STI Science and Technology Institute

GLM Single Group Flash Analysis

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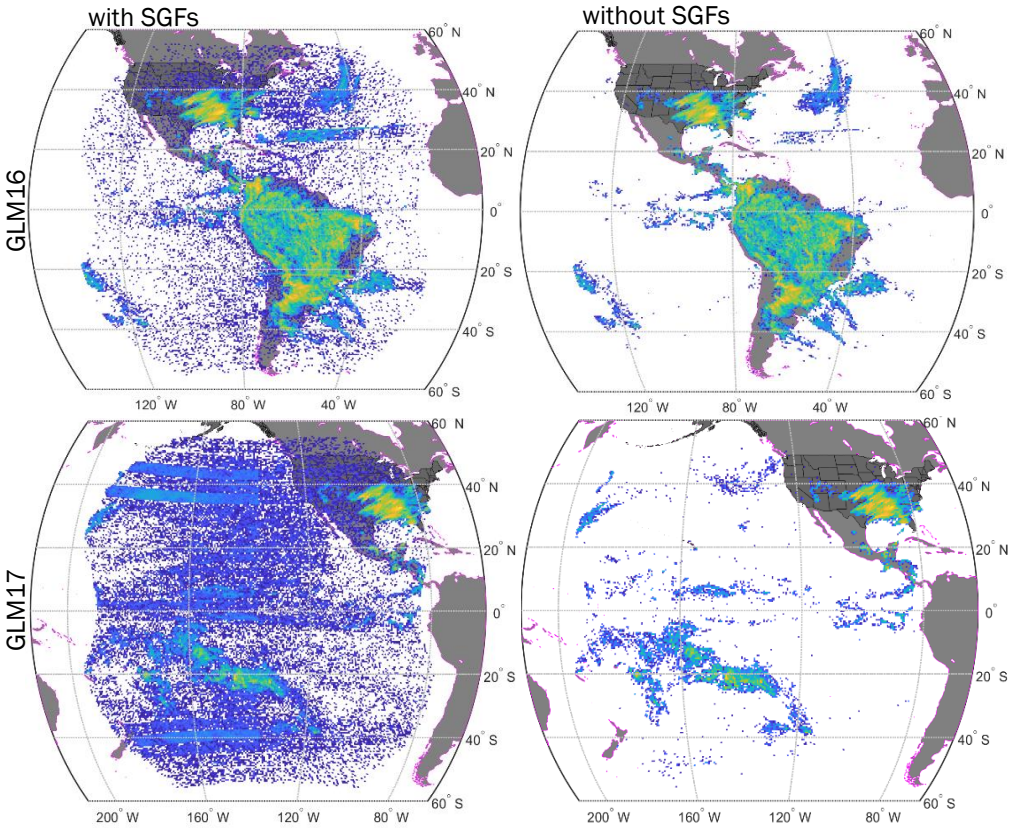
Introduction

The current operational GLM Lightning Cluster Filter Algorithm (LCFA) removes all flashes with only a single group

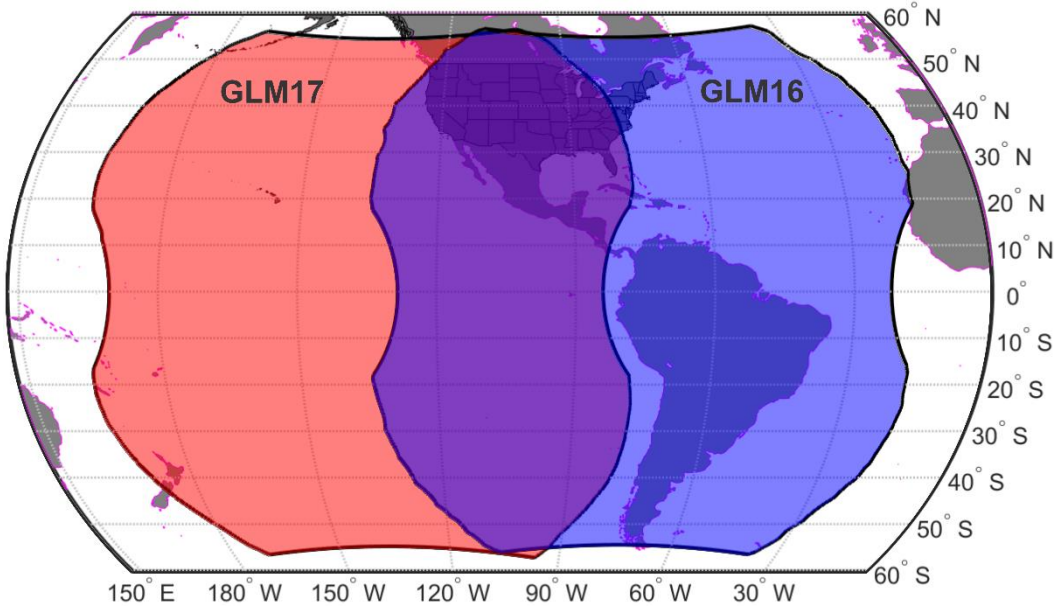
- Example GLM data with and without SGFs

