The CLEAR Benchmark Dataset v1.0: Description and Products

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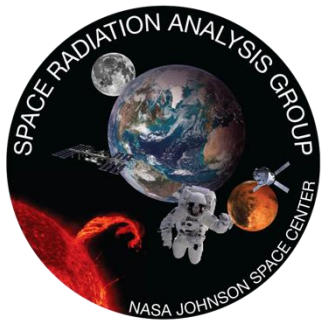
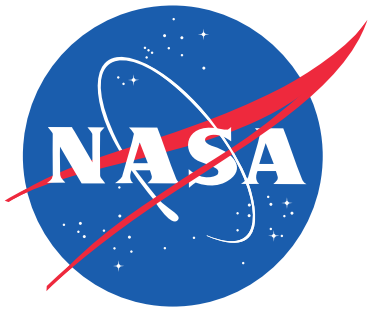




Contents

Goals of the CLEAR Benchmark Dataset

- Develop a high-quality solar energetic particle (SEP) dataset for model development and validation for the CLEAR Center and the research community

- Apply consistent and reproducible SEP event definitions with FetchSEP (https://github.com/ktindiana/fetchsep)

- Provide extensive information about each SEP event
  - Comprehensive proton flux quantities
  - Flare, CME, etc associations from a list compiled by Steve Johnson at NASA JSC Space Radiation Analysis Group (SRAG)
  - Additional flare and CME associations from Ian Richardson's SEP list

- Automated list generation for reproducibility and ease of updating

Links

- Benchmark dataset webpage hosted by CCMC
  https://ccmc.gsfc.nasa.gov/swxcoe-clear/view_clear_csv.php

- CLEAR Center deliverables to CCMC
  https://ccmc.gsfc.nasa.gov/swxcoe/clear/

- CLEAR website
  https://clear.engin.umich.edu

- FetchSEP git repo (general and dataset v1.0 release)
  https://github.com/ktindiana/fetchsep
  https://github.com/ktindiana/fetchsep/releases/tag/CLEAR_Benchmark_v1.0

Overview of Dataset Products

Overview of the Dataset

- **Product of the CLEAR Space Weather Center of Excellence**
- Two SEP lists: Operational (1.7 MB) and Energy-bin calibrated (426 KB)
- Full dataset (2.53 GB zip file,13.1 GB unzipped)
- GOES-06, -07, -08, -10, -11, -13, -15 archived fluxes from NOAA, and GOES-16 to -19 real-time fluxes archived on iSWA
- Spans the date range 1986-01-01 to 2025-09-10
- Proton information produced with the FetchSEP python package
- Flare, CME, radio, shock information compiled by Steve Johnson and Ian Richardson
- Users can choose to generate the Benchmark dataset from scratch using deployment scripts in the FetchSEP github repository (~24 hours processing time with a stable internet connection, generates ~25 GB of data) https://github.com/ktindiana/fetchsep

CLEAR Benchmark Dataset Lists

Operational list

- For statistical analysis, development and validation of models with the goal of predicting operational values, and as a historical record of operational values
  - Integral fluxes from NOAA archives for GOES-06 to GOES-19 spacecraft
    - Each GOES spacecraft time series processed independently
    - SEP event information selected from the primary spacecraft for final list
    - January 1986 to September 2025

Energy-bin calibrated list (GOES cross-calibrated with IMP-8 and PAMELA)

- For scientific studies, model development and validation for scientific purposes, and dosimetry calculations
  - Differential, background-subtracted, cross-calibrated GOES fluxes with Sandberg et al. 2014 and Bruno 2017 effective energies
    - >10, >100, >30, >50 MeV fluxes are estimated from differential channels
    - GOES-13 and GOES-15 time series processed independently
    - SEP event information selected from the primary spacecraft into final list
    - May 2010 to September 2017

The Full Dataset

Proton Flux Background

- For each GOES satellite:
  - Time series of original fluxes for full history of satellite (5 min cadence)
  - Time series of calculated mean background
  - Time series of sigma and threshold (mean + 3sigma)
  - Time series of enhanced-only fluxes with background values set to zero
  - Diagnostic plots and visualizations showing mean background, all high points, and points identified as SEP enhancements

SEP Event Information

- For each GOES satellite:
  - List of SEP events
  - List of non-event (quiet) time periods
  - JSON + txt files in the CCMC SEP Scoreboard schema and used in SPHINX for validation
  - Plots of total, background-only, and enhanced-only fluxes, and SEP event definitions
  - Plots of Weibull fits when onset peak is calculated
- Two summary SEP event lists drawn from the primary satellite at the time of the SEP event

Each product is described in further detail in later slides.

SEP Event Definitions

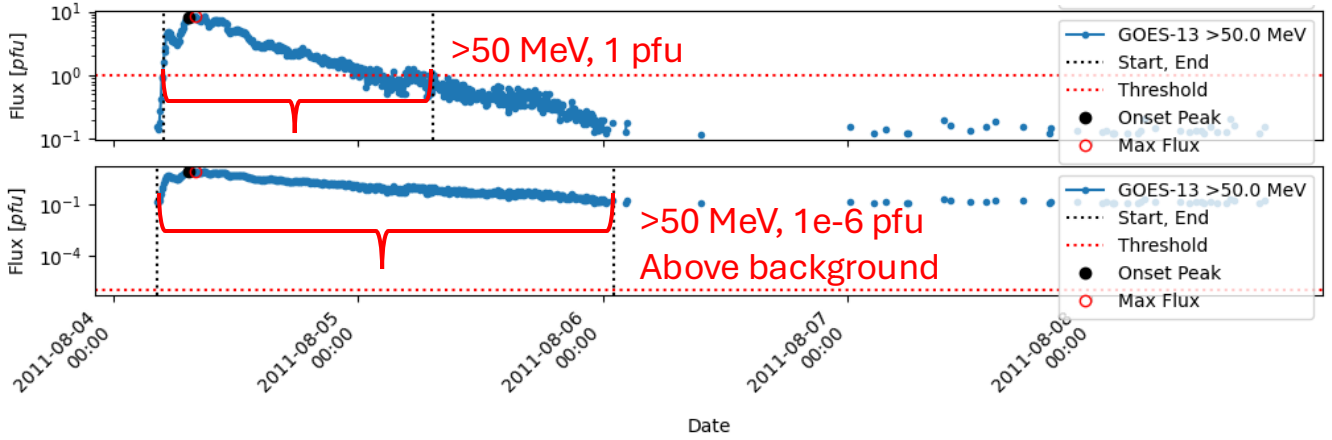
Threshold Crossings

- Operational event definitions:
  - >10 MeV, 10 pfu (SWPC, SRAG EVA)
  - >100 MeV, 1 pfu (SRAG)
  - >30 MeV, 1 pfu (situational awareness)
  - >50 MeV, 1 pfu (situational awareness)

Above Background

- SEP event above background is indicated by an arbitrary low threshold of 1e-6 pfu:
  - >10 MeV, 1e-6 pfu
  - >100 MeV, 1e-6 pfu
  - >30 MeV, 1e-6 pfu
  - >50 MeV, 1e-6 pfu

>50 MeV Event Definitions



Provided values:

- SEP Start and End Times
- Onset peak (when available)
- Maximum flux
- SEP fluence spectrum
- SEP time series
- Duration
- Rise time to peak/max

Methodology to Produce Dataset

Workflow to Create the Benchmark Dataset

- Analyze the time series of each GOES satellite independently

Using FetchSEP > IDSEP:

- ➢Calculate the particle flux background at every time step
- ➢Identify SEP enhancements above background

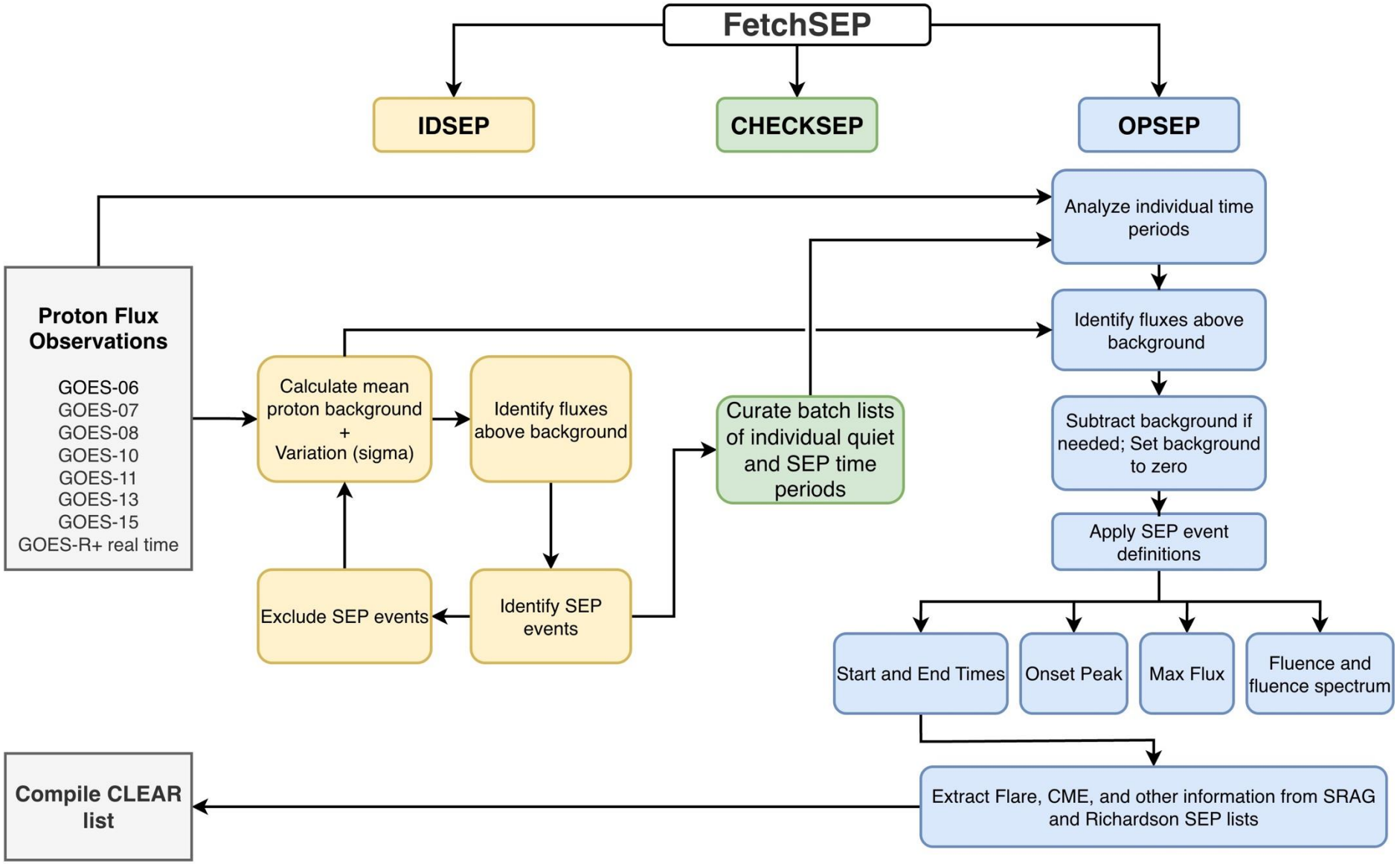
Using FetchSEP > CHECKSEP

- ➢Curate lists of time periods that separate the time series into quiet periods and SEPs with **only one SEP event per time period** (batch lists, already curated and provided for CLEAR)

Using FetchSEP > OPSEP:

- ➢Analyze each time period and calculate parameters for each SEP event
- ➢For the operational dataset, set all values identified as background to zero
- ➢For the energy-bin calibrated dataset, subtract the mean background then set all values identified as background to zero
- ➢Associate each SEP event with flare, CME, radio, etc information using reference lists from Steve Johnson (SRAG) and Ian Richardson (University of Maryland)

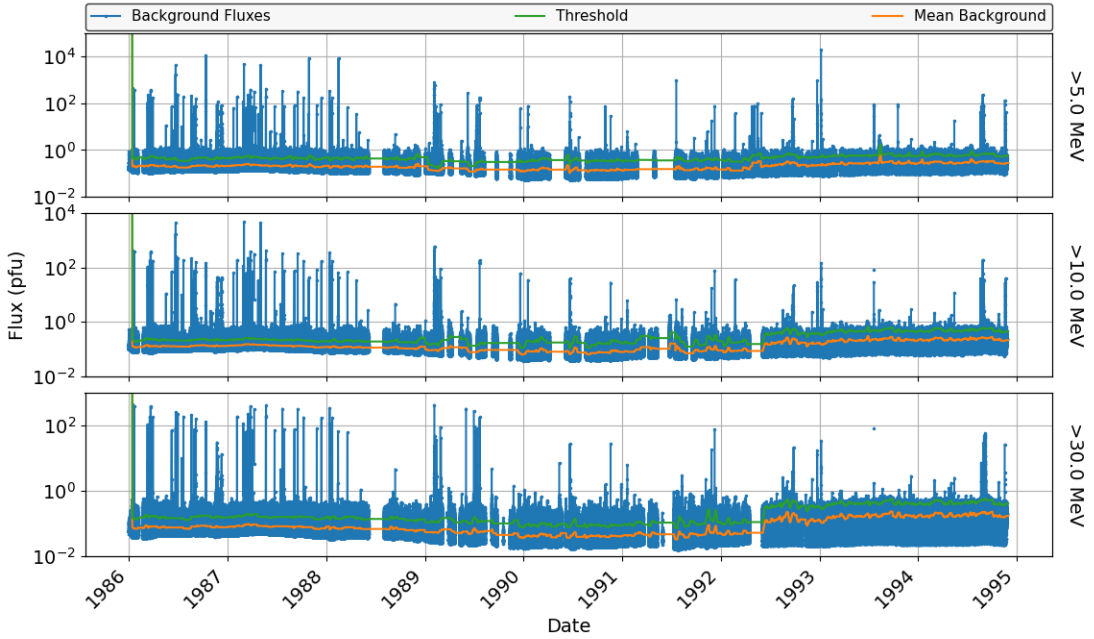
Workflow to Create Benchmark Dataset



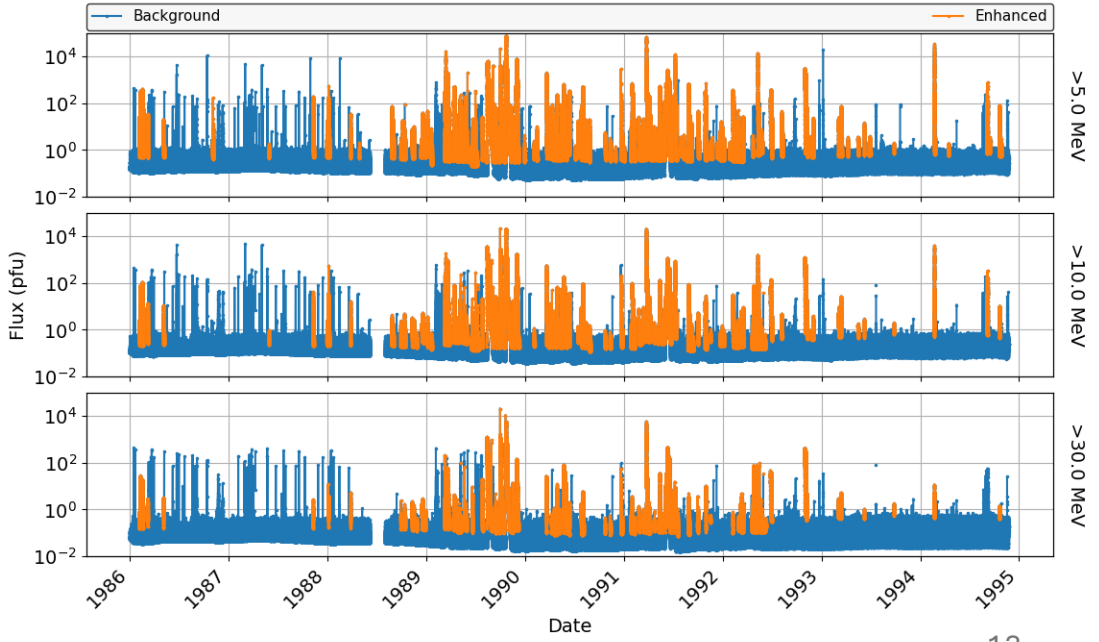
Procedure to Create the Benchmark Dataset

- Run FetchSEP > IDSEP to download the data and **calculate the mean background and sigma** for every point in time; important parameters specified in fetchsep.cfg
- Avoid “pollution” from spikes or poor-quality measurements with quality checks
- Create a rough list of SEP event enhancements
- Procedure iterated 3 times to generate robust results (files labeled it0, it1, it2)

