

GLM Flash Energy Trending and NCA Applications

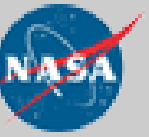
GLM Science Meeting, Huntsville AL

Sept. 11, 2019

William Koshak, NASA/MSFC

Overview

- Analysis Periods
- Frequency Distribution
- Spatial Variation
- Diurnal Variation
- Long-Term Trends
- GLM-16 NCA Applications
- Scale_Factor & Add_Offset



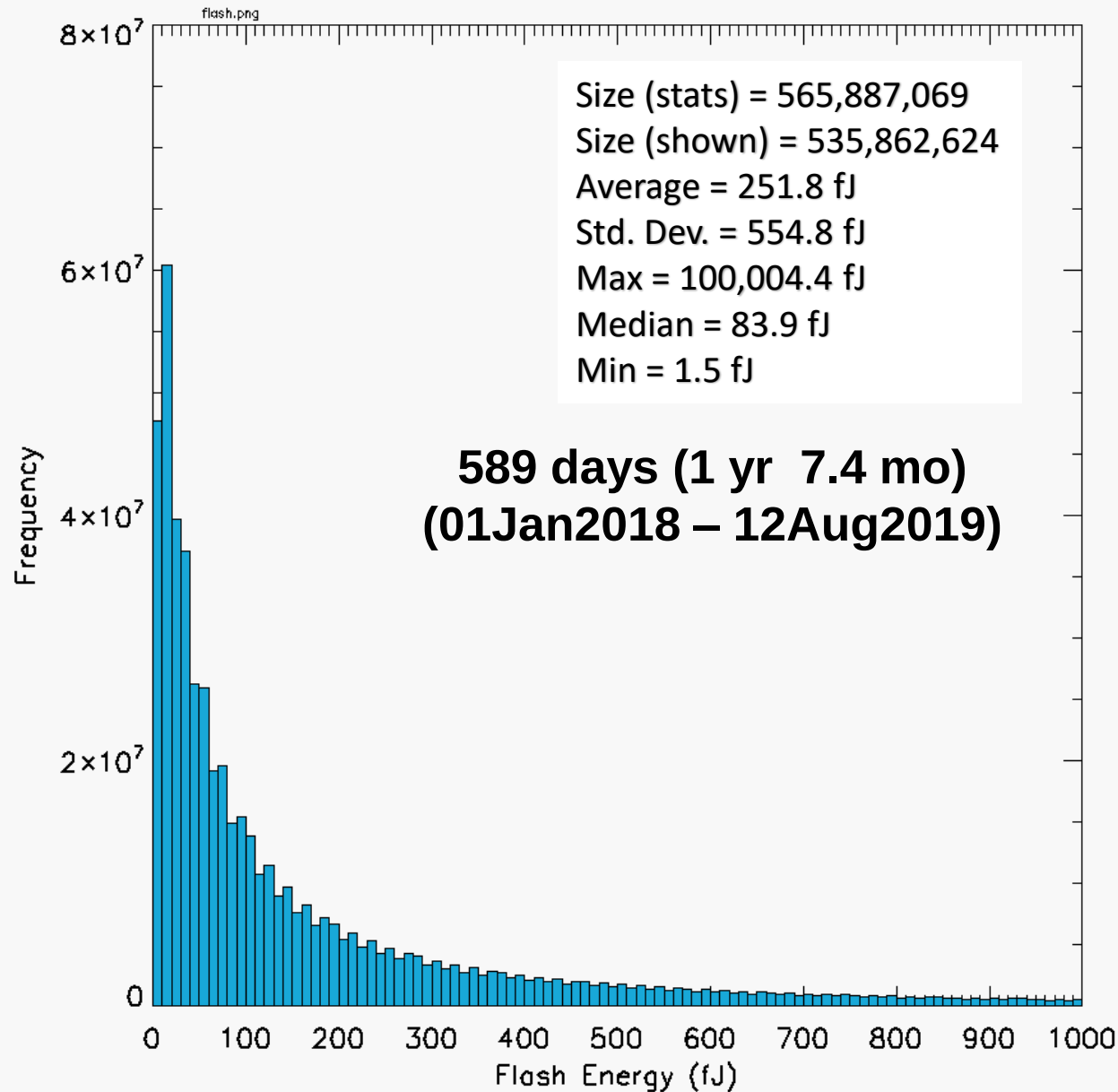
Analysis

- **Region:** Entire GLM FOV
- **Filtration:** Keep only those flashes with flash_quality_flag = 0
- **Purpose:** Long-term trending of flash data product (for baselining) as we move through s/w fixes, and possible instrument degradation well into the future.
- **GLM-16:**
 - **Period:** 1 Jan 2018* - 12 Aug 2019
 - **# Days:** 589
 - **# Flashes:** 565,887,069
- **GLM-17:**
 - **Period:** 04 Dec 2018* (i.e., post-drift + cal + 7d INR + ADR 855) - 12 Aug 2019
 - **# Days:** 252
 - **# Flashes:** 70,457,719

* Prov Achieved: 19 Jan 2018 (GLM-16), 20 Dec 2018 (GLM-17)

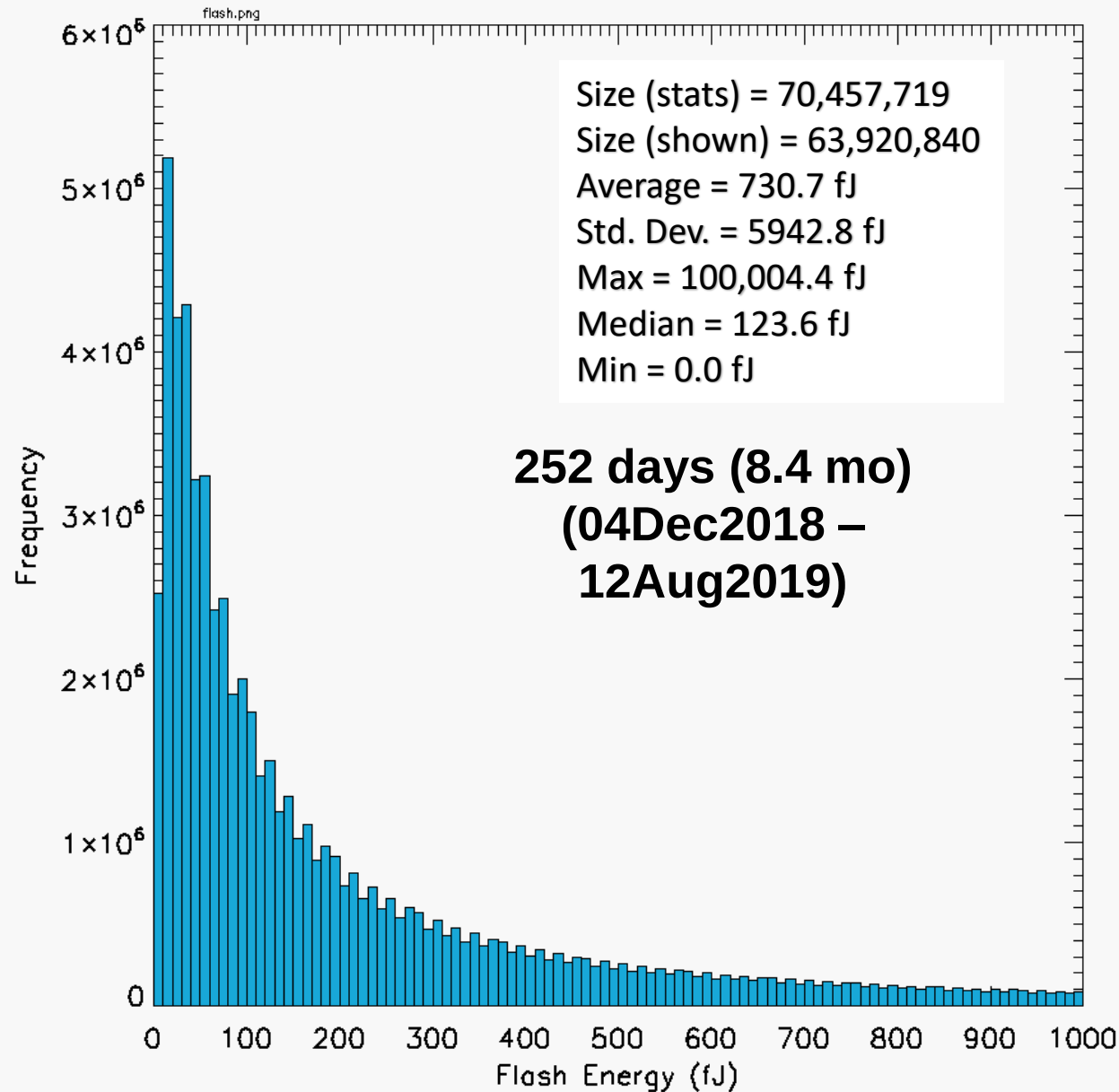
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GLM-16

