GOES-19 Geostationary Lightning Mapper (GLM) Provisional PS-PVR

March 13, 2025

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Outline

Introduction

Review of Beta Certification

Product Quality Evaluation Overview

Provisional Maturity Assessment

PLPT Details

Path to Full Validation

Summary and Recommendations

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Product Quality Evaluation Overview

Provisional Maturity Assessment

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Cal/Val Team Members

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- *Randy Longenbaugh (SNL)*
- *Michael Peterson (LANL)*

NASA Flight for INR

- David Igli
- Alan Reth
- Bin Tan

Special Thanks to CVCT PRO

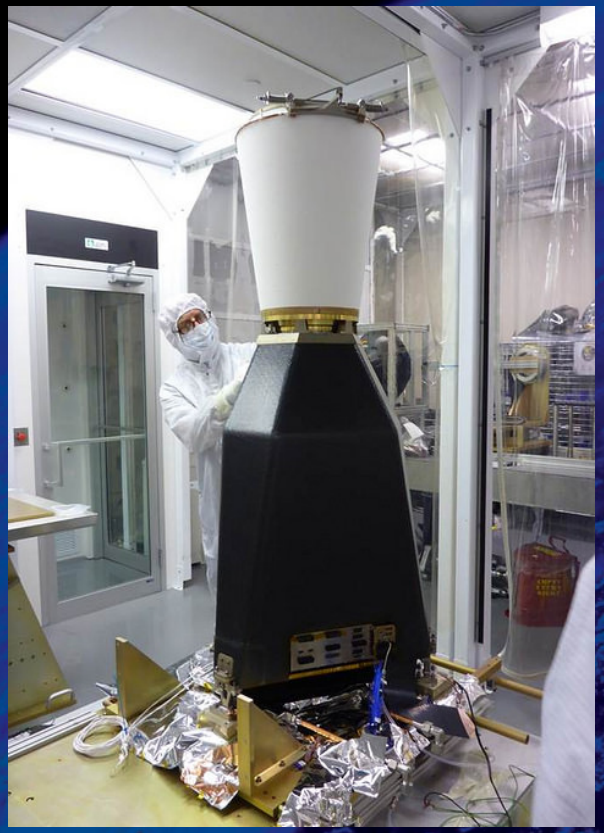
- Liz Kline
- Jon Fulbright

Photos courtesy of William Koshak & Pete Armstrong, or publicly available

GLM Overview

REQUIREMENTS:

- Provide continuous, full-disk lightning measurements for storm warning and nowcasting.
- Provide early warning of tornadic activity.
- Accumulate a long-term database to track decadal changes [of lightning].



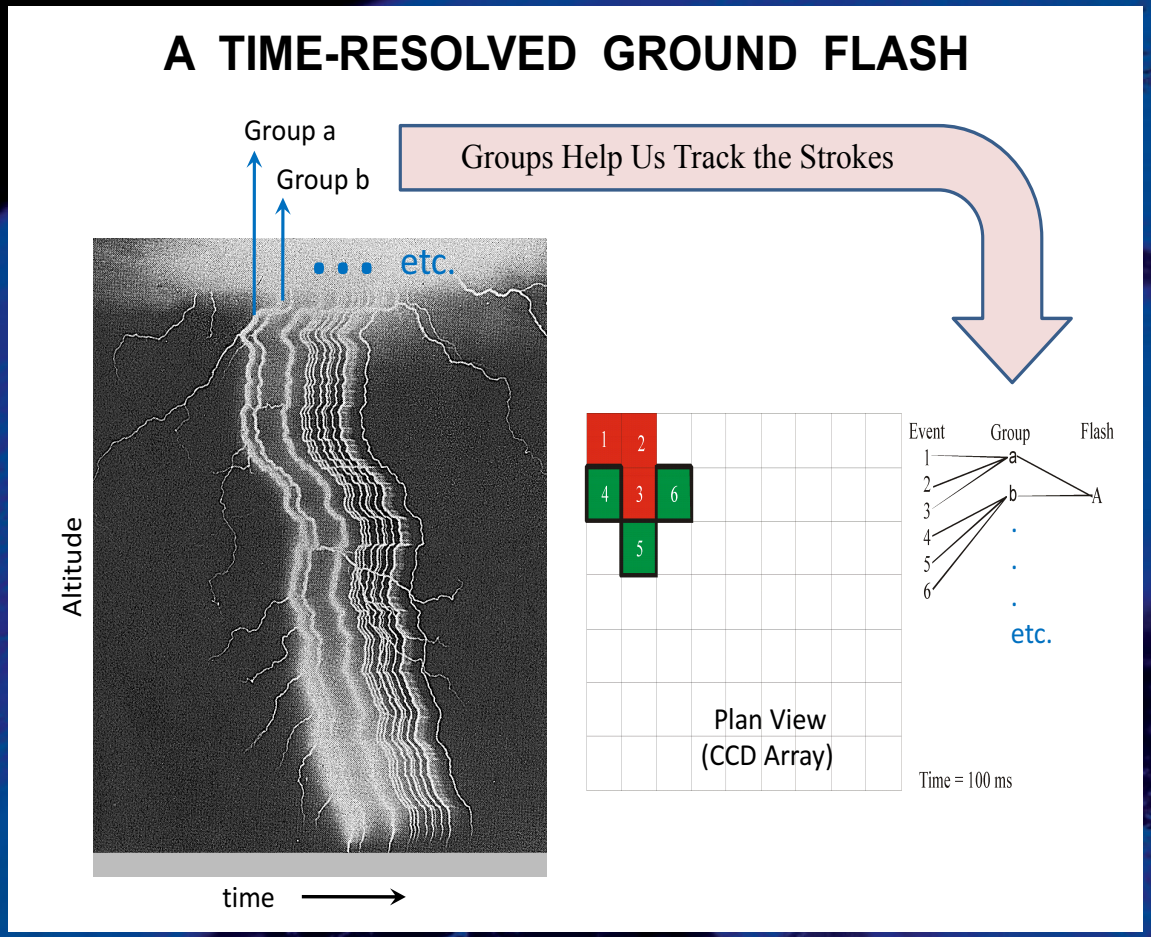
INSTRUMENT DETAILS:

- High-speed nadir-staring camera
- CCD imager (1372x1300 pixels)
- Near uniform spatial resolution
- 8 km nadir, 14 km edge of FOV
- Coverage ~ ± 54 latitude
- Single band 777.4 nm
- 2 ms frame rate
- 7.7 Mbps downlink data rate
  - TRMM/LIS only 8 kbps
- 20 sec product latency

GLM is the first lightning mapper to be flown in geostationary orbit. Heritage LEO sensors include: Optical Transient Detector (1995-2000), and TRMM/LIS (1997-2015)

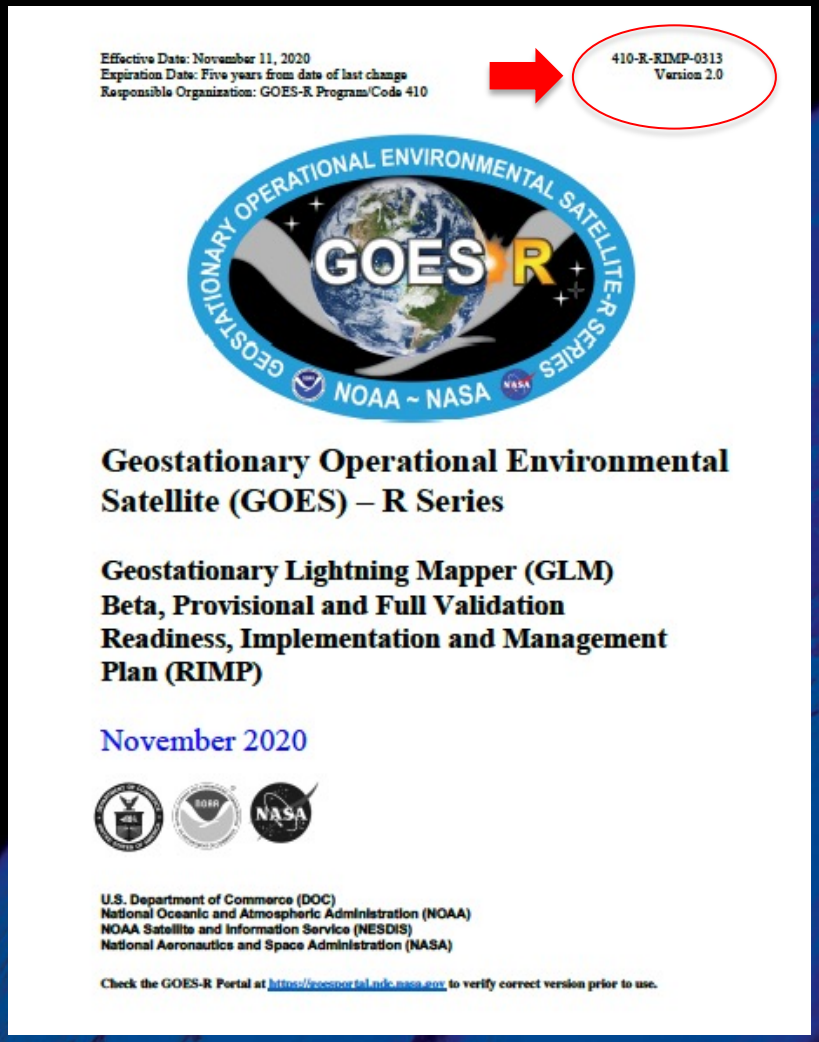
GLM Data Products Description

- Events: pixel-level optical detection in one frame.
- Groups: one or more (side/corner) adjacent pixel detections in one frame.
- Flashes: one or more groups within 330 ms (i.e. ~ interstroke duration), & within 16.5km.



Important Validation Principles

(see RIMP for more details)



Effective Date: November 11, 2020
Expiration Date: Five years from date of last change
Responsible Organization: GOES-R Program/Code 410

410-R-RIMP-0313
Version 2.0

Geostationary Operational Environmental Satellite (GOES) – R Series

Geostationary Lightning Mapper (GLM) Beta, Provisional and Full Validation Readiness, Implementation and Management Plan (RIMP)

November 2020

U.S. Department of Commerce (DOC)
National Oceanic and Atmospheric Administration (NOAA)
NOAA Satellite and Information Service (NESDIS)
National Aeronautics and Space Administration (NASA)

Check the GOES-R Portal at https://goesrportal.ndc.nasa.gov to verify correct version prior to use.

- Targets of Opportunity (TOO): VAL of a Lightning Sensor differs from VAL of typical imager; i.e. since lightning transient, VAL is restricted to TOO.
- Flash DE & FAR are Estimates: Because reference data normally doesn't detect all lightning.
- Source Physics: GLM detects in the optical (near-IR) and many of the reference datasets are in the RF. (e.g., LMAs see discharge breakdown in the VHF that might not show up in optical → apple/orange).
- Source Scattering: Optical is cloud-scattered, but cloud is transparent to radio. So often see GLM detections near cloud edges where no radio sources.
- ISS/LIS & FEGS are Critical: More of an apple/apple comparison w/GLM.

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Time-Line Highlights

SpaceX Falcon Heavy Liftoff of NOAA's GOES-U on June 25, 2024. [Credit: SpaceX]

- 25 Jun 2024 GOES-U Launch
- 07 Jul 2024 Attained Geo. Orbit (now GOES-19)
- 18 Jul 2024 Arrived @ Checkout Location 89.5°W longitude
- 26 Jul 2024 GLM Powered On
- 20 Aug 2024 GLM Door Opened & 1st Light
- 17 Oct 2024 Public Release
- 16 Dec 2024 G19 GLM Rev C Installed into DE
- 17 Dec 2024 - 05 Jan 2025 Beta Certification Quick-looks (Virts/Bateman)
- **13 Jan 2025 Beta Certification** (DE 79.7% & FAR 0.7% from Bateman tool)

Risks to Reaching Provisional
(Summary Status at Beta Certification)

There are no substantial risks or liens towards reaching Provisional on planned PS-PVR date of 13 Mar 2025

- Primary emphasis for PROV will be larger sample size PLPT analyses, and more robust documentation of GLM-19 performance.
- Instrument h/w performance is very good and does not pose a substantial risk to achieving provisional

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Introduction

Review of Beta Certification

Product Quality Evaluation Overview

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Performance Baseline Mapping

MRD	Parameter	MRD Value	Perf. Baseline (Model)		Related PLPTs
1259	Production Mapping Accuracy [INR]	**5km** (= $\|\mu\|+3\sigma$ < 140 µrad)	Nav error (7 d averaging) of 96 µrad for GOES-E		-011, (also -001, -002,-003, -004, -005, -006)
1260	Product Measurement Range	(0-41900 evts/s, 0-8170 grps/s, **0-600 flsh/s**)	Instr Vendor showed can handle peak 100Kevts/s (600flsh/s)		G16/17/18/19 Independent [see -009,-010 in G16 Full PS-PVR]
1261	Product Measurement Accuracy	**70%** total flash detection efficiency (DE)	Instr. Side	EOL*	-001, -002,-003, -004, -005, -006, -009,-010
			Primary	**88%**	
			Redundant	89%	
1264	Product Measurement Precision	**5%**	Open, with Flight reporting FAR ~ 2.6%		-001, -002,-003, -004, -005, -006, -009,-010
2112	Product Time Tag	**GOES-R system shall time tag product observations**	n/a		-001, -002,-003, -004, -005, -006

*EOL = End of Life with reduction to flash DE by ~6% due to Coherency Filter removing single-group flashes

Top Level Evaluation

	Past Status	Current Status	Future Outlook
DE	• No beta validation done, only quick-looks for beta certification. • **79.7%** (Bateman tool; Dec 17-31 2024) • 85-86% (Virts tool; 17 Dec 2024 – 05 Jan 2025)	• More validation data accumulated with some regional gap filling. • +/- 1 sec time window used is optimal based on detailed simulations • **75.3%** (Bateman tool; Feb 12-28, 2025) • 81-83% (Virts tool; Feb 12 – Mar 5, 2025)	• Add Put Back Algorithm to further improve DE. • Keep 1st event in flashes not retained by the Coherency Algorithm (not only increases DE but increases detected details of a flash). • Modify Single Group Flash (SGF) filter to save SGFs that are likely due to lightning (SGFs close to other flashes).
FAR	• No beta validation done, only quick-looks for beta certification. • **0.7%** (Bateman tool; Dec 17-31 2024) • 1.52% (Virts tool; 17 Dec 2024 – 04 Jan 2025)	• More validation data accumulated with some regional gap filling. • +/- 10 min time window used is optimal based on detailed simulations • **1.8%** (Bateman tool; Feb 12-28, 2025) • 5.31% (Virts tool; Feb 12 – Mar 4, 2025) FAR increased slightly above 5% spec in Virts analysis since pushes farther into Equinox season.	• FAR could be reduced by raising thresholds and/or tuning noise filters.

