

Table 3. Proton fluxes, selected TSA and VDA parameters, ion fluences, and Fe/O ratios for 55–80 MeV proton events in 1996–2016.

ID	SOHO/ERNE 55–80 MeV proton flux			Proton TSA (67.7 MeV)		Proton VDA			Fluence [cm ² sr ⁻¹]		Fe/O ratio
	Onset	I_{\max} [pfu MeV ⁻¹]	End	L [AU]	$t_{\text{rel}} + 500$ s	s [AU]	$t_0 + 500$ s	R^2	$p^+ > 10$ MeV	O 5–15 MeV/n	
0	24-Sep-1997 03:59	1.5×10^{-3}	29-Sep-1997 08:34	1.21	03:40	6.08 ± 0.42	01:18±00:35	0.818	2.8×10^4	2.5×10^1	$< 6.7 \times 10^{-2}$
1	07-Oct-1997 14:43	8.0×10^{-4}	09-Oct-1997 04:49	1.22	14:23	2.39 ± 0.13	13:03±00:10	0.951	1.4×10^4	8.2×10^0	$< 2.0 \times 10^{-1}$
2	04-Nov-1997 06:41	1.5×10^{-1}	06-Nov-1997 12:37	1.23	06:21	2.44 ± 0.09	05:43±00:07	0.977	2.6×10^6	7.4×10^2	3.9×10^{-1}
3	06-Nov-1997 12:37	1.5×10^{-1}	13-Nov-1997 22:26	1.20	12:18	2.61 ± 0.24	12:21±00:17	0.873	1.3×10^7	7.1×10^3	4.3×10^{-1}
4	13-Nov-1997 22:26	2.0×10^{-3}	14-Nov-1997 14:29	1.24	22:06	2.11 ± 0.12	21:46±00:09	0.947	4.6×10^4	7.1×10^0	$< 2.3 \times 10^{-1}$
5	14-Nov-1997 14:29	1.0×10^{-3}	19-Nov-1997 05:06	1.19	14:10	2.19 ± 0.18	13:31±00:14	0.891	3.6×10^4	2.8×10^1	6.0×10^{-2}
6	20-Apr-1998 11:13	1.0×10^{-1}	02-May-1998 14:10	1.18	10:54	2.55 ± 0.13	10:17±00:10	0.958	N/A	N/A	N/A
7	02-May-1998 14:10	1.0×10^{-1}	06-May-1998 08:29	1.08	13:53	1.16 ± 0.11	13:55±00:08	0.868	2.5×10^6	2.4×10^2	6.7×10^{-1}
8	06-May-1998 08:29	4.0×10^{-1}	09-May-1998 04:32	1.13	08:11	1.39 ± 0.19	07:52±00:14	0.765	2.3×10^6	6.9×10^2	3.4×10^{-1}
9	09-May-1998 04:32	6.0×10^{-3}	24-May-1998 16:12	1.10	04:15	2.56 ± 0.13	03:32±00:10	0.960	5.9×10^5	2.7×10^2	1.9×10^{-1}
10	16-Jun-1998 20:35	1.0×10^{-3}	24-Jun-1998 09:53	1.19	20:16	1.43 ± 0.19	19:29±00:15	0.762	1.8×10^5	1.2×10^2	6.0×10^{-2}
11	18-Oct-1998 22:22	4.0×10^{-3}	23-Oct-1998 01:33	1.17	22:03	N/A			1.6×10^5	7.8×10^1	1.7×10^{-1}
12	14-Nov-1998 06:16	1.5×10^{-1}	22-Nov-1998 07:17	1.15	05:58	1.23 ± 0.05	06:05±00:05	0.714	N/A	N/A	N/A
13	22-Nov-1998 07:17	8.0×10^{-3}	24-Nov-1998 02:53	1.15	06:59	1.51 ± 0.09	06:51±00:06	0.952	9.6×10^4	1.1×10^1	1.5×10^{-1}
14	24-Nov-1998 02:53	6.0×10^{-3}	04-Dec-1998 15:06	1.09	02:36	3.72 ± 0.46	02:22±00:35	0.781	2.1×10^5	9.2×10^1	7.0×10^{-2}
15	24-Apr-1999 14:30	3.0×10^{-3}	30-Apr-1999 07:02	1.14	14:12	1.75 ± 0.10	13:48±00:07	0.953	1.1×10^6	3.4×10^2	7.0×10^{-2}
