



# GOES-16/17 GLM Validation Brief Status Overview

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NASA/MSFC, ST11

with inputs from extended Cal/Val Team

*Presentation at University of Maryland College Park;  
planning meeting: Space-Based Follow-on Mission to  
Understand Terrestrial Optical Flashes*



# Product Maturity Levels



## GOES-R Product (L1b and L2+) Maturity Levels

### Beta Validation

#### Preparation Activities

- Initial calibration applied (L1b).
- Rapid changes in product input tables, and possibly product algorithms, can be expected.
- Product quick looks and initial comparisons with ground truth data (if any) are not adequate to determine product quality.
- Anomalies may be found in the product and the resolution strategy may not exist.

#### End state

- Products are made available to users to gain familiarity with data formats and parameters.
- Product has been minimally validated and may still contain significant errors.
- Product is not optimized for operational use.

### Provisional Validation

#### Preparation Activities

- Validation and quality assurance (QA) activities are ongoing, and the general research community is now encouraged to participate.
- Severe algorithm anomalies are identified and under analysis. Solutions to anomalies are in development and testing.
- Incremental product improvements may still be occurring.
- Users are engaged in the Customer Forums (L2+ products only), and user feedback is assessed.

#### End state

- Product performance (L1b or L2+) has been demonstrated through analysis of a small number of independent measurements obtained from selected locations, periods, and associated ground-truth/field program efforts.
- Product analysis are sufficient to communicate product performance to users relative to expectations.
- 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.
- Testing has been fully documented.
- Product ready for operational use and for use in comprehensive calibration/validation activities and product optimization.

### Full Validation

#### Preparation Activities

- Validation, QA, and anomaly resolution activities are ongoing.
- Incremental product improvements may still be occurring.
- Users are engaged and user feedback is assessed.

#### End state

- Product performance for all products is defined and documented over a wide range of representative conditions via ongoing ground-truth and validation efforts.
- Products are operationally optimized, as necessary, considering mission parameters of cost, schedule, and technical competence as compared to user expectations.
- All known product anomalies are documented and shared with the user community. e.g., blooming, data gaps, parallax, ...
- Product is operational.



# Peer Stakeholder – Product Validation Review (PS-PVR)



## GLM-16:

**09 Jun 2017: Beta PS-PVR ... PASSED**

**19 Jan 2018: Prov PS-PVR ... PASSED**

**01 Nov 2018: Full PS-PVR ... PASSED**

## GLM-17:

**02 Oct 2018: Beta PS-PVR ... PASSED**

**03 Dec 2018: Prov PS-PVR ... PASSED**

**LATE 2019: Full PS-PVR**



# G16 Full Performance Summary



MRD	Parameter	MRD Value	Performance Result from various Tools			
			VaLiD	LATA	INR	Mach SIT
1259	Production Mapping Accuracy	5km ( = $ \mu+3\sigma  < 140 \mu\text{rad}$ )	n/a	3km	101.5 $\mu\text{rad}$ (3.6 km)	n/a
1260	Product Measurement Range	(0-41900 evts/s, 0-8170 grps/s, 0-600 flsh/s)	n/a	n/a	n/a	verified *LCFA can handle above max rate spec
1261	Product Measurement Accuracy	70% total flash detection efficiency (DE)	78%	n/a	n/a	n/a
1264	Product Measurement Precision	5% (flash FAR) [also MRD 639 which states same 5% value]	22%	n/a	n/a	n/a

PORD	Parameter	PORD Value	Performance Results	
			LATA	INR
094	GLM Navigation Error	4km ( = $ \mu+3\sigma  < 112 \mu\text{rad}$ )	n/a	3.6 km
098	Event Time Tag Accuracy	1 ms	- 0.8 ms	n/a

\*LCFA = Lightning Cluster Filter Algorithm.  
 - MRD1259 & PORD 094: 28  $\mu\text{rad}$  per km.



