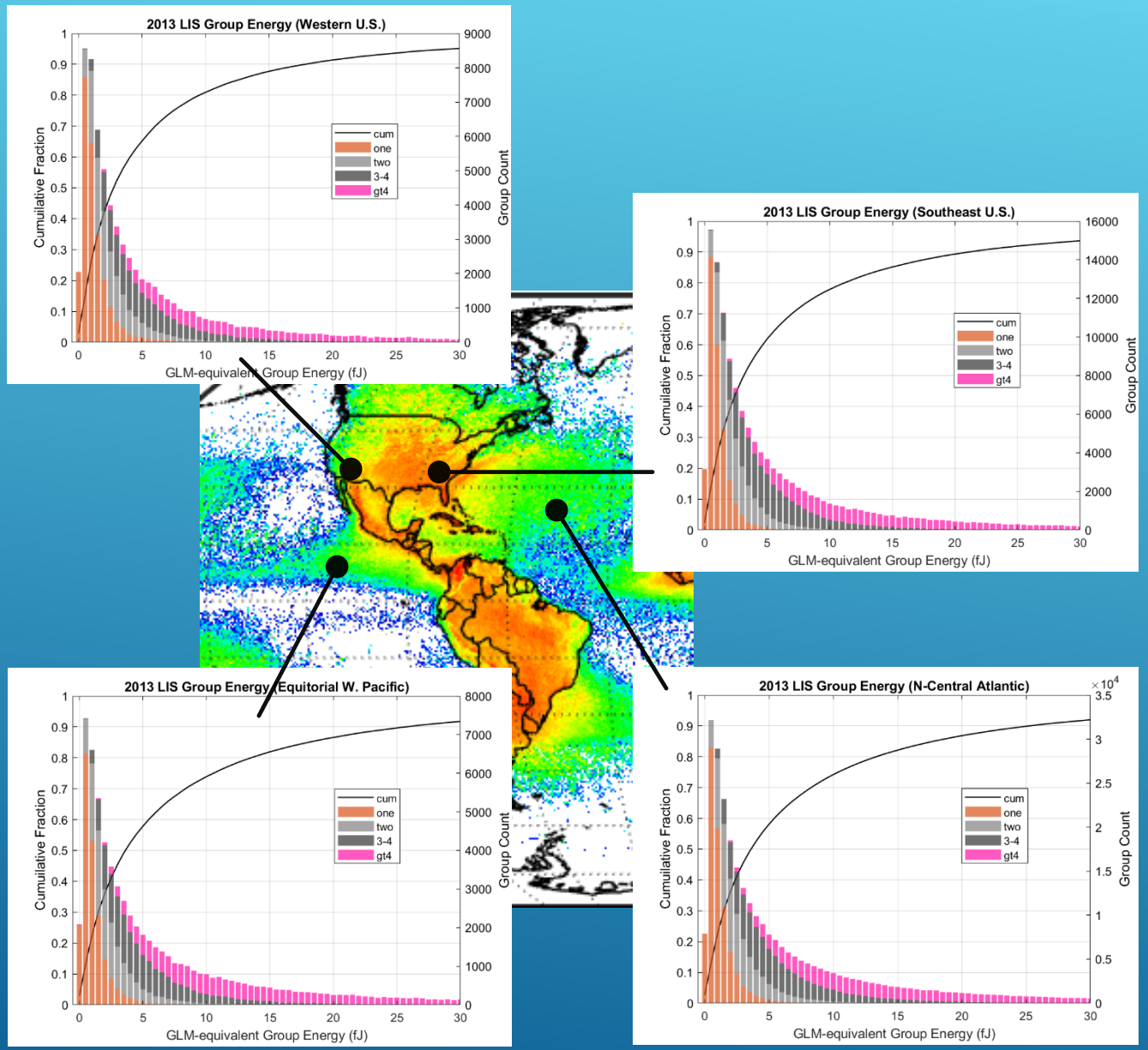
Group and Flash parameters Related to Detection

A group will be reported by GLM IFF at least one event has seen optical energy above its threshold.

A flash will be reported by GLM IFF at least one group is reported, meaning that one of its events has sees optical energy above its threshold

Therefore, the distributions of the maximum event energy in the group or flash can be used to produce a direct estimate of group and flash DE

The associated cumulative distributions are approximately (1 – fractional DE)



TRMM-LIS Group Energy By Region

LIS radiance has been converted to equivalent GLM energy (Zhang and Cummins, 2020).