INR/time	• No beta validation done, only quick-looks for beta certification.
	• Mode of the error distributions were:
	  • **3.1** km location error
	  • **0.8** ms timing error
		• Feb 12 – Mar 1 INR dataset indicates navigation meets requirements in both NS and EW angles
		• Mode of the error distributions are:
		  • **3.7 km** location error
		  • **0.8 ms** timing error
			• Monthly 3° grid cloud-top height maps preferred to reduce parallax, but hard sell to Program given spec already met.

Performance Summary

MRD	Parameter	MRD Value	Performance Result			
			VaLiD	LATA	INR	Mach SIT
1259	Production Mapping Accuracy	5km (= $\|\mu\|+3\sigma < 140$ µrad)	n/a	**3.7km**	**96 µrad**	n/a
1260	Product Measurement Range	(0-41900 evts/s, 0-8170 grps/s, 0-600 flsh/s)	n/a	n/a	n/a	**no cases where LCFA* unable to handle raw or filtered data rates**
1261	Product Measurement Accuracy	70% total flash detection efficiency (DE)	**75.3%**	n/a	n/a	n/a
1264	Product Measurement Precision	5% (flash FAR) [also MRD 639 which states same 5% value]	**1.8%**	n/a	n/a	n/a
2112	Product Time Tag	GOES-R system shall time tag product observations	n/a	**-0.8 ms**	n/a	n/a

*LCFA = Lightning Cluster Filter Algorithm.

Outline

Introduction

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Product Quality Evaluation Overview

Provisional Maturity Assessment

PLPT Details

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Provisional Validation

Preparation Activities	Assessment
Validation activities are ongoing and the general research community is now encouraged to participate.	Yes. The general research community has been participating and providing feedback.
Severe algorithm anomalies are identified and under analysis. Solutions to anomalies are in development and testing.	Operational and algorithm anomalies have been identified. Critical ones have been resolved; others in various stages of implementation. A few under investigation. See ADRs/WRs to follow.
Incremental product improvements may still be occurring.	Yes. Incremental product improvements are expected.

Provisional Validation

End State	Assessment
Product performance has been demonstrated through analysis of a small number of independent measurements obtained from select locations, periods, and associated ground truth or field campaign efforts.	This has been demonstrated.
Product analysis is sufficient to communicate product performance to users relative to expectations (Performance Baseline).	This has been communicated in PS-PVR.
Documentation of product performance exists that includes recommended remediation strategies for all anomalies and weaknesses. Any algorithm changes associated with severe anomalies have been documented, implemented, tested, and shared with the user community.	Have been documented, for example this PS-PVR and the ReadMe file.
Testing has been fully documented.	Testing has been fully documented in this PS-PVR.
Product is ready for operational use and for use in comprehensive cal/val activities and product optimization.	We concur.

Recommendation

CWG believes that the GLM-19 L2 product (events, groups, flashes) has reached the Provisional Maturity as defined by the GOES-R Program.

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ADRs Since GLM-18 Full DO Build Content

(since 23 Nov 2023)

WR	ADR	Title	PR or DO	Date in OE	Impact to this VAL
9720	1345	GLM Blooming Filter tuning	PR.13.07.04	8/6/24	
	1348	GLM Coastline intermittent Read and Write errors	HOLD	TBD	
9641	1350	GLMFED not produced in Test/Storage slots	DO.13.00.02	1/23/24	
	1390	Fix GLM CAL INR for All Filters LUT	HOLD	TBD	
	1403	GOES-U GLM CDRL79 Rev A for PLT	PR.13.07.00	5/30/24	
	1405	Increase GLM time window in GRIP	PR.13.06.00	5/22/24	GS only
9917	1416	GLM background corner point metadata errors	HOLD	TBD	
	1419	Install GLM FED product on the PPZ	HOLD	TBD	
	1474	Errata for G19 GLM CDRL79 Rev A LUTs	PR.13.07.03	7/31/24	
	1512	G19 GLM CDRL79 Rev B LUTs	PR.13.10.05	12/10/24	
	1528	G19 GLM CDRL79 Rev C LUTs	PR.14.00.03	1/10/25	
	1536	G19 GLM CDRL79 Rev D LUTs	PR.14.00.04	1/27/25	
	1545	GLM Slot-Dependent LUTs for G16, G17, and G19	In_Work	Mar ’25	
	1547	Request for GLM G19 CDRL38 Nominal Pixel Locations	In_Work	Flight	

WRs Since GLM-18 Full

(since 23 Nov 2023)

WR	ADR	Title	PR or DO	Date in OE	Impact to this VAL
7538	1060	Interim Solution to Facilitate GLM Gridded Data	Closed	Cl. 4/27/23	
9187		Unable to Load GLM Events in PADIV	HOLD	TBD	
9667		G16/G18 GLM L2 Product Outage to GeoCloud Endpoint	EI.27.01.00	9/26/24	
9700		Tracking: COOP FINDING: G16/G18 GLM L2/INST-CAL Archive Impacts to MLS/LZSSc	HOLD	TBD	
9724		CBU GLM Landmarking Very Delayed	In_Analysis	Product Monitor	
9736		GGSS Ops: Update GLM FED to handle NFS slowness	DO.15.00.00	April 2025	
9517		GGSS Ops: GLMFED Failed to Rename Errors to AWIPS TNCF in ITE	DO.14.00.00	11/18/24	
9808		SOZ OE GLM FED OUTAGE J275	Closed	Cl. 5/2/24	
9846		G16/G18 GLM-FED Outages: 11/6 & 11/9	Closed	Cl. 5/2/24	
9888		GGSS Ops: Increased False Lightning Events for GLM	DO.14.00.00	11/18/24	
9911		GGSS Ops: Incorrect publishing of GLM AllFilters LUT resulting in incorrect LUT being used in ops [aka “LUT Flapping”]	In_Analysis	future enhancement	
9923		GOES-18 Degraded GLM INR Performance	Closed Flight	9/23/24	
9949		GGSS Ops: Delivery of Sectorized GLM (GLM FED) from CBU to NWS ceased	In_Test	TBD	
9959		GGSS Ops: G18 GLM low events impacting GLM derived products	In_Analysis	future enhancement	
10107		G16/G18 GLM EPM issues during EM Handover	In_Analysis	TBD	

Provisional Analysis Period

- **13 Jan 2025: Beta Certification**
- **12 Feb 2025 – 05 Mar 2025: Provisional Analysis Period (3 weeks)**
- **06 Mar 2025 – 12 Mar 2025; Examination & Integration of Val Results**
- **13 Mar 2025: GLM-19 Provisional PS-PVR**
- **14 Mar 2025: Potential Govt. Shutdown**
- **21 Mar 2025 – 01 Apr 2025: G19 Drift from 89.5°W to 75.2°W** (10days; GRB off)
- **04 Apr 2025: Date G19 to be Declared as Operational GOES-East Satellite**

Post-Launch Product Tests

Test ID	Abbreviated Test Titles for GLM
PLPT-GLM-001	Validate DE/FAR using med/long-range networks (e.g., NLDN, EN, GLD360)
PLPT-GLM-002	Validate DE/FAR using short-range networks (e.g., LMAs)
PLPT-GLM-003	Validate Storm DE and Storm FAR using very long range systems (WWLLN, NEXRAD)
PLPT-GLM-004	Validate DE/FAR using very short-range optical systems (FEGS)
PLPT-GLM-005	Validate DE/FAR using orbit-based optical systems (e.g., ISS/LIS)
PLPT-GLM-006	Validate DE/FAR using ground-based E-field networks (e.g. HAMMA, LIP)
PLPT-GLM-009	Validate L1b-L2 Cluster/Filter by comparing w/Spec (i.e. Mach) code
PLPT-GLM-010	Validate L0-L1b Filter Algorithms by comparing w/Spec (i.e. Mach) code
PLPT-GLM-011	Validate GLM INR w/comparisons to well-located ground points
PLPT-GLM-012	Validate GLM BG DCC radiances with trending & comparisons
PLPT-GLM-013	Validate GLM Flash Energies with trending & comparisons

003: VaLiD analysis @ larger time window (+/- 10 min) provides Storm DE
004: No concurrent FEGS field campaign for this PROV analysis
005: ISS/LIS no longer operational; so GLM-to-GLM comparisons employed (Virts & Koshak, 2025)
006: Not required since 002 LMA analyses provided

Full test plans and procedures are given in the GLM Readiness, Implementation, and Management Plan (RIMP v2.0; 410-R-RIMP-0313)