16	09-May-1999 18:40	2.0×10^{-3}	14-May-1999 02:03	1.18	18:21	2.35 ± 0.11	17:38±00:08	0.965	4.9×10^4	9.4×10^0	1.7×10^{-1}
17	27-May-1999 11:16	1.0×10^{-2}	01-Jun-1999 19:49	1.14	10:58	1.63 ± 0.08	10:38±00:06	0.964	2.2×10^5	2.1×10^1	1.5×10^{-1}
18	01-Jun-1999 19:49	1.8×10^{-2}	03-Jun-1999 15:06	1.21	19:29	2.26 ± 0.14	19:11±00:11	0.924	2.5×10^6	6.0×10^2	1.2×10^{-1}
19	11-Jun-1999 01:09	5.0×10^{-3}	07-Jul-1999 00:58	1.15	00:51	1.81 ± 0.09	00:40±00:07	0.963	1.7×10^5	1.1×10^2	1.0×10^{-1}
20	09-Jan-2000 21:30	8.0×10^{-4}	14-Jan-2000 01:54	1.21	21:11	4.55 ± 0.26	02:40±00:22	0.941	8.4×10^4	6.5×10^1	1.0×10^{-1}
21	18-Jan-2000 18:24	3.0×10^{-3}	26-Jan-2000 12:00	1.23	18:04	3.62 ± 0.15	16:58±00:13	0.959	8.5×10^4	7.1×10^0	$< 2.3 \times 10^{-1}$
22	12-Feb-2000 05:15	1.0×10^{-3}	16-Feb-2000 09:59	1.06	04:59	2.91 ± 0.15	04:01±00:11	0.957	4.2×10^4	5.9×10^0	$< 2.8 \times 10^{-1}$
23	17-Feb-2000 21:18	2.0×10^{-3}	18-Feb-2000 09:57	1.15	21:00	1.41 ± 0.06	20:57±00:05	0.951	3.6×10^4	4.7×10^0	3.5×10^{-1}
24	18-Feb-2000 09:57	1.5×10^{-2}	22-Feb-2000 17:11	1.18	09:38	1.48 ± 0.04	09:34±00:03	0.943	3.7×10^5	1.1×10^1	6.2×10^{-1}
25	02-Mar-2000 09:13	1.5×10^{-3}	03-Mar-2000 02:47	1.13	08:55	2.36 ± 0.09	08:16±00:07	0.977	8.4×10^3	3.5×10^0	$< 4.7 \times 10^{-1}$
26	03-Mar-2000 02:47	1.0×10^{-3}	08-Mar-2000 08:54	1.14	02:29	1.91 ± 0.08	02:12±00:06	0.970	2.2×10^4	2.0×10^1	7.3×10^{-1}
27	04-Apr-2000 16:03	2.0×10^{-3}	10-Apr-2000 05:01	1.18	15:44	1.39 ± 0.04	15:28±00:03	0.987	2.0×10^6	1.6×10^3	6.0×10^{-2}
28	23-Apr-2000 14:00	2.0×10^{-3}	27-Apr-2000 12:00	1.16	13:42	3.46 ± 0.24	12:47±00:20	0.823	5.0×10^4	1.2×10^0	$< 1.4 \times 10^0$
29	06-Jun-2000 18:25	4.0×10^{-3}	10-Jun-2000 17:26	1.15	18:07	0.79 ± 0.08	18:36±00:07	0.875	3.7×10^6	1.8×10^3	1.0×10^{-2}
30	10-Jun-2000 17:26	2.0×10^{-1}	15-Jun-2000 12:00	1.13	17:08	1.56 ± 0.06	17:00±00:04	0.981	2.5×10^6	1.7×10^2	6.3×10^{-1}
31	18-Jun-2000 02:29	1.0×10^{-3}	21-Jun-2000 12:00	1.17	02:10	1.46 ± 0.06	02:06±00:05	0.929	6.6×10^4	5.1×10^1	1.3×10^{-1}
32	14-Jul-2000 10:37	$> 1.0 \times 10^{-1}$	22-Jul-2000 12:03	1.09	10:20	1.05 ± 0.10	10:39±00:09	0.725	$5.8 \times 10^{7.5}$	8.9×10^5	1.5×10^{-1}
33	22-Jul-2000 12:03	1.5×10^{-2}	27-Jul-2000 23:06	1.17	11:44	2.23 ± 0.05	11:29±00:04	0.991	5.5×10^5	1.5×10^2	6.0×10^{-2}