Frequency Distribution of Flash Energies



GLM-17

Frequency Distribution of Flash Energies

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Spatial Variation

589 days (1 yr 7.4 mo)
(01Jan2018 – 12Aug2019)

Flash Counts

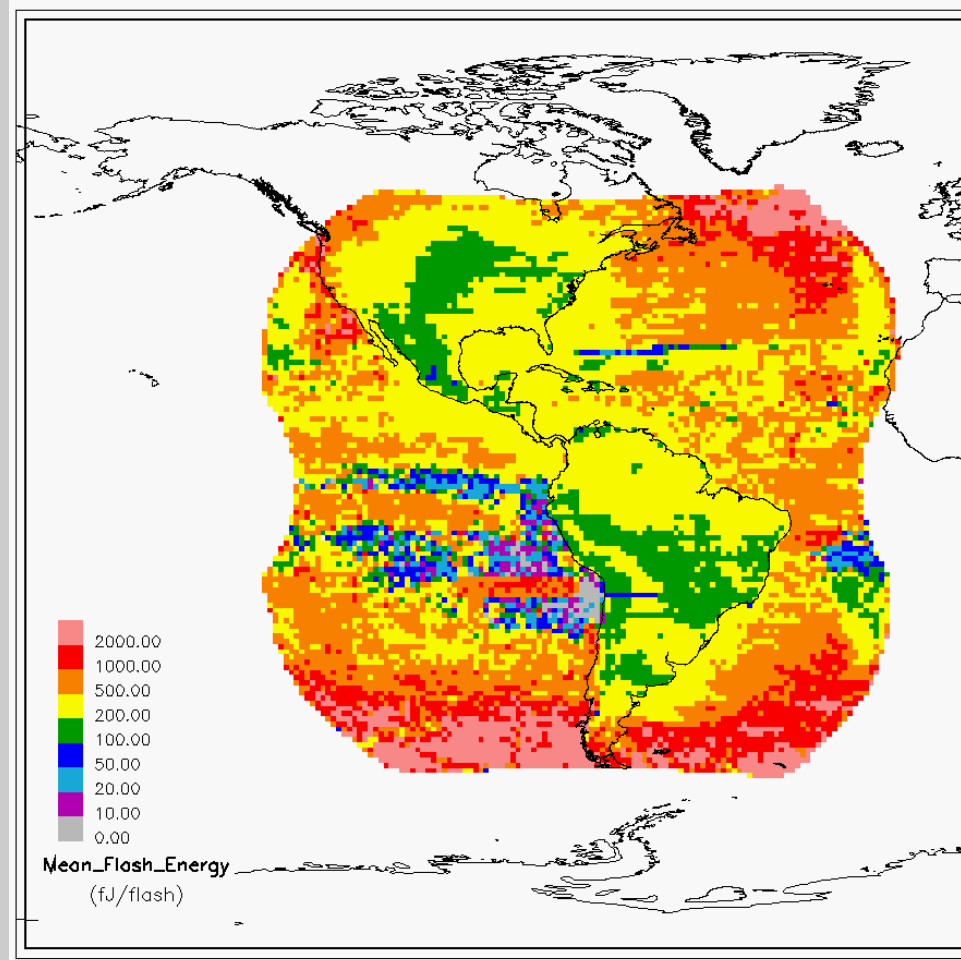
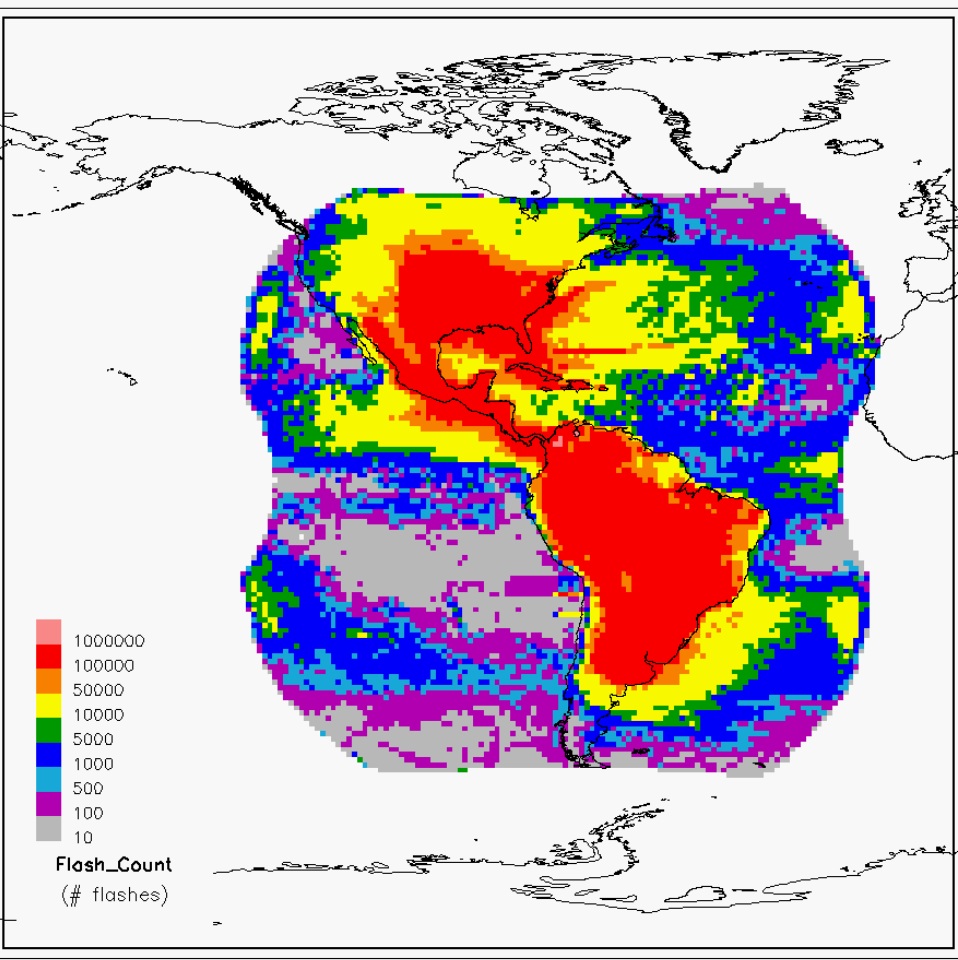
Mean Flash Energy

GLM-16

Flashes more energetic over oceans, for sufficient sample size. Agrees with TRMM/LIS findings in Beirle et al. (2014).

Flash energy increases towards limb since:

- beneath cloud bare channel detection suspected.
- Source stronger over ocean.
- Min detectable energy increases toward edge.