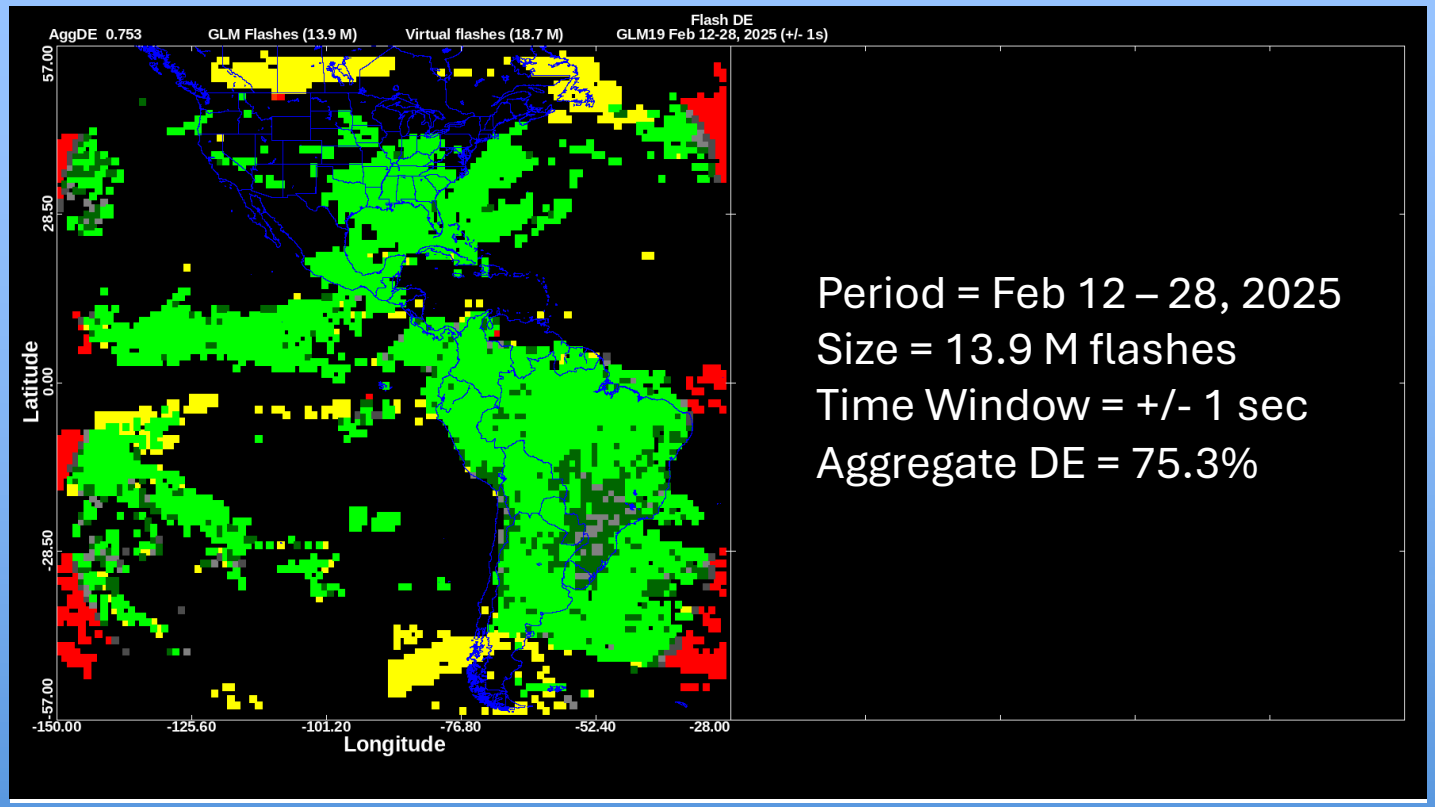
Primary PLPT Tools

Item	Tool	Description	Code Language	Developer
1	VaLiD	Validate Lightning Data tool performs shallow/deep dives of GLM data using wide range of ground-based datasets discussed in RIMP.	C	Bateman/USRA
2	Cluster/Filter	In-house code for L0-L1b and L1b-L2 processing	Matlab	Mach/USRA
3	HUDAT	Huntsville Area Marx Meter Array (HAMMA) User Data Analysis Technology with emphasis on lightning energy/physics.	IDL	Bitzer/UAH
4	STROKE	STorm Retrievals frOm KSC E-Fields examines ground-based electric fields, lightning field changes, and the charges deposited by lightning in KSC, Florida.	IDL	Koshak/MSFC
5	INR/Parallax	Validates GLM INR with comparisons to well-located ground points and employs GLM background images & lightning, ABI background images, and Laser beacon data	IDL	Buechler/UAH
6	TT/DCC	Trending Tools for long-term trending of Deep Convective Clouds.	IDL	Buechler/UAH
7	TT/Lightning	Trending Tools for long-term trending of lightning counts, flash duration, and lightning energy.	IDL, WL	Buechler/UAH Koshak/MSFC
8	LMT	24/7 Lightning Monitoring Tool (aka "Product Monitor") that alerts of problematic GLM performance	TBD	Product Area Lead
9	CompareLLS	Compare Lightning Location System tool performs shallow/deep dives of GLM data using wide range of ground-based datasets discussed in RIMP.	Matlab	Cummins, UA
10	XLMA	X Lightning Mapping Array tool for making standard 4-D plots of flashes.	IDL	Krehbiel & Rison of NMT
11	lmatools	Analyzes LMA data [sort VHF source data into flashes; calculate flash areas, volumes, and channel lengths; produce gridded products; time series statistics of flash rate and size data; simulate LMA performance].	Python	Bruning/TTU
12	FEGST	Fly's Eye GLM Simulator Tool: Data acquisition, display, storage software, and s/w for analyzing FEGS data & inter-comparing it with other lightning optical datasets (e.g. GLM, ISS/LIS).	IDL	Quick/NPP
13	ADTs	Ancillary Dataset Tools will be developed for processing datasets such as ABI, NEXRAD, SEVERI, WWLLN; some of these tools will be piggybacked to VaLiD.	Matlab & McIDas scripts	Mach/USRA Bateman/USRA
14	SITs	Specialized Impromptu Tools written “on-the-fly” to handle any analyses that are needed, but that were unexpected.	C, IDL, Matlab, Mathematica	Cal/Val Team
15	LATA	Location And Time Accuracy (LATA) Tool: Produces a variety of plots/histograms that characterize the overall location/time accuracy of GLM flashes/groups/events.	Matlab	Virts/NPP

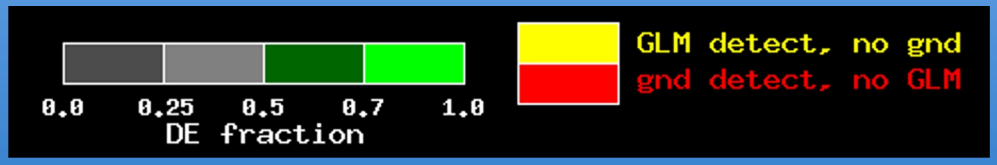
GLM-19 DE (Bateman/UAH)

PASSED

PLPT-GLM-001



Period = Feb 12 – 28, 2025
Size = 13.9 M flashes
Time Window = +/- 1 sec
Aggregate DE = 75.3%

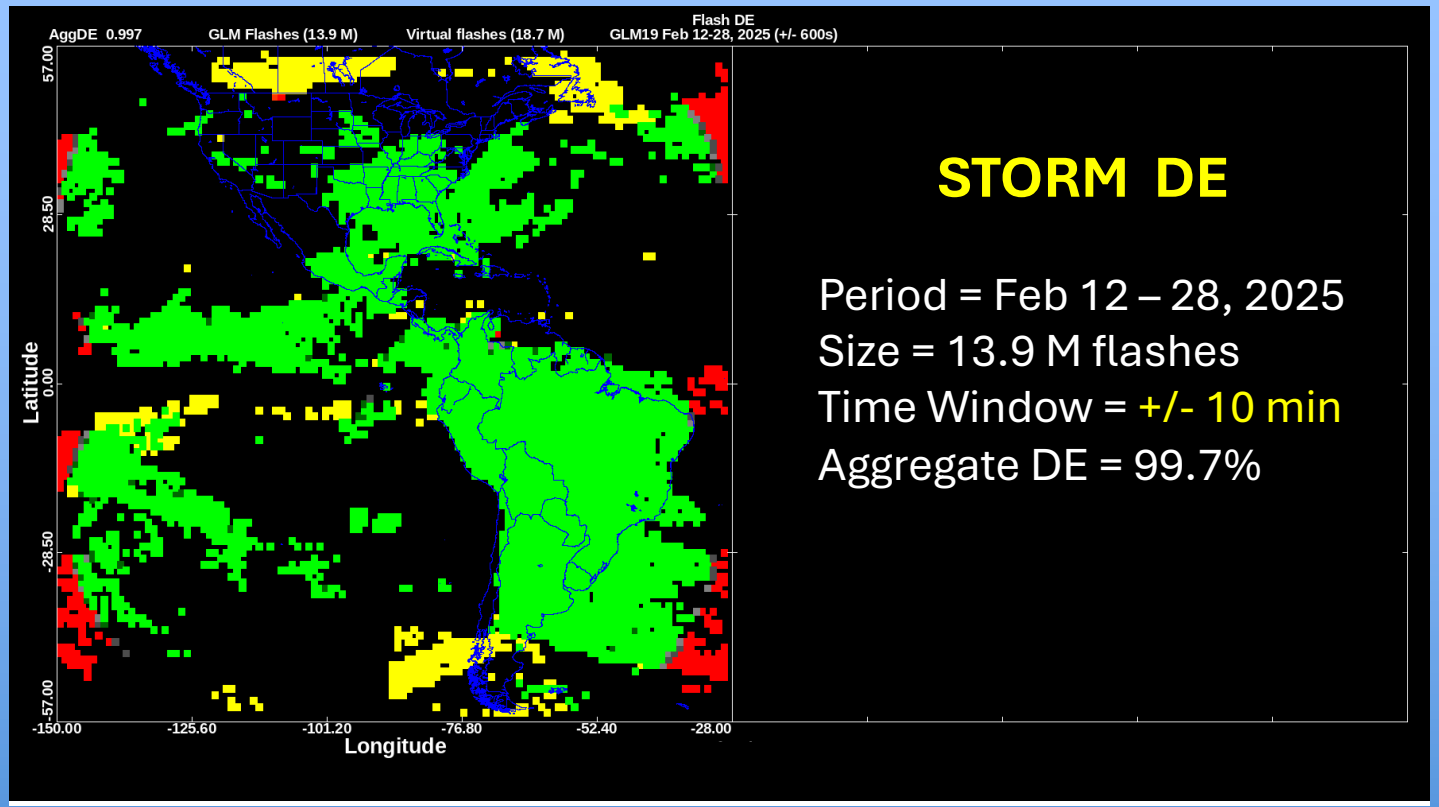


- **GLM-19 compared to clustered ground networks**

GLM-19 Storm DE (Bateman/UAH)

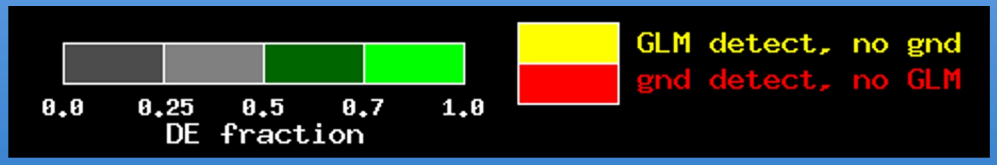
PASSED

PLPT-GLM-003



STORM DE

Period = Feb 12 – 28, 2025
Size = 13.9 M flashes
Time Window = +/- 10 min
Aggregate DE = 99.7%

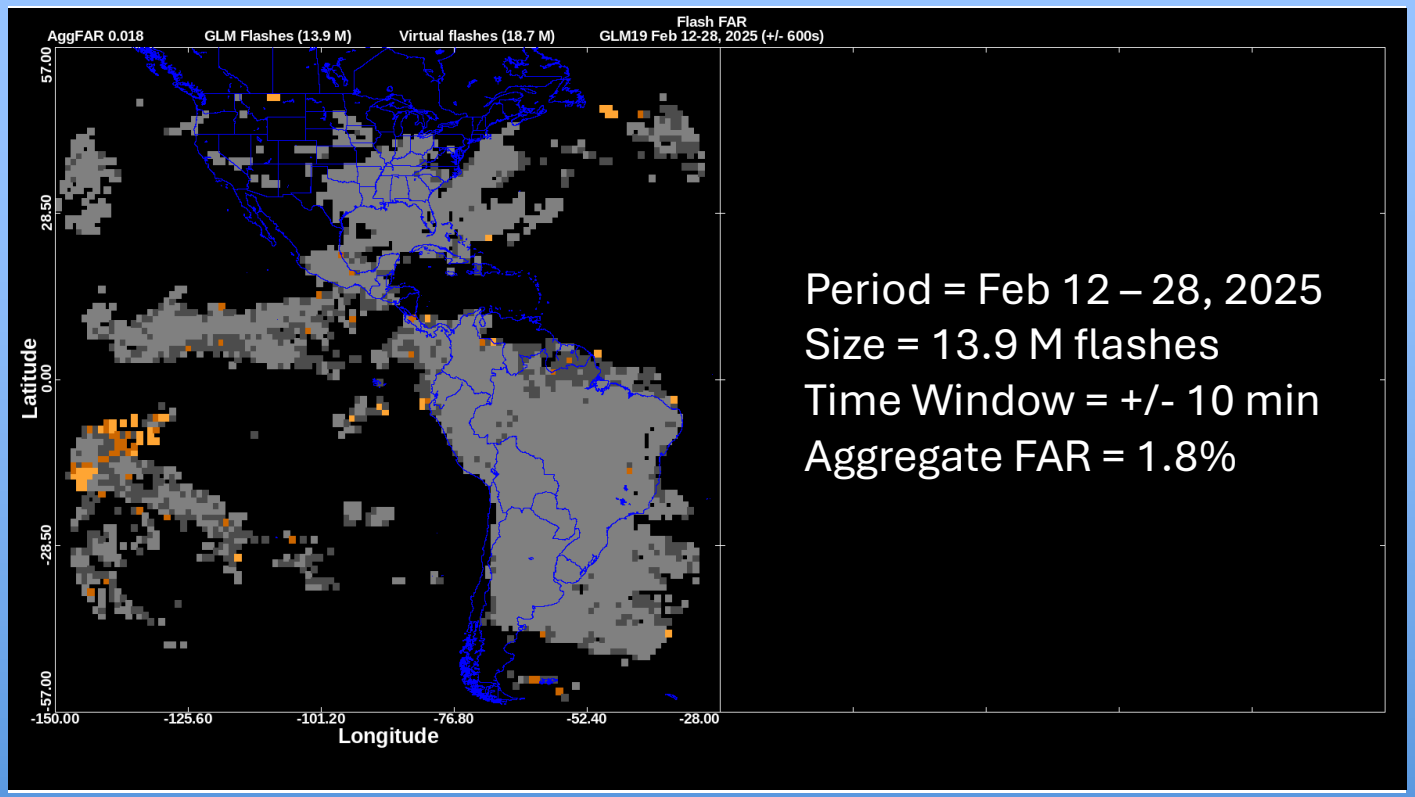


- **GLM-19 compared to clustered ground networks**
- **Time window (for matching) opened to get storm DE.**

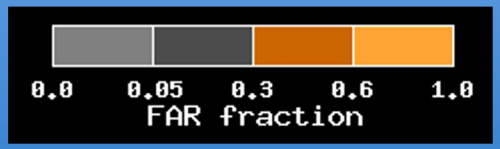
GLM-19 FAR (Bateman/UAH)