34	27-Jul-2000 23:06	2.0×10^{-3}	10-Aug-2000 00:00	1.23	22:46	3.42 ± 0.28	21:28±00:22	0.890	5.8×10^5	1.3×10^2	7.0×10^{-2}
35	12-Sep-2000 13:09	1.5×10^{-2}	26-Sep-2000 11:54	1.19	12:50	1.76 ± 0.12	12:37±00:09	0.926	1.6×10^7	9.6×10^3	3.0×10^{-2}
36	16-Oct-2000 07:39	2.00×10^{-2}	25-Oct-2000 12:40	1.07	07:23	1.52 ± 0.07	07:06±00:05	0.966	1.1×10^6	3.8×10^2	3.8×10^{-1}
37	25-Oct-2000 12:40	2.0×10^{-3}	29-Oct-2000 00:00	1.15	12:22	2.45 ± 0.15	10:10±00:12	0.938	9.7×10^5	2.3×10^2	1.7×10^{-1}
38	08-Nov-2000 23:20	$> 6.0 \times 10^{-2}$	24-Nov-2000 05:43	1.11	23:03	0.31 ± 0.04	23:25±00:03	0.802	N/A	N/A	N/A
39	24-Nov-2000 05:43	7.0×10^{-2}	14-Dec-2000 12:59	1.18	05:24	2.02 ± 0.19	05:29±00:14	0.864	N/A	N/A	N/A
40	05-Jan-2001 18:33	2.0×10^{-3}	08-Jan-2001 04:56	1.13	18:15	2.20 ± 0.13	17:44±00:10	0.938	N/A	N/A	N/A
41	21-Jan-2001 04:40	2.0×10^{-3}	28-Jan-2001 16:58	1.23	04:20	2.21 ± 0.47	08:27±00:37	0.497	N/A	N/A	N/A
42	28-Jan-2001 16:58	5.0×10^{-2}	03-Feb-2001 22:53	1.20	16:39	3.89 ± 0.21	15:21±00:17	0.910	N/A	N/A	N/A
43	29-Mar-2001 11:49	1.8×10^{-2}	02-Apr-2001 12:24	1.09	11:32	4.03 ± 0.27	09:22±00:20	0.925	N/A	N/A	N/A
44	02-Apr-2001 12:24	6.0×10^{-3}	02-Apr-2001 22:41	1.08	12:07	0.88 ± 0.06	12:30±00:06	0.602	N/A	N/A	N/A
45	02-Apr-2001 22:41	2.0×10^{-1}	09-Apr-2001 16:20	1.09	22:24	2.33 ± 0.49	22:07±00:35	0.561	N/A	N/A	N/A
46	09-Apr-2001 16:20	1.8×10^{-2}	10-Apr-2001 07:34	1.08	16:04	N/A			N/A	N/A	N/A
47	10-Apr-2001 07:34	4.0×10^{-2}	12-Apr-2001 11:01	1.08	07:17	1.38 ± 0.15	06:56±00:11	0.841	N/A	N/A	N/A
48	12-Apr-2001 11:01	8.0×10^{-2}	15-Apr-2001 14:05	1.06	10:45	2.97 ± 0.05	10:02±00:05	0.937	N/A	N/A	N/A
49	15-Apr-2001 14:05	1.5×10^{-1}	18-Apr-2001 02:51	1.11	13:48	1.57 ± 0.10	13:53±00:07	0.938	N/A	N/A	N/A
50	18-Apr-2001 02:51	2.0×10^{-1}	26-Apr-2001 12:00	1.12	02:33	1.95 ± 0.07	02:17±00:05	0.983	N/A	N/A	N/A
51	07-May-2001 13:05	6.0×10^{-3}	12-May-2001 09:54	1.18	12:46	1.44 ± 0.09	12:47±00:07	0.944	N/A	N/A	N/A
52	20-May-2001 06:49	3.0×10^{-2}	25-May-2001 02:17	1.18	06:30	2.19 ± 0.11	05:56±00:08	0.962	N/A	N/A	N/A
53	04-Jun-2001 17:13	2.0×10^{-3}	09-Jun-2001 10:44	1.15	16:55	1.73 ± 0.06	16:28±00:05	0.982	N/A	N/A	N/A
54	15-Jun-2001 16:08	4.0×10^{-2}	19-Jun-2001 04:17	1.25	15:47	2.32 ± 0.08	15:18±00:06	0.980	N/A	N/A	N/A

Table 3. continued.