Spatial Variation

252 days (8.4 mo)
(04Dec2018 –
12Aug2019)

Flash Counts

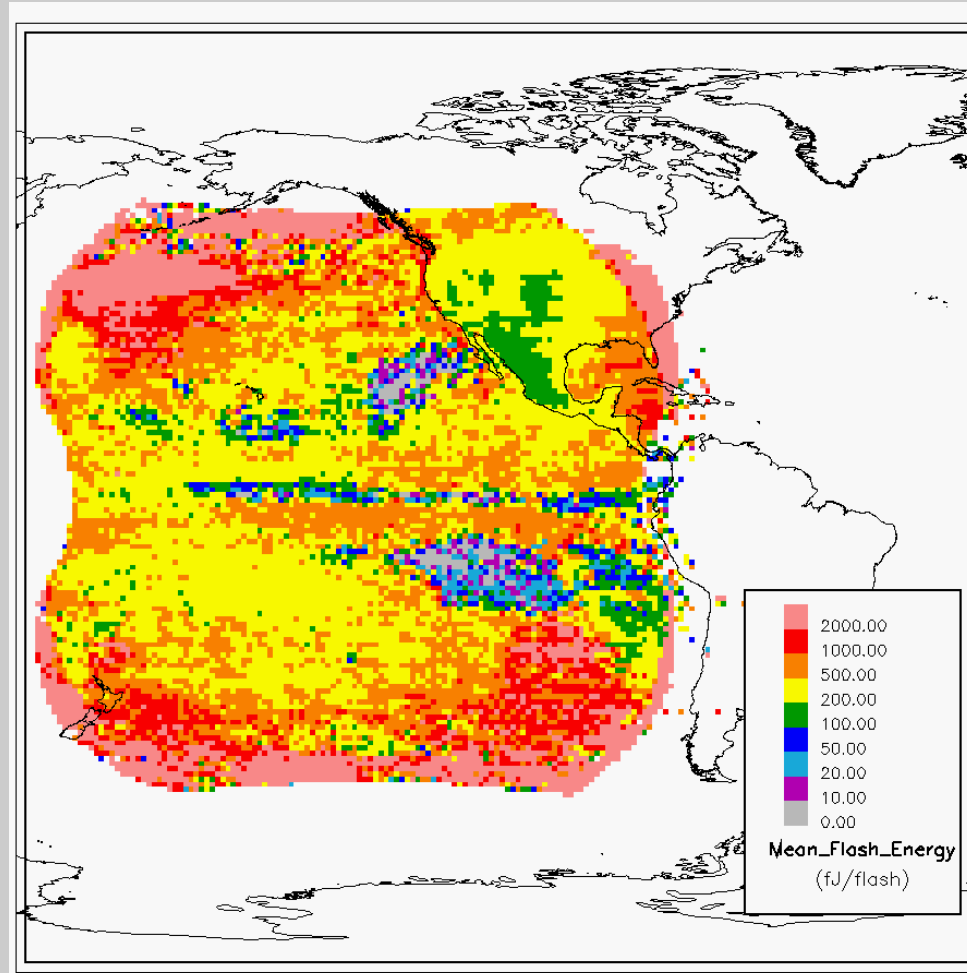
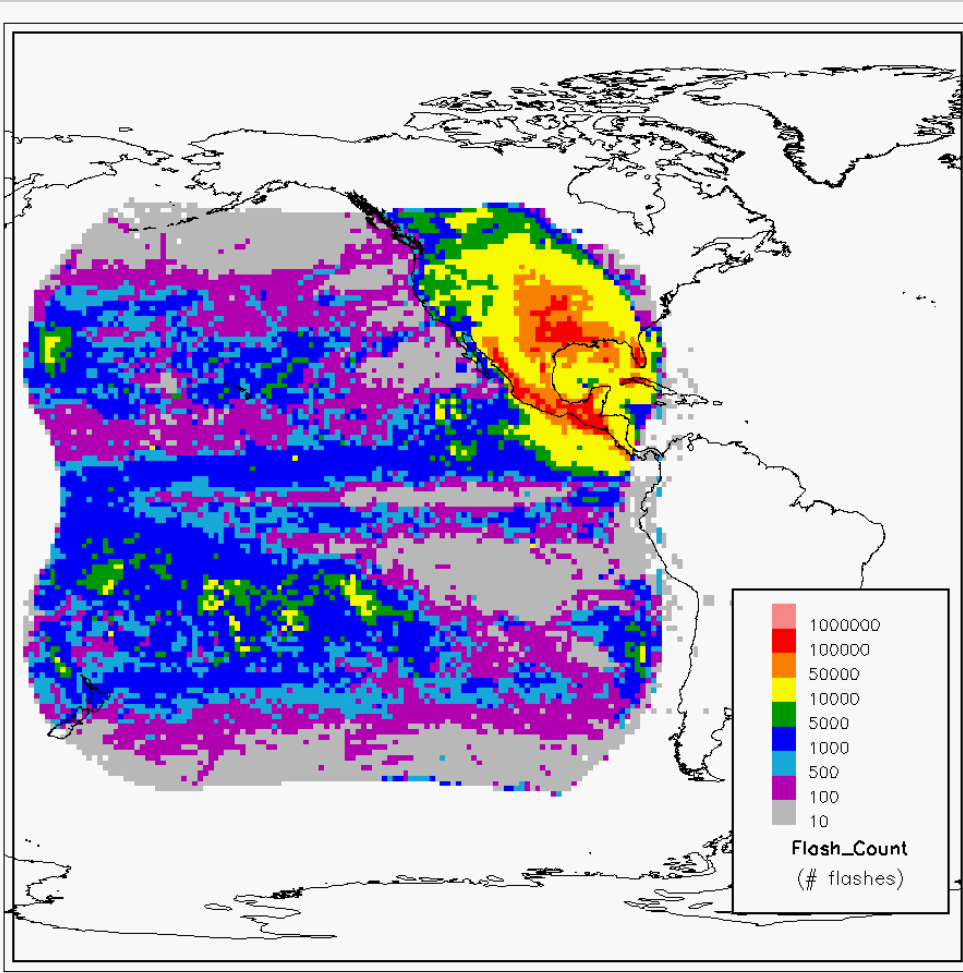
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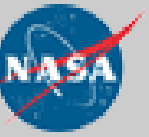
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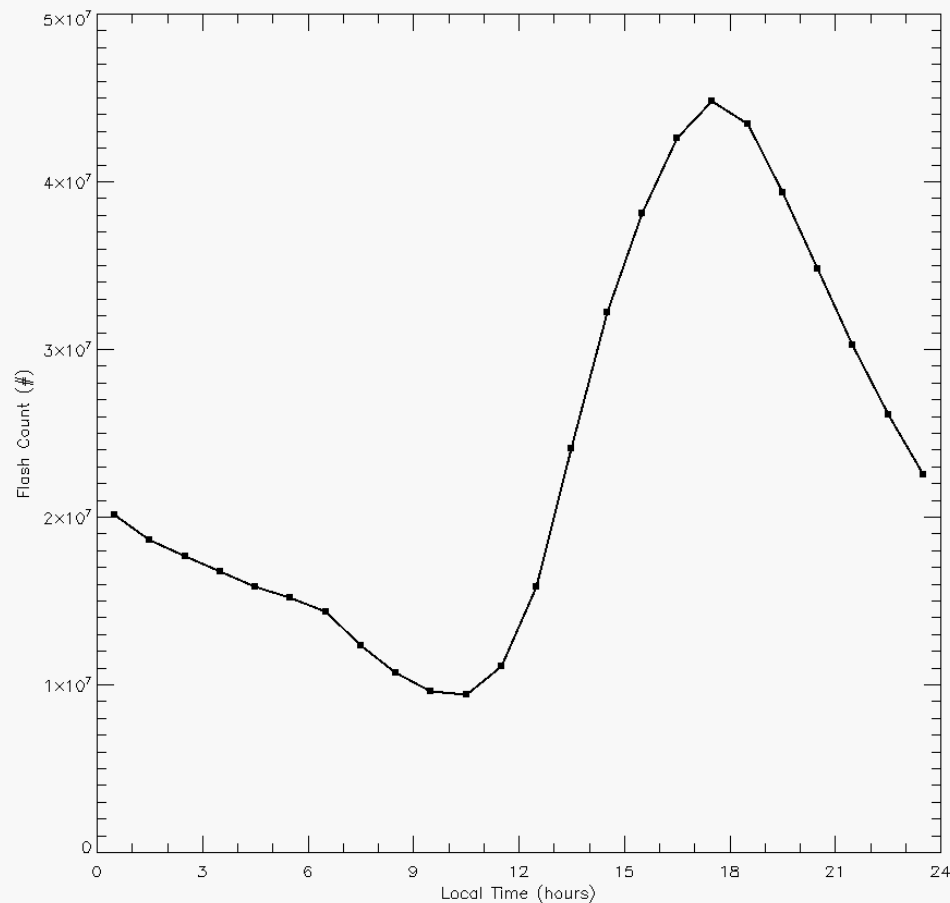
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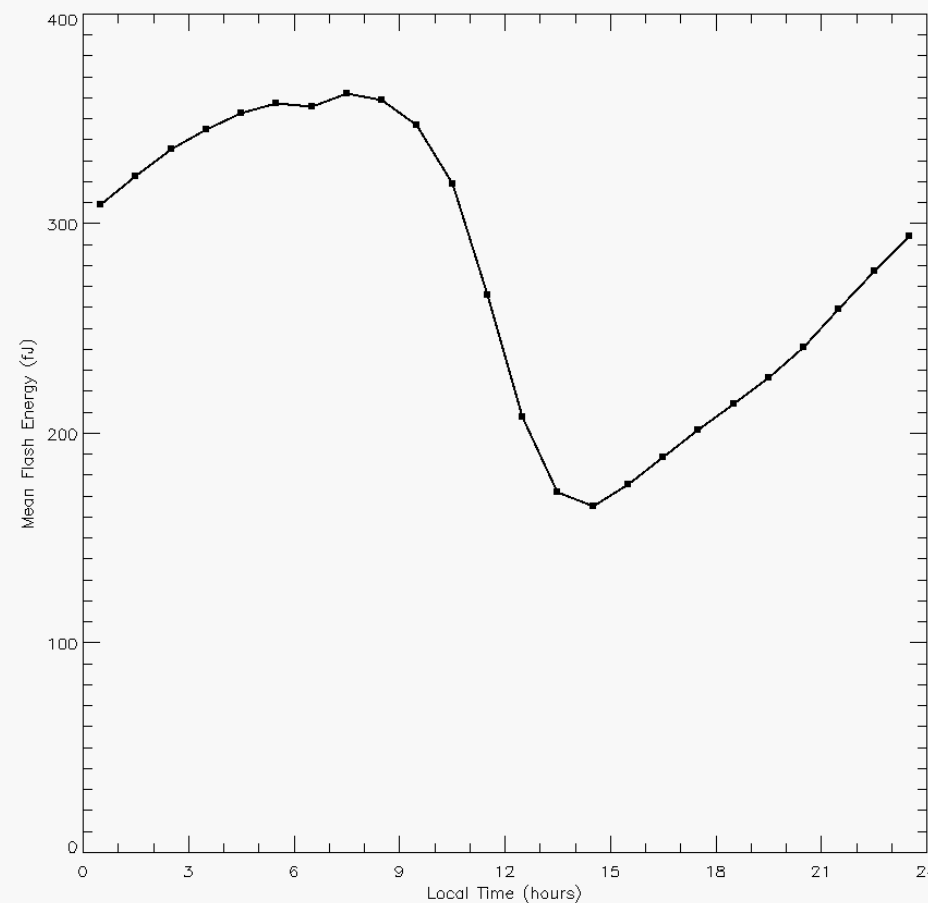
Diurnal Variation