Mean background for GOES-06 with SEP periods removed

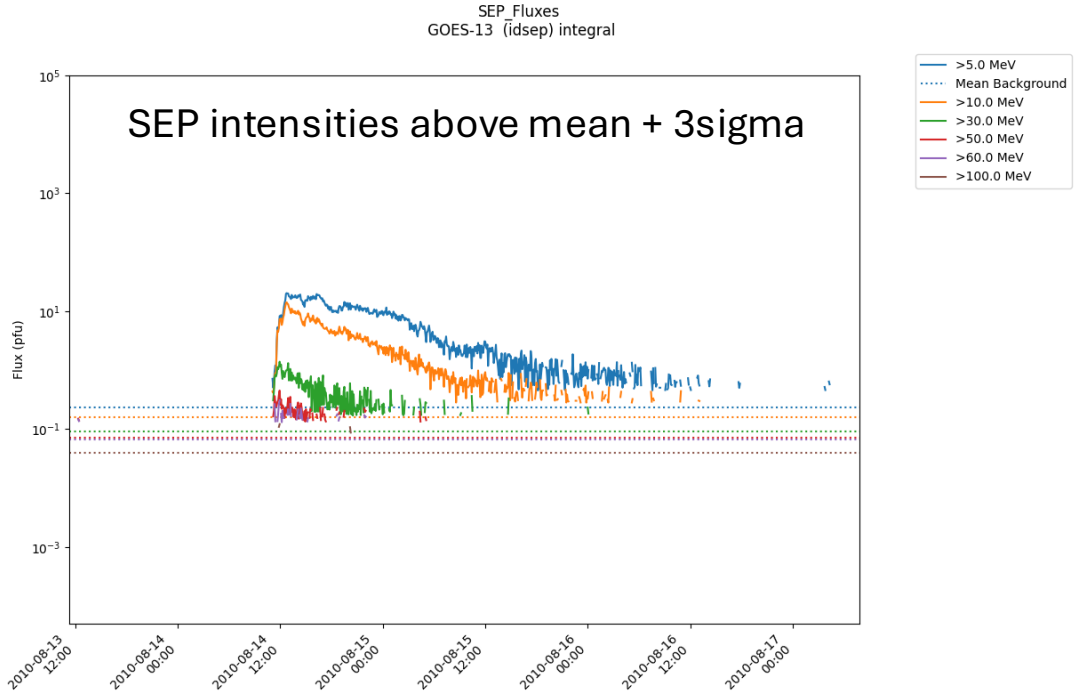


Enhancements identified as SEP events

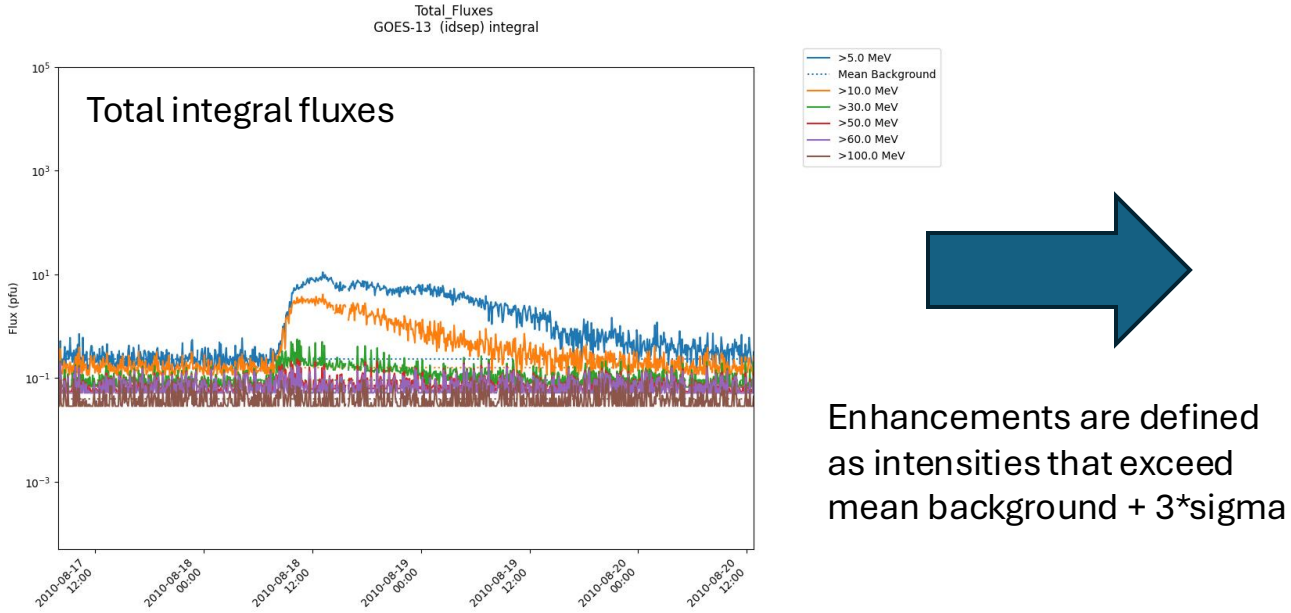


Procedure to Create the Benchmark Dataset

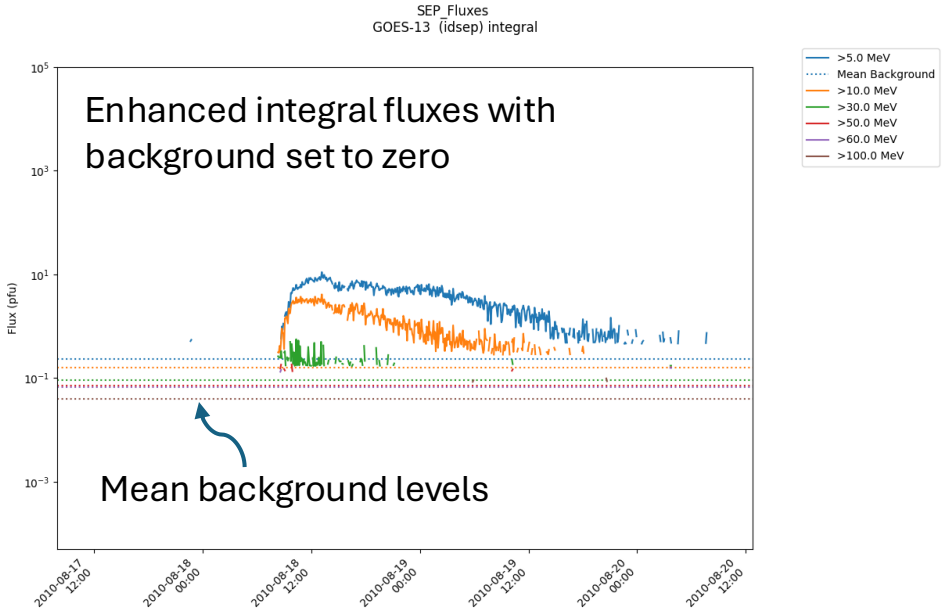
- Use FetchSEP > CHECKSEP visualization GUI to curate batch lists of individual SEP event and non-event (quiet) periods; curated lists are saved in the git repo in fetchsep/reference/CLEAR https://github.com/ktindiana/fetchsep/tree/main/fetchsep/reference/CLEAR
- Run FetchSEP > OPSEP for each time period using the mean background and sigma calculated with IDSEP to identify SEP enhancements (and perform background subtraction, as appropriate)



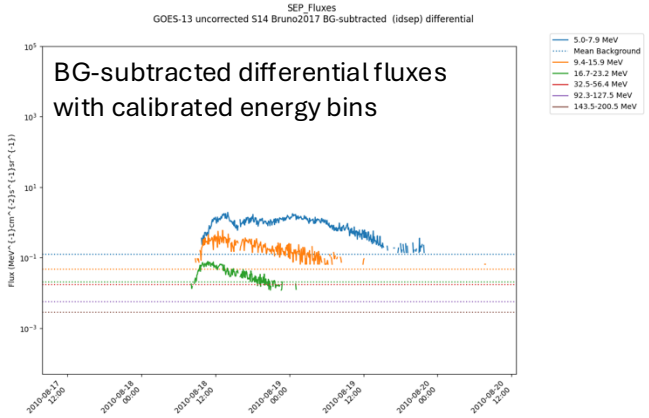
Identification of Background and SEP Enhancements



Enhancements are defined as intensities that exceed mean background + 3*sigma

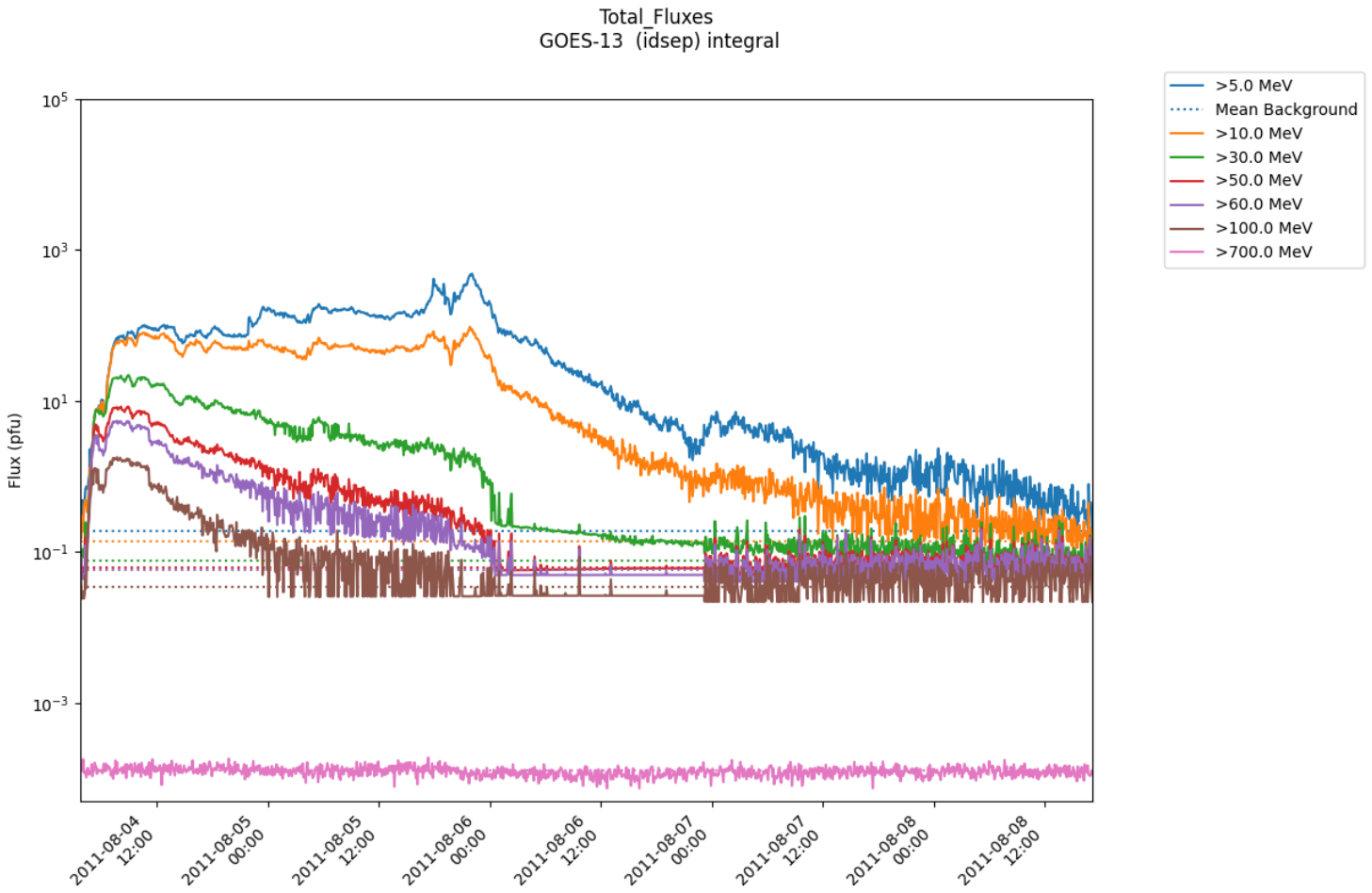


- For the Operational List, no background subtraction was performed. The background fluxes were identified and set to zero.
- For the Energy-bin Calibrated List, background subtraction was performed on the GOES differential fluxes, then all points identified as background were set to zero. Calibrated energy bins (Sandberg et al. 2014, Bruno 2017) were applied and fluxes were converted to integral fluxes.



NOAA provides “corrected” and “uncorrected” differential fluxes (removal of electron contamination). Sandberg et al. (2014) and Bruno (2017) energy-bin calibrations were performed for uncorrected fluxes, so uncorrected fluxes were used here. Additionally, GOES-13 and -15 have East and West-facing EPEAD detectors. The West-facing detector was chosen.

Example: Separation of Background and SEP Enhancements - GOES integral fluxes



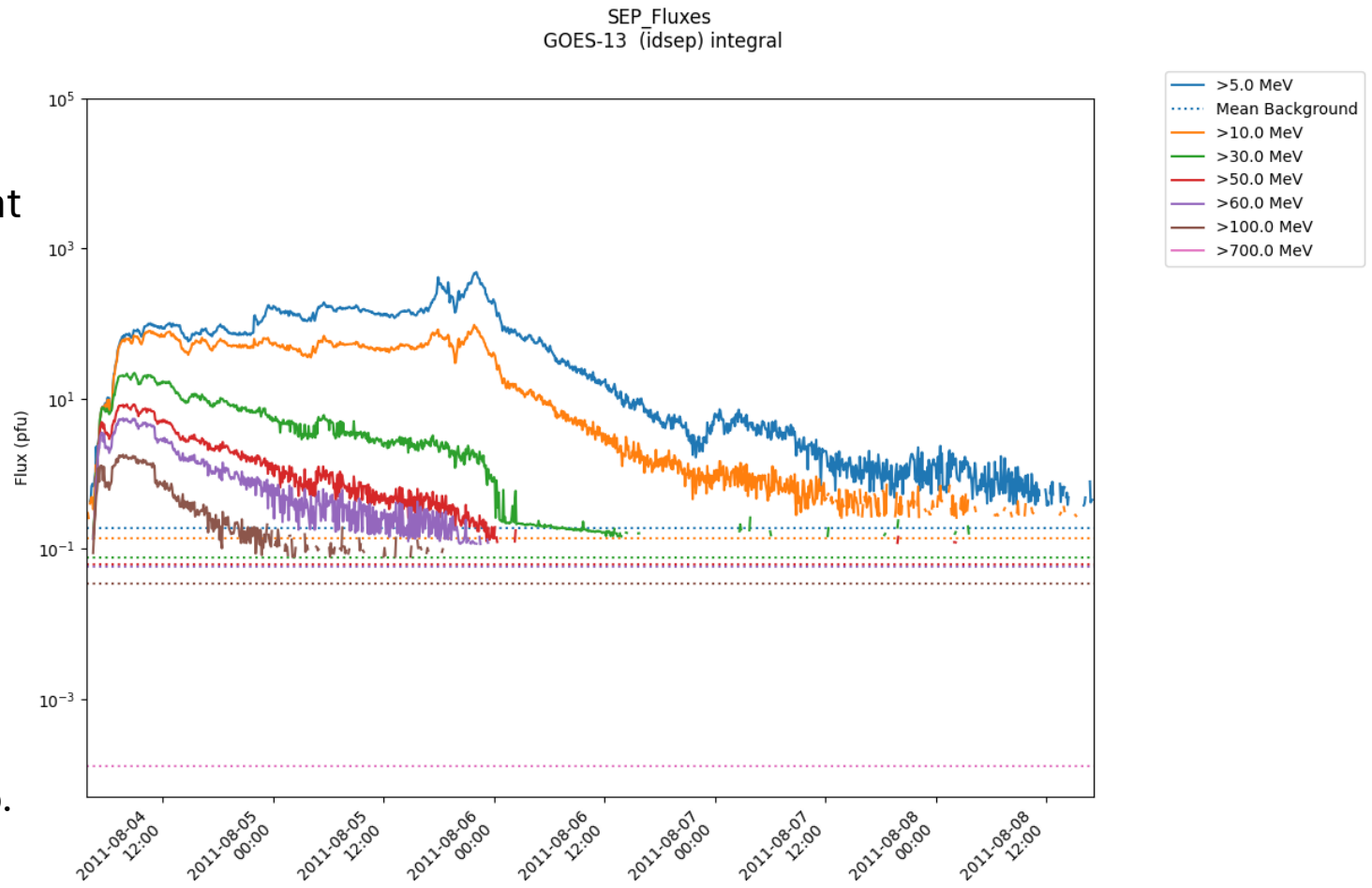
Example: Separation of Background and SEP Enhancements - GOES integral fluxes