ID	SOHO/ERNE 55–80 MeV proton flux			Proton TSA (67.7 MeV)		Proton VDA			Fluence [cm ⁻² sr ⁻¹]		Fe/O ratio
	Onset	I_{\max} [pfu MeV ⁻¹]	End	L [AU]	t_{rel} + 500 s	s [AU]	t_0 + 500 s	R^2	p^+ >10 MeV	O 5–15 MeV/n	
55	19-Jun-2001 04:17	8.0×10^{-3}	24-Jun-2001 05:27	1.17	03:58	2.25±0.09	03:28±00:07	0.943	N/A	N/A	N/A
56	10-Aug-2001 07:22	6.0×10^{-4}	15-Sep-2001 12:24	1.16	07:04	N/A			N/A	N/A	N/A
57	15-Sep-2001 12:24	3.0×10^{-3}	23-Sep-2001 21:36	1.09	12:07	1.32±0.07	11:54±00:05	0.958	2.6×10^5	1.1×10^1	1.5×10^{-1}
58	24-Sep-2001 11:18	$>1.0 \times 10^{-1}$	01-Oct-2001 08:53	1.14	11:00	2.10±0.16	10:34±00:12	0.892	7.4×10^{7S}	1.6×10^5	6.0×10^{-2}
59	01-Oct-2001 08:53	2.0×10^{-2}	19-Oct-2001 01:58	1.11	08:36	0.38±0.19	12:00±00:15	0.177	2.9×10^{7S}	3.3×10^4	2.0×10^{-2}
60	19-Oct-2001 01:58	7.0×10^{-3}	19-Oct-2001 17:22	1.27	01:37	1.90±0.12	01:38±00:09	0.891	2.0×10^5	$<1.1 \times 10^0$	N/A
61	19-Oct-2001 17:22	1.0×10^{-2}	22-Oct-2001 15:51	1.22	17:02	2.32±0.03	16:42±00:03	0.992	7.1×10^5	1.6×10^2	1.7×10^{-1}
62	22-Oct-2001 15:51	2.0×10^{-2}	04-Nov-2001 16:45	1.08	15:34	1.66±0.11	15:23±00:08	0.932	1.2×10^6	1.7×10^2	2.2×10^{-1}
63	04-Nov-2001 16:45	$>1.0 \times 10^{-1}$	16-Nov-2001 12:00	1.23	16:25	1.45±0.13	16:16±00:09	0.883	7.2×10^{7S}	4.1×10^5	1.1×10^{-1}
64	22-Nov-2001 20:54	5.0×10^{-2}	10-Dec-2001 12:00	1.11	20:37	2.49±0.07	20:10±00:06	0.959	6.8×10^{7S}	3.6×10^5	5.0×10^{-2}
65	26-Dec-2001 05:48	4.0×10^{-1}	10-Jan-2002 10:30	1.15	05:30	1.54±0.12	04:51±00:08	0.912	3.2×10^7	2.2×10^4	1.4×10^{-1}
66	10-Jan-2002 10:30	1.0×10^{-3}	14-Jan-2002 08:03	1.11	10:13	5.94±0.87	05:00±01:05	0.721	7.6×10^6	1.7×10^3	1.1×10^{-3}
67	14-Jan-2002 08:03	2.0×10^{-3}	24-Jan-2002 16:16	1.09	07:46	1.56±1.09	10:06±01:21	0.108	2.3×10^6	3.5×10^2	4.6×10^{-3}
68	27-Jan-2002 13:38	5.0×10^{-3}	04-Feb-2002 03:57	1.16	13:20	2.34±0.07	12:56±00:05	0.988	2.6×10^5	2.3×10^1	5.4×10^{-1}
69	20-Feb-2002 05:58	1.0×10^{-2}	26-Feb-2002 12:37	1.14	05:40	1.62±0.08	05:52±00:06	0.960	2.2×10^{5S}	5.2×10^2	5.7×10^{-1}
70	18-Mar-2002 04:16	4.0×10^{-3}	22-Mar-2002 00:00	1.28	03:55	2.81±0.05	03:21±00:05	0.915	3.4×10^6	5.0×10^3	6.0×10^{-2}
71	17-Apr-2002 10:32	2.0×10^{-3}	21-Apr-2002 01:45	1.14	10:14	1.09±0.08	09:51±00:09	0.543	7.3×10^5	3.6×10^3	5.0×10^{-2}
72	21-Apr-2002 01:45	$>5.0 \times 10^{-1}$	16-May-2002 13:10	1.12	01:27	1.15±0.05	01:27±00:04	0.912	5.9×10^{7S}	6.6×10^5	8.0×10^{-2}