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Flash Counts



Mean Flash Energy



GLM-16

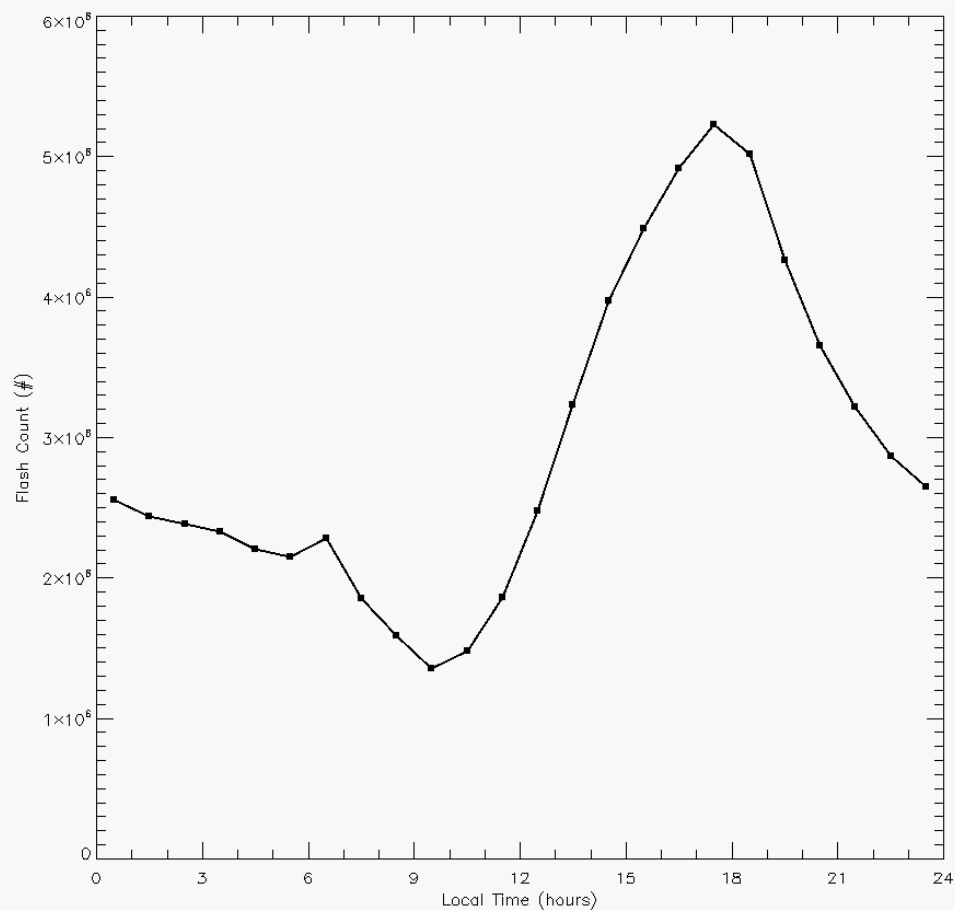
Roughly an inverse relation between flash count and mean flash energy. Agrees with TRMM/LIS findings in Chronis and Koshak (2017).