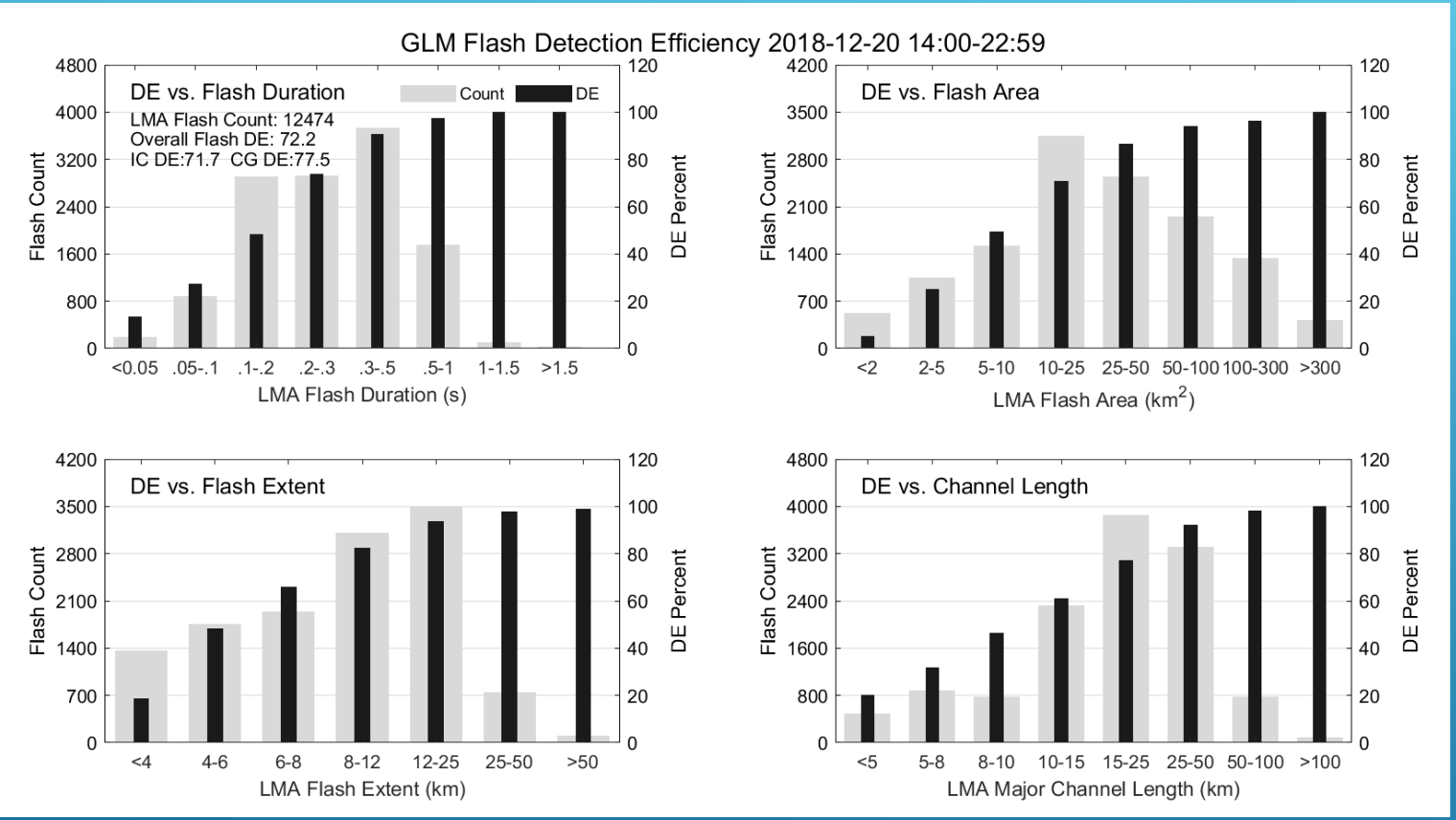
Most-probable group energy is 0.5 – 1.0 fJ

Most groups are smaller than a GLM pixel

Little variation in group energy or group size (pixels per group) by region (slightly "brighter" over ocean)

