

SEP Events from STEREO A (Dec. 2006 - Jan. 2024) and B (Dec. 2006 - Sept. 2014) (Updated on 3/3/2024)

The list is compiled by Dr. Lan Jian (lan.jian@nasa.gov) using the criterion that the flux of 13-100 MeV protons from HET measurements > 10 pfu (1 pfu = 1 p cm⁻²sr⁻¹s⁻¹), to mimic the list of Solar Proton Events provided by NOAA Space Weather Prediction Center using the GOES spacecraft data (<http://www.swpc.noaa.gov/ftpdir/indices/SPE.txt>). Checking with the data is highly recommended because there are data gaps sometimes.

Hourly data from Hight Energy Telescope (von Roseninge et al., Space Sci. Rev., 2008) are used. The events in 2006 are in the solar wind, outside the Earth's bow shock. There are no events reaching the criterion in 2007-2010 at either STEREO spacecraft.

There is a list of >25 MeV proton events and relevant solar events in a separate study by Richardson et al. (Solar Phys. 2014).

# of STA	Start Time				End Time				Maximum Flux (pfu)	Fluence (cm ⁻² sr ⁻¹)	Comments
	Year	Month	Day	Hour	Year	Month	Day	Hour			
1	2006	12	6	20.5	2006	12	11	22.5	1031.77	83391997	CME and flare
2	2006	12	13	3.5	2006	12	14	17.5	449.22	21894825	CME and flare
3	2011	3	9	8.5	2011	3	9	16.5	26.88	676257	gradual rise, CME and flare
4	2011	3	21	3.5	2011	3	22	21.5	685.06	25013660	CME
5	2011	6	4	16.5	2011	6	7	23.5	2021.23	103897555	CME and flare
6	2011	11	4	0.5	2011	11	5	0.5	124.00	4049773	flare and CME
7	2012	1	24	8.5	2012	1	26	20.5	27.86	4183357	CME
8	2012	1	28	5.5	2012	1	31	11.5	1311.82	23479615	the 2nd rise is based on 1/24/2012 flux, no clear source
9	2012	3	9	23.5	2012	3	12	22.5	15.92	3465837	gradual rise, fast CMEs on 3/7 and 3/8
10	2012	3	21	9.5	2012	3	21	20.5	37.48	920542	3/21 7:25 CME, no good flare

11	2012	3	24	1.5	2012	3	24	11.5	69.65	995532	3/24 00:10 CME, no good flare
12	2012	5	27	12.5	2012	5	28	7.5	546.73	8425291	5/26 20:57 CME, no good flare
13	2012	7	23	4.5	2012	7	27	19.5	27002.30	443080467	7/23 2:36 CME
14	2012	9	20	20.5	2012	9	22	16.5	175.77	10051864	9/19 12:25 CME
15	2012	9	27	13.5	2012	9	29	11.5	154.23	7638152	9/27 9:55 CME
16	2012	11	8	12.5	2012	11	9	5.5	19.36	841853	11/8 10:55 CME
17	2013	3	5	4.5	2013	3	7	17.5	1151.18	51289550	3/5 03:25 CME
18	2013	8	20	6.5	2013	8	22	12.5	260.53	21631482	8/19 23:24 CME
19	2013	10	5	14.5	2013	10	6	1.5	21.18	720568	CME and flare?
20	2013	10	11	8.5	2013	10	12	4.5	152.47	4274389	CME and flare
21	2013	11	2	5.5	2013	11	3	7.5	56.64	2612211	CME and flare
22	2013	11	4	13.5	2013	11	6	1.5	98.69	4677715	2nd and gradual rise in a SEP event, CME, no flare at the right time
23	2013	11	7	11.5	2013	11	8	5.5	47.71	1925607	CME, no flare at the right time
24	2013	12	26	10.5	2013	12	27	9.5	28.10	1632087	CME, no M or X class flare detected by GOES
25	2014	1	9	3.5	2014	1	10	2.5	24.71	1576536	SEP onset on 1/6, gradual increase, CME, no M or X class flare detected by GOES
26	2014	2	25	2.5	2014	2	26	9.5	108.28	5745902	weaker SEP events ahead, CME, X4.9 flare detected by GOES
27	2014	3	12	16.5	2014	3	12	20.5	24.01	283356	CME, M2.5 flare detected by GOES at N14W70
28	2014	8	28	20.5	2014	8	29	0.5	23.47	289856	no STA images, STB observed halo CME on 8/28 when A & B were only 30° apart in longitude, data gaps