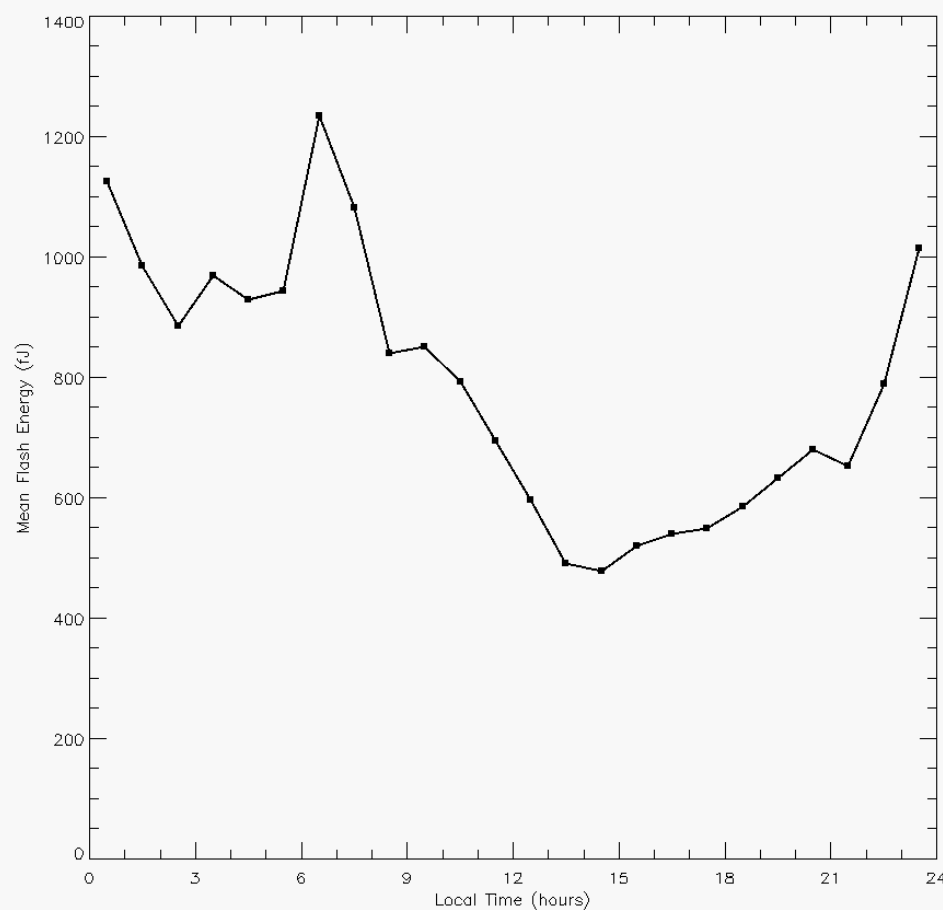
Diurnal Variation

252 days (8.4 mo)
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Flash Counts



Mean Flash Energy



GLM-17

Roughly an inverse relation between flash count and mean flash energy, but oceanic results (G17) more erratic than land (G16) in agreement with TRMM/LIS findings in Chronis and Koshak (2017), but also due to noise (see later).

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Long-Term Trend

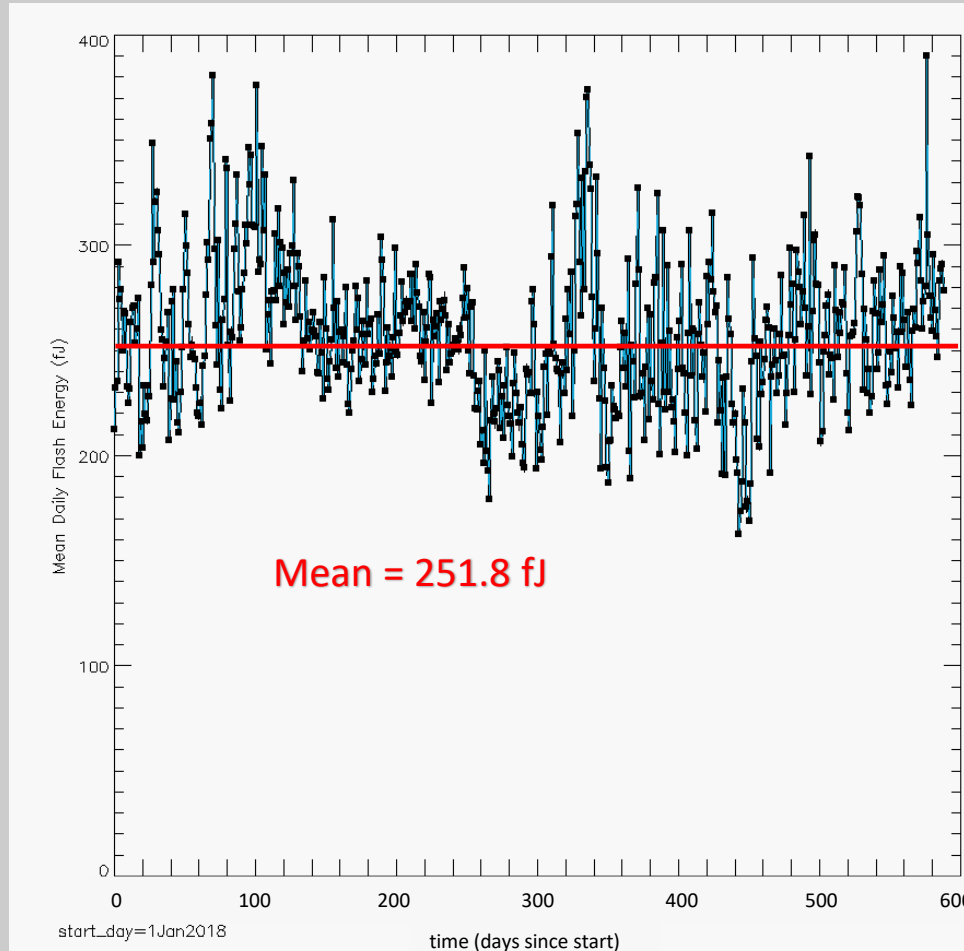
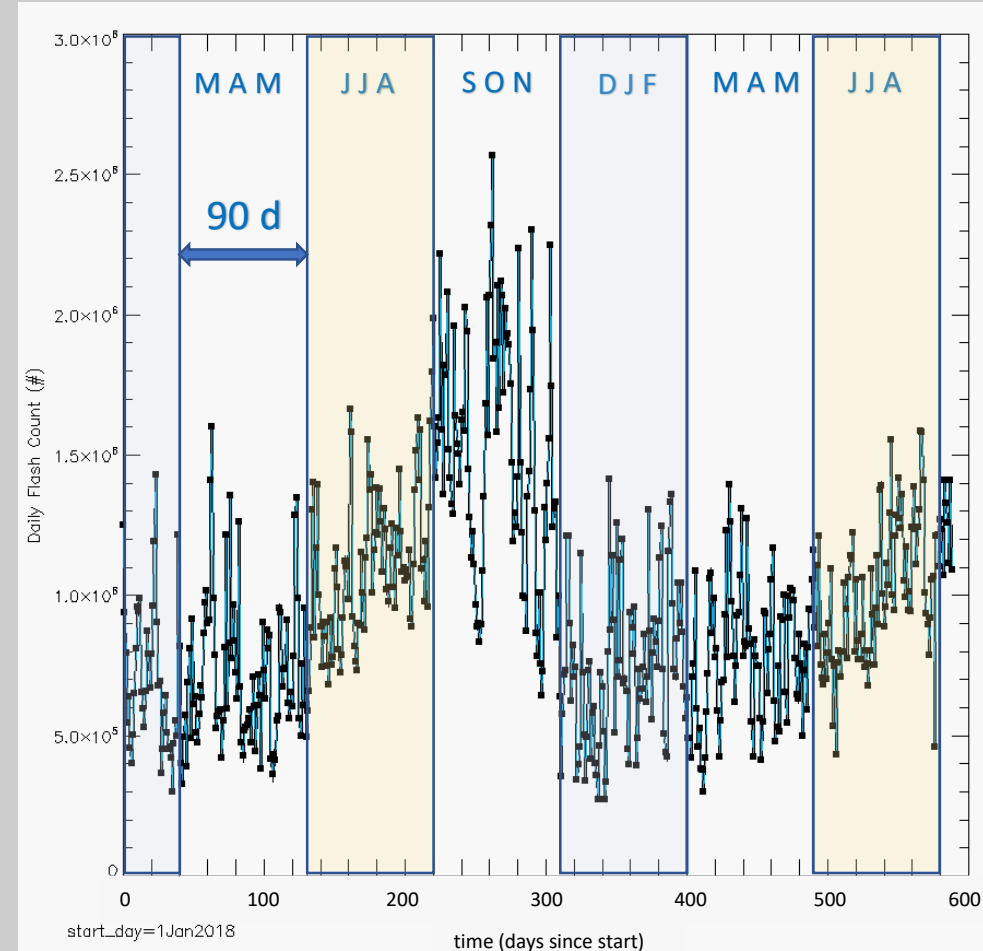
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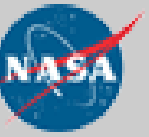
Flash Counts

Mean Flash Energy

GLM-16

- Seasonal variability in count & energy.
- Both Hemispheres Active during NH Fall (SON).
- Mean flash energy mostly driven by continental lightning.