- Acronyms
  - Single Group Flashes (SGFs)
  - Multiple Group Flashes (MGFs)
    - Operational algorithm
  - GLM on GOES-16 (GLM16)
  - GLM on GOES-17 (GLM17)



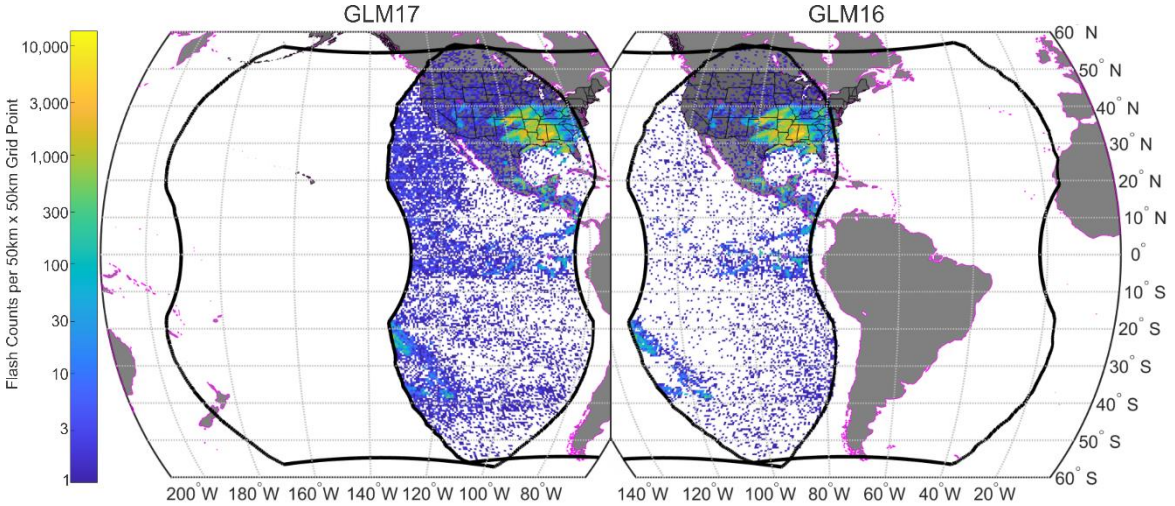
Introduction (cont)

- How much “real lightning” is removed by the SGF filter?
  - How much GLM lightning consists of only a single group?
- Protocol
  - Create a “ground truth” dataset
    - Common flashes between GLM16 and GLM17
  - Compare ground truth to GLM16 and GLM17 SGFs and MGFs
    - Determine fraction (and locations) of SGFs and MGFs that are in/not in the ground truth dataset