Enhancements are defined as intensities that exceed mean + 3sigma

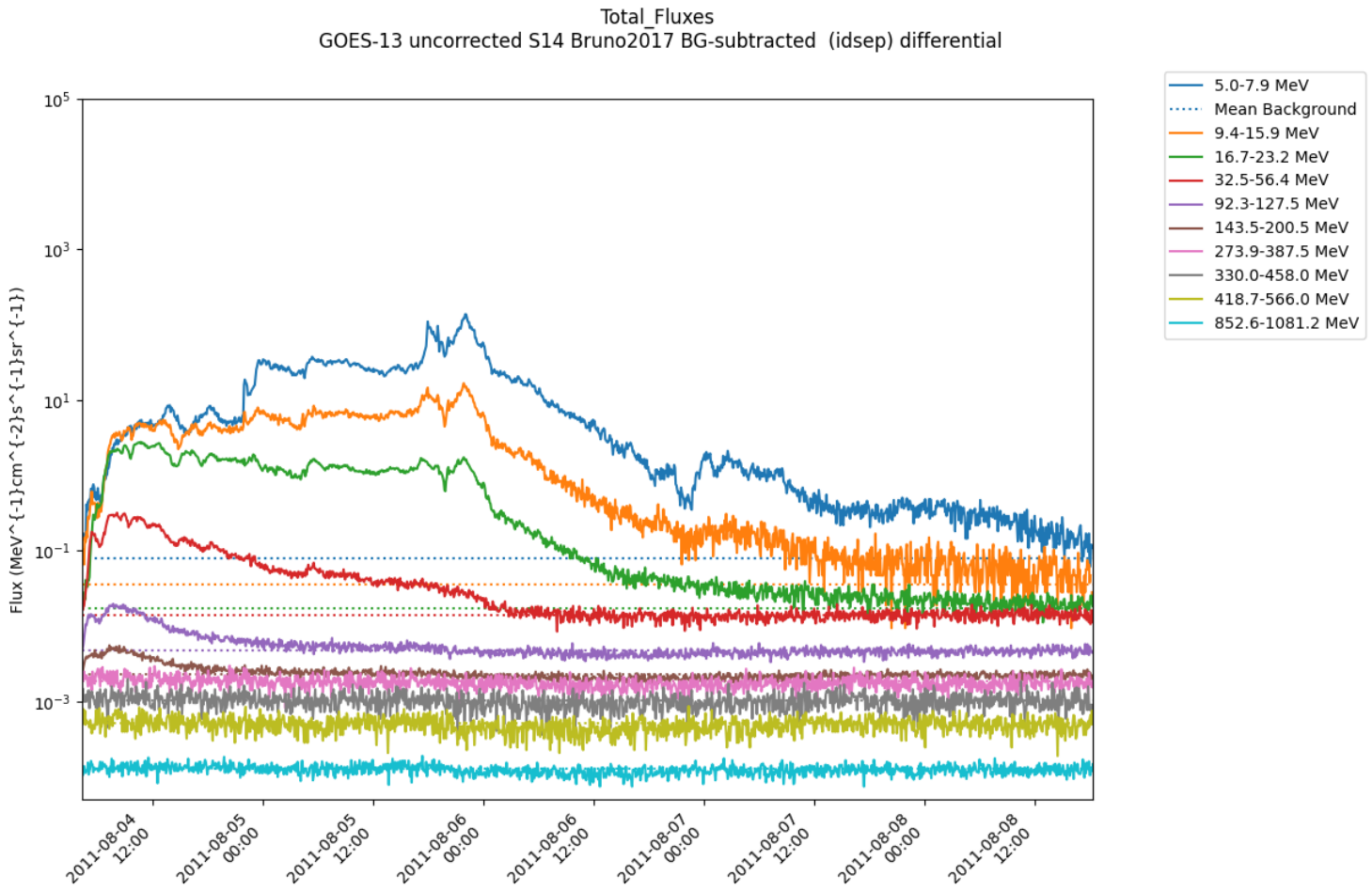
For GOES integral fluxes from NOAA, the enhanced fluxes and background were simply separated.

No background subtraction was performed.

Fluxes identified as background were set to zero.



Example: Separation of Background and SEP Enhancements – GOES Energy-Bin Calibrated

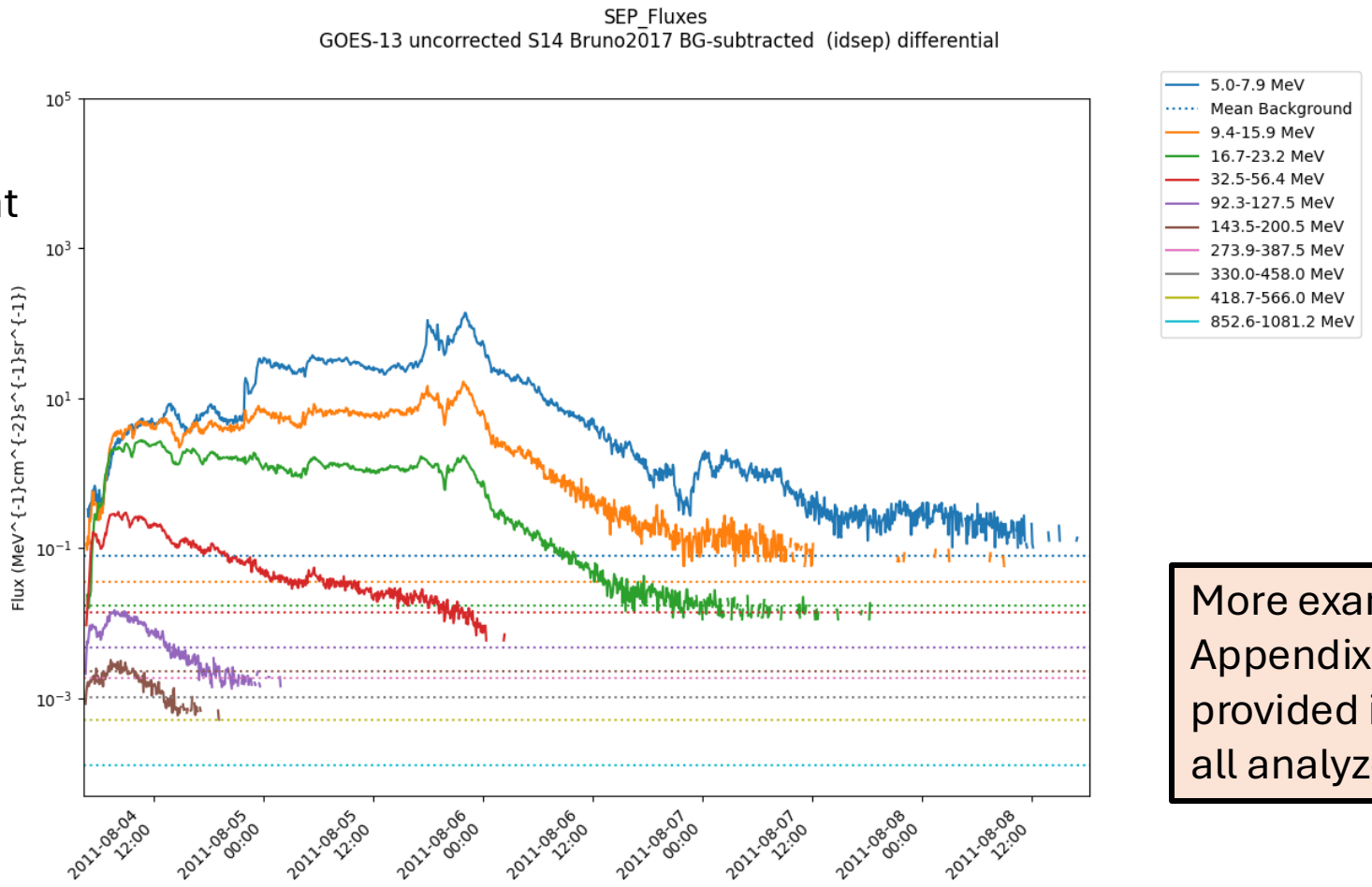


Examble: Separation of Background and SEP Enhancements – GOES Energy-Bin Calibrated

Enhancements are defined as intensities that exceed mean + 3sigma

For GOES differential, energy bin-calibration fluxes, background subtraction was performed on the differential fluxes.

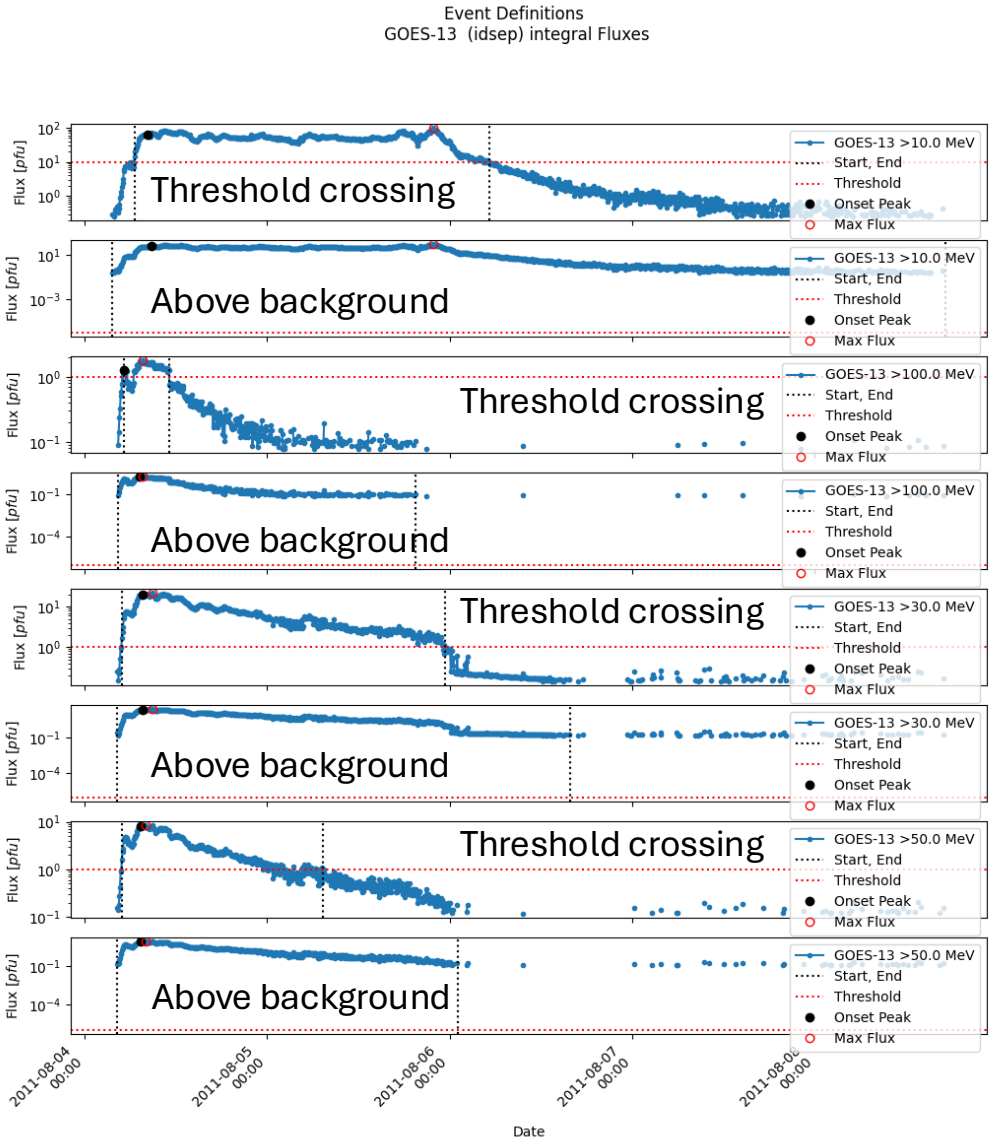
The differential fluxes were later converted to integral fluxes for >10, >100, >30, >50 MeV.



More examples in Appendix. Similar plots are provided in the dataset for all analyzed time periods.

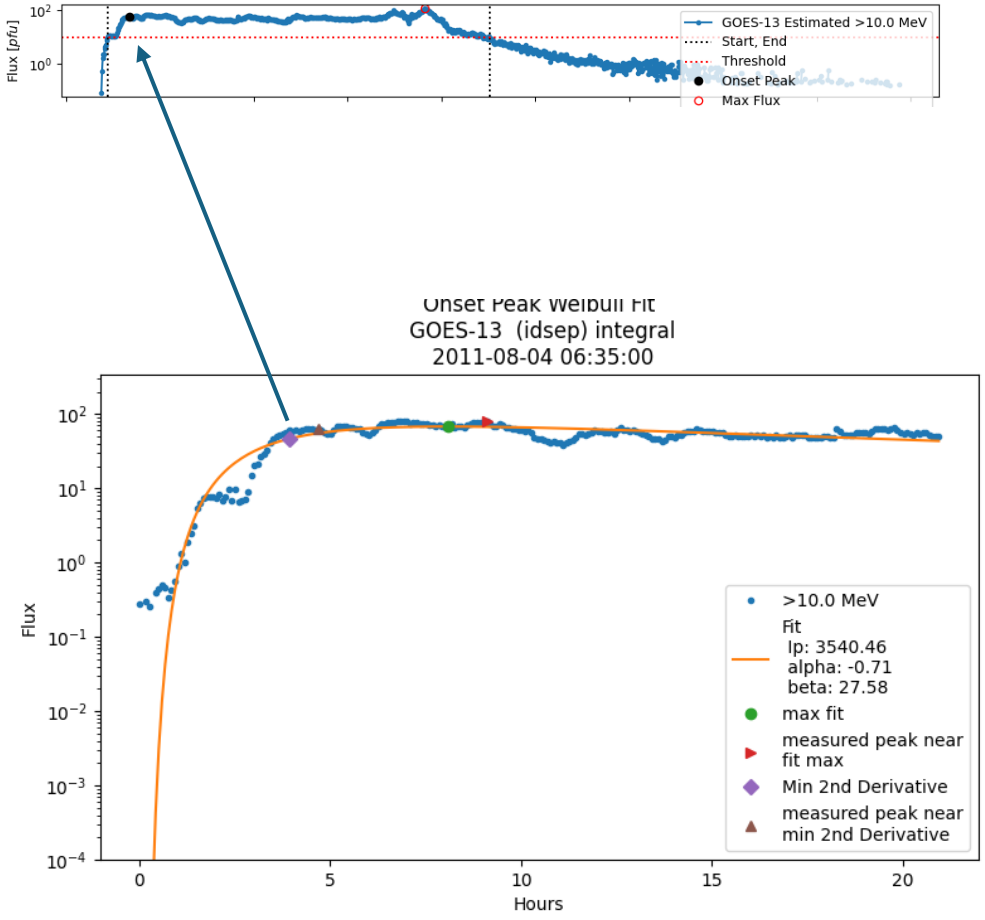
SEP Event Identification

- Threshold crossings identified by 3 consecutive points above threshold
  - >10 MeV, 10 pfu
  - >100 MeV, 1 pfu
  - >30 MeV, 1 pfu
  - >50 MeV, 1 pfu
- SEP enhancements above background require a certain number of non-zero points for a few hours (criteria printed in logs)
  - Avoid identifying noise as SEP
  - Applied a threshold of 1e-6 pfu chosen because it is a small number and background flux is set to zero



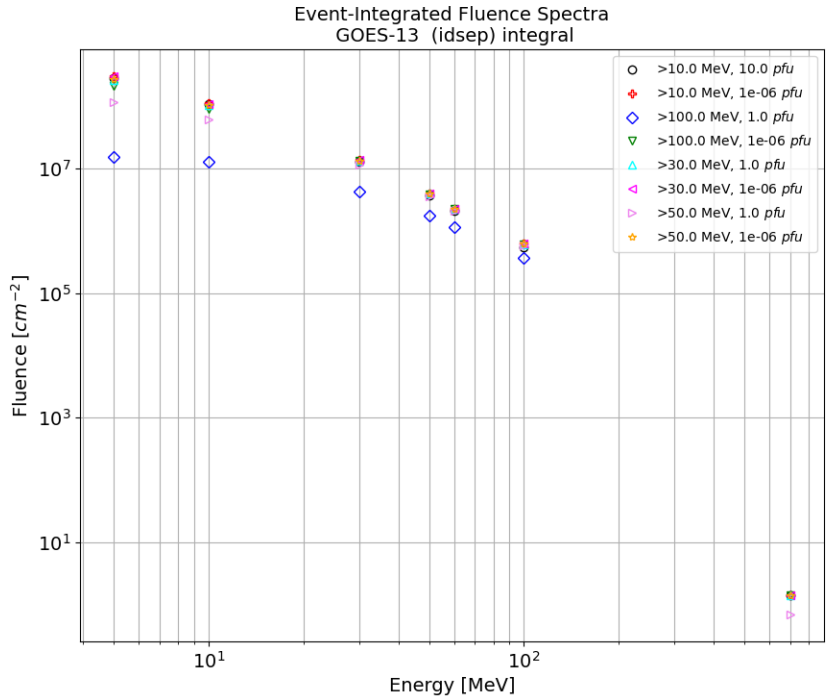
SEP Onset Peak Estimation

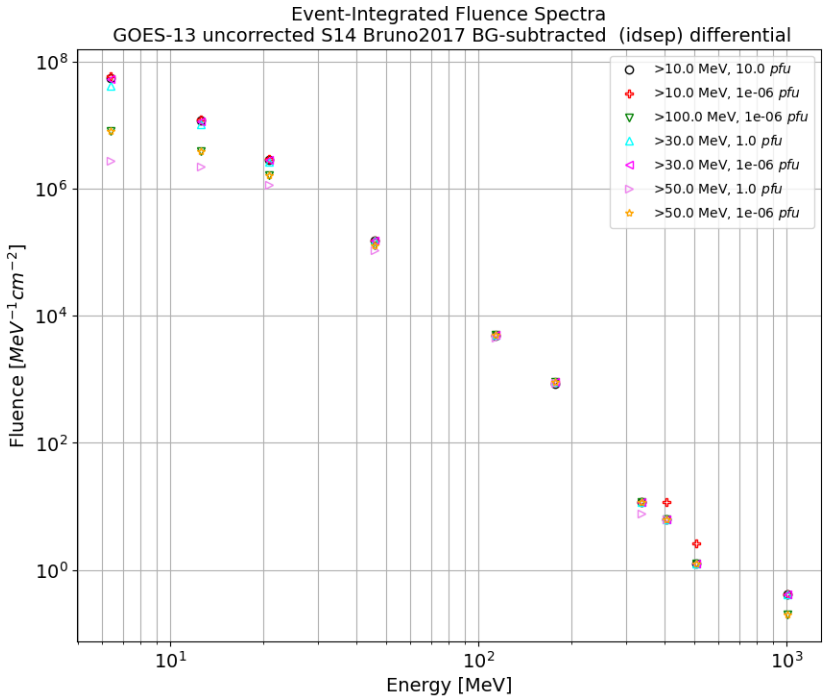
- The first peak after an initial SEP rise is termed here as the ”onset” peak
- The maximum flux of an SEP event might be due to the passage of a CME
- The two types of peaks are calculated individually
- The onset peak is estimated using an algorithm that fits a Weibull to the initial rise phase of the event – **Experimental product!**
  - Often works well, but can sometimes identify a peak in the wrong place
  - The quality of the fits are filtered with strict criteria, so many events will not include an onset peak
  - Plots of all fits are provided with the dataset