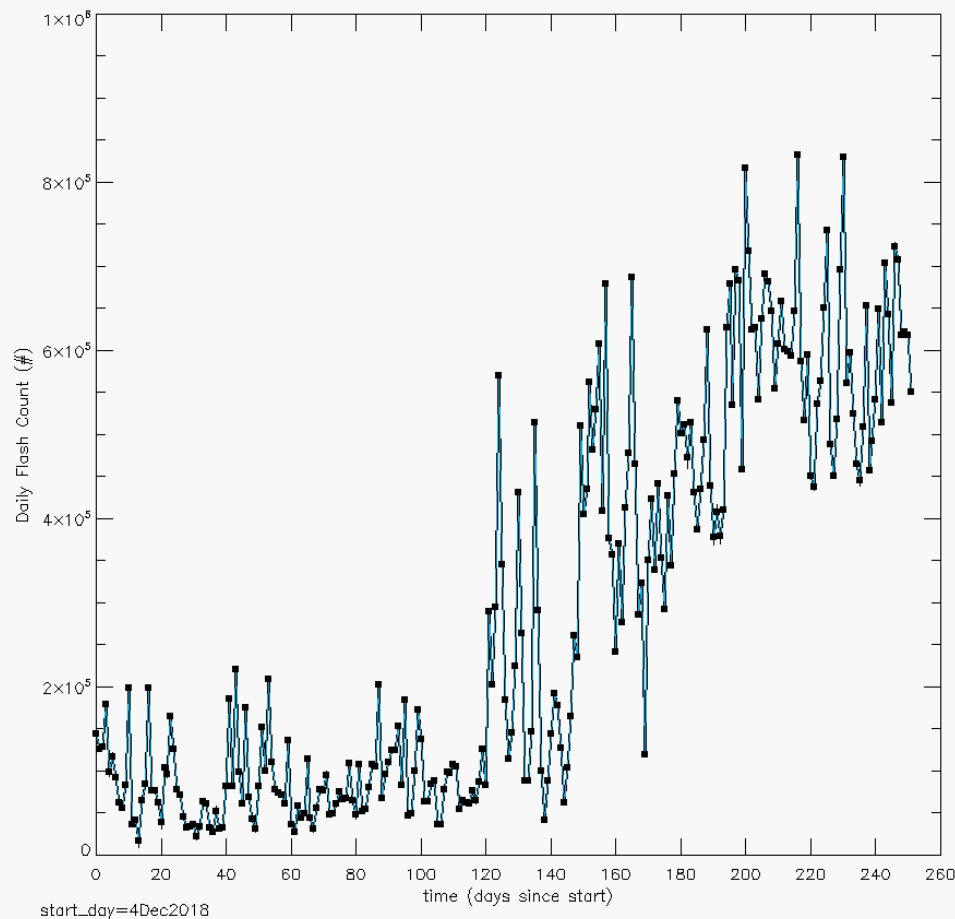




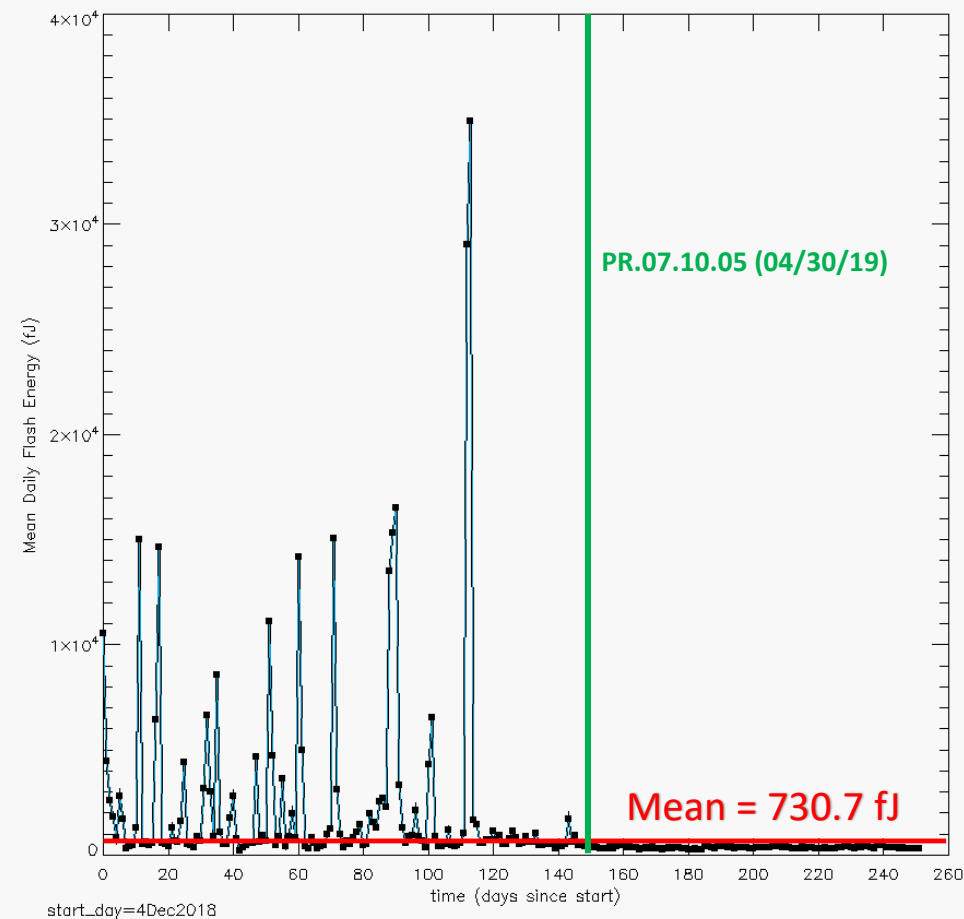
Long-Term Trend

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Flash Counts



Mean Flash Energy



GLM-17

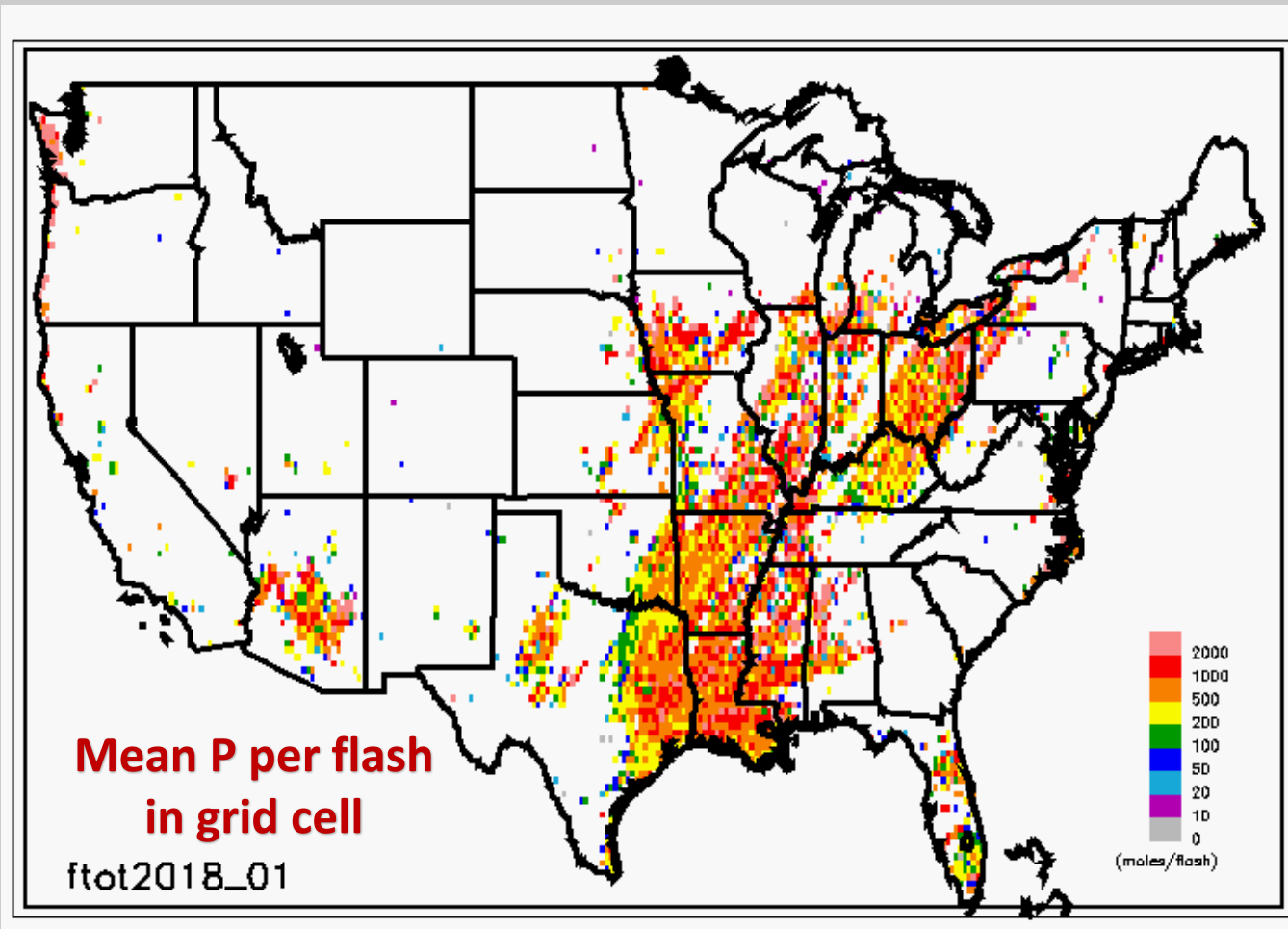
- Large energy excursions first half of period.
- PR.07.10.05 (04/30/19)
GLM-17 FM2 CDRL 79 Rev D LUT
 - Enabled contrast leakage filter with leakage fraction = 2.0
 - Updated 2nd Lev thresholds to balance threshold-to-noise ratio, to better suppress hot pixel false events, and to suppress “Bahama Bar” false lightning artifacts.