29	2014	9	2	7.5	2014	9	4	15.5	579.95	7634659	no STA images, STB observed a halo CME on 9/1 when A & B were only 30° apart in longitude
30	2014	9	25	19.5	2014	9	26	9.5	255.22	4290746	no STA images, STB COR2 observed a halo CME at 21 UT on 9/24 at 21UT. Because there are large data gaps at STA, the fluence may be incorrect.
31	2014	10	15	6.5	2014	10	16	21.5	176.26	3342622	solar observation is too short to tell
32	2014	12	13	19.5	2014	12	17	21.5	2037.31	51565621	flare from short EUVI movie, ICME on 12/16 with speed of about 600 km/s
33	2015	3	6	19.5	2015	3	6	23.5	56.15	786543	solar observation is too short to tell
	2017	7	23	10.5	2017	7	25	0.5	988.68	47761109	CME and 2 B-class flares on 7/23
34	2017	7	25	4.5	2017	7	25	9.5	18.06	301259	the same event with the previous one, separated by a dip in intensity profile
	2017	9	13	8.5	2017	9	16	2.5	57.36	6073828	CME and flares
35	2017	9	18	11.5	2017	9	19	8.5	257.78	5040994	CME, gradual increase, following the pervious one
36	2020	11	30	16.5	2020	12	2	2.5	80.74	5769985	an M4.4 flare on 11/29, CMEs on 11/26 and 11/29 (two bumps in SEP profile)
37	2021	10	9	8.5	2021	10	9	14.5	17.54	350419	an M1.6 flare and a CME on 10/9, https://kauai.ccmc.gsfc.nasa.gov/DONKI/view/SEP/17919/1

38	2021	10	28	16.5	2021	10	30	20.5	393.45	16888503	an X1.0 flare and a CME on 10/28, https://kauai.ccmc.gsfc.nasa.gov/DONKI/view/SEP/18099/1
39	2022	3	28	12.5	2022	3	28	22.5	32.02	836446	an M4.0 flare and a CME on 3/28
40	2022	3	30	18.5	2022	3	31	1.5	64.47	1031315	an X1.3 flare and a CME on 3/30
41	2023	2	25	21.5	2023	2	26	11.5	95.676	2436935.688	an M6.3 flare and a CME on 2/25, https://kauai.ccmc.gsfc.nasa.gov/DONKI/view/SEP/23937/1
42	2023	5	10	2.5	2023	5	10	15.5	15.41204	648425.484	two M-class flares on 5/9, a CME on 5/7 reached STA on 5/9, https://kauai.ccmc.gsfc.nasa.gov/DONKI/view/SEP/25046/1
43	2023	7	18	3.5	2023	7	19	9.5	74.7509	4074387.948	two M-class flares on late 7/17, near west limb though, https://kauai.ccmc.gsfc.nasa.gov/DONKI/view/SEP/26062/1
44	2023	7	29	0.5	2023	7	30	6.5	41.8571	2934288.288	M4.1 flare near west limb, https://www.lmsal.com/solarsoft/latest_events_archive/events_summary/2023/07/28/gev_20230728_1539/index.html
45	2023	8	8	3.5	2023	8	8	21.5	14.9253	891838.872	four events are within one SEP, X1.5 flare and CME near west limb on late 8/7, M3.6 flare near west limb on 8/8 https://kauai.ccmc.gsfc.nasa.gov/DONKI/view/SEP/26419/3
	2023	8	8	23.5	2023	8	9	2.5	11.14082	150696.36	
	2023	8	9	4.5	2023	8	9	6.5	10.88254	114264.36	
	2023	8	9	8.5	2023	8	9	12.5	11.01808	188511.156	

46	2023	9	1	5.5	2023	9	1	7.5	22.6861	177245.64	3 M-class flares on 9/1 in west hemisphere
47	2024	1	29	5.5	2024	1	30	7.5	93.873	4231773.972	M6.8 flare and CME on 1/29, https://kauai.ccmc.gsfc.nasa.gov/DONKI/view/SEP/28836/2