PASSED

PLPT-GLM-001



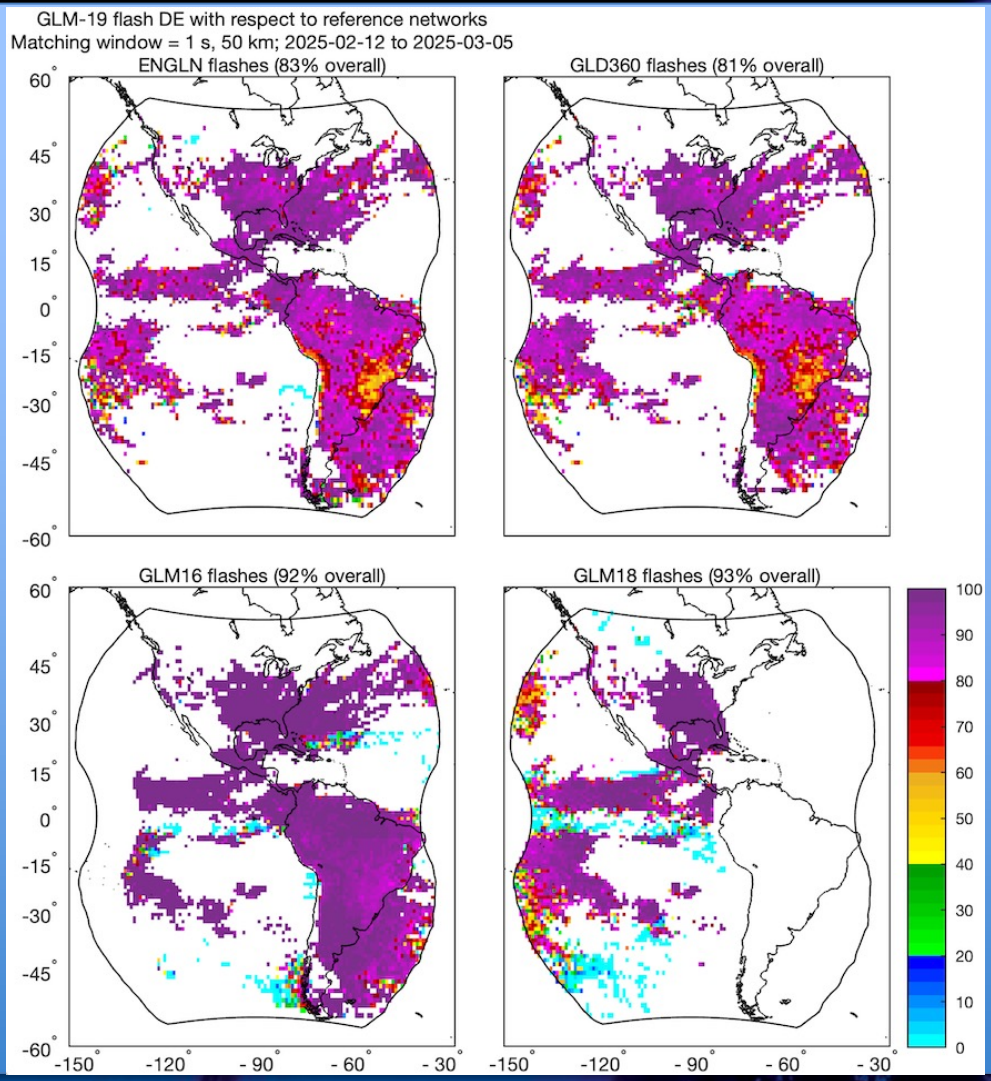
Period = Feb 12 – 28, 2025
Size = 13.9 M flashes
Time Window = +/- 10 min
Aggregate FAR = 1.8%



- **GLM-19 compared to clustered ground networks**

Flash Detection Efficiency (Virts/UAH)

GLM-19 vs. ENGLN, GLD360, GLM-16, and GLM-18



PASSED

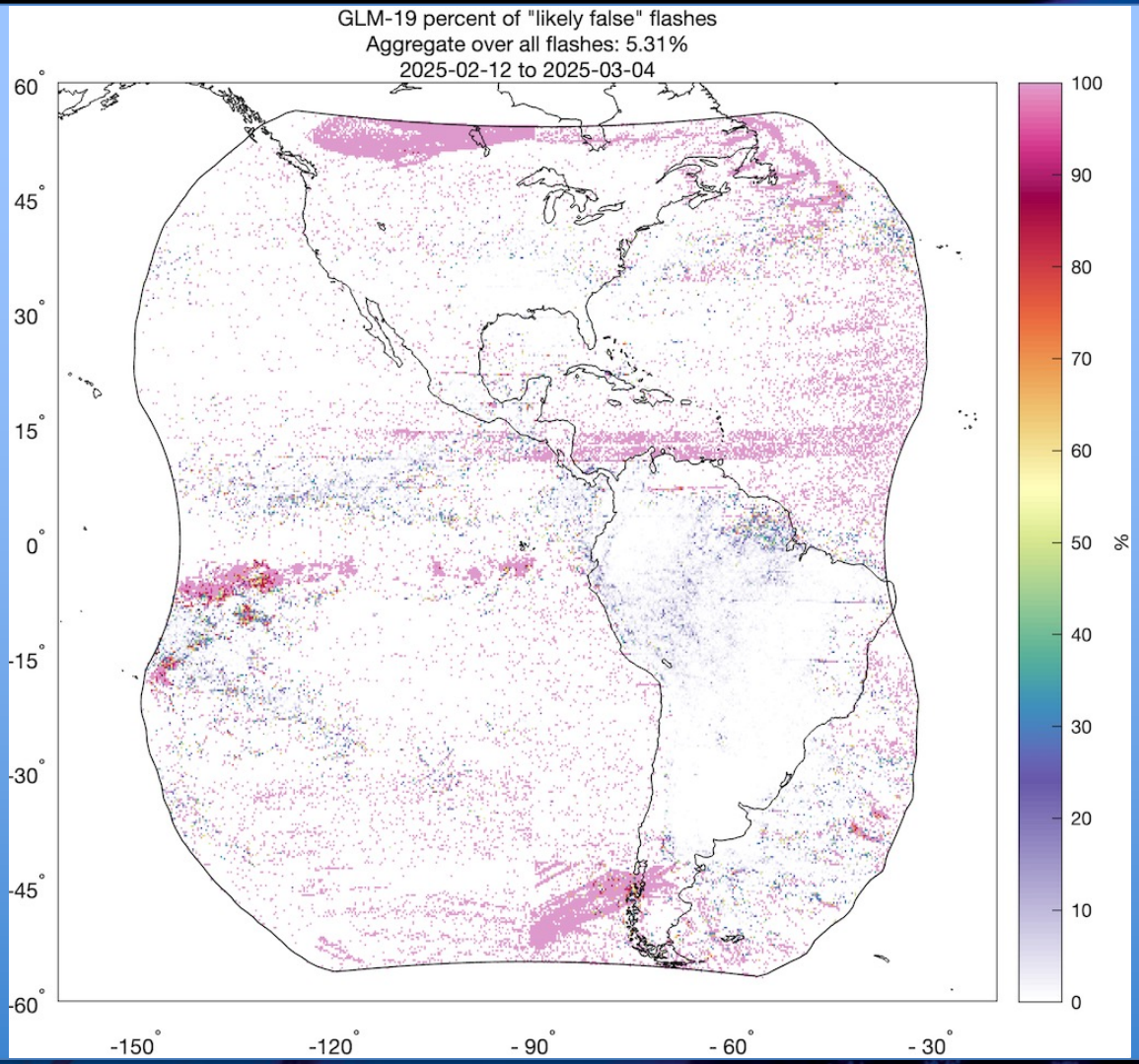
PLPT-GLM-001
PLPT-GLM-005

- **Simulations indicate temporal matching windows of ~±1 s most accurately estimate the true aggregate GLM DE**
- **DE vs. GLM-16 and GLM-18 is 92-93% (blue areas are "likely false" GLM16/18 flashes)**
- **DE vs. ground networks is 81-83% (lower over parts of South America and near the limb)**

NOAA's GOES-19 satellite has not been declared operational and its data are preliminary and undergoing testing. Users receiving these data through any dissemination means (including, but not limited to, PDA and GRB) assume all risk related to their use of GOES-19 data and NOAA disclaims any and all warranties, whether express or implied, including (without limitation) any implied warranties of merchantability or fitness for a particular purpose.

Flash False Alarm Rate (Virts/UAH)

GLM-19 vs. ENGLN, GLD360, GLM-16, and GLM-18



PASSED*

PLPT-GLM-001
PLPT-GLM-005

- **Simulations indicate temporal matching windows of ~minutes most accurately estimate the true aggregate GLM FAR**
- ***5.31% of GLM-19 flashes can't be matched w/any reference flash. Near 5% spec; near Equinox (Feb 26 worst day-of-yr for solar intrusion).**
- **GLM-16 and GLM-18 for the same period: 4.36% and 5.71% "likely false" flashes**

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GOES-19 GLM DE (Bitzer/UAH)

Detection Efficiency Relative to Lightning Mapping Array

PASSED

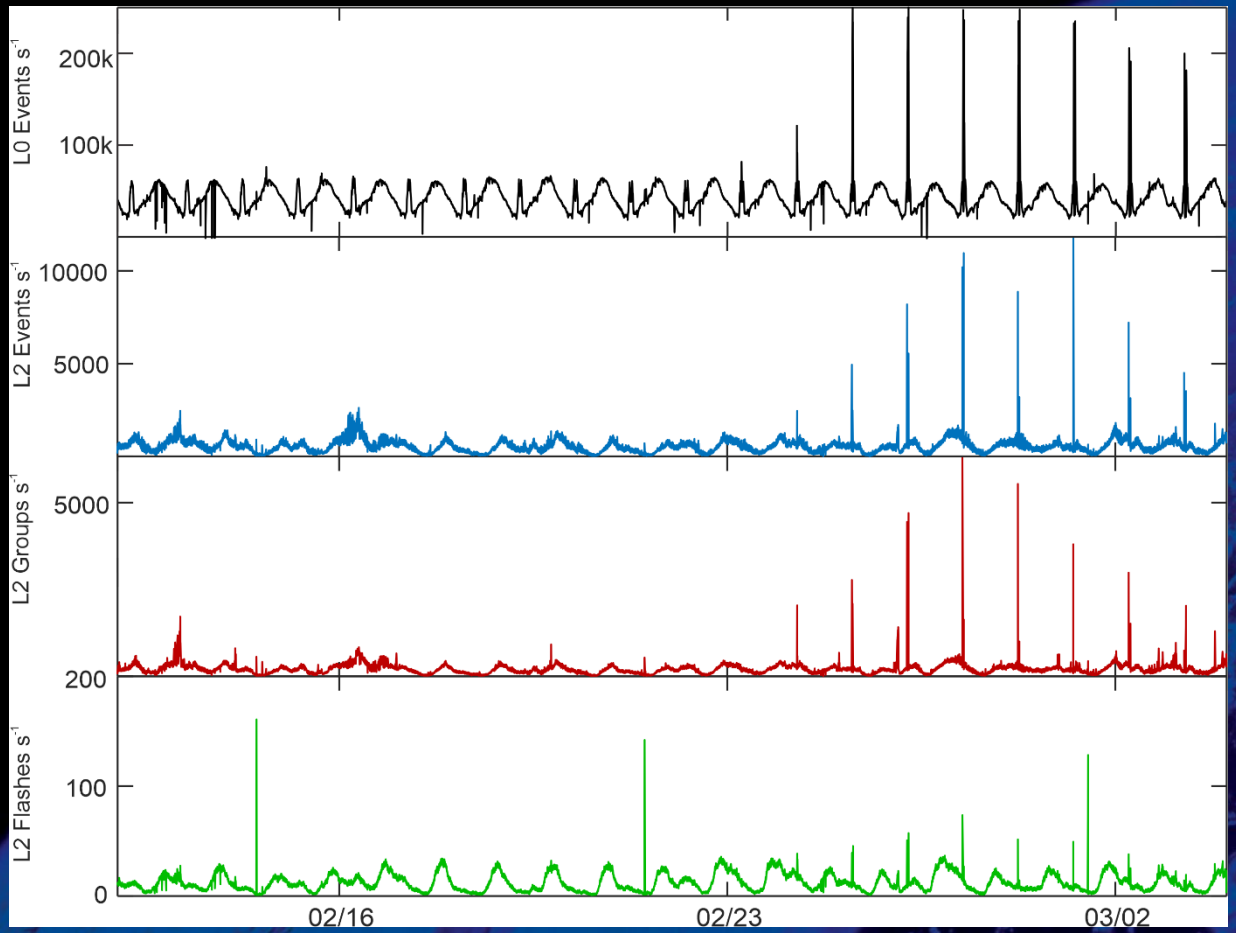
PLPT-GLM-002

- As a reference lightning data set, use the North Alabama Lightning Mapping Array (NALMA).
- Sort NALMA VHF sources into flashes, and find GLM-19 data that occurs during a flash and within the spatial footprint.
- Analysis is from one storm on Feb 16, 2024, from 00Z-10Z.