Overview

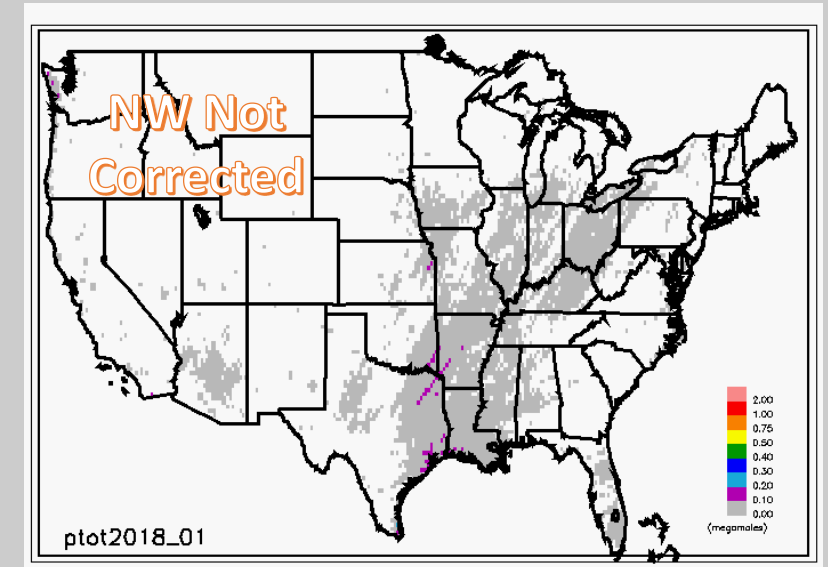
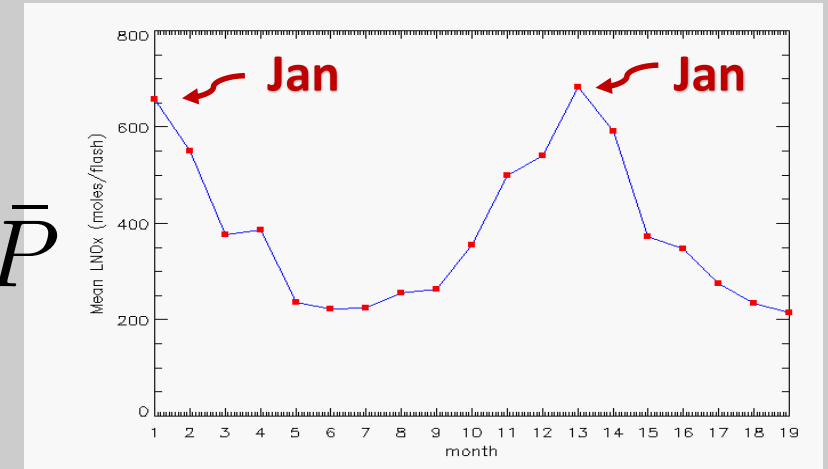
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19 mo Trend (Jan2018-Jul2019) of GLM-16 CONUS LNOx Estimate

$$P = \left[\frac{Y}{\beta N_A} \right] Q \quad (\text{in moles})$$

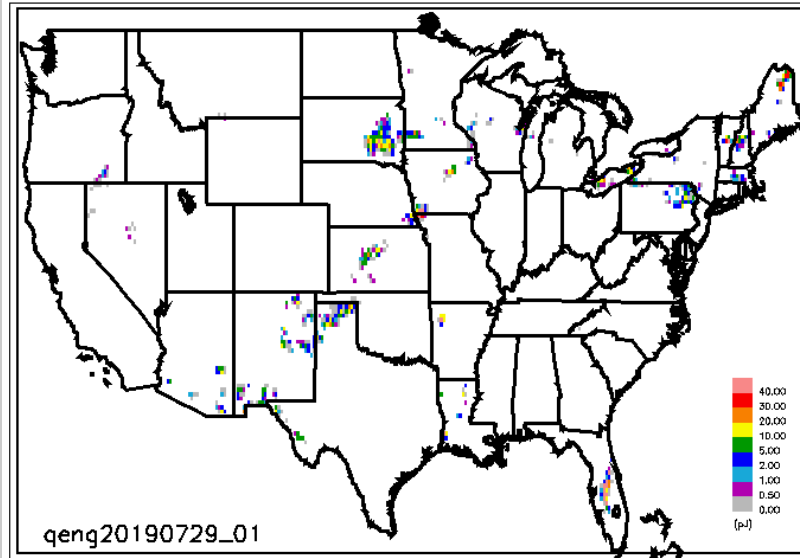
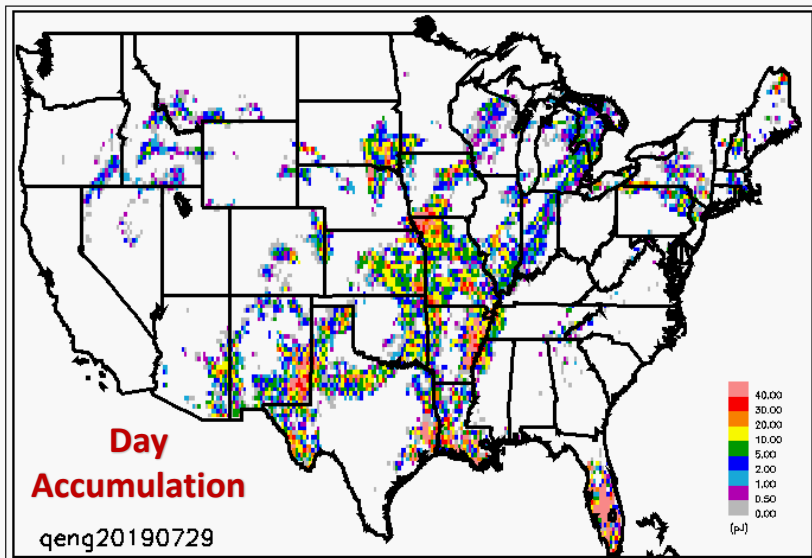