SEP Fluence Spectra

- The Operational list includes fluence spectra in the GOES integral channels (>5 through >700 MeV)
- The Energy-bin calibrated list provides fluence spectra from the GOES background-subtracted, energy bin calibrated fluxes in the differential channels
- Spectra are generated using the start and end times for each event definition, e.g. >10 MeV, 10 pfu or >10 MeV, 1e-6 pfu (above background)

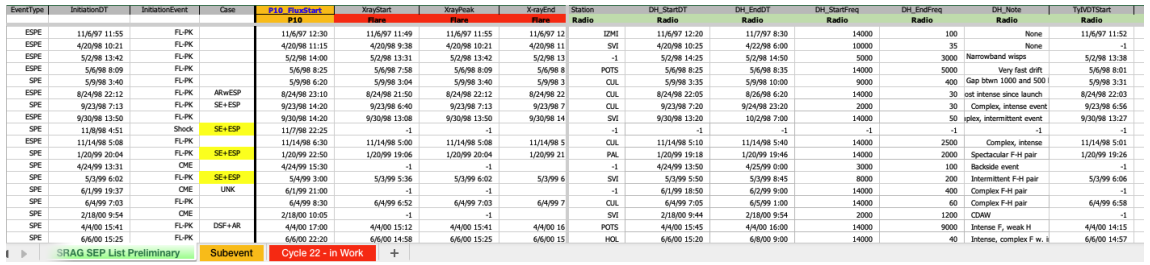




Flare, CME, Radio, Shock Associations

- Steve Johnson (Leidos, NASA JSC SRAG, a.s.johnson@nasa.gov) maintains an SEP list, also called the SRAG list, with extensive associated information derived from many space weather sources:
  - NOAA products including some older bulletins that exist only in print
  - All space weather instruments
  - Careful interpretation of each SEP event with comments
- A version of Steve's list was made machine readable and included in the FetchSEP repo: https://github.com/ktindiana/fetchsep/blob/main/fetchsep/reference/SRAG_SEP_List_R11_CLEARversion.csv
- The SRAG list contains proton information and is a valuable standalone resource. It focuses on operationally-relevant SEP events that exceed operational thresholds.
- Ian Richardson (University of Maryland, NASA GSFC) maintains a list that includes smaller SEP events. The SRAG list was supplemented with these smaller events (marked with "IGR List") .
- Using an automated method, the start time of each SEP event identified by FetchSEP was compared with timing in this combined list to extract the correct association information.

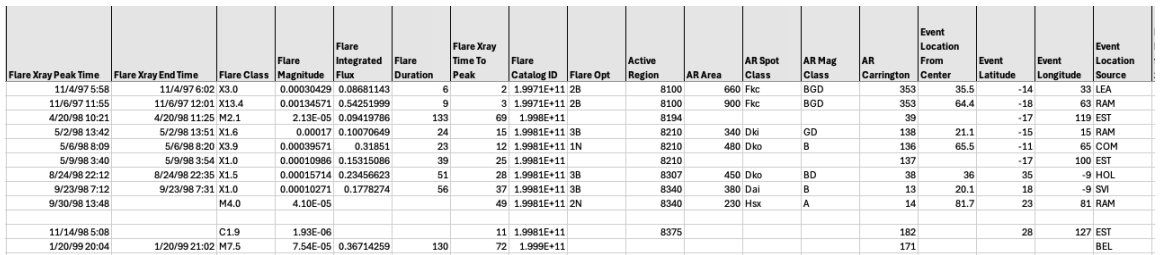
Steve's SRAG list in Excel



EventType	InitiationDT	InitiationEvent	Case	P10_FluxStart	XrayStart	XrayPeak	XrayEnd	Station	DH_StartDT	DH_EndDT	DH_StartFreq	DH_EndFreq	DH_Note	TyIVDTStart
				P10	Flare	Flare	Flare	Radio	Radio	Radio	Radio	Radio	Radio	Radio
ESPE	11/6/97 11:55	FL-PK		11/6/97 12:30	11/6/97 11:49	11/6/97 11:55	11/6/97 12	IZMI	11/6/97 12:20	11/7/97 8:30	14000	100	None	11/6/97 11:52
ESPE	4/20/98 10:21	FL-PK		4/20/98 11:15	4/20/98 9:38	4/20/98 10:21	4/20/98 11	SVI	4/20/98 10:25	4/22/98 6:00	10000	35	None	-1
ESPE	5/2/98 13:42	FL-PK		5/2/98 14:00	5/2/98 13:31	5/2/98 13:42	5/2/98 13	-1	5/2/98 14:25	5/2/98 14:50	5000	3000	Narrowband wisps	5/2/98 13:38
ESPE	5/6/98 8:09	FL-PK		5/6/98 8:25	5/6/98 7:58	5/6/98 8:09	5/6/98 8	POTS	5/6/98 8:25	5/6/98 8:35	14000	5000	Very fast drift	5/6/98 8:01
SPE	5/9/98 3:40	FL-PK		5/9/98 6:20	5/9/98 3:04	5/9/98 3:40	5/9/98 3	CUL	5/9/98 3:35	5/9/98 10:00	9000	400	Gap btwn 1000 and 500	5/9/98 3:31
ESPE	8/24/98 22:12	FL-PK	ARwESP	8/24/98 23:10	8/24/98 21:50	8/24/98 22:12	8/24/98 22	CUL	8/24/98 22:05	8/26/98 6:20	14000	30	ost intense since launch	8/24/98 22:03
SPE	9/23/98 7:13	FL-PK	SE+ESP	9/23/98 14:20	9/23/98 6:40	9/23/98 7:13	9/23/98 7	CUL	9/23/98 7:20	9/24/98 23:20	2000	30	Complex, intense event	9/23/98 6:56
ESPE	9/30/98 13:50	FL-PK		9/30/98 14:20	9/30/98 13:08	9/30/98 13:50	9/30/98 14	SVI	9/30/98 13:20	10/2/98 7:00	14000	50	iplex, intermittent event	9/30/98 13:27
SPE	11/8/98 4:51	Shock	SE+ESP	11/7/98 22:25	-1	-1		-1	-1	-1	-1	-1	-1	-1
ESPE	11/14/98 5:08	FL-PK		11/14/98 6:30	11/14/98 5:00	11/14/98 5:08	11/14/98 5	CUL	11/14/98 5:10	11/14/98 5:40	14000	2500	Complex, intense	11/14/98 5:01
SPE	1/20/99 20:04	FL-PK	SE+ESP	1/20/99 22:50	1/20/99 19:06	1/20/99 20:04	1/20/99 21	PAL	1/20/99 19:18	1/20/99 19:46	14000	2000	Spectacular F-H pair	1/20/99 19:26
SPE	4/24/99 13:31	CME		4/24/99 15:30	-1	-1		-1	4/24/99 13:50	4/25/99 0:00	3000	100	Backside event	-1
SPE	5/3/99 6:02	FL-PK	SE+ESP	5/4/99 3:00	5/3/99 5:36	5/3/99 6:02	5/3/99 6	SVI	5/3/99 5:50	5/3/99 8:45	8000	200	Intermittent F-H pair	5/3/99 6:06
SPE	6/1/99 19:37	CME	UNK	6/1/99 21:00	-1	-1		-1	6/1/99 18:50	6/2/99 9:00	14000	400	Complex F-H pair	-1
SPE	6/4/99 7:03	FL-PK		6/4/99 8:30	6/4/99 6:52	6/4/99 7:03	6/4/99 7	CUL	6/4/99 7:05	6/5/99 1:00	14000	60	Complex F-H pair	6/4/99 6:58
SPE	2/18/00 9:54	CME		2/18/00 10:05	-1	-1		SVI	2/18/00 9:44	2/18/00 9:54	2000	1200	CDAW	-1
SPE	4/4/00 15:41	FL-PK	DSF+AR	4/4/00 17:00	4/4/00 15:12	4/4/00 15:41	4/4/00 16	POTS	4/4/00 15:45	4/4/00 16:00	14000	9000	Intense F, weak H	4/4/00 14:15
SPE	6/6/00 15:25	FL-PK		6/6/00 22:20	6/6/00 14:58	6/6/00 15:25	6/6/00 15	HOL	6/6/00 15:20	6/8/00 9:00	14000	40	Intense, complex F w. i	6/6/00 14:57

SRAG SEP List Preliminary | Subevent | Cycle 22 - in Work

Machine-readable SRAG + IGR list in csv



Flare Xray Peak Time	Flare Xray End Time	Flare Class	Flare Magnitude	Flare Integrated Flux	Flare Duration	Flare Xray Time To Peak	Flare Catalog ID	Flare Opt	Active Region	AR Area	AR Spot Class	AR Mag Class	AR Carrington	Event Location From Center	Event Latitude	Event Longitude	Event Location Source
11/4/97 5:58	11/4/97 6:02	X3.0	0.00030429	0.08681143	6	2	1.9971E+11	2B	8100	660	Fkc	BGD	353	35.5	-14	33	LEA
11/6/97 11:55	11/6/97 12:01	X13.4	0.00134571	0.54251999	9	3	1.9971E+11	2B	8100	900	Fkc	BGD	353	64.4	-18	63	RAM
4/20/98 10:21	4/20/98 11:25	M2.1	2.13E-05	0.09419786	133	69	1.998E+11		8194				39		-17	119	EST
5/2/98 13:42	5/2/98 13:51	X1.6	0.00017	0.10070649	24	15	1.9981E+11	3B	8210	340	Dki	GD	138	21.1	-15	15	RAM
5/6/98 8:09	5/6/98 8:20	X3.9	0.00039571	0.31851	23	12	1.9981E+11	1N	8210	480	Dko	B	136	65.5	-11	65	COM
5/9/98 3:40	5/9/98 3:54	X1.0	0.00010986	0.15315086	39	25	1.9981E+11		8210				137		-17	100	EST
8/24/98 22:12	8/24/98 22:35	X1.5	0.00015714	0.23456623	51	28	1.9981E+11	3B	8307	450	Dko	BD	38	36	35	-9	HOL
9/23/98 7:12	9/23/98 7:31	X1.0	0.00010271	0.1778274	56	37	1.9981E+11	3B	8340	380	Dai	B	13	20.1	18	-9	SVI
9/30/98 13:48		M4.0	4.10E-05			49	1.9981E+11	2N	8340	230	Hsx	A	14	81.7	23	81	RAM
11/14/98 5:08		C1.9	1.93E-06			11	1.9981E+11		8375				182		28	127	EST
1/20/99 20:04	1/20/99 21:02	M7.5	7.54E-05	0.36714259	130	72	1.999E+11						171				BEL

Science-Quality Flare X-ray Values

- In 2022, NOAA issued guidance that GOES-15 and previous X-ray data should have corrections removed that were initially applied by SWPC to make them align with GOES-07. Removal of the correction aligns the data with GOES-R+, which have been determined to be correct. https://www.ncei.noaa.gov/data/goes-space-environment-monitor/access/science/xrs/GOES_1-15_XRS_Science-Quality_Data_Readme.pdf
- To address this issue and apply additional corrections, NOAA released reprocessed science-quality X-ray fluxes for GOES-08 to GOES-15 on October 28, 2025
- The SRAG+IGR list was updated with X-ray science data from the flare summary (flsum) files
- If a flare was present in the SRAG+IGR list, but was not found in the flsum files, the SWPC correction was manually removed by dividing by 0.7
- Previous flare values are retained and marked as “Deprecated” to enable comparison with old NOAA products and previously published SEP lists
- See additional info in the Appendix

Detailed Description of Products

CLEAR Benchmark Dataset – The Lists

- SEP lists compiled from all GOES primary satellite measurements with accompanying flare, CME, radio, etc, information

- **Operational SEP event list:**
  `GOES_integral_PRIMARY.1986-02-03.2025-09-10_sep_events.csv`

- **Energy-bin Calibrated SEP event list:**
  `GOES_differential_energy_bin_calibrated_PRIMARY.2010-08-02.2017-09-20_sep_events.csv`

Note that the GOES satellites are operational satellites that serve our government space weather needs. For this reason, there are always at least two GOES satellites flying at once – one is the ***primary satellite*** that serves data used in real-time operations, one is the ***secondary satellite*** that serves as a back up. The primary satellite is the official source of operational data at the time.

Benchmark Dataset Products from IDSEP

Using GOES-06 files as examples

Original GOES fluxes extracted from NOAA archives

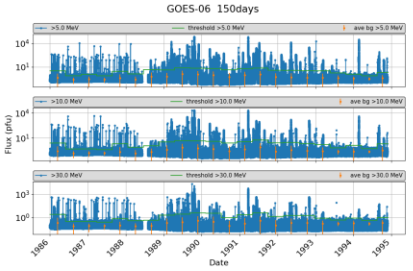
`fluxes_GOES-06_integral_19860101_19941130.csv`

dates	5.0--1	10.0--1	30.0--1	50.0--1	60.0--1	100.0--1	700--1
1986-01-01 00:00:00	0.18	0.136	0.0598	0.0532	0.0513	0.0285	0.000187
1986-01-01 00:05:00	0.268	0.107	0.0598	0.0532	0.0513	0.0285	0.000225
1986-01-01 00:10:00	0.15	0.106	0.0598	0.0532	0.0513	0.0285	0.000205
1986-01-01 00:15:00	0.199	0.155	0.107	0.0628	0.0516	0.0285	0.00021
1986-01-01 00:20:00	0.159	0.115	0.0682	0.0614	0.0596	0.0368	0.00019
1986-01-01 00:25:00	0.15	0.106	0.0598	0.0532	0.0513	0.0285	0.0002
1986-01-01 00:30:00	0.15	0.106	0.0598	0.0532	0.0513	0.0285	0.000195
1986-01-01 00:35:00	0.15	0.106	0.0598	0.0532	0.0513	0.0285	0.000212
1986-01-01 00:40:00	0.17	0.126	0.0793	0.0726	0.0706	0.0479	0.000203

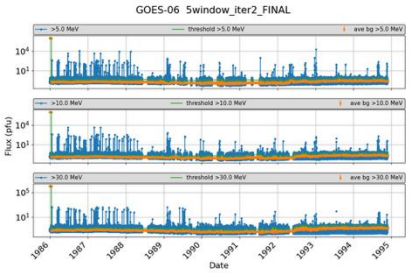
- In folders `output/idsep/*`
- Full original time series of GOES satellite for all energy bins `fluxes_GOES-06_integral_19860101_19941130.csv`
- Time series of mean background: `csv/background_mean_fluxes_optimized_FINAL.csv` (used in next step with opsep)
- Time series of sigma (expected level of variation in the background): `csv/background_sigma_optimized_FINAL.csv` (used in next step with opsep)
- Time series of mean + 3*sigma threshold, used to separate background and enhanced fluxes: `csv/background_threshold_optimized_FINAL.csv`
- Time series of SEP fluxes with background set to zero: `csv/SEP_fluxes_FINAL.csv`
- Time series of SEP fluxes with mean background subtracted and background set to zero: `csv/SEP_fluxes_background-subtracted_FINAL.csv`

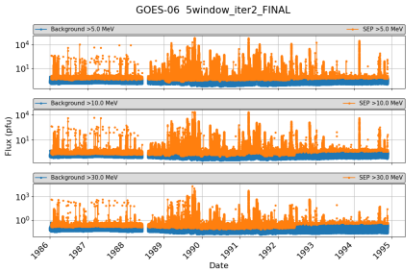
Benchmark Dataset Products from IDSEP

- In folder `plots/idsep/*`
- Flux time series (blue) with initial estimate of mean background and sigma (orange points) with threshold (green) using windows of 150 days
  `GOES-06_integral_FluxWithThreshold_150days_2.png`

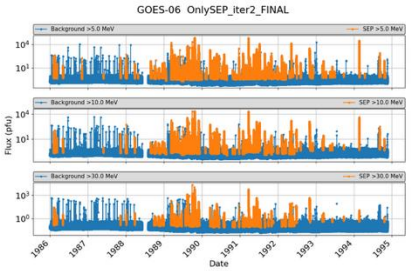


- Time series with high flux/SEP flux removed (blue), mean background with/without sigma (orange line), and threshold (green) for iterations 0,1 and 2 (final)
  `GOES-06_integral_FluxWithThreshold_5window_iter1_2.png`
  `GOES-06_integral_FluxWithThreshold_5window_nosigma_iter2_FINAL_2.png`