Area (km^2) from LMA	Num Flashes from LMA	DE GLM-19	DE GLM-16
All	2416	0.782	0.711
> 8	2225	0.811	0.738
> 16	1884	0.850	0.775
> 32	1367	0.910	0.849
> 64	910	0.960	0.914
> 100	630	0.976	0.941

- **GLM-19 detects >70% of all LMA flashes in the time period.**
- **GLM 19 outperforms GLM 16 for this storm, across all areas. In particular, there is a noteworthy increase for small flashes.**

GLM-19 LCFA Peak Rate Spec (Mach/USRA)



- Algorithm did not crash during test period ~150k events/sec
- The LCFA continued to process the filtered events into groups and flashes
- No cases were found where the algorithm crashed in the GLM-19 test period (February 12, 2025 to March 3, 2025)

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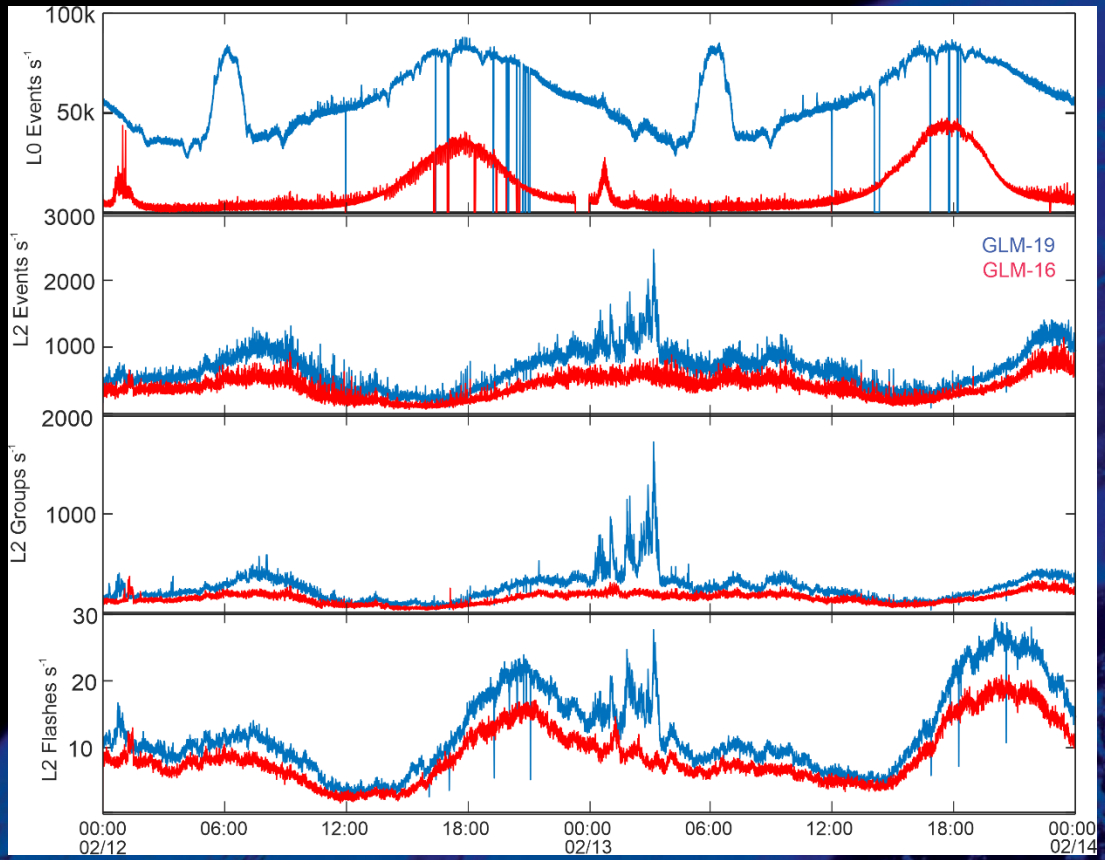
GLM-19 & GLM-16 Data Rate Comparison (Mach/USRA)



- GLM-19 L0 event rates significantly higher than GLM-16 L0 data rates
- GLM-19 L2 event/group/flash rates slightly higher than GLM-16 event/group/flash rates
- Some of the differences may be due to the slightly different FOVs for GLM-19 and GLM-16

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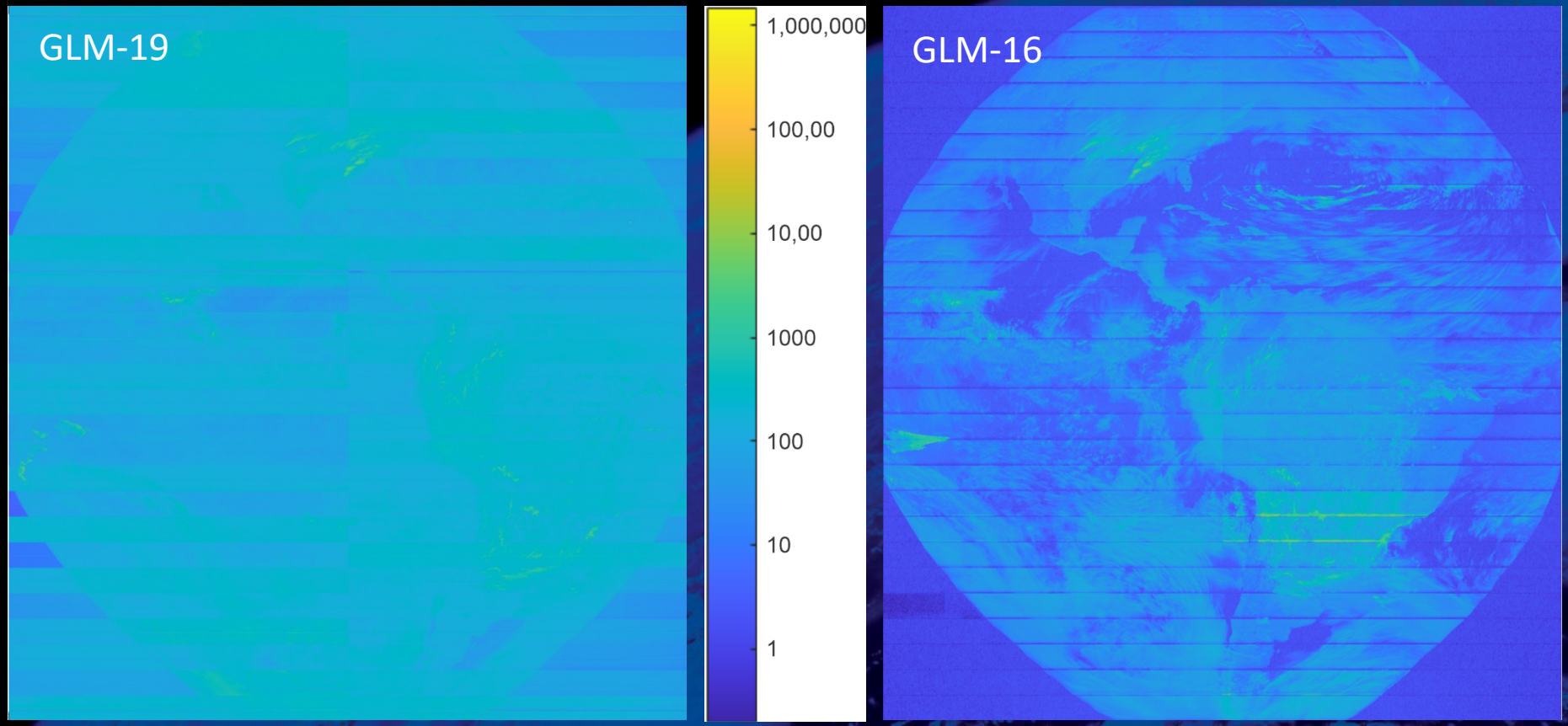
GLM-19 Raw (L0) Events Compared to GLM-16 Raw (L0) Events (Mach/USRA)



- 48 hour L0 events (2025/02/12 – 13)
- GLM-19 48 hour L0 event count: 3.2e9
- GLM-16 48 hour L0 event count: 0.6e9

- GLM-19 significantly higher L0 event count
- GLM-19 more L0 noise

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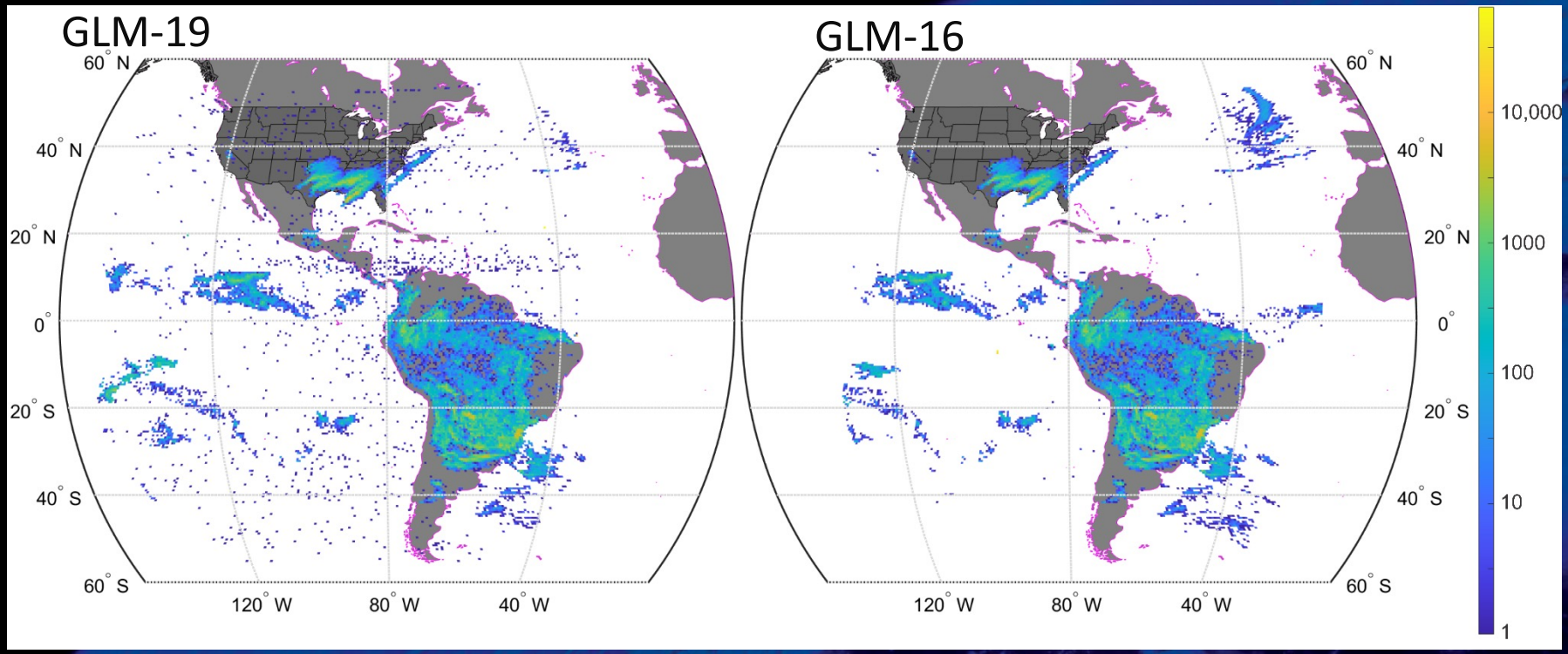
GLM-19 L2 LCFA Results Compared to GLM-16 L2 LCFA Results (Mach/USRA)

Flashes

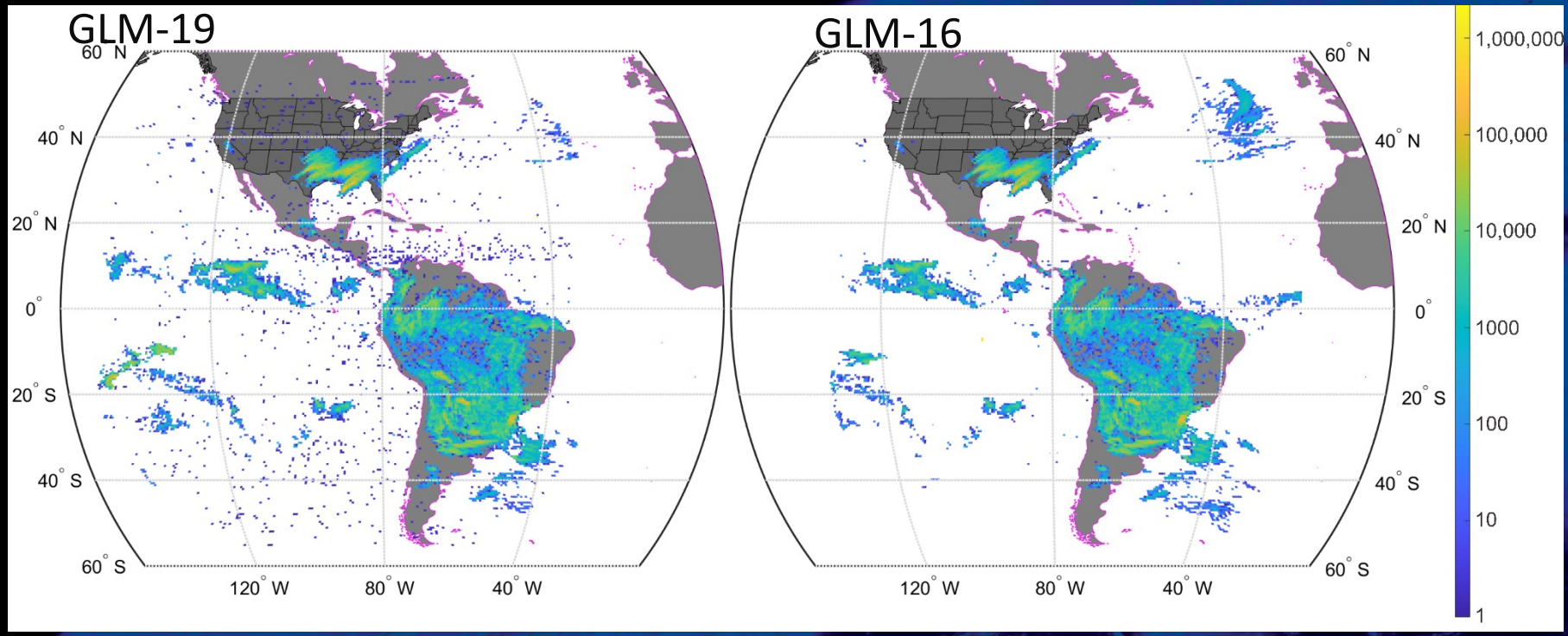


- 48 hour LCFA Results (2025/02/12 – 13)
- GLM-19 48 hour flash count: 1.6e6
- GLM-16 48 hour flash count: 1.5e6