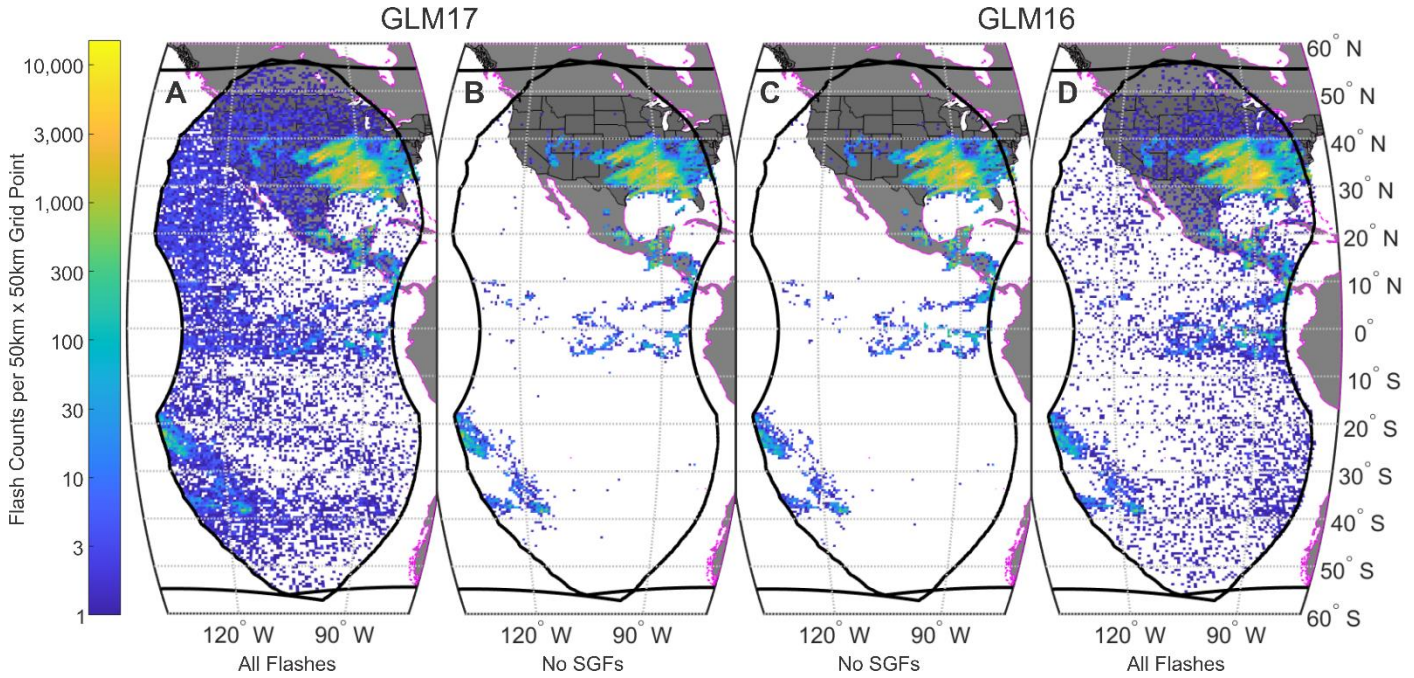
Study Dataset

- L1b events (not filtered for SGFs)
  - 00:00Z 16 March 2021 to 00:00Z 19 March 2021
  - Clustered into L2 flashes (without the Operational Algorithm group and flash count and temporal limits)
- GLM16 and GLM17 flashes in overlap region
- 740248 GLM16 flashes in overlap region (including SGFs)
- 623084 GLM17 flashes in overlap region (including SGFs)



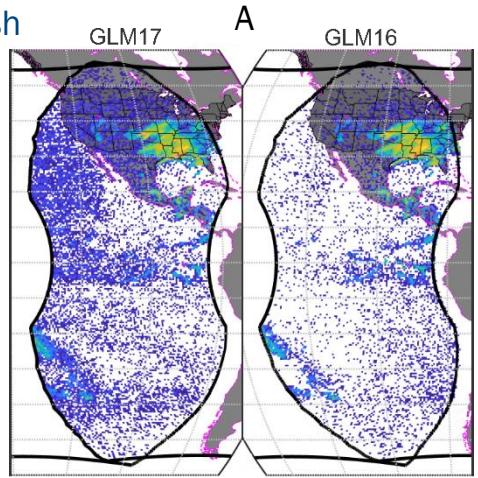
Operational Algorithm (w/SGF filter) vs. All Flashes (no SGF filter)

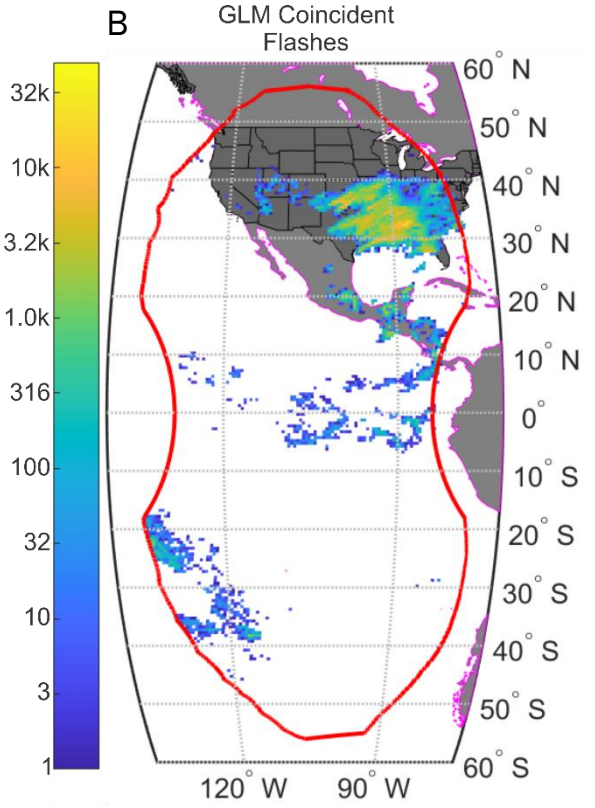
- GLM16
  - 661699 MGFs (C)
  - 740248 total flashes (D)
  - 11% SGFs
- GLM17
  - 520407 MGFs (B)
  - 623084 total flashes (A)
  - 16% SGFs
- SGFs small fraction of data (~10-15%)
  - Plots including SGFs look “noisier”
  - Most “noise” grid boxes have 1-2 SGFs