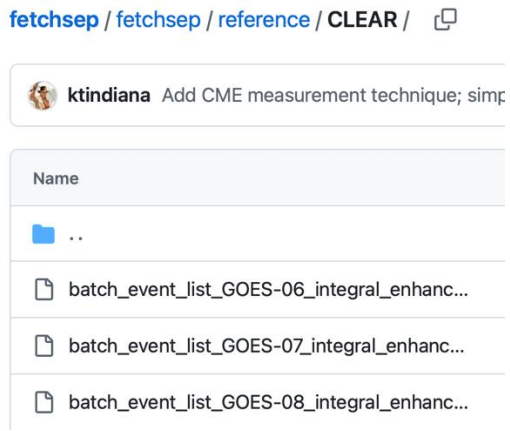
- All fluxes above threshold identified as enhancement (orange) and background (blue)
  `GOES-06_integral_SEP_BG_5window_iter2_FINAL_2.png`



- Enhancements identified as SEP events (orange) for iterations 0,1, and 2 (final)
  `GOES-06_integral_SEP_BG_OnlySEP_iter2_FINAL_2.png`
  `GOES-06_integral_SEP_BG_FINALSEP_2.png` (repeat plot)

Batch Lists of Event/Quiet Time periods

- Curated lists for each satellite indicating quiet periods and SEP event periods; Used when running OPSEP to analyze these time periods individually
- The lists are stored in the FetchSEP repo as part of the deployment script:
  - https://github.com/ktindiana/fetchsep/tree/main/fetchsep/reference/CLEAR
  - `batch_event_list_GOES-06_integral_enhance_idsep_CLEAR.txt`



- The batch lists are also stored in the Benchmark dataset files in folders `output/idsep/*`
  - `batch_event_list_GOES-06_integral_enhance_idsep_CLEAR.txt`

batch_event_list_GOES-06_integral_enhance_idsep_CLEAR.txt — Edited

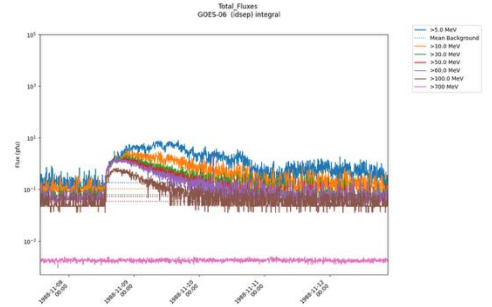
```
#Start Time,End Time,Experiment,Flux Type,Flags,User Experiment Name,User Filename,Options,BGStart,BGEnd,JSON Type,Spacecraft,IDSEP Path,Location,Species
1986-01-01 00:00:00,1986-02-03 07:05:00,GOES-06,integral,IDSEPEnhancement,,,,,,observations,,./output/idsep/GOES-06_integral/csv,earth,protons
1986-02-03 07:05:00,1986-02-04 23:10:00,GOES-06,integral,IDSEPEnhancement,,,,,,observations,,./output/idsep/GOES-06_integral/csv,earth,protons
1986-02-04 23:10:00,1986-02-06 07:05:00,GOES-06,integral,IDSEPEnhancement,,,,,,observations,,./output/idsep/GOES-06_integral/csv,earth,protons
1986-02-06 07:05:00,1986-02-07 12:45:00,GOES-06,integral,IDSEPEnhancement,,,,,,observations,,./output/idsep/GOES-06_integral/csv,earth,protons
1986-02-07 12:45:00,1986-02-10 14:05:00,GOES-06,integral,IDSEPEnhancement,,,,,,observations,,./output/idsep/GOES-06_integral/csv,earth,protons
```

Benchmark Dataset Products from OPSEP

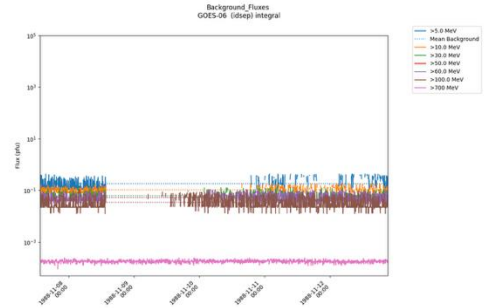
- In folders `output/opsep/*`
- List of all non-event periods with proton information for the GOES satellite:
  - `GOES-06_integral_enhance_idsep.1986-01-01.1994-11-30_non_events.csv`
- List of all SEP event periods with proton, flare, CME, radio, etc information for the GOES satellite:
  - `GOES-06_integral_enhance_idsep.1986-01-01.1994-11-30_sep_events.csv`
- Original flux time series for the analyzed individual time period:
  - `GOES-06_integral_enhance_idsep.1986-01-01T000000Z_fluxes_all_bins.csv`
- JSON file containing all derived information in the CCMC JSON format and accompanying txt flux time series (used in SPHINX for validation):
  - `GOES-06_integral_enhance_idsep.1986-01-01T000000Z.json`
    `GOES-06_integral_enhance_idsep.1986-01-01T000000Z.10.0.MeV.txt, etc`
- Single row of Benchmark dataset:
  - `GOES-06_integral_enhance_idsep.1986-01-01T000000Z.csv`

Benchmark Dataset Products from OPSEP

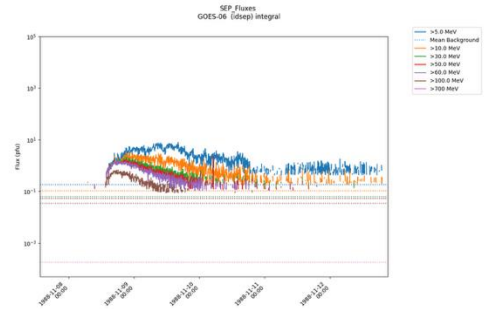
- In folders `plots/opsep/*`
- Original fluxes
  `1988-11-07T132500Z_GOES-06_integral_enhance_idsep_All_Bins_Total_Fluxes.png`



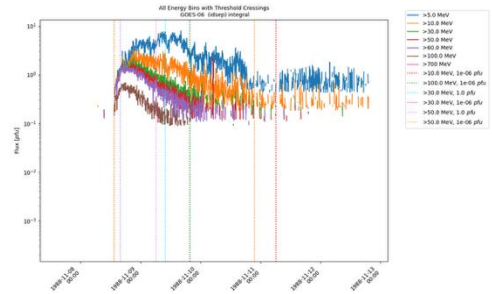
- Background fluxes below mean + 3*sigma threshold (from idsep)
  `1988-11-07T132500Z_GOES-06_integral_enhance_idsep_All_Bins_Background_Fluxes.png`



- Enhanced fluxes above mean + 3*sigma threshold
  `1988-11-07T132500Z_GOES-06_integral_enhance_idsep_All_Bins_SEP_Fluxes.png`

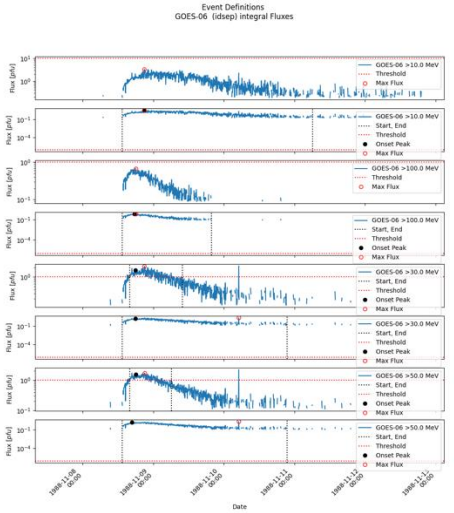


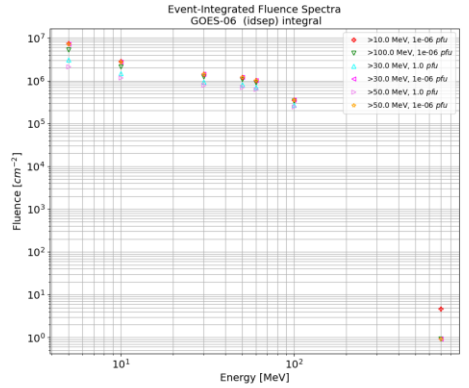
- Enhanced fluxes with SEP event start and end times
  `1988-11-07T132500Z_GOES-06_integral_enhance_idsep_All_Bins.png`

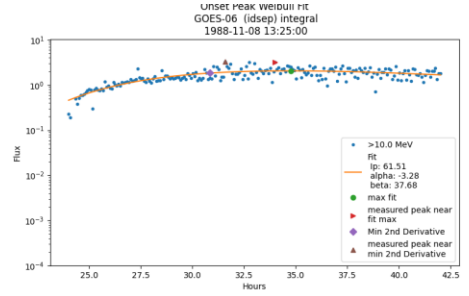


Benchmark Dataset Products from OPSEP

- In folders `plots/opsep/*`
- Event definitions for each energy channel and threshold combination with onset peak (black circle) and maximum flux (red circle)
  `1988-11-07T132500Z_GOES-06_integral_enhance_idsep_Event_Def.png`
- Event-integrated fluence spectra for all event definitions
  `1988-11-07T132500Z_GOES-06_integral_enhance_idsep_Fluence.png`
- Weibull fits to the start of the SEP event to identify the onset peak
  `1988-11-08T132500Z_GOES-06_integral_enhance_idsep_Weibull_profile_fit_10.0MeV.png`







Description of SEP List Columns

CLEAR Benchmark List Contents

Experiment	Flux Type	Options	Background Subtraction	Time Period Start	Time Period End	All Fluxes Time Series
GOES-13	integral		None	2012-05-16 01:55:00	2012-05-23 05:55:00	GOES-13_integral_enhance_idsep.2012-05-16T015500Z_fluxes_all_bins.csv
GOES-13	integral		None	2012-05-25 23:05:00	2012-05-31 04:45:00	GOES-13_integral_enhanc
GOES-13	integral		None	2012-06-13 00:00:00	2012-06-19 04:55:00	GOES-13_integral_enhanc

Source of proton fluxes

Special data selections or energy bin calibrations

Original fluxes in integral or differential energy channels

None if no subtraction; "IDSEP" if background calculated by idsep was used

Time period analyzed by opsep to derive SEP information (from curated batch lists)

File containing original fluxes for time period

Experiment	Flux Type	Options	Background Subtraction
GOES-13	differential	S14;Bruno2017;uncorrected	IDSEP
GOES-13	differential	S14;Bruno2017;uncorrected	IDSEP
GOES-13	differential	S14;Bruno2017;uncorrected	IDSEP

Values in background-subtracted energy bin calibrated data set derived from GOES uncorrected* differential fluxes

*NOAA provides corrected and uncorrected archived differential fluxes. Uncorrected refers to selecting the columns containing the uncorrected data in the original NOAA files.

CLEAR Benchmark List Contents

>10.0 MeV 10.0 pfu Flux Time Series	>10.0 MeV 10.0 pfu SEP Start Time	>10.0 MeV 10.0 pfu SEP End Time	>10.0 MeV 10.0 pfu SEP Duration (hours)	>10.0 MeV 10.0 pfu Onset Peak (pfu)	>10.0 MeV 10.0 pfu Onset Peak Time	>10.0 MeV 10.0 pfu Rise Time to Onset (minutes)	>10.0 MeV 10.0 pfu Max Flux (pfu)	>10.0 MeV 10.0 pfu Max Flux Time	>10.0 MeV 10.0 pfu Rise Time to Max (minutes)
GOES-13_integral_enhance_idsep.2012-05-16T015500Z.10.0.MeV.txt	2012-05-17 02:10:00	2012-05-18 16:20:00	38.16666667	255.44	2012-05-17 04:30:00	140	255.44	2012-05-17 04:30:00	140
GOES-13_integral_enhan	2012-05-27 05:35:00	2012-05-27 12:35:00	7	11.12	2012-05-27 07:50:00	135	14.777	2012-05-27 10:45:00	310

Time series for >10 MeV energy channel after background removal (and subtraction, if performed); associated with JSON	Time >10 MeV SEP event starts; blank if threshold not crossed	Time >10 MeV event ends; blank if threshold not crossed	Duration of SEP event	Value of initial onset peak derived via automated fitting in OpSEP; only present if SEP event; Missing if fit failed	Time of onset peak; only if SEP event	Onset Peak Time – Start Time	Maximum flux during SEP event or during full time period if no event; always present	Time of maximum flux; always present	Max Flux Time – Start Time

CLEAR Benchmark List Contents

>10.0 MeV 10.0 pfu Fluence (cm^-2)	>10.0 MeV 10.0 pfu Fluence Spectrum (cm^-2)	>10.0 MeV 10.0 pfu Fluence Spectrum Energy Bins (MeV)	>10.0 MeV 10.0 pfu Fluence Spectrum Energy Bin Centers (MeV)	>10.0 MeV 10.0 pfu Quality Flags
95581058.84	[203008296.01845598; 95549053.04587044; 29255273.82025184; 14184115.266194066; 10250803.916646158;	[[5.0; -1]; [10.0; -1]; [30.0; -1]; [50.0; -1]; [60.0; -1]; [100.0; -1]; [700.0; -1]]	[5.0; 10.0; 30.0; 50.0; 60.0; 100.0; 700.0]	
3399851.425	[13087815.932913193;	[[5.0; -1]; [10.0; -1]; [	[5.0; 10.0; 30.0; 50.0	
1548597.707	[10107667.212517256;	[[5.0; -1]; [10.0; -1]; [	[5.0; 10.0; 30.0; 50.0	
11900615.86	[23072410.62490753; 1	[[5.0; -1]; [10.0; -1]; [	[5.0; 10.0; 30.0; 50.0	
8388942.461	[14181278.671921657;	[[5.0; -1]; [10.0; -1]; [	[5.0; 10.0; 30.0; 50.0	
61686135.34	[299005729.1058991; 6	[[5.0; -1]; [10.0; -1]; [	[5.0; 10.0; 30.0; 50.0	
67361101.02	[168026479.60835955;	[[5.0; -1]; [10.0; -1]; [	[5.0; 10.0; 30.0; 50.0	I
88139328.43	[209950730.72098374;	[[5.0; -1]; [10.0; -1]; [	[5.0; 10.0; 30.0; 50.0	E

Event-integrated Fluence for the energy channel between >10 MeV, 10 pfu Start and End Time

Event-integrated fluence spectrum between >10 MeV, 10 pfu Start and End Time

Energy bins for fluence spectrum in original (integral or differential) energy channels of input data

Energy bin centers for fluence spectrum

Automatically-derived quality flags

Quality flags to indicate that the user may want to take a closer look:

I – Time period ended while SEP was still enhanced (interrupted)

G – A large data gap is present

T – A data gap likely affects the start or end time of an SEP event

E – The particle environment was already enhanced at the start of the time period

S – The max flux is likely an erroneous spike in the data

CLEAR Benchmark List Contents

>10.0 MeV 1e-06 pfu Flux Time Series	>10.0 MeV 1e-06 pfu SEP Start Time	>10.0 MeV 1e-06 pfu SEP End Time
GOES-13_integral_enhance_idsep.2012-05-16T015500Z.10.0.MeV.txt	2012-05-17 01:55:00	2012-05-21 18:50:00
GOES-13_integral_enhance_	2012-05-26 23:05:00	2012-05-29 17:10:00

Next event definition, >10 MeV above background (indicated by1e-6 pfu)

>10 MeV above background Start Time

>10 MeV above background End Time

- SEP event information continues in the next columns for each event definition
- >10 MeV, 10 pfu
- >10 MeV, 1e-6 pfu
- >100 MeV, 1 pfu
- >100 MeV, 1e-6 pfu
- >30 MeV, 1 pfu
- >30 MeV, 1e-6 pfu
- >50 MeV, 1 pfu
- >50 MeV, 1e-6 pfu
- Flare, CME, etc associations

CLEAR Benchmark List Contents

Cycle	EventType	Case
24	ESPE	AR
24	SPE	Farside
24	SPE	AR

Solar Cycle number

*See description

*See description

EventType

- Present only for events in the SRAG SEP list; not indicated for all events in CLEAR list
- **SubEvent:** below >10 MeV, 10 pfu
- **SPE:** >10 MeV, 10 pfu crossed
- **ESPE:** >100 MeV, 1 pfu crossed

An SEP list maintained at SRAG by Steve Johnson contains extensive information related to SEP events. Additional source information is drawn from Ian Richardson's SEP list. The CLEAR list includes more enhancements than either list, so some will have no association information.