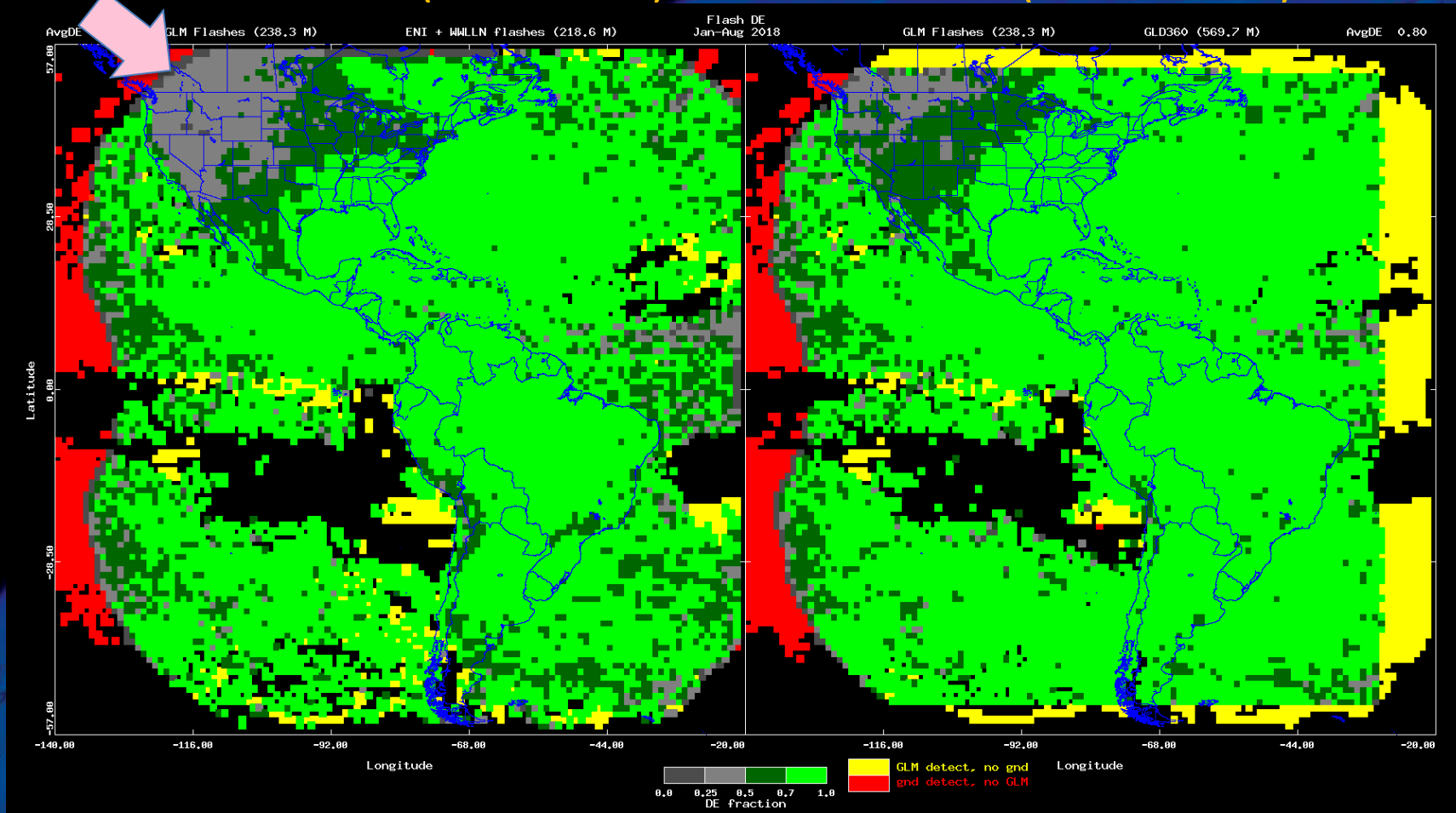
# EXAMPLE G16 Performance

Flash DE Map, Jan-Aug 2018 (Bateman)

Possible  
to fix ?

75% DE (vs. ENTLN)

80% DE (vs. GLD360)



~240 million GLM Flashes



# Primary Planned Fixes

DO.08.00.00; DE: ~ April 2019, OE: ~Late June 2019)

Category	Issue	ADR
DETECTION & NOISE	Adjust 2 <sup>nd</sup> Level Thresholds (remove false event “bars” @ RTEP boundaries)	647
	Coherency Filter LUT update (depends on 647)	648
	Blooming Filter	374
	Single Event Filter (SEF); better than a SGF	519*
	Data Burst/Loss (e.g., EXIS cruciform scan, data formatter)	615, 649
	Keep 1 <sup>st</sup> Event in Flash	652*
	Put Back Filter (still under testing)	TBD
LOCATION	GLM Parallax (3° monthly grid of optimal cloud heights)	645*
	GLM GPA INR: Account for diurnal variation	650*
TIME	Time Order, GLM L2	375
ENERGY	Optical Energy Distortions in PDA Stream; Dark Flashes; Duplicate Groups & Events	738*, 739*, 740*

New Products (ADR 461\*/646\* : GLM Data Quality & Gridded Product requires SPSRB approval.

\* Might be implemented before, during, or after DO.08.00.00



# GLM-Detected Bolide Studies



- Peter Jenniskens et al.,: Detection of meteoroid impacts by the GLM on the GOES-16 satellite, *Meteoritics & Planetary Science*, 1-25, 2018.
- Peter Brown et al., The Hamburg meteorite fall: fireball trajectory, orbit and dynamics, *Meteoritics & Planetary Science*, in review, 2018.
  - ADR Analyses: Problem discovered by Koshak in comparing LMATC/Rudlosky Jan 2018 Michigan Bolide to PDA data.

Rudlosky/LMATC/Peterson:

