Table 1. Major Solar Energetic Particle Events of Cycle 23 (1996-2003)

No.	SEP Date	SEP Time	CME Time	V2 km/s	W2 deg	M[e]	Source Loc.[f]	AR No.	Flare Imp.[g]	Flare Onset	Metric II Onset[h]	DH II Onset[i]	I_p pfu[j]	I_e efu[k]
01	1997/11/04	07:00	06:10 P	785	H	10	S14W33	8100	X2.1/2B	05:52	05:58	06:00	72	2.1e-02
02	1997/11/06	13:00	12:10 P	1556	H	..	S18W63	8100	X9.4/2B	11:49	11:53	12:10	490	1.0e-01
03	1998/04/20	11:00	10:07 O	1863	165	24	S43W90	...	M1.4/?	09:38	09:56	10:25	1700	3.4e-02
04	1998/05/02	14:00	14:06 P	938	H	8	S15W15	8210	X1.1/3B	13:31	13:41	14:25	150	4.8e-02
05	1998/05/06	08:00	08:29 P	1099	190	70	S11W65	8210	X2.7/1N	07:58	08:05	08:15	210	8.1e-02
06	1998/05/09	05:00	03:35 P	2331	178	8	S11W90	8210	M7.7/?	03:04	03:26	03:35	12	3.8e-03
07	1999/04/24	15:00	13:31 NP	1495	H	19	>NW90	...	...	...	N?	13:50	32	3.7e-03
08	1999/05/03	13:00	06:06 NP	1584	H	..	N15E32	8530	M4.4/2N	05:36	05:50	05:50	14	...
09	1999/06/01	20:00	19:37 NP	1772	H	11	>NW90	...	C1.2 ?	18:53	N?	18:50	48	6.2e-03
10	1999/06/04	08:00	07:26 NP	2230	150	5	N17W69	8552	M3.9/2B	06:52	07:02	07:05	64	2.6e-02
11	2000/02/18	10:00	09:54 NP	890	118	5	>NW90	...	...	...	09:19	09:38	13	2.0e-02
12	2000/04/04	17:00	16:32 NP	1188	H	6	N16W66	8933	C9.7/2F	15:12	15:25	15:45	55	1.4e-02
13	2000/06/06	19:00	15:54 P	1119	H	18	N20E18	9026	X2.3/?	14:58	15:16	15:20	84	...
14	2000/06/10	18:00	17:08 NP	1108	H	11	N22W38	9026	M5.2/3B	16:40	16:55	17:15	46	...
15	2000/07/14	11:00	10:54 P	1674	H	..	N22W07	9077	X5.7/3B	10:03	10:19	10:30	24000	1.9e-01
16	2000/07/22	12:00	11:54 NP	1230	105	15	N14W56	9085	M3.7/2N	11:17	11:25	11:45	17	7.3e-03
17	2000/09/12	13:00	11:54 NP	1550	H	..	S17W09	9163	M1.0/2N	11:31	11:33	12:00	320	2.3e-02
18	2000/10/16	08:00	07:27 NP	1336	H	..	N05W90	9193	M2.5/?	06:40	07:08	07:10	15	3.3e-03
19[b]	2000/10/25	12:00	08:26 O	770	H	18	N10W66	9199	C4.0?	08:45	N	09:30	15	1.6e-03
20	2000/11/08	23:00	23:06 O	1345	H	..	N10W77	9213	M7.4/3F	22:42	23:15	23:20	14800	3.2e-01
21	2000/11/24	14:00	15:30 P	1245	H	10	N22W07	9230	X2.3/2B	14:51	15:07	15:25	94	...
22[a]	2001/01/28	17:00	15:54 O	916	250	12	S04W59	9313	M1.5/1N	15:40	N	15:45	49	9.8e-03
23	2001/03/29	11:00	10:26 P	942	H	3	N20W19	9393	X1.7/1F	09:57	10:03	10:12	35	2.3e-02
24	2001/04/02	23:00	22:06 P	2505	244	10	N19W72	9390	X20/?	21:32	21:52	22:05	1100	1.1e-01
25	2001/04/10	08:00	05:30 P	2411	H	17	S23W09	9415	X2.3/3B	05:06	05:13	05:24	355	1.6e-02
26	2001/04/12	12:00	10:31 P	1184	H	5	S19W43	9415	X2.0/?	09:39	10:18	10:36	51	...
27	2001/04/15	14:00	14:06 P	1199	167	..	S20W85	9415	X14/2B	13:19	13:48	14:05	951	1.2e-01
28	2001/04/18	03:00	02:30 NP	2465	H	8	S23W92	9424	C2.2/?	02:11	02:17	02:55	321	2.2e-02
29	2001/04/26	14:00	12:30 P	1006	H	9	N17W31	9433	M7.8/2B	11:26	13:35	12:40	57	...
30	2001/05/07	13:00	12:06 NP	1223	205	30	>NW90	...	...	...	N?	13:12	30	2.8e-03
31	2001/06/15	16:00	15:56 NP	1701	H	8	>SW90	...	...	15:24	15:33	15:42	26	9.9e-03
32	2001/08/09	19:00	?	...	...	11	S17E19?	9570	C7.8/?	18:22	N	N	17	...
33	2001/08/16	01:00	23:54[d] B	1575	H	40	Backside	...	...	...	N?	00:10	493	...
34	2001/09/15	12:00	11:54 O	478	130	4	S21W49	9608	M1.5/1N	11:04	11:29	11:50	11	3.0e-03
35	2001/09/24	11:00	10:30 P	2402	H	22	S16E23	9632	X2.6/?	09:32	N	10:45	12900	5.5e-02
36	2001/10/01	13:00	05:30 P	1405	H	22	S20W84	9628	M9.1/?	04:41	N	05:36	2360	...
37	2001/10/19	17:30	16:50 P	901	H	5	N15W29	9661	X1.6/2B	16:13	16:24	16:45	11	3.4e-03
38	2001/10/22	17:00	15:06 NP	1336	H	11	S21E18	9672	M6.7/2N	14:27	14:53	15:15	24	8.2e-03
39	2001/11/04	17:00	16:35 O	1810	H	11	N06W18	9684	X1.0/3B	16:03	16:10	16:30	31700	1.2e-01
40	2001/11/17	06:00	05:30 NP	1380	H	15	S13E42	9704	M2.8/1N	04:49	05:00	05:20	34	3.1e-03
41	2001/11/22	21:00	20:30 NP	1443	H	...	S25W67	9704	M3.8/2B	20:18	20:22	20:50	...	...
42	2001/11/22	24:00	23:30 O	1437	H	13	S15W34	9704	M9.9/?	22:32	22:31	22:40	...	7.3e-03
43	2001/12/26	05:30	05:30 O	1406	212	7	N08W54	9742	M7.1/1B	04:32	05:02	05:20	779	1.0e-01
44	2001/12/28	24:00	20:06 NP	2044	H	25	S26E90	9756	X3.4/?	20:02	19:59	20:30	76	...
45	2002/01/08	03:00[c]	17:54 O	1794	H	25	>NE90	...	...	...	N?	18:30	91	...
46	2002/01/14	24:00	05:35 O	1492	H	35	S28W83	...	M4.4/?	05:29	6:08	06:25	15	...
47	2002/02/20	06:00	06:30 NP	952	H	48	N12W72	9825	M5.1/1N	05:52	6:15	06:20	13	4.3e-02
48	2002/03/15	03:00[c]	23:06 O	907	H	10	S08W03	9866	M2.2/1F	22:09	N	22:45	13	2.2e-03
49	2002/03/18	06:00	02:54 O	989	H	18	S09W46	9866	M1.0/?	02:16	N	02:55	53	...
50	2002/03/22	13:30	11:06 NP	1750	H	15	S09W90	9866	M1.6/?	10:12	10:47	11:30	16	1.2e-03
51	2002/04/17	10:30	08:26 NP	1218	H	10	S14W34	9906	M2.6/2N	07:46	08:08	08:30	24	...
52	2002/04/21	02:30	01:27 O	2409	241	9	S14W84	9906	X1.5/1F	00:43	01:19	01:30	2520	6.5e-02
53	2002/05/22	06:00	03:50 P	1494	H	15	S30W34		C5.0/?	03:18	N	04:10	820	2.1e-03
54	2002/07/07	13:00	11:06 NP	1329	>205	12	S13W90	10017	M1.0/?	11:15	N	11:35	22	8.7e-03
55	2002/07/15	10:30[c]	21:30 P	1300	>188	10	N19W01	10030	M1.8/?	21:03	N	21:15	234	9.0e-04
56	2002/07/20	06:00	21:30 P	2017	H	10	>SE90	10039	X3.3/?	21:04	21:07	21:30	28	...
57	2002/08/14	03:00	02:30 O	1309	133	7	N09W54	10061	M2.3/1N	01:47	01:57	02:20	26	5.0e-02
58	2002/08/22	02:30	02:06 P	1005	H	12	S07W62	10069	M5.4/2B	01:47	01:55	02:45	36	1.0e-02
59	2002/08/24	01:30	01:27 P	1878	H	8	S02W81	10069	X3.1/1F	00:49	01:09	01:45	317	5.9e-02
60	2002/11/09	15:00	13:31 P	1838	H	7	S12W29	10180	M4.6/2B	13:08	13:17	13:20	404	7.1e-03

[a] CME association may be by chance.
[b] Compound of two events, the second one starting around 09:50 UT (see text).
[c] Time corresponds to the next day
[d] Time corresponds to previous day.
[e] Mass in unit of 10^{15} g.
[f] >NW90 (>SW90) means beyond northwest (southwest) limb.
[g] ? Denotes no optical flare information; EPL - Eruptive prominence at limb.
[h] N - No burst; N? - Maybe occulted.
[i] First instance the burst is seen at or below 14 MHz
[j] 1 pfu = 1 particle $(\mathrm{cm}^2\ \mathrm{s\ sr})^{-1}$
[k] 1 efu = 1 electron $(\mathrm{cm}^2\ \mathrm{s\ sr\ eV})^{-1}$

Table 2. Properties of Preceding CMEs

Date	T2	V2	W2	T1	V1	W1	Loc.	AR	ΔT	ΔR	ΔV	I_p	Remarks
97/11/04	06:10	785	360	11:11[a]	352	122	S14W33	8100	19.7	36.9	433	72	DHII
97/11/06	12:10	1556	360	04:20	307	59	S18W63	8100	9.2	15.5	1249	490	III
98/05/02	14:06	938	360	05:31	542	360	S15W15	8210	9.0	26.3	396	150	III, weak DHII?
98/05/06	08:29	1099	190	00:02	786	110	S11W65	8210	8.7	36.2	313	210	mII
98/05/09	03:35	2331	178	13:01[a]	432	85	S11W90	8210	15.2	35.0	1899	12	cxIII; DHII?
00/06/06	15:54	1119	360	15:30	929	90	N20E18	9026	0.3	2.5	190	84	mII, DHII
00/07/14	10:54	1674	360	20:30[a]	839	62	N22W07	9077	14.7	64.6	835	24000	DHIII
00/11/24	15:30	1245	360	05:30	994	360	N22W07	9236	10.0	52.5	251	94	mII, DHII, minor
01/03/29	10:26	942	360	19:27[a]	258	59	N20W19	9393	15.9	22.3	684	35	DHIII
01/04/02	22:06	2505	244	12:50	731	155	N19W72	9393	9.0	35.0	1774	1100	mII, DHII, minor
01/04/10	05:30	2411	360	15:54[a]	1192	360	S23W09	9415	13.8	86.2	1219	355	mII,DHII, minor
01/04/12	10:31	1184	360	21:30[a]	469	74	S19W43	9415	13.8	34.4	715	51	cxIII
01/04/15	14:06	1199	167	17:54[a]	830	113	S16W71	9415	20.1	87.1	369	951	mII, cxIII
01/04/26	12:30	1006	360	08:30	740	91	N17W31	9433	4.3	17.4	266	57	DHIII
01/09/24	10:30	2402	360	21:54[a]	633	163	S16E23	9632	13.1	43.7	1769	12900	none
01/10/01	05:30	1405	360	01:54	478	68	S20W90	9628	4.5	12.1	927	2360	cxIII
01/10/19	16:50	901	360	01:27	558	254	N15W29	9661	15.9	46.9	343	11	mII, DHII, minor
02/05/22	03:50	1494	360	00:06	1265	117	S19W56	9948	3.6	22.4	358	820	mII
02/07/15	21:30	1307	111	20:30	1105	360	N19W01	0030	1.1	7.6	168	234	DHII
02/07/20	22:06	2017	360	20:42[b]	1351	83	S13E99[c]	0039	0.7	6.2	666	28	mII
02/08/22	02:06	1013	360	04:06[a]	395	70	S07W62	0069	22.3	55.7	531	36	cxIII
02/08/24	01:27	1878	360	13:27[a]	321	103	S02W81	0069	12.3	21.5	1557	317	cxIII, minor?
02/11/09	13:31	1793	360	18:30[a]	840	62	S12W29	0180	19.2	84.4	998	404	cxIII

[a] Time corresponds to previous day

[b] Preceeding CME identified in polarized brightness images

[c] Estimated longitude

Table 3. Ratios of Median Particle Intensities

Ratio	Protons	Electrons
I(P)/I(ALL)	3.89	2.13
I(NP)/I(ALL)	0.54	0.56
I(P)/I(NP)	7.24	3.78

Table 4. Intensities of P and NP events

Group	$I_p \geq 50$ pfu	$I_p < 50$ pfu	Total
P	18	5	23
NP	5	15	20

Table 5. Correlation of particle intensities with CME speed (V) and flare size (F)

Group	V vs I_p	V vs I_e	F vs I_p	F vs I_e
ALL	0.45	0.29	0.35	0.53
–Frontside	0.59	0.45	0.36	0.65
P	0.43	0.11	0.12	0.74
–Frontside	0.70	0.22	0.22	0.86
NP	0.58	-0.06	-0.16	-0.03
–Frontside	0.46	0.03	-0.25	-0.06
O	0.68	0.78	0.71	0.67
–Frontside	0.74	0.78	0.78	0.67