Case

- Present only for events in the SRAG SEP list; **not indicated for all events in CLEAR list**
- Rough descriptor of event source
- **AR:** solar eruption source
- **ESP:** peak in lower energies the result of a CME passage or enhancement only due to shock passage
- **Farside:** solar source beyond the limb
- **FE:** the result of a filament eruption
- **PrevEv:** Previous event ongoing at this even start
- **Unknown:** unknown event source
- **Pending:** source/analysis still to be determined
- No description means enhancement not in SRAG+IGR list

CLEAR Benchmark List Contents

Flare Xray Start Time Deprecated	Flare Xray Peak Time Deprecated	Flare Xray End Time Deprecated	Flare Class Deprecated	Flare Magnitude Deprecated	Flare Integrated Flux Deprecated
2012-05-17 01:25:00	2012-05-17 01:47:00	2012-05-17 02:14:00	M5.1	5.10E-05	0.099
2012-07-06 23:01:00	2012-07-06 23:08:00	2012-07-06 23:14:00	X1.1	0.00011	0.043

Flare start time in original SWPC archived files

Flare peak time in original SWPC archived files

Flare end time in original SWPC archived files

Flare class in original SWPC archived files

Flare magnitude in original SWPC archived files

Flare integrated fluence between start and end times in original SWPC archived files

- NOAA guidance states "SWPC scaling factors: The archived fluxes have all been scaled to GOES-7. To get true fluxes for all data, users must remove the SWPC scaling factors, divide the short band flux by 0.85 and divide the long band flux by 0.7. Such corrected fluxes and corresponding flare indices (e.g., an X2.1 flare) will agree with those of the GOES-R series.
- The original fluxes published in SWPC products and other SEP lists are retained here and labeled "Deprecated"

CLEAR Benchmark List Contents

Flare Xray Start Time	Flare Xray Peak Time	Flare Xray End Time	Flare Class	Flare Magnitude	Flare Integrated Flux	Flare Duration	Flare Xray Time To Peak	Flare Catalog ID	GOES Xray Satellite	Flare Opt
2012-05-17 00:43:00	2012-05-17 01:47:00	2012-05-17 02:15:00	M7.3	7.32E-05	0.150933415	92	64	201205170043	15	1F
									15	
2012-07-06 23:00:00	2012-07-06 23:08:00	2012-07-06 23:14:00	X1.6	0.0001615	0.067092761	14	8	201207062300	15	
Science-quality Flare start time from	Science-quality Flare peak time	Science-quality Flare end time	Science-quality Flare class	Science-quality Flare magnitude	Science-quality Flare integrated fluence	Science-quality Flare end - start	Science-quality Flare peak - start	If NOAA NCEI flare summary available, flare ID	Satellite used for Xray data	Xray flare optical class

NOAA released reprocessed science-quality X-ray fluxes for GOES-08 to GOES-15. Flare summary files were used if available. In that case, Flare Catalog ID will be specified. Otherwise, historical fluxes were divided by 0.7 to remove SWPC calibration factors. https://www.ncei.noaa.gov/data/goes-space-environment-monitor/access/science/

CLEAR Benchmark List Contents

Active Region	AR Area	AR Spot Class	AR Mag Class	AR Carrington	Event Location From Center	Event Latitude	Event Longitude	Event Location Source	Event Location from Center 2	Event Latitude 2	Event Longitude 2	Event Location Source 2
11476	230	Cao	B	183	76.3	11	76	LEA	88	7	88	LMSAL
11482				103		15	122	EST		15	121	CDAW
11515	670	Ekc	BGD	206	59.9	-18	50	EST	59.9	-13	59	LMSAL

SEP source region	Size at start of day	Mount Wilson class at start of day	Modified Zurich class at start of day	Carrington longitude at start of day	Flare latitude	Flare longitude	See next slide	A second location for source eruption, typically from LMSAL SolarSoft

*See further notes about flare location on next slide

CLEAR Benchmark List Contents

- Flare location order of preference:
  - Optical location from SWPC Edited Solar Events product
    ftp://ftp.swpc.noaa.gov/pub/warehouse
    https://www.swpc.noaa.gov/products/solar-and-geophysical-event-reports
  - From weekly SWPC Preliminary Report and Forecast of Solar Geophysical Data (PRF)
    https://www.swpc.noaa.gov/products/report-and-forecast-solar-and-geophysical-activity
    ftp://ftp.swpc.noaa.gov/pub/warehouse
  - GOES SXI in event list if no optical (During G12)
  - LMSAL Solar Soft (after Oct 2002) https://www.lmsal.com/solarsoft/latest_events_archive.html
  - If no optical a prorated position calculated from last PRF longitude
  - Farside is estimated using solar rotation to highly likely candidate
  - No location if no likely candidate stands out
  - Pure ESP events no location since enhancement is due to shock not AR
- Event location source:
  - Observing station. e.g. HOL, LEA
  - EST indicates a calculated location for farside active regions
  - BEL if beyond East Limb
  - BWL if beyond West Limb

CLEAR Benchmark List Contents

Radio Rbr245Max	Radio Rbr2695Max	Radio Rbr8800	Radio TyIII_Imp
1400	540	630	3
			2
270	520	1900	2

Peak of radio burst at 245 MHz

Peak of Ten flare (2695 MHz) radio burst

Peak of 8800 MHz radio burst

- Radio burst data from SWPC Edited Solar Events product
  ftp://ftp.swpc.noaa.gov/pub/warehouse
  https://www.swpc.noaa.gov/products/solar-and-geophysical-event-reports
- 8800 MHz radio burst data from radio burst achive
  https://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-features/solar-radio/radio-bursts/reports/spectral-listings/

CLEAR Benchmark List Contents

Radio m_TyII Start Time	Radio m_TyII End Time	Radio TyII Imp	Radio TyII Speed	Radio m_TyII Start Frequency	Radio m_TyII End Frequency	Radio Station
5/17/12 1:31	5/17/12 1:41	3	645	180	25	LEA
5/26/12 20:47	5/26/12 20:53	1	751	121	25	PAL
7/6/12 23:09	7/6/12 23:21	3	1771	180	25	PAL

Metric Type II burst start time	Metric Type II burst end time		Shock speed of metric Type II burst	Metric Type II burst start frequency	Metric Type II burst end frequency	Observing station

- Radio burst data from SWPC Edited Solar Events product
  ftp://ftp.swpc.noaa.gov/pub/warehouse
  https://www.swpc.noaa.gov/products/solar-and-geophysical-event-reports

CLEAR Benchmark List Contents

Radio DH Start Time	Radio DH End Time	Radio DH Start Frequency	Radio DH End Frequency	Radio DH Note	Radio TyIV Start Time	Radio TyIV End Time	Radio TyIV Imp	Radio TyIV Duration
2012-05-17 01:40:00	2012-05-17 06:20:00	16000	300	CDAW	2012-05-17 01:32:00	2012-05-17 02:52:00	2	80
2012-05-26 20:50:00	2012-05-26 23:20:00	16000	300	Ahead Only	2012-05-26 21:02:00	2012-05-26 22:24:00	1	82
2012-07-06 23:10:00	2012-07-07 03:40:00	16000	300	Multiple tones	2012-07-06 23:22:00	2012-07-06 23:38:00	1	16

DH radio burst start time

DH radio burst end time

DH radio burst start frequency

DH radio burst end frequency

Note from webpage

Type IV radio burst start time

Type IV radio burst end time

Type IV radio burst duration

Decameter - hecameter radio data may come from either WIND or CDAW and there are inconsistencies between lists.
WIND: https://spdf.gsfc.nasa.gov/pub/data/stereo/documents/websites/solar-radio/wind/data_products.html
CDAW: https://cdaw.gsfc.nasa.gov/CME_list/radio/waves_type2.html
Type IV radio burst data from SWPC Edited Solar Events product.

CLEAR Benchmark List Contents

CDAW CME First Look Time	CDAW CME Speed	CDAW CME Width	CDAW CME Mean Position Angle	DONKI CME Start Time	DONKI CME Speed	DONKI CME Half Width	DONKI CME Lat	DONKI CME Lon	DONKI CME Time at 21.5	DONKI CME Catalog ID	DONKI CME Measurement Technique
2012-05-17 01:48:00	1582	Halo	261	2012-05-17 01:48:00	1500	45	-10	75	2012-05-17 03:30:00	2012-05-17T01:48:00-CME-001	
2012-05-26 20:57:00	1966	Halo	291	2012-05-26 22:54:00	1100	70	5	110	2012-05-26 22:40:00	2012-05-26T22:54:00-CME-001	
2012-07-06 23:24:00	1828	Halo	233	2012-07-06 23:12:00	1200	40	-35	65	2012-07-07 02:35:00	2012-07-06T23:12:00-CME-001	
First appearance on LASCO L2	Plane-of-sky speed	2D full width	LASCO MPA measured counter-clockwise from North	First appearance on LASCO L2	3D speed from cone fit	3D half width of CME	Solar source latitude	Solar source longitude	Time CME at 21.5 Rsun (ENLIL inner boundary)	CME ID	SWPC_Cat or STEREOCat, if specified

CDAW CME information: https://cdaw.gsfc.nasa.gov/CME_list/index.html
DONKI information: https://kauai.ccmc.gsfc.nasa.gov/DONKI/
DONKI CMEs selected as Prime, from M2M or SEPVAL catalogs, leading edge (LE) preferred to shock (SH) measurement, plane-of-sky measurements excluded.

CLEAR Benchmark List Contents

ESP_CME	ESP CDAW CME First Look Time	ESP CDAW CME LASCO Speed	ACE CME Passage Time	ACE Bz	Sudden Impulse Time	Sudden Impulse Amplitude	GLE Event Number	PRF	Comments
							GLE 71	1916	
								1917	
								1923	Put EST location first
								1923/1924	
								1924	
			7/20/12 4:30					1925	Complicated flare w/2
			7/21/12 15:30		7/21/12 16:12			1925	

ESP CME same CME that caused initial event? - RELAT or UNRELAT

Info about CME that caused ESP phase

ACE shock passage information

1 AU shock passage information

If GLE, number

SWPC PRF report

Comments made by Steve Johnson about any notable event characteristics

	Comments
1959	
1963	
1965	
	IGR List

IGR List appears in Comments if the flare and CME association information was taken from Ian Richardson's list

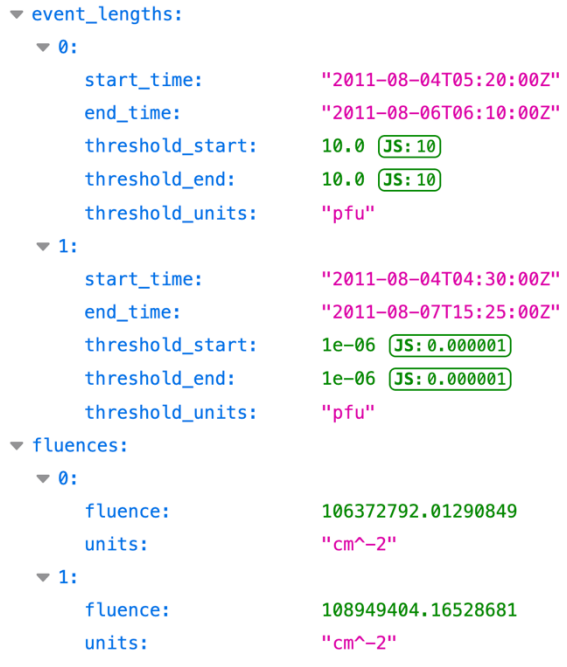
*Weekly SWPC Preliminary Report and Forecast of Solar Geophysical Data (PRF)
ftp://ftp.swpc.noaa.gov/pub/warehouse

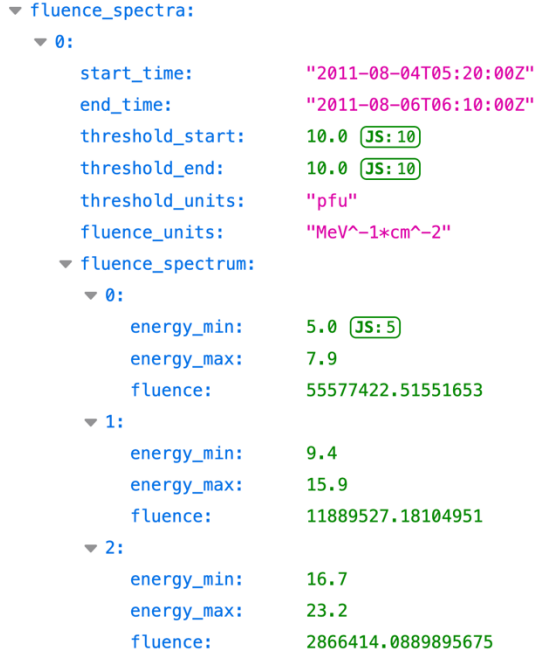
Working with the CLEAR Benchmark Lists

- The list csv files may be easily read into Python using Pandas:
  ```
  df = pd.read_csv('GOES_integral_PRIMARY.1986-02-03.2025-09-10_sep_events.csv')
  ```
- Time columns should be cast as datetime:
  ```
  cols = [col for col in df.columns.tolist()if 'Time' in col and 'Series' not in col]
  for col in cols: df[col] = pd.to_datetime(df[col])
  ```
- Missing/unavailable information is represented as empty cells in the csv file and should be automatically converted to appriopriate null values by Pandas
- All time columns are in YYYY-MM-DD HH:MM:SS format
- Note that if you open the csv file with Excel and make any changes or save the file, Excel will change the format of the datetime columns. To convert back, you will need to convert every datetime column by going to Custom Format and specifying "yyyy-mm-dd hh:mm:ss" or account for the different format in your codes.

JSON Files for each Time Period

- Note that much of the information in a row of the CLEAR Benchmark lists is also contained in the individual json files, which are similar in structure to the CCMC json scheme
- The SEP event and quiet time period json files are used in the SPHINX validation framework as the “ground truth” for every moment in time.



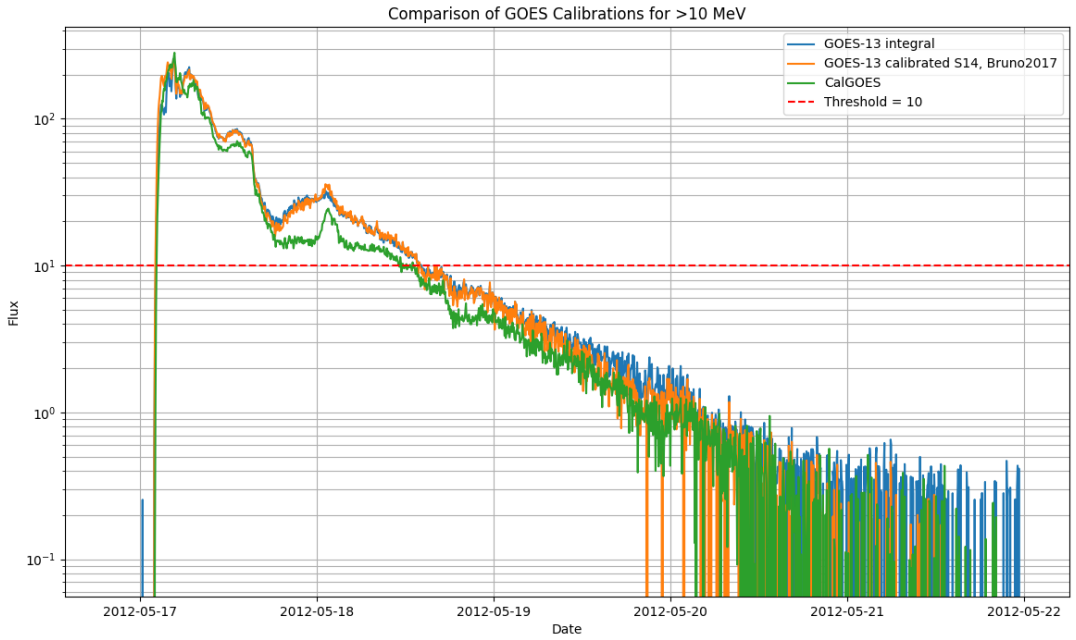


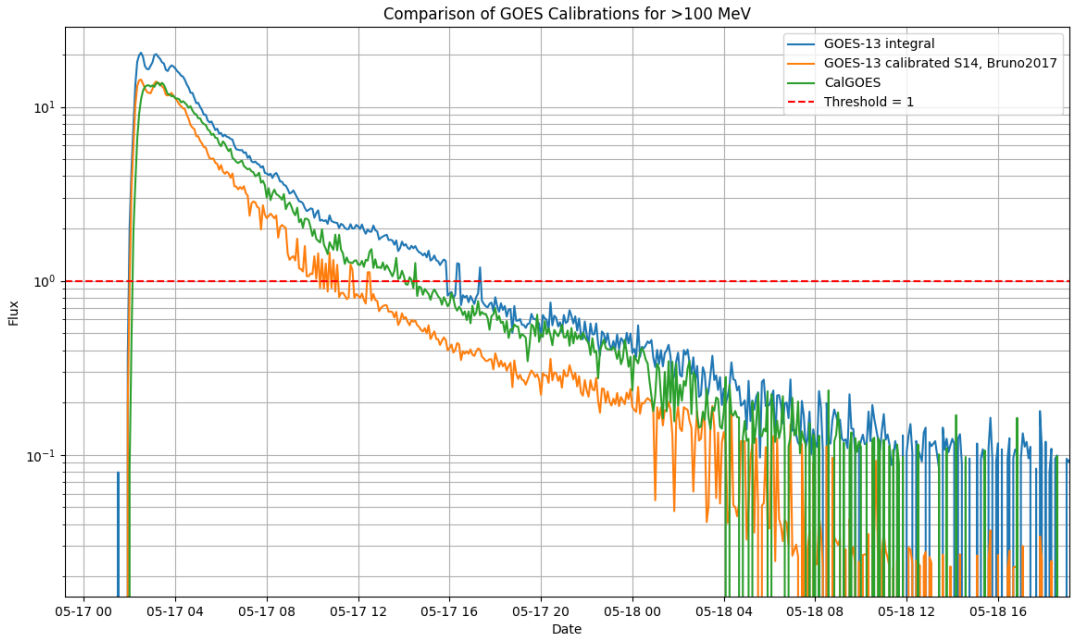
Mirrors schema at https://ccmc.gsfc.nasa.gov/static/files/SEPSB/sepscoreboard_visual_schema.pdf