- GLM-19 slightly higher flash count
- GLM-19 more “scattered” (noise?)
- Given the much higher L0 rates, the filtering and LCFA are doing well

GLM-19 L2 LCFA Results Compared to GLM-16 L2 LCFA Results (Mach/USRA)

Groups



- 48 hour LCFA Results (2025/02/12 – 13)
- GLM-19 48 hour group count: 3.5e7
- GLM-16 48 hour event count: 2.7e7

- GLM-19 slightly higher group count
- GLM-19 more “scattered” (noise?)
- Given the much higher L0 rates, the filtering and LCFA are doing well

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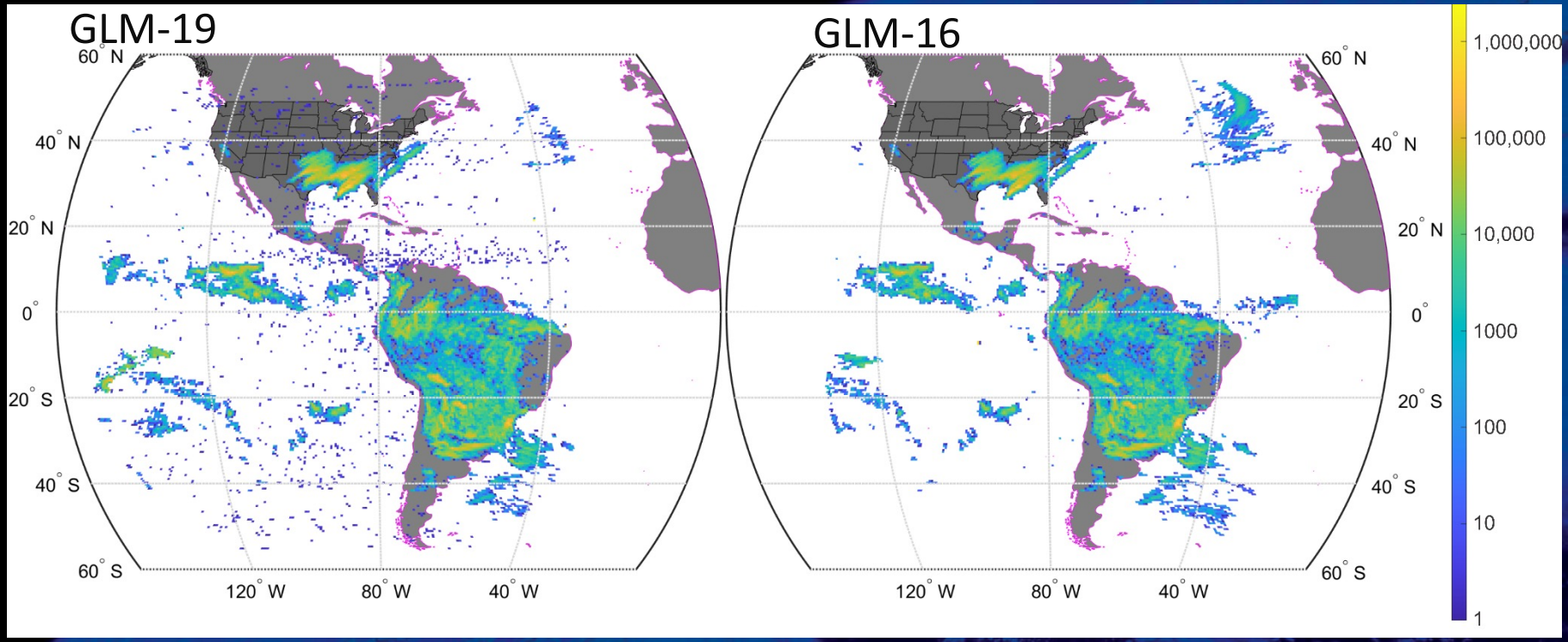
GLM-19 L2 LCFA Results Compared to GLM-16 L2 LCFA Results (Mach/USRA)

Events



- 48 hour LCFA Results (2025/02/12 – 13)
- GLM-19 48 hour event count: 8.7e7
- GLM-16 48 hour event count: 7.0e7

- GLM-19 slightly higher event count
- GLM-19 more “scattered” (noise?)
- Given the much higher L0 rates, the filtering and LCFA are doing well

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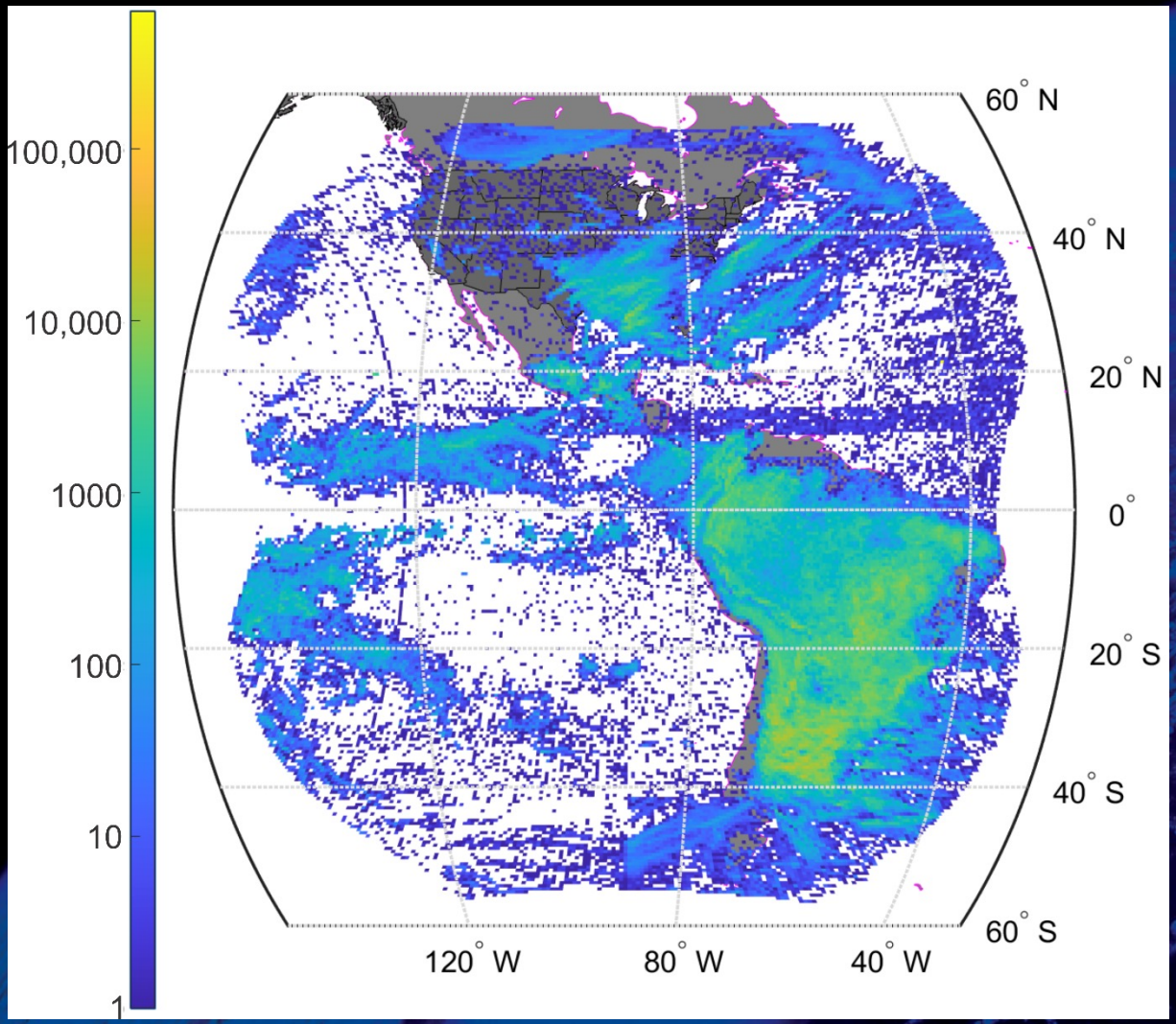
L1b-L2 LCFA Code (Mach/USRA)

PASSED

PLPT-GLM-009



- Example LCFA flashes for 2025/02/12 to 2025/03/03
- No clustering errors
- Clustering working well
- Filtering can be improved

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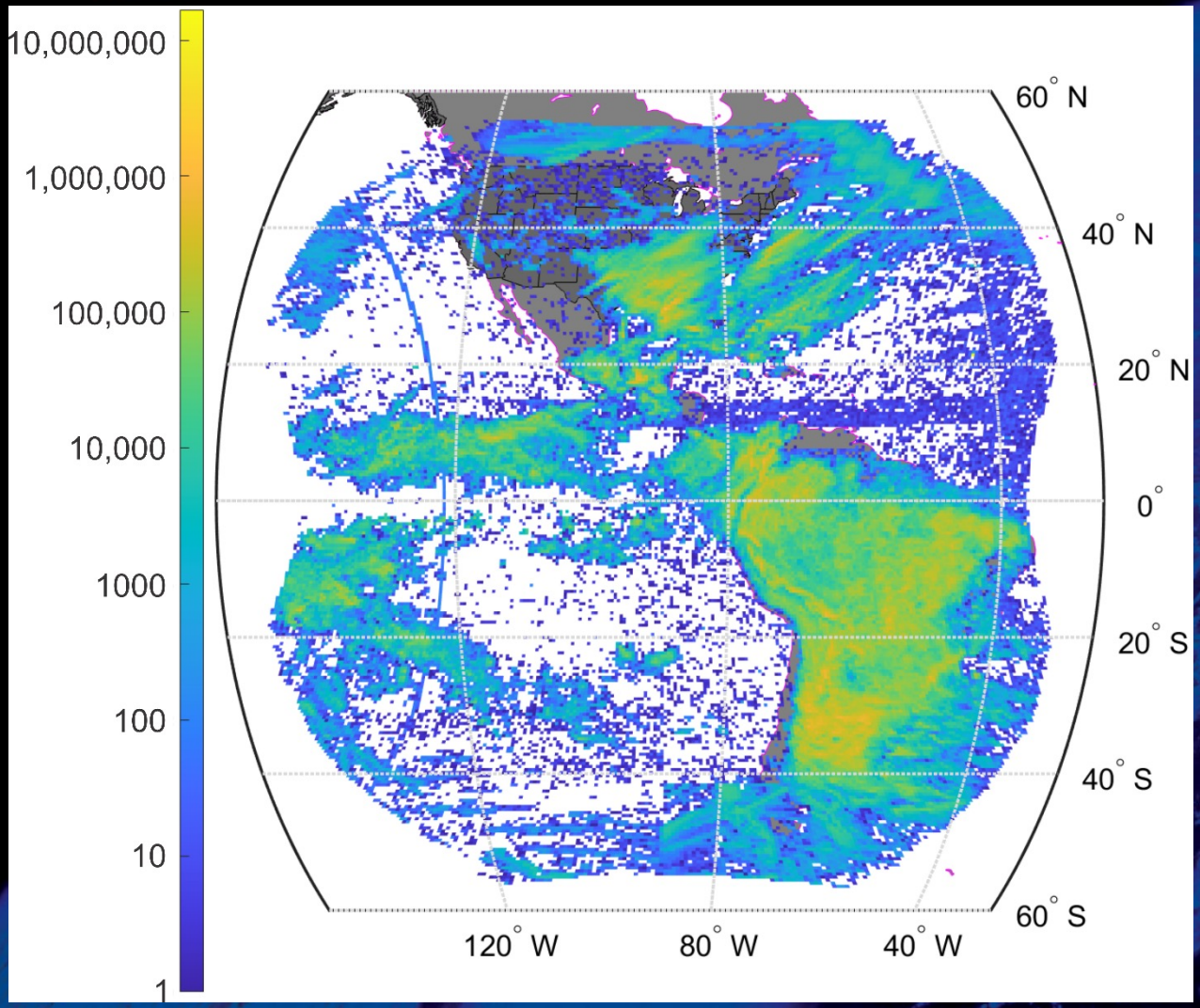
L0-L1b Code (Mach/USRA)