Common Flash Determination

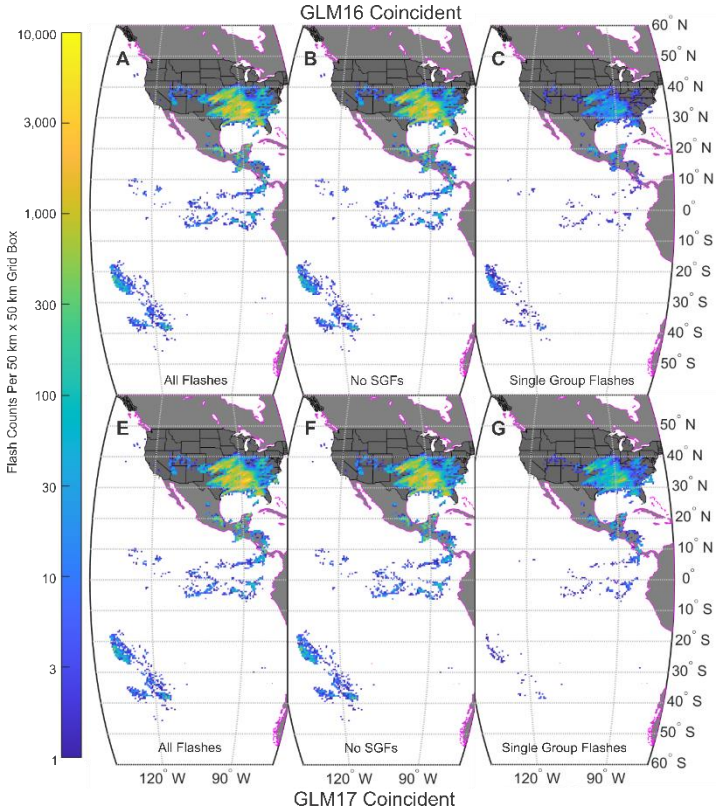
- Spatial limit in this analysis is set to 20 km
  - Based on parallax measurements in Mach (2021)
- Temporal limit is set to 0.5 s
  - GLM flash times are more accurate than 0.5s
  - The larger time window allows for the possibility of one GLM missing the initial groups of a flash
- Utilizing the parameters above…
  - 558490 GLM16 common flashes
  - 586423 GLM17 common flashes
  - Not always one-to-one GLM16 to GLM17 flashes





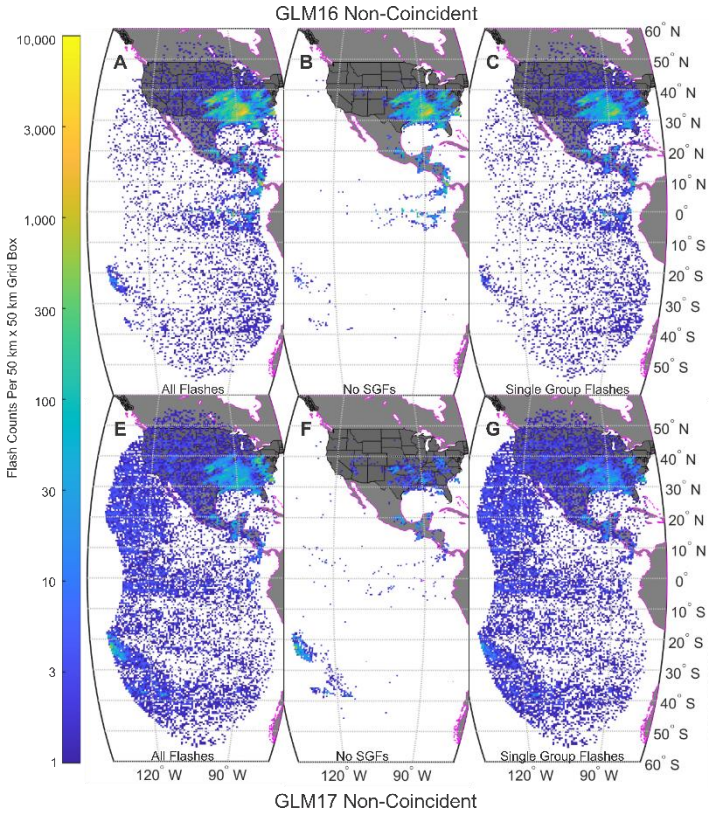
Results: Coincident Flashes

	Coincident Flashes		
	All	**Multiple Group Flashes**	**Single Group Flashes**
GLM16	**558490 (75%)**	**537218 (73%)**	**21272 (3%)**
GLM17	**586423 (94%)**	**508454 (82%)**	**77969 (13%)**