Results for 2012 are indistinguishable

Comparison of G16 with the KSC LMA System: Sample Day

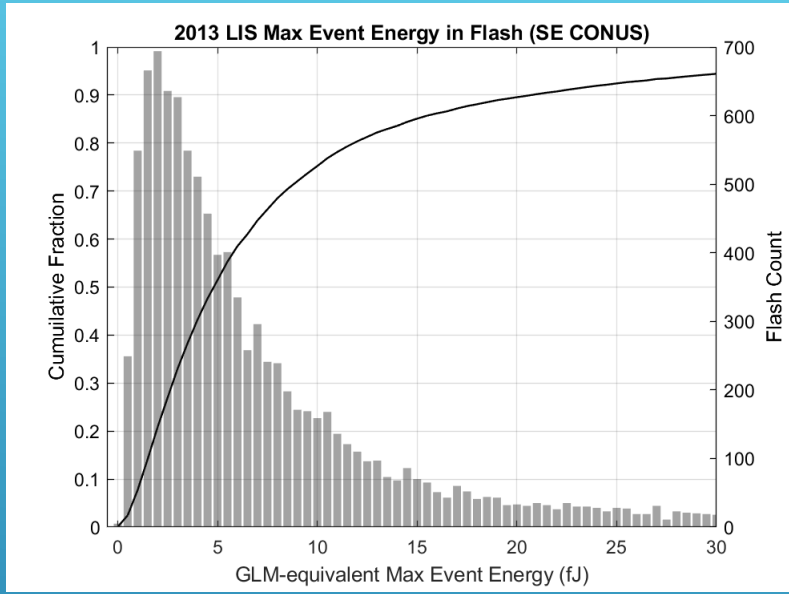


Results from Zhang and Cummins study (JGR in-review)

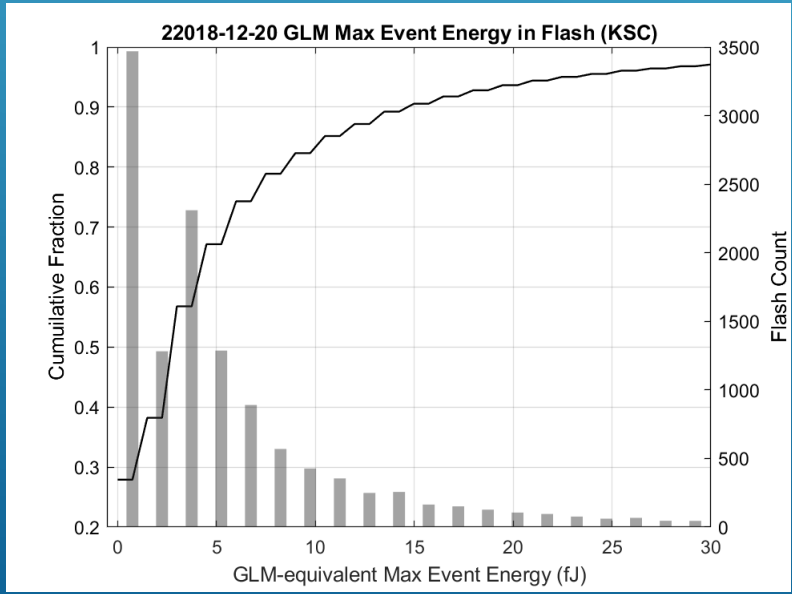
- Overall DE of 72.2%
  - Lower for IC flashes
- Strong dependence on flash duration and size

Highest Energy Event in a Flash

TRMM-LIS CONUS



GLM Florida



Validation of LIS Energy Conversion

Zhang and Cummins 2020 (in review) developed expressions relating LIS Radiance to GLM Energy

The TRMM-LIS dataset is a global full year (2013) employing LIS-defined flashes, with radiance converted to GLM-equivalent energy

The GLM dataset is one day of lightning in 2018 near KSC, produced by a wintertime synoptic-scale disturbance. Native resolution was 1.5 fJ at this time.

The accuracy of the assumptions leading to these expressions is validated by the similarity of the histograms to the left

GLM DE ESTIMATION APPROACH

Technical Approach

- Optical group and flash source distributions are produced using TRMM-LIS
- Brightest events in groups and flashes are determined, taking into account the difference in GLM and LIS pixel sizes.
- The **missed groups/flashes** are those who's brightest GLM-sized event falls below GLM threshold
  - Regional variation; time-of-day variation; storm-specific variation
- The following findings serve as upper bounds on GLM detection
  - Values are LIS-relative
  - Does not address storm-specific "source" issues of flash size, height, and cloud scattering
- These findings also illustrate the value of even modest improvements of GLM detection threshold on GLM performance