Appendix

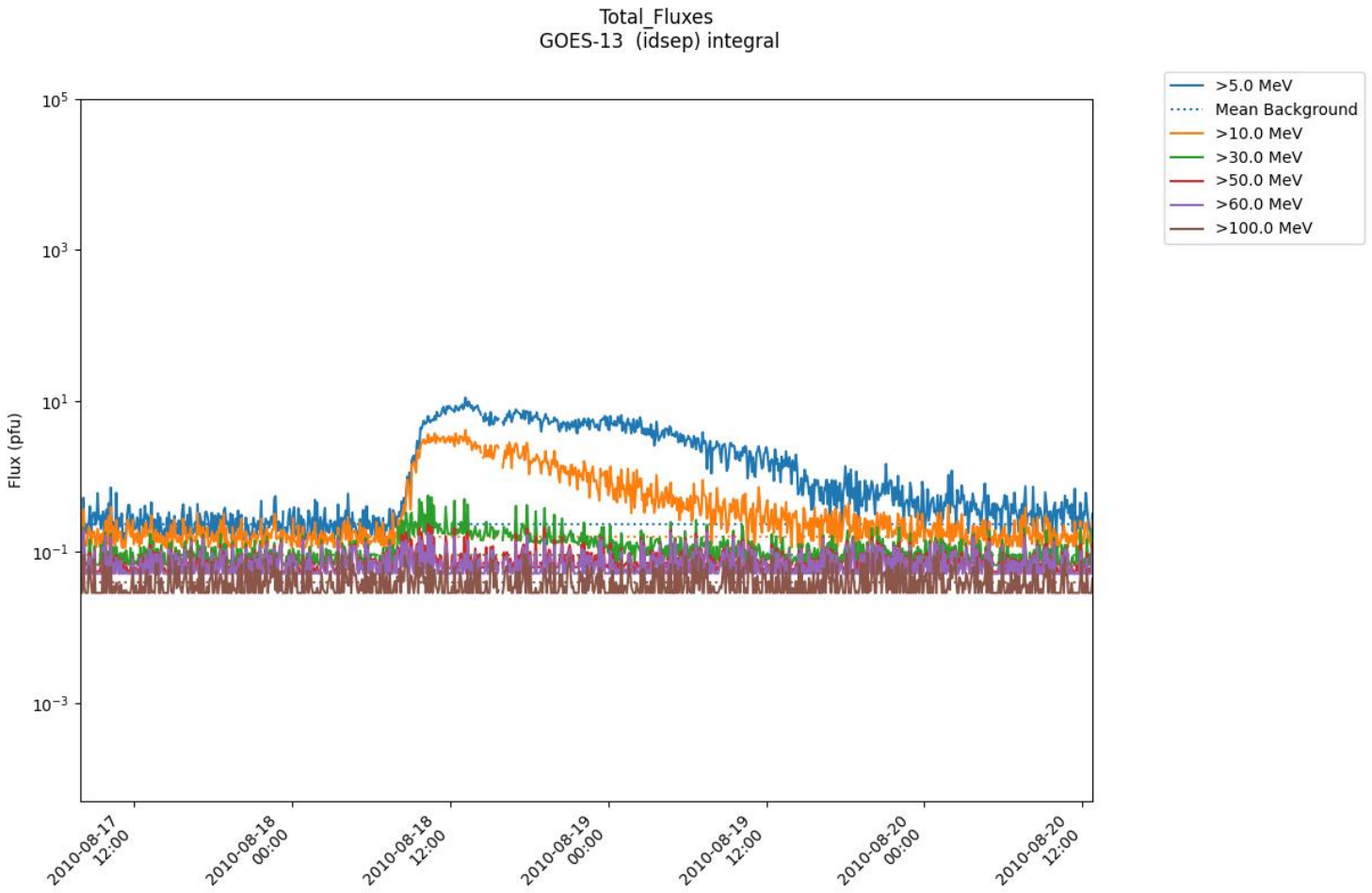
Comparison of Datasets

- May 17, 2012 fluxes compared for the Operational and Energy Bin Calibrated lists
- Plotted alongside the CalGOES calibrated dataset used by SRAG





Separation of Background and SEP Enhancements - GOES integral fluxes



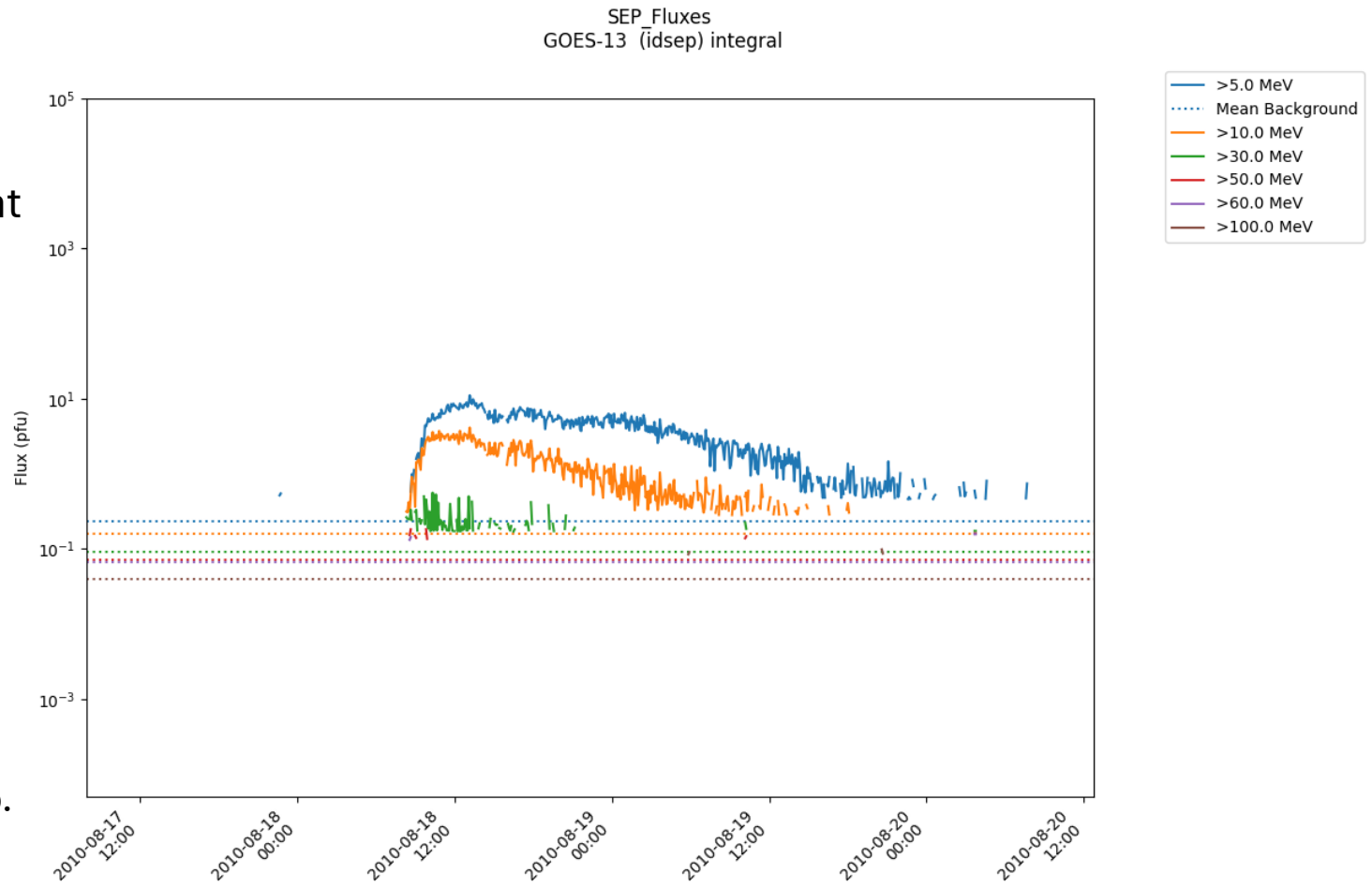
Separation of Background and SEP Enhancements - GOES integral fluxes

Enhancements are defined as intensities that exceed mean + 3sigma

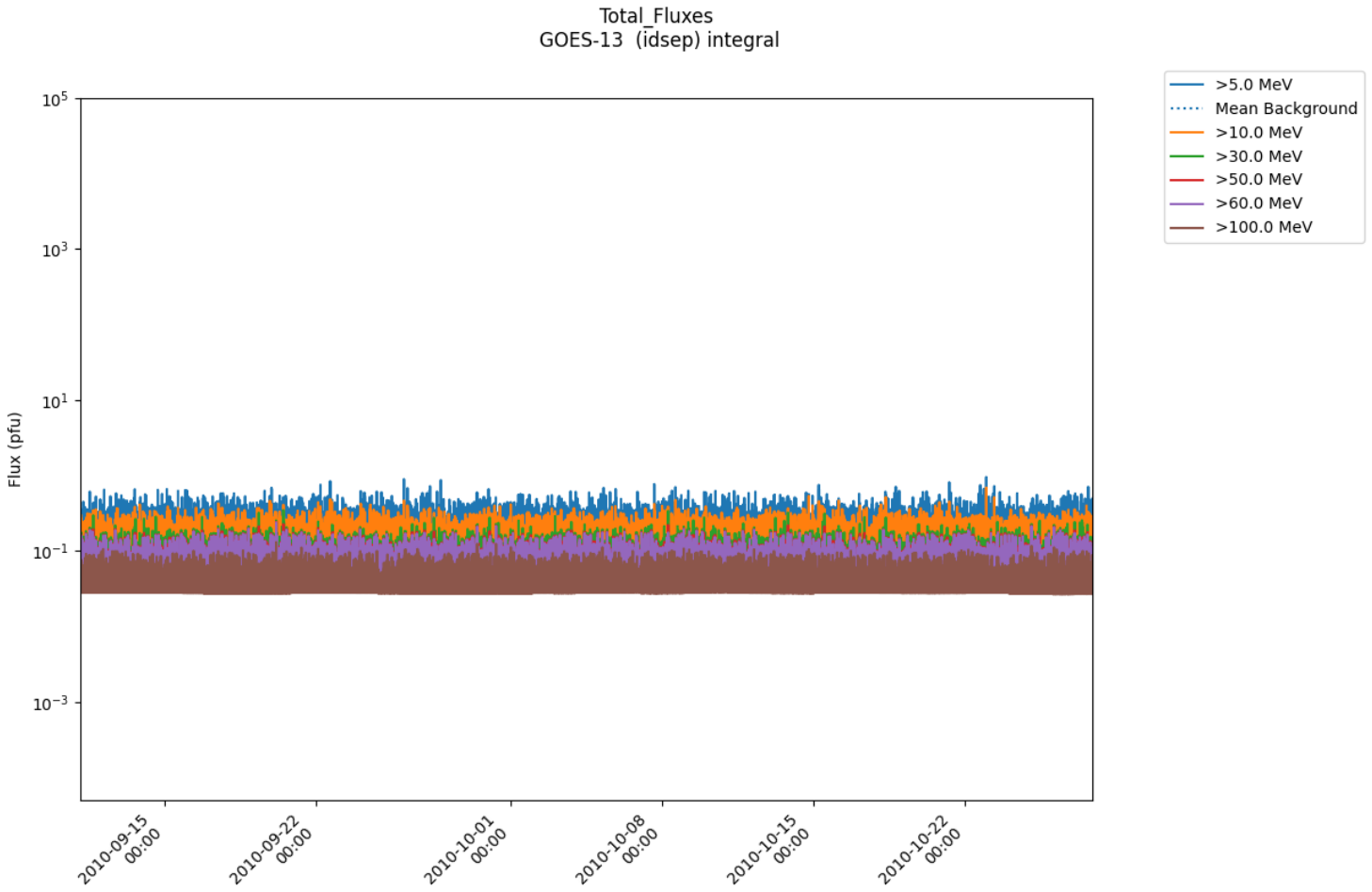
For GOES integral fluxes from NOAA, the enhanced fluxes and background were simply separated.

No background subtraction was performed.

Fluxes identified as background were set to zero.



Separation of Background and SEP Enhancements - GOES integral fluxes



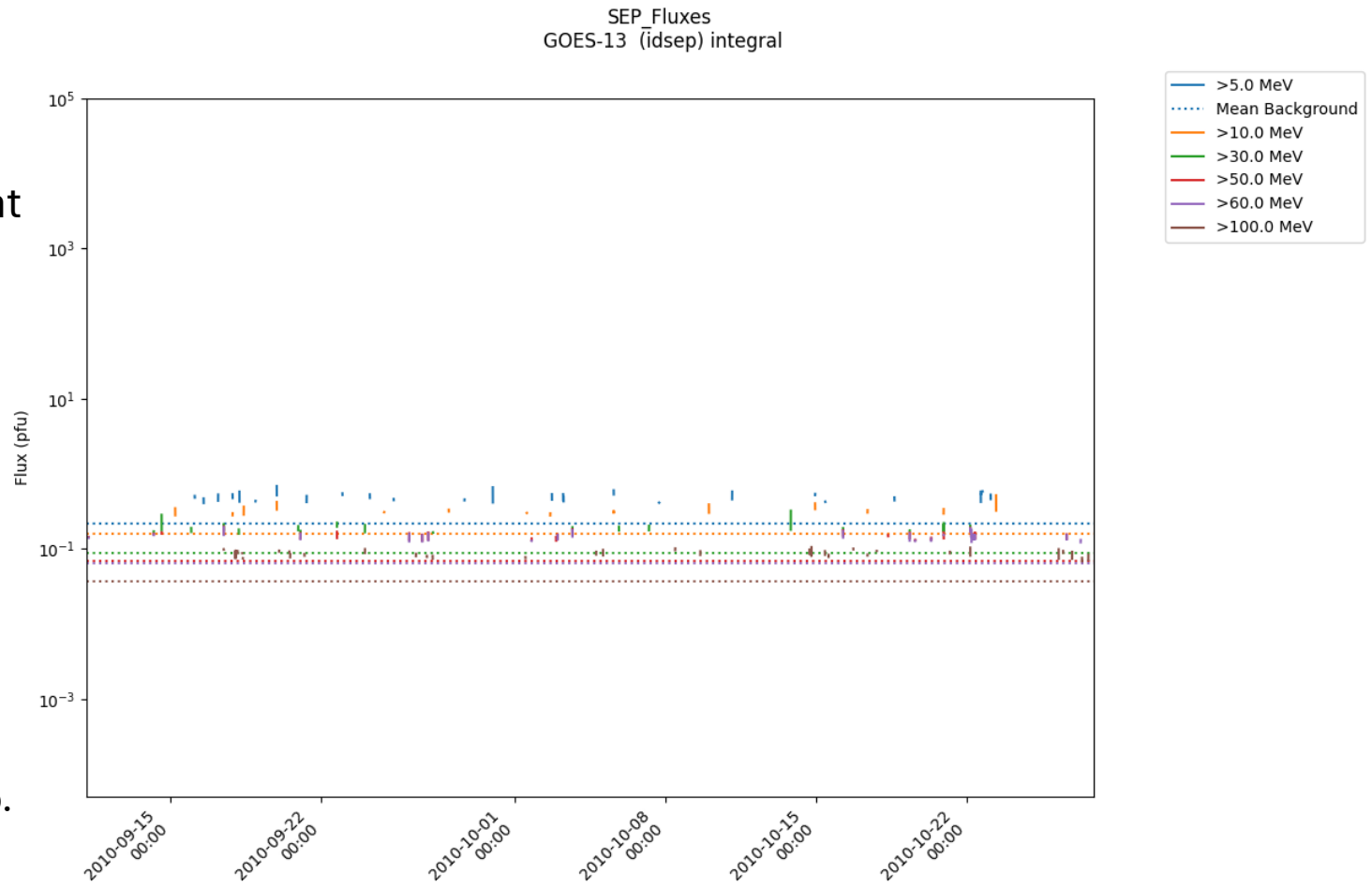
Separation of Background and SEP Enhancements - GOES integral fluxes

Enhancements are defined as intensities that exceed mean + 3sigma

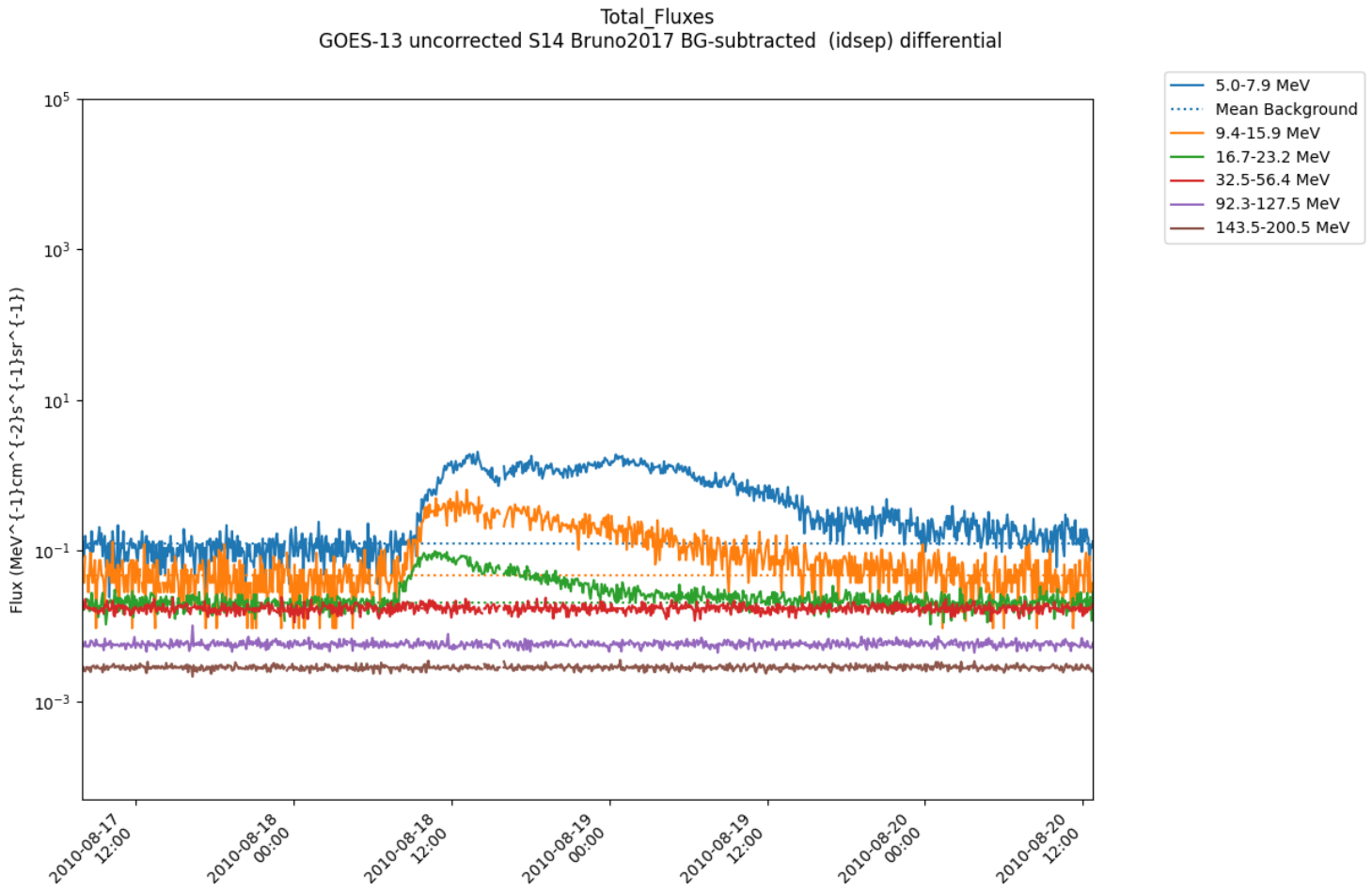
For GOES integral fluxes from NOAA, the enhanced fluxes and background were simply separated.

No background subtraction was performed.

Fluxes identified as background were set to zero.



Separation of Background and SEP Enhancements – GOES Energy Bin Calibrated

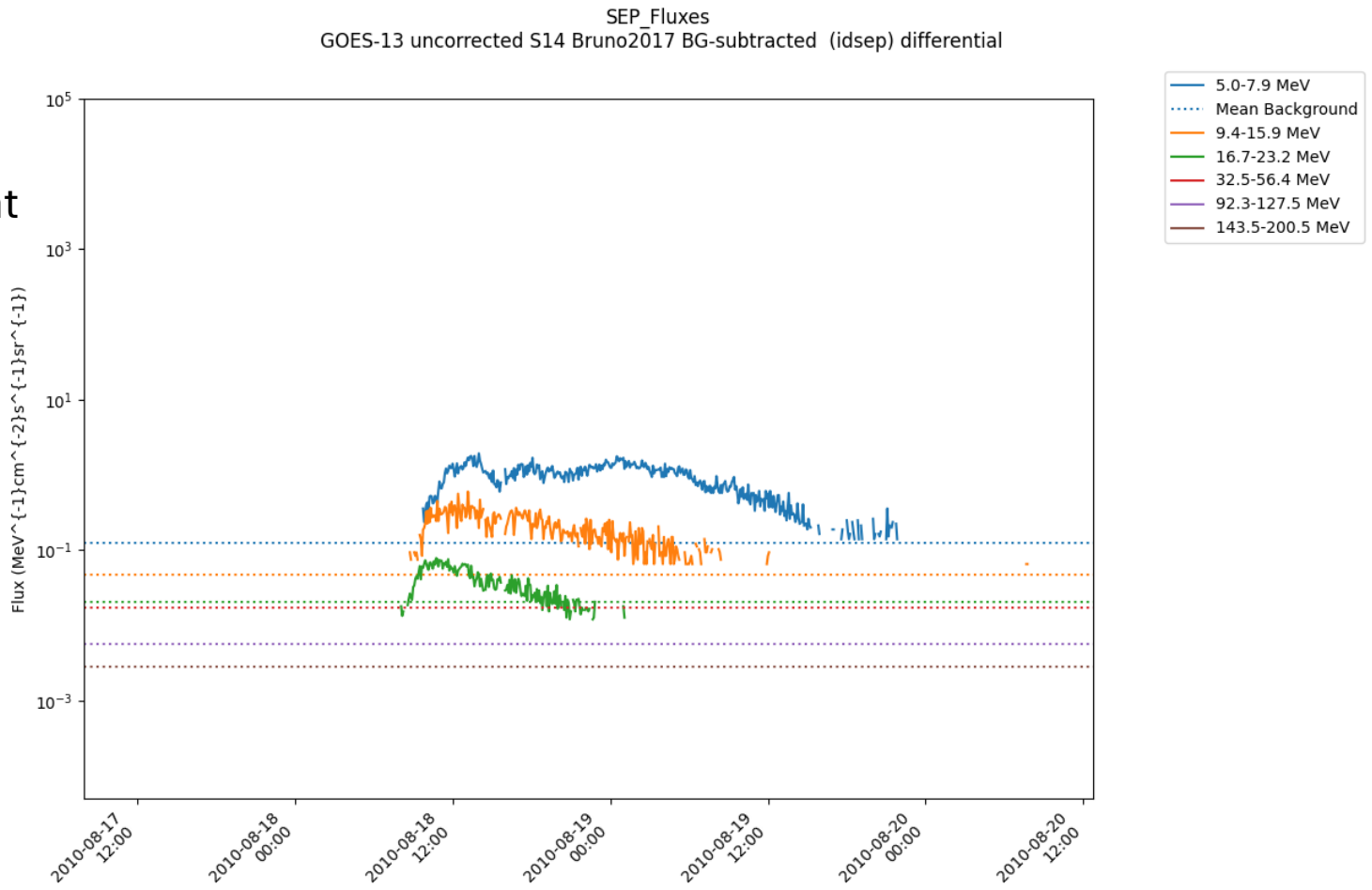


Separation of Background and SEP Enhancements – GOES Energy Bin Calibrated

Enhancements are defined as intensities that exceed mean + 3sigma

For GOES differential, energy bin-calibration fluxes, background subtraction was performed on the differential fluxes.

The differential fluxes were later converted to integral fluxes for >10, >100, >30, >50 MeV.



NOAA X-ray Science Data

- https://www.ncei.noaa.gov/data/goes-space-environment-monitor/access/science/xrs/
- NOAA README: The retrospective XRS science-quality data has been reprocessed with many corrections. The science-quality data differs from the operational data in several ways.
- First, in the science data, the calibration coefficients are smoothly varying values, while sporadic calibration updates in the operational data resulted in step functions in the irradiances.
- Second, as described in Section 3.1, the science-quality data was corrected so that it does not contain the SWPC scaling factors.
- A third major adjustments were bandpass corrections.
- A fourth major correction for the science-quality data was the revision or creation of data quality flags.

NOAA X-ray Science Data

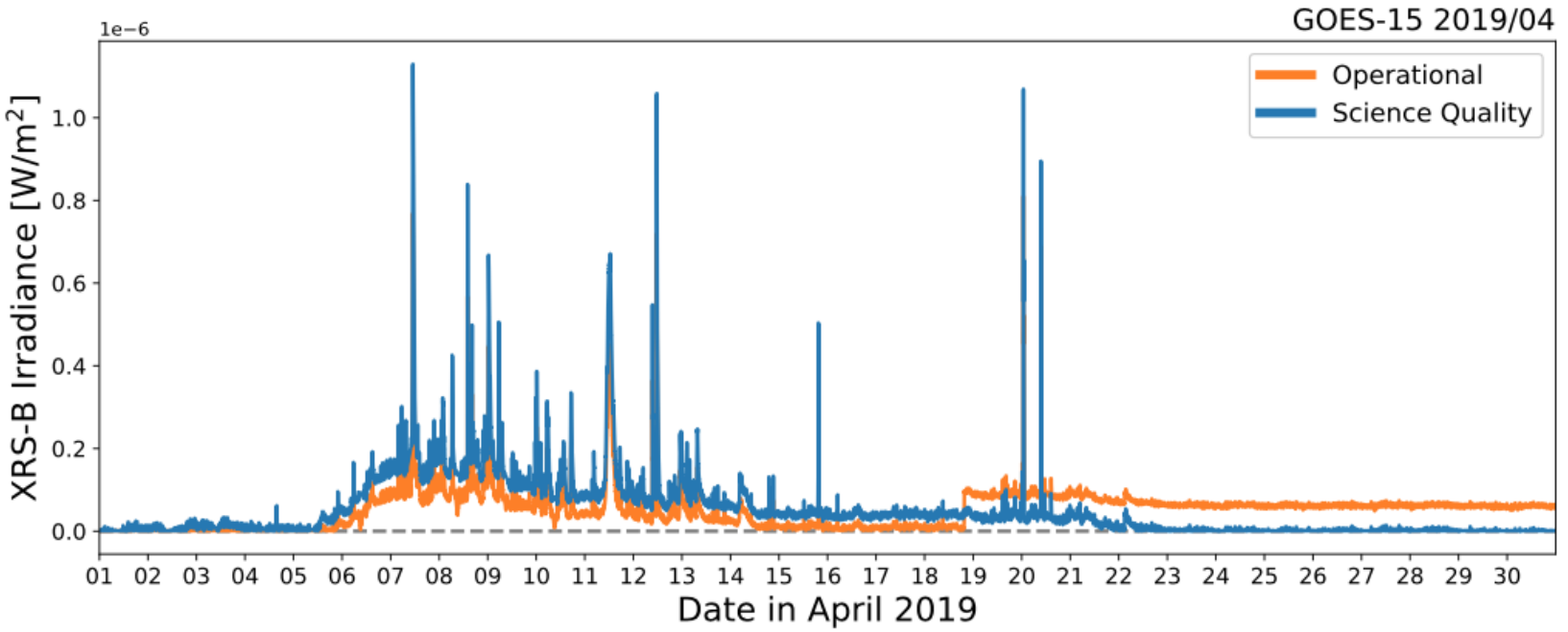


Figure 3: Comparison of operational (orange) and science-quality (blue) 1-minute averaged GOES-15 XRS-B data for the month of April 2019. The operational data has the original SWPC scaling and a discontinuity on 18 April due to a background adjustment. The science-quality data reflects the revised scaling and smooth calibration changes.

Updated Flare X-ray Values – SRAG SEP List

Flare Xray Start Time Deprecated	Flare Xray Peak Time Deprecated	Flare Xray End Time Deprecated	Flare Class Deprecated	Flare Magnitude Deprecated	Flare Integrated Flux Deprecated	Flare Duration Deprecated	Flare Xray Time To Peak Deprecated	Flare Xray Start Time	Flare Xray Peak Time	Flare Xray End Time	Flare Class	Flare Magnitude	Flare Integrated Flux
1997-11-04 05:52:00	1997-11-04 05:58:00	1997-11-04 06:02:00	X2.1	0.00021	0.005	10	6	1997-11-04 05:56:00	1997-11-04 05:58:00	1997-11-04 06:02:00	X3.0	0.00030429	0.08681143
1997-11-06 11:49:00	1997-11-06 11:55:00	1997-11-06 12:01:00	X9.4	0.00094	0.036	12	6	1997-11-06 11:52:00	1997-11-06 11:55:00	1997-11-06 12:01:00	X13.4	0.00134571	0.54251999
1998-04-20 09:38:00	1998-04-20 10:21:00	1998-04-20 11:18:00	M1.4	1.40E-05	0.061	100	43	1998-04-20 09:12:00	1998-04-20 10:21:00	1998-04-20 11:25:00	M2.1	2.13E-05	0.09419786
1998-05-02 13:31:00	1998-05-02 13:42:00	1998-05-02 13:51:00	X1.1	0.00011	0.067	20	11	1998-05-02 13:27:00	1998-05-02 13:42:00	1998-05-02 13:51:00	X1.6	0.00017	0.10070649
1998-05-06 07:58:00	1998-05-06 08:09:00	1998-05-06 08:20:00	X2.7	0.00027	0.21	22	11	1998-05-06 07:57:00	1998-05-06 08:09:00	1998-05-06 08:20:00	X3.9	0.00039571	0.31851
1998-05-09 03:04:00	1998-05-09 03:40:00	1998-05-09 03:55:00	M7.7	7.70E-05	0.11	51	36	1998-05-09 03:15:00	1998-05-09 03:40:00	1998-05-09 03:54:00	X1.0	0.00010986	0.15315086
1998-08-24 21:50:00	1998-08-24 22:12:00	1998-08-24 22:35:00	X1.0	0.0001	0.16	45	22	1998-08-24 21:44:00	1998-08-24 22:12:00	1998-08-24 22:35:00	X1.5	0.00015714	0.23456623
1998-09-23 06:40:00	1998-09-23 07:13:00	1998-09-23 07:31:00	M7.1	7.10E-05	0.12	51	33	1998-09-23 06:35:00	1998-09-23 07:12:00	1998-09-23 07:31:00	X1.0	0.00010271	0.1778274
1998-09-30 13:08:00	1998-09-30 13:50:00	1998-09-30 14:48:00	M2.8	2.80E-05	0.11	100	42						
1998-11-14 05:00:00	1998-11-14 05:08:00	1998-11-14 05:15:00	C1.3	1.30E-06	0.001	15	8	1998-11-14 05:15:00	1998-11-14 05:18:00	1998-11-14 05:22:00	C2.4	2.47E-06	0.00107314
1999-01-20 19:06:00	1999-01-20 20:04:00	1999-01-20 21:00:00	M5.2	5.20E-05	0.25	114	58	1999-01-20 18:52:00	1999-01-20 20:04:00	1999-01-20 21:02:00	M7.5	7.54E-05	0.36714259
1999-05-03 05:36:00	1999-05-03 06:02:00	1999-05-03 06:32:00	M4..4	4.40E-05	0.099	56	26	1999-05-03 05:30:00	1999-05-03 06:02:00	1999-05-03 06:32:00	M6.4	6.41E-05	0.14326149
own													
1999-06-04 06:52:00	1999-06-04 07:03:00	1999-06-04 07:11:00	M3.9	3.90E-05	0.024	19	11	1999-06-04 06:49:00	1999-06-04 07:03:00	1999-06-04 07:11:00	M5.6	5.63E-05	0.03546686
2000-04-04 15:12:00	2000-04-04 15:41:00	2000-04-04 16:05:00	C9.7	9.70E-06	0.023	53	29	2000-04-04 15:06:00	2000-04-04 15:41:00	2000-04-04 16:07:00	M1.3	1.40E-05	0.03535714
2000-06-06 14:58:00	2000-06-06 15:25:00	2000-06-06 15:40:00	X2.3	0.00023	0.36	42	27	2000-06-06 14:58:00	2000-06-06 15:25:00	2000-06-06 15:40:00	X3.3	0.00033143	0.52078801
2000-06-10 16:40:00	2000-06-10 17:02:00	2000-06-10 17:19:00	M5.2	5.20E-05	0.073	39	22	2000-06-10 16:32:00	2000-06-10 17:00:00	2000-06-10 17:19:00	M7.4	7.49E-05	0.10781314
2000-07-14 10:03:00	2000-07-14 10:24:00	2000-07-14 10:43:00	X5.7	0.00057	0.75	40	21	2000-07-14 10:03:00	2000-07-14 10:24:00	2000-07-14 10:43:00	X8.2	0.00082143	1.09437346
2000-07-22 11:17:00	2000-07-22 11:34:00	2000-07-22 12:02:00	M3.7	3.70E-05	0.07	45	17	2000-07-22 11:06:00	2000-07-22 11:34:00	2000-07-22 12:03:00	M5.3	5.33E-05	0.10691314
2000-09-12 11:31:00	2000-09-12 12:13:00	2000-09-12 13:13:00	M1.0	1.00E-05	0.045	102	42	2000-09-12 11:20:00	2000-09-12 12:12:00	2000-09-12 13:20:00	M1.4	1.44E-05	0.06949543
2000-10-16 06:40:00	2000-10-16 07:28:00	2000-10-16 09:11:00	M2.5	2.50E-05	0.16	151	48	2000-10-16 06:42:00	2000-10-16 07:35:00	2000-10-16 09:03:00	M3.7	3.70E-05	0.22488943
2000-10-25 08:45:00	2000-10-25 11:25:00	2000-10-25 15:21:00	C4.0	4.00E-06	0.065	396	160						
2000-11-08 22:42:00	2000-11-08 23:28:00	2000-11-09 00:05:00	M7.4	7.40E-05	0.21	83	46						
2000-11-24 14:51:00	2000-11-24 15:13:00	2000-11-24 15:21:00	X2.3	0.00023	0.16	30	22	2000-11-24 14:47:00	2000-11-24 15:13:00	2000-11-24 15:21:00	X3.3	0.00034	0.23323886