Results: Non-Coincident Flashes

	Non-Coincident Flashes		
	All	**Multiple Group Flashes**	**Single Group Flashes**
GLM16	**181758 (25%)**	**125582 (17%)**	**56176 (8%)**
GLM17	**36661 (6%)**	**11953 (2%)**	**24708 (4%)**



Conclusions

- 11-16% of flashes that pass the L1b filters are SGFs
- 75-94% of flashes that pass the L1b filters are coincident between GLM16 and GLM17
- Most of the flashes (73-82%) that are coincident are MGFs
- A small fraction (3-13%) of the coincident flashes are SGFs
- Non-coincident flashes tend to have a more random distribution
- Coincident flashes tend to cluster with other coincident flashes

- The Single Group Flash eliminates most non-coincident flashes (successful filter)
- There is room for improvement

Future Work

- Some SGFs are coincident between the two GLMs
- Simply keeping the SGFs (or just eliminating Single Event Flashes) NOT the solution
- Coincident SGFs cluster with the coincident MGFs
- Working on “Innocence by Association” filter for SGFs

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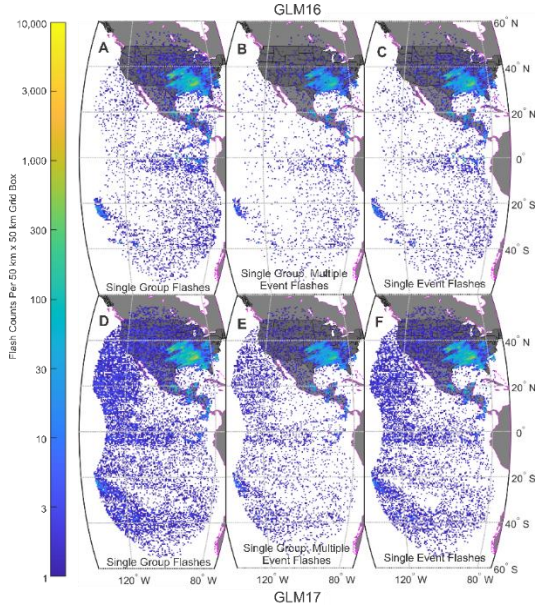

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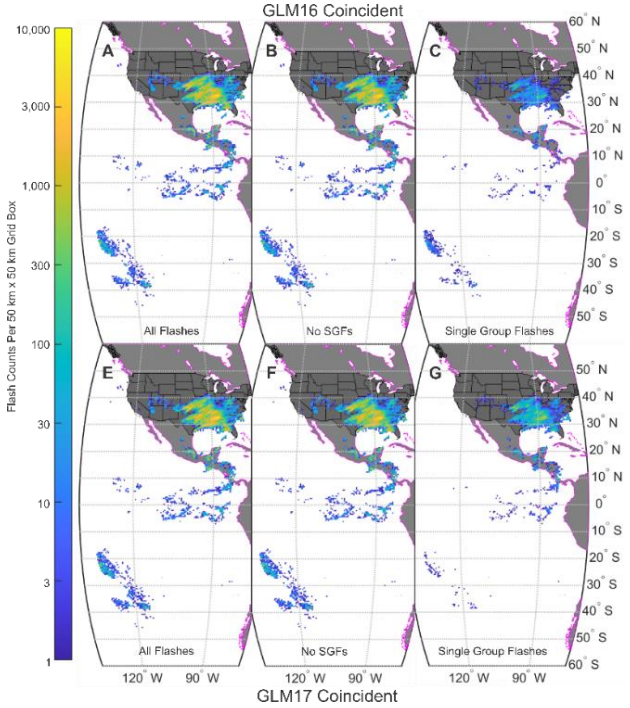

QUESTIONS?

Extra Information: Coincidence Determination

- Two general ways to determine temporal and spatial separation
  - Difference between flash start times (Δt_1, Δt_3)
  - Time gap between flashes (Δt_2, Δt_4)
  - Distance between flash centroids distances (Δd_1, Δd_3)
  - Minimum distance between events in the two flashes (Δd_2, Δd_4)
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  - Note that for the coincidence determination, Δt_4 will be considered 0 s
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