# of STB	Start Time				End Time				Maximum Flux (pfu)	Fluence (cm ⁻² sr ⁻¹)	Comments
	Year	Month	Day	Hour	Year	Month	Day	Hour			
1	2006	12	6	19.5	2006	12	12	0.5	1142.04	39073	CME and flare
2	2006	12	13	3.5	2006	12	14	18.5	413.87	51967	the 2 are 1 event, flare and CME
	2006	12	15	4.5	2006	12	15	8.5	16.08	38294	
3	2011	3	8	1.5	2011	3	8	9.5	39.12	909795	the 2 are 1 event, flare and CME
	2011	3	8	14.5	2011	3	8	17.5	14.40	181029	
4	2011	9	22	12.5	2011	9	26	3.5	1191.64	106348294	flare and CME
5	2011	10	4	19.5	2011	10	5	1.5	12.10	290412	10/4 11:25 and 12:10 CME
6	2012	1	23	9.5	2012	1	25	6.5	47.02	4352497	1/23 two fast CMEs
	2012	3	4	20.5	2012	3	5	21.5	74.18	2784298	CME
7	2012	3	6	2.5	2012	3	6	8.5	12.41	295315	it is the declining stage of the previous event
8	2012	3	7	2.5	2012	3	10	20.5	1584.10	76224430	3/7 00:15 CME
9	2012	3	27	5.5	2012	3	29	4.5	43.68	3803015	gradual, CME and flare
10	2012	7	12	21.5	2012	7	13	0.5	11.59	159477	7/12 7:46 C3.1 S21E06, 15:37 X1.4 S13W03, CME
	2012	7	25	2.5	2012	7	25	4.5	17.13	163708	7/23 2:25 halo CME,

11	2012	7	25	15.5	2012	7	28	1.5	25.06	3761808	it is the 2nd jump of the previous after a dip of flux, no good flare
12	2012	8	31	21.5	2012	9	3	7.5	546.41	44217386	8/31 19:25 CME
13	2012	9	22	23.5	2012	9	23	10.5	23.86	763412	CME
14	2012	9	28	5.5	2012	9	28	7.5	11.62	118808	CME
15	2013	3	6	5.5	2013	3	7	14.5	30.47	2776362	3/5 3:45 NE halo CME
16	2013	4	11	8.5	2013	4	12	18.5	180.50	8075118	4/11 7:10 CME
17	2013	5	13	18.5	2013	5	15	8.5	301.16	11616014	there is a second increase, CMEs
18	2013	6	21	6.5	2013	6	22	2.5	25.96	1415836	CME
19	2013	8	21	3.5	2013	8	22	13.5	22.01	2242099	CME
20	2013	10	11	13.5	2013	10	12	6.5	15.51	37452	CME and flare
21	2013	10	25	14.5	2013	10	26	7.5	31.90	38233	CME and flare
22	2013	11	7	13.5	2013	11	8	21.5	547.98	61693	a second sharp rise after a gradual SEP event started on 11/2, CME, no flare at the right time
23	2013	12	26	10.5	2013	12	27	1.5	26.93	46662	CME, no M or X class flare detected by GOES
24	2014	2	25	2.5	2014	2	28	3.5	214.94	37144	two weaker SEPs ahead, CME, X4.9 flare detected by GOES
25	2014	4	2	16.5	2014	4	3	7.5	104.50	38777	13:54 CME on 4/2 seen by STA COR2 when A & B were 42° apart in longitude
26	2014	9	1	12.5	2014	9	4	21.5	2299.93	52242	no STA images, STB observed a halo CME on 9/1 when A & B were only 30° apart in longitude

27	2014	9	25	4.5	2014	9	27	14.5	238.91	36559	no STA images, STB COR2 observed a halo CME at 21 UT on 9/24 at 21UT; data became unavailable after the event
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Records:

1. 3/12/2004, add the SEP events in January 2011 - September 2013
2. 5/1/2014, remove the SEP events from LET observed by both STEREO A and B in 2007-2010, add the SEP events from HET in Dec 2006 - Dec 2010 and Oct 2013 - Mar 2014 using consistent criterion, add leading notes
3. 2/11/2015, add the SEP events during Apr 2014 - Jan 2015 for STA, Apr - Sept 2014 for STB
4. 6/9/2015, change the comments for 9/25/2014 event, and add some notes at the top
5. 11/8/2016, add the SEP events during Jan 2015 - Oct 2016 for STA
6. 7/15/2017, update the list to Dec 2016 for STA
7. 11/3/2017, update the list to Sept 2017 for STA
8. 2/13/2019, update the list to January 2019 for STA, merge the SEPs in the same event
9. 1/5/2022, update the list to Nov 2021 for STA
10. 10/17/2022, update the list to September 2022 for STA
11. 3/3/2024, update the list to January 2024 for STA