$\bar{P}$

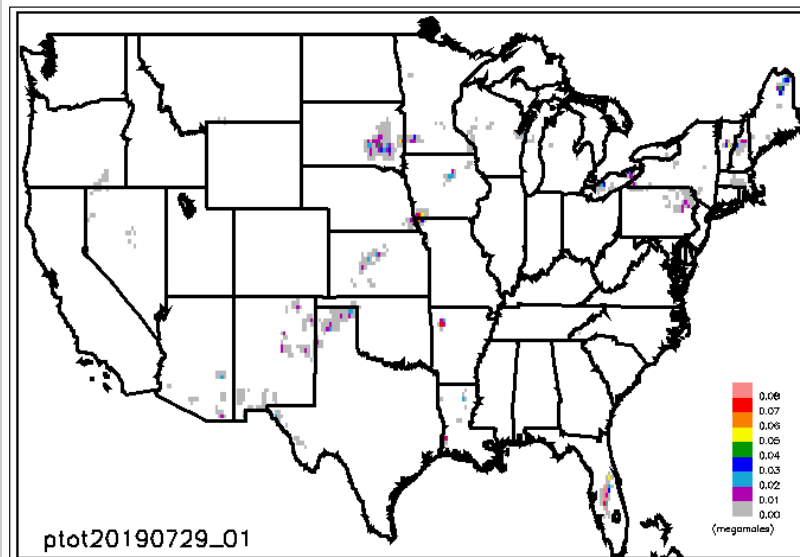
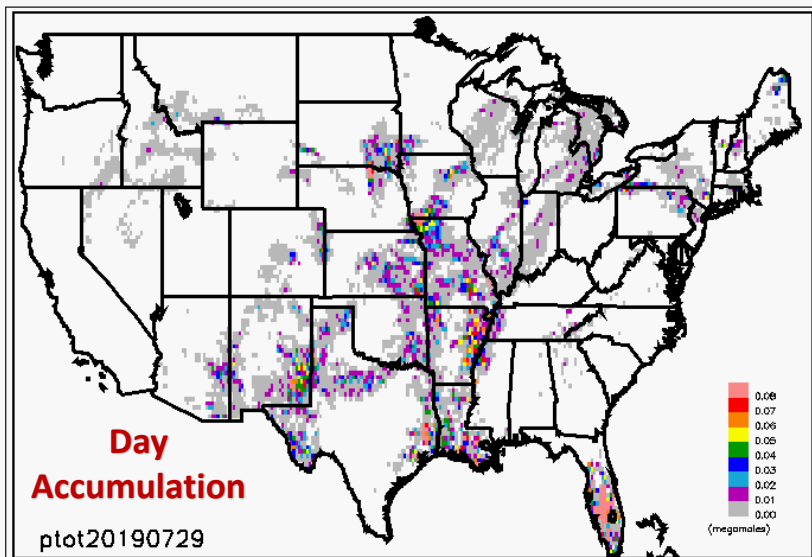


Total P from all flashes
in grid cell

Hourly Energy/LNOx for Input into CMAQ



Energy (pJ)



LNOx (Mmol)

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Huge Energies Consistent with Bare Channel Detection near FOV Edge

$$q = mj + b, \quad \rightarrow \quad m = \frac{q^* - b}{65,535}$$

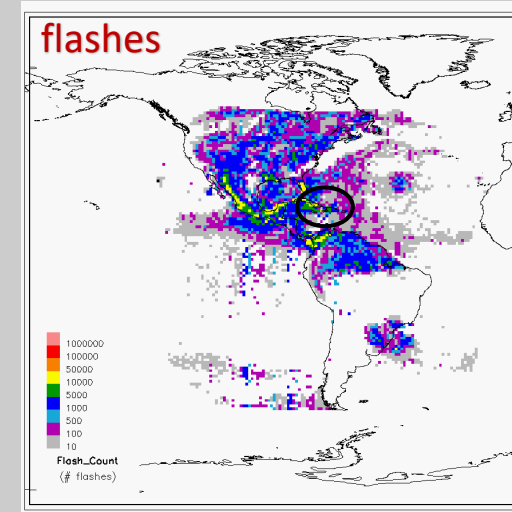
Table 1: Summary of Results for GLM.

Lightning	q^* (fJ)	Max LIS (fJ)	99.8% Level (fJ)	Recommended Values	
				m (fJ/SDN)	b (fJ)
events	1247	921.2	226	0.019024	0.28515
groups	6553	27,631.9	1207	0.099988	0.28515
flashes	65,535	202,881.0	17,460	0.999996	0.28515

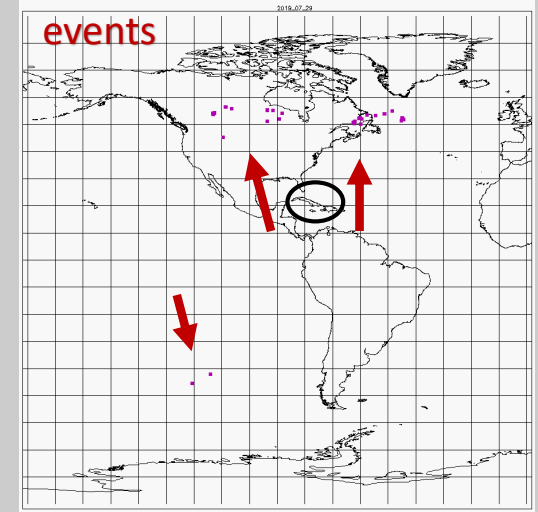
Present Values
 $m = 1.52597$
 $b = 0$

Table 2: Percent Removed by the q^* Filter.

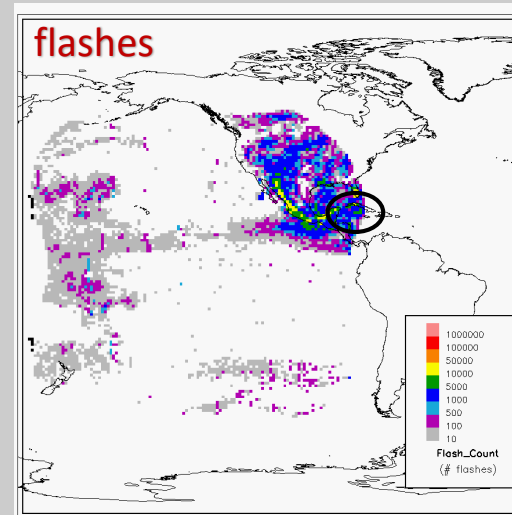
Period	#Events (filtered)	GLM-16		#Events (filtered)	GLM-17	
		#Groups (filtered)	#Flashes (filtered)		#Groups (filtered)	#Flashes (filtered)
July 26	223	24	0	949	80	7
July 27	105	10	3	2699	53	1
July 28	101	6	0	1162	54	1
July 29	71	12	0	1257	67	2
July 30	33	3	0	2578	150	0
July 26-30	533	55	3	8645	404	11
Count	227,791,072	83,730,417	4,729,247	81,672,826	32,481,803	2,531,028
Percent	0.0002	0.00007	0.00006	0.01	0.001	0.0004



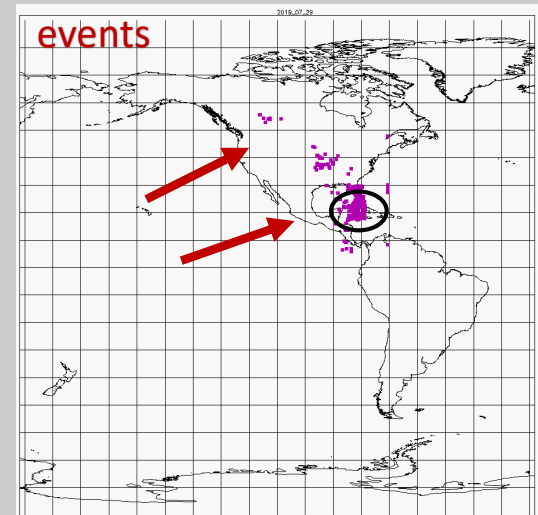
G16: 26-30 July 2019



GLM-16: 29 July 2019



G17: 26-30 July 2019



GLM-17: 29 July 2019