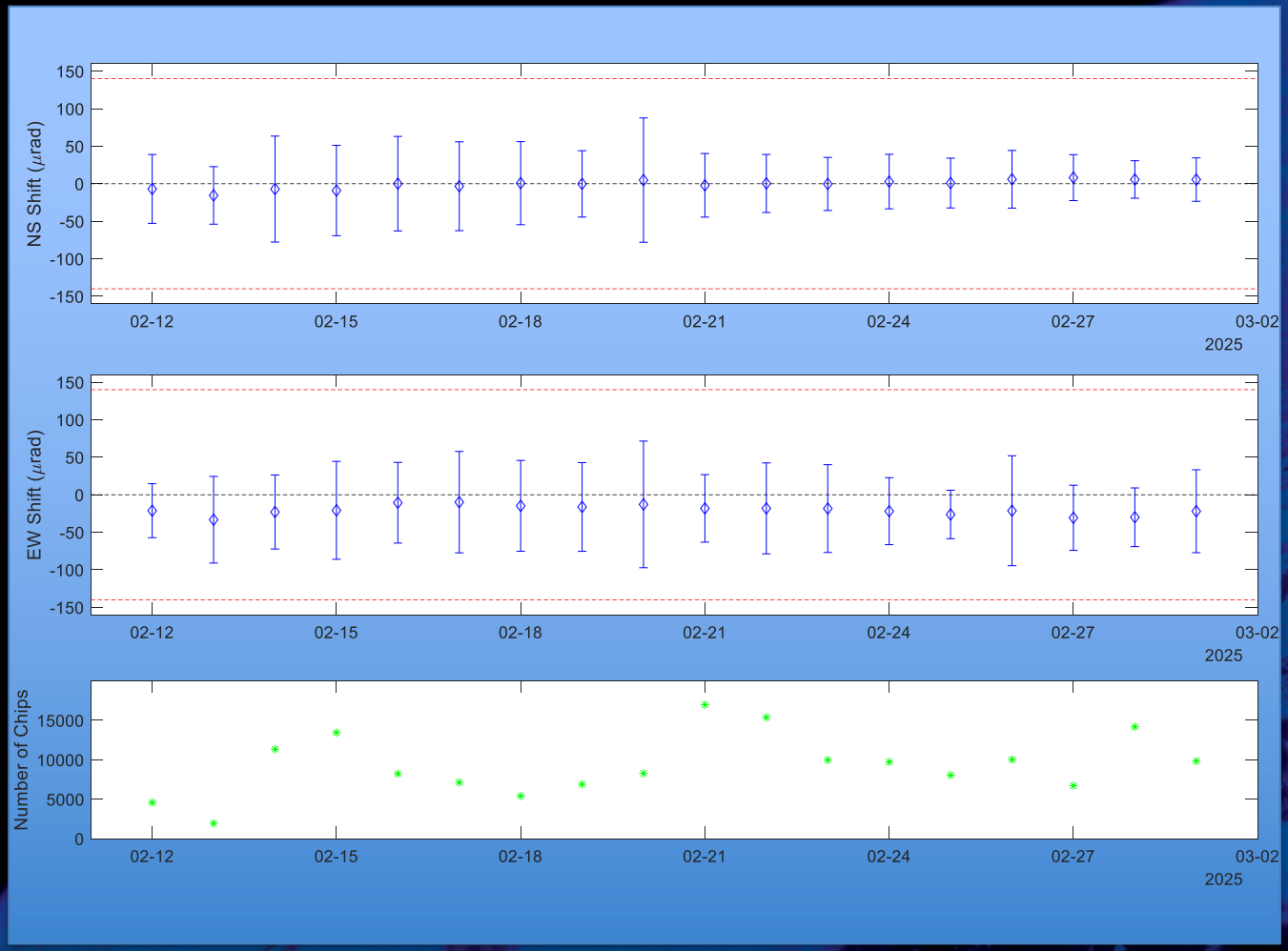


PASSED

PLPT-GLM-010

- Example LCFA filtered events for 2025/02/12 to 2025/03/03
- Some artifacts are present
- “Noise” is also present
- Given the very high L0 raw event rates, L0-L1b filters are working well

GLM INR (Flight IPATS)



PASSED

PLPT-GLM-011

- **IPATS analysis of GLMINR-003 datasets (IPATS: INR Performance Assessment Tool Set)**
- **Feb 12 – Mar 01 dataset indicates navigation meets requirements in both NS and EW angles**
- **MRD requirement ($|\mu|+3\sigma < 140$ μrad)**
- **Updated instrument parameters produced significantly better navigation performance**

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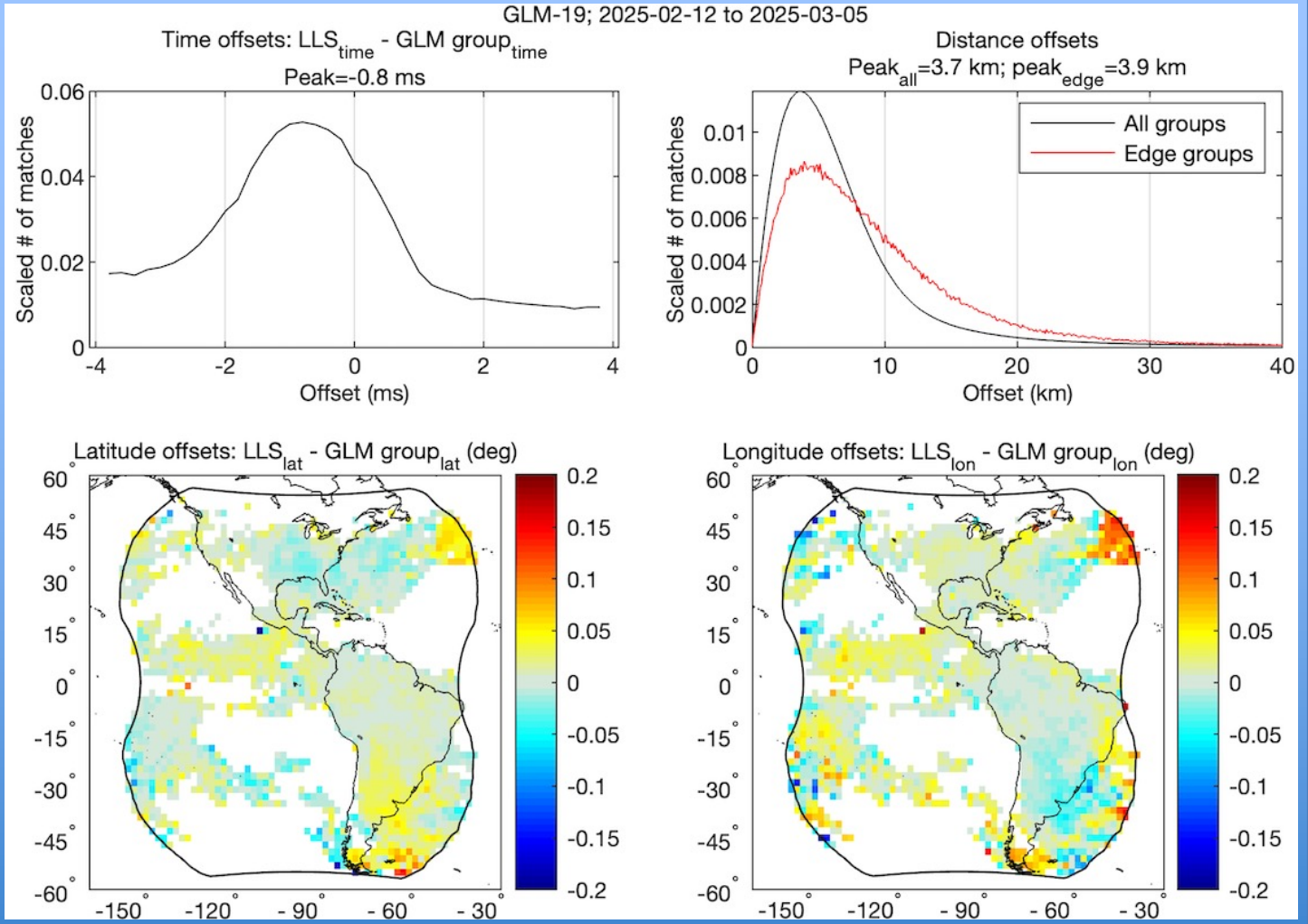
Timing/Location Accuracy (Virts/UAH)

GLM-19 vs. ENGLN and GLD360



PASSED

PLPT-GLM-011

- **Offsets between GLM-19 group and "best" reference match**
- **Sub-millisecond timing accuracy**
- **~Half-pixel location accuracy over most of the domain**
- **Similar location accuracy to GLM-18 when it was declared provisional**

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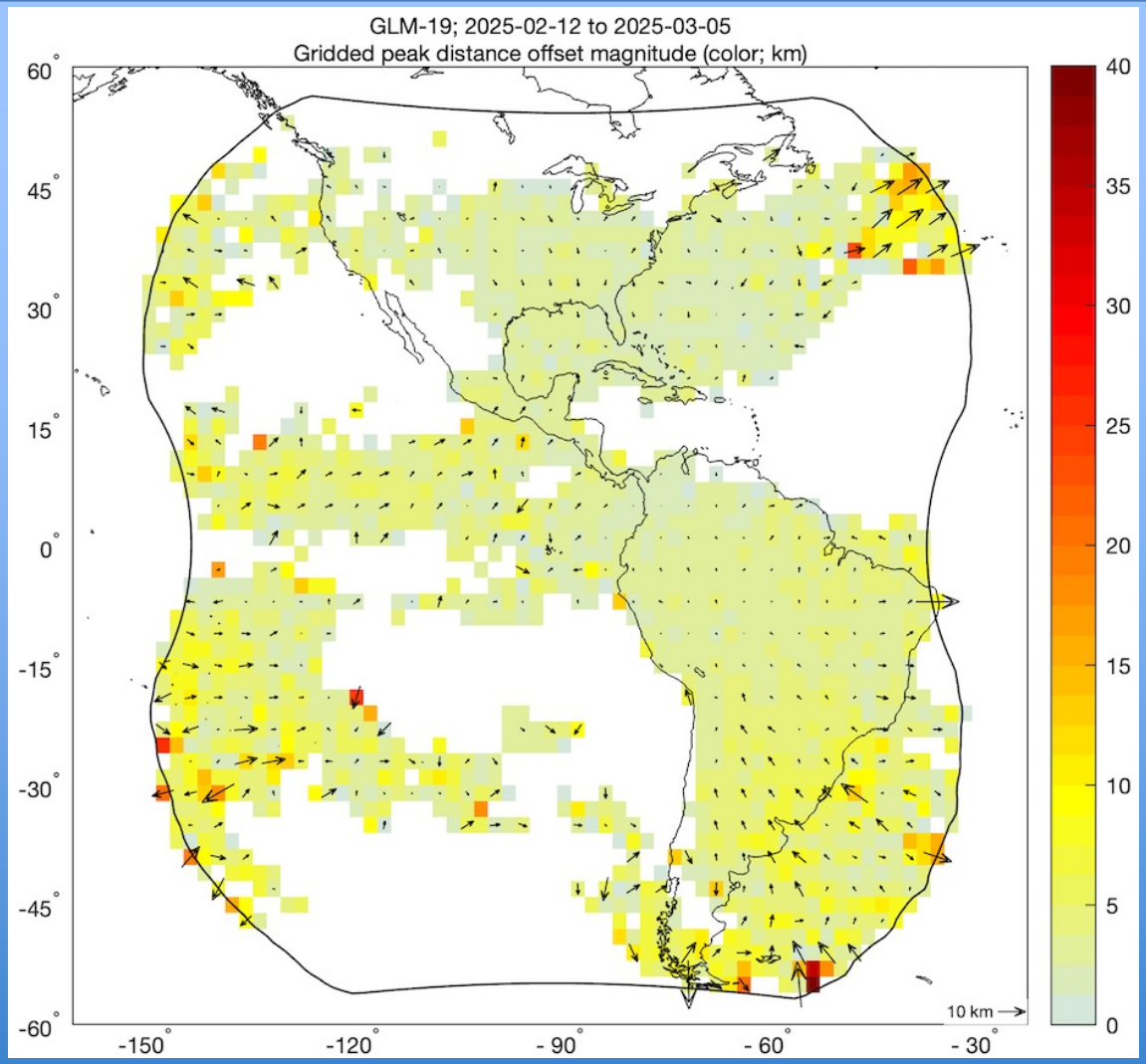
Location Accuracy (Virts/UAH)

GLM-19 vs. ENGLN and GLD360



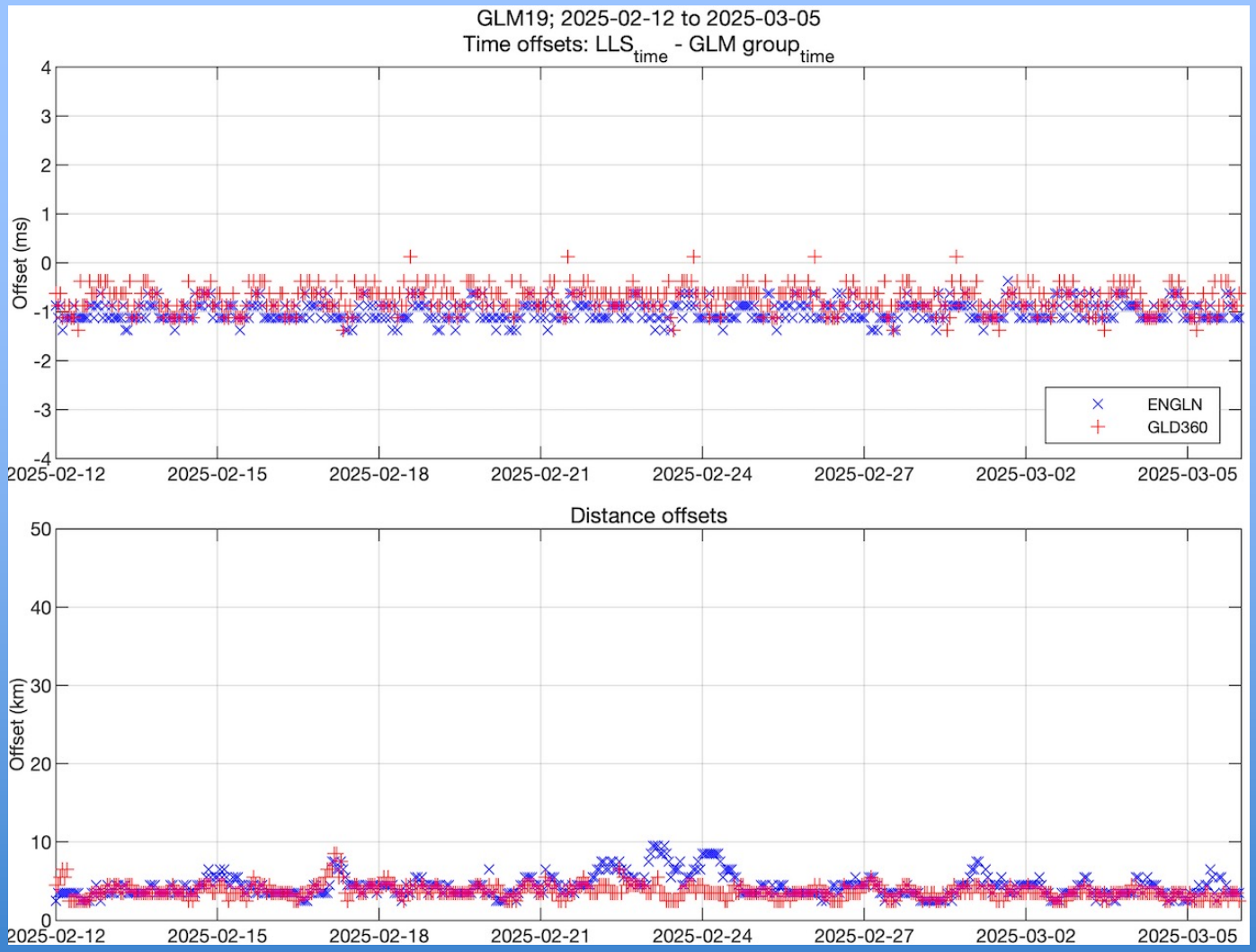
PASSED

PLPT-GLM-011

- **Vectors indicate how GLM-19 groups would need to be shifted to best match the reference networks**
- **Lockheed Martin tuning has lessened the normal parallax pattern of errors**

Timing/Location Accuracy (Virts/UAH)

GLM-19 vs. ENGLN and GLD360



PASSED

PLPT-GLM-011

- **Hourly time series of peak time and distance offsets from the reference networks**
- **Consistent temporal and spatial accuracy over the ~3-week analysis period**

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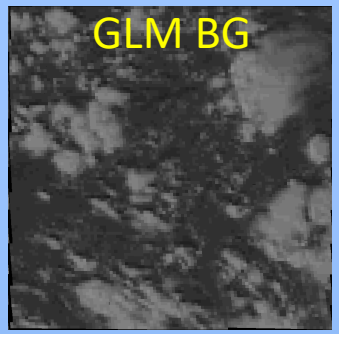
Deep Convective Cloud (DCC) Analysis (Buechler/UAH)

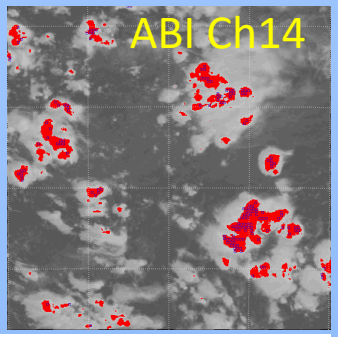
GLM 19

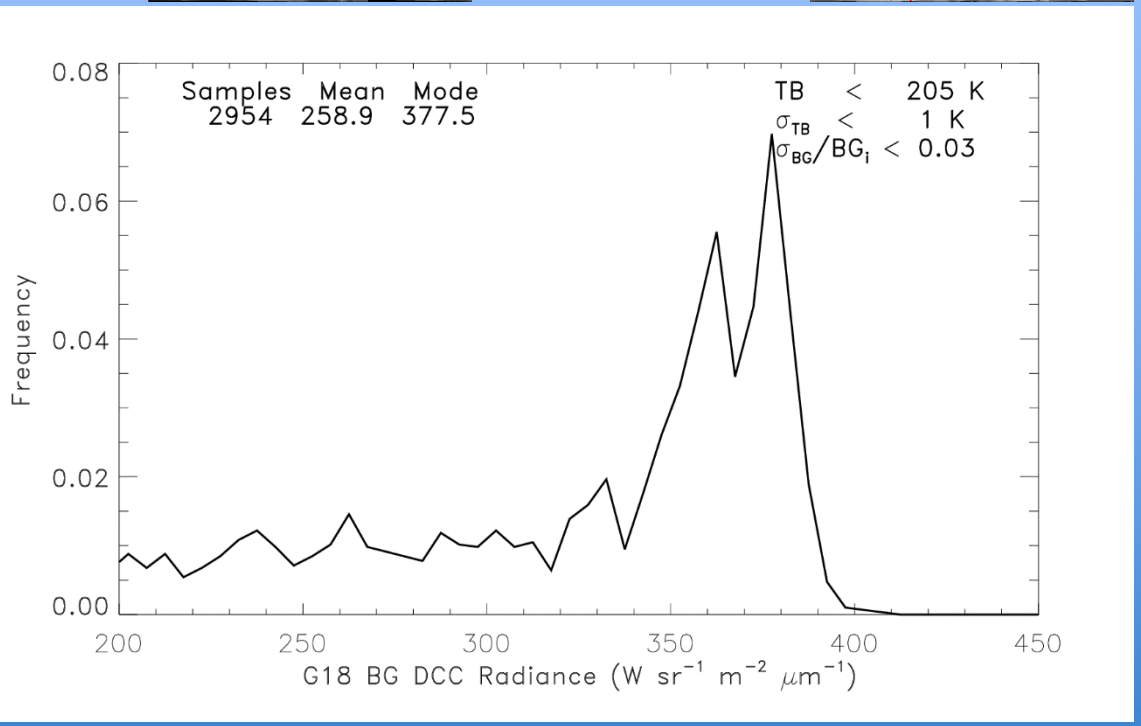
PASSED

PLPT-GLM-012



TB < 205K
DCC Blue





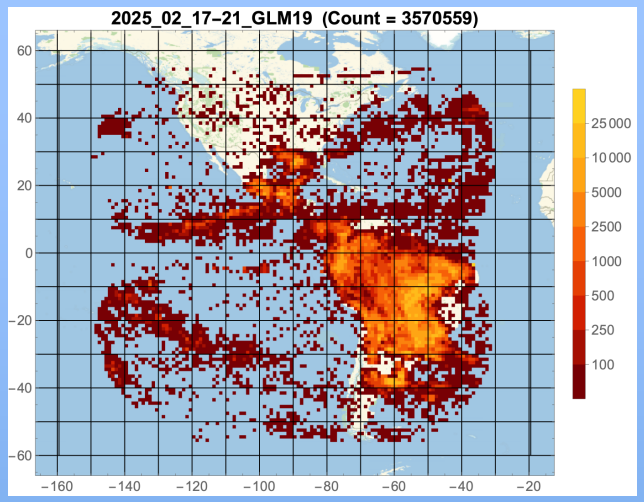
- **GLM background pixels co-located with ABI CH14 TB < 205 K**
- **Mode of distribution is 377.5 W sr^{-1} m^{-2} μm^{-1}**
- **Results consistent with theoretical expected values**
- **Values consistent with LIS**
- **Values consistent with GLMs 16, 17, and 18**

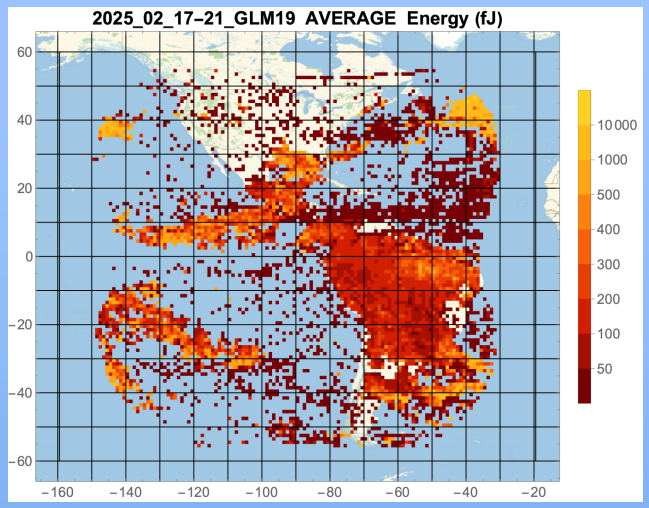
Optical Energy (Koshak/MSFC)

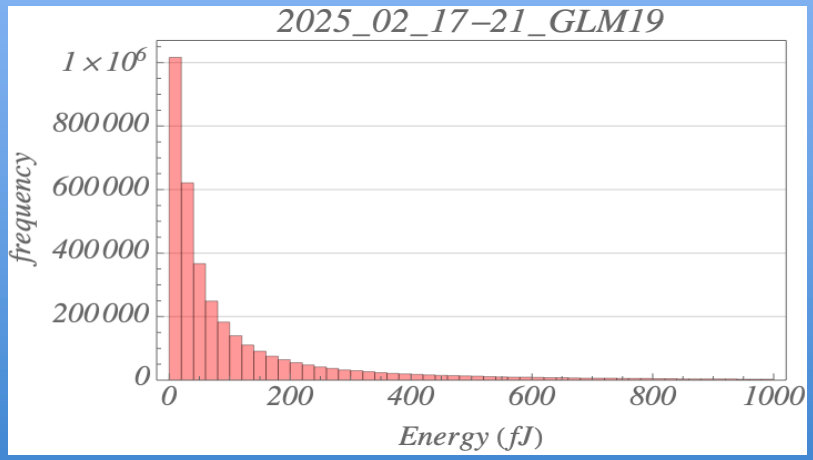
Bench-marking for long-term degradation checks

PASSED

PLPT-GLM-013







- **GLM-19**
- **Feb 17-21, 2025**
- **3.57 M flashes**
- **153.9 fJ ave**
- **Ave is smaller than typical 254 fJ for GLM-16 due to noise (see Mach results above).**

Outline

Introduction

Review of Beta Certification

Product Quality Evaluation Overview

Provisional Maturity Assessment

PLPT Details

Path to Full Validation

Summary and Recommendations

Future Updates & Enhancements

WR	ADR	Title	PR or DO	Date in OE	Impact to this VAL
	1348	GLM Coastline intermittent Read and Write errors	HOLD	TBD	
	1390	Fix GLM CAL INR for All Filters LUT	HOLD	TBD	
9917	1416	GLM background corner point metadata errors	HOLD	TBD	
	1419	Install GLM FED product on the PPZ	HOLD	TBD	
	1545	GLM Slot-Dependent LUTs for G16, G17, and G19	In_Work	Mar '25	
	1547	Request for GLM G19 CDRL38 Nominal Pixel Locations	In_Work	Flight	

WR	ADR	Title	PR or DO	Date in OE	Impact to this VAL
9187		Unable to Load GLM Events in PADIV	HOLD	TBD	
9700		Tracking: COOP FINDING: G16/G18 GLM L2/INST-CAL Archive Impacts to MLS/LZSSc	HOLD	TBD	
9724		CBU GLM Landmarking Very Delayed	In_Analysis	Product Monitor	
9736		GGSS Ops: Update GLM FED to handle NFS slowness	DO.15.00.00	April 2025	
9911		GGSS Ops: Incorrect publishing of GLM AllFilters LUT resulting in incorrect LUT being used in ops [aka "LUT Flapping"]	In_Analysis	future enhancement	
9949		GGSS Ops: Delivery of Sectorized GLM (GLM FED) from CBU to NWS ceased	In_Test	TBD	
9959		GGSS Ops: G18 GLM low events impacting GLM derived products	In_Analysis	future enhancement	
10107		G16/G18 GLM EPM issues during EM Handover	In_Analysis	TBD	

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Summary

- **Flash DE meeting 70% spec:**
  - 75.3% (Bateman tool; Feb 12-28, 2025)
  - 81-83% (Virts tool; Feb 12 – Mar 5, 2025)
- **Flash FAR meets 5% spec:**
  - 1.8% (Bateman tool; Feb 12-28, 2025)
  - 5.31% (Virts tool; Feb 12 – Mar 4, 2025). FAR increased slightly above 5% spec possibly because analysis pushes farther into noisier Equinox season.
- **Location/timing meeting spec:**
  - 3.7 km and -0.8 ms
  - INR angles well within the 140 microradian spec
- **Max Data Rates meeting spec:**
  - Can handle max Event, Group, and Flash data rates

Recommendations

CWG believes that the GLM-19 L2 product (events, groups, flashes) has reached the Provisional Maturity as defined by the GOES-R Program.