73	22-May-2002 06:46	2.0×10^{-3}	06-Jun-2002 04:47	1.18	06:27	2.82±0.21	00:56±00:17	0.905	6.5×10^6	6.5×10^4	4.0×10^{-2}
74	07-Jul-2002 12:13	5.0×10^{-3}	15-Jul-2002 23:28	1.17	11:54	1.77±0.05	11:34±00:04	0.989	1.2×10^6	1.6×10^2	1.5×10^{-1}
75	16-Jul-2002 10:31	7.0×10^{-3}	02-Aug-2002 12:00	1.20	10:12	0.56±0.14	08:03±00:11	0.477	1.3×10^7	3.2×10^4	5.0×10^{-2}
76	14-Aug-2002 06:44	saturated	16-Aug-2002 00:00	1.15	06:26	1.29±0.08	02:09±00:07	0.936	9.4×10^{5S}	3.1×10^3	2.0×10^{-2}
77	18-Aug-2002 22:10	2.0×10^{-3}	20-Aug-2002 08:46	1.10	21:53	1.36±0.04	21:48±00:04	0.843	1.5×10^5	1.7×10^3	1.7×10^0
78	20-Aug-2002 08:46	6.0×10^{-3}	22-Aug-2002 02:30	1.13	08:28	1.98±0.04	08:09±00:04	0.966	6.9×10^4	3.2×10^3	1.7×10^0
79	22-Aug-2002 02:30	5.0×10^{-2}	24-Aug-2002 01:35	1.16	02:12	2.25±0.15	01:45±00:11	0.931	1.6×10^6	5.7×10^2	9.3×10^{-1}
80	24-Aug-2002 01:35	5.0×10^{-1}	06-Sep-2002 04:01	1.18	01:16	2.77±0.08	00:42±00:06	0.987	1.7×10^7	3.6×10^4	1.0×10^{-1}
81	06-Sep-2002 04:01	2.0×10^{-3}	18-Sep-2002 21:36	1.16	03:43	0.89±0.10	00:29±00:09	0.788	2.7×10^6	6.1×10^3	4.0×10^{-2}
82	09-Nov-2002 14:37	5.0×10^{-3}	18-Nov-2002 01:07	1.17	14:18	2.66±0.10	13:19±00:09	0.925	8.6×10^6	2.2×10^4	5.0×10^{-2}
83	19-Dec-2002 22:21	2.0×10^{-3}	22-Dec-2002 00:00	1.07	22:05	1.61±0.07	21:44±00:06	0.967	1.4×10^5	$<1.1 \times 10^0$	N/A
84	23-Apr-2003 01:32	2.0×10^{-3}	04-May-2003 03:54	1.10	01:15	2.24±0.19	00:43±00:14	0.893	9.3×10^4	1.2×10^0	2.7×10^0
85	28-May-2003 01:54	4.0×10^{-3}	31-May-2003 02:56	1.07	01:38	1.36±0.25	02:54±00:19	0.624	2.6×10^6	2.5×10^4	1.4×10^{-1}
86	31-May-2003 02:56	5.0×10^{-2}	03-Jun-2003 14:47	1.05	02:40	2.82±0.16	02:02±00:11	0.950	7.5×10^5	8.3×10^2	1.7×10^{-1}
87	26-Oct-2003 17:55	saturated	28-Oct-2003 11:18	1.10	17:38	1.86±0.11	17:16±00:08	0.934	1.2×10^{7S}	6.0×10^4	1.0×10^{-1}
88	28-Oct-2003 11:18	saturated	02-Nov-2003 10:05	1.04	11:02	2.74±0.12	10:32±00:09	0.963	5.4×10^{7S}	2.7×10^6	1.8×10^{-1}
89	02-Nov-2003 10:05	N/A	02-Nov-2003 17:54	1.07	09:49	2.98±0.07	09:03±00:10	0.936	6.0×10^{5S}	1.6×10^3	6.0×10^{-2}
90	02-Nov-2003 17:54	saturated	18-Nov-2003 00:00	1.09	17:37	3.79±0.22	16:37±00:24	0.867	5.4×10^{7S}	1.5×10^6	4.0×10^{-2}
91	20-Nov-2003 08:59	3.0×10^{-3}	02-Dec-2003 00:00	1.06	08:43	1.21±0.22	07:25±00:17	0.626	2.7×10^6	4.8×10^3	3.0×10^{-2}
92	11-Apr-2004 05:00	4.0×10^{-3}	15-Apr-2004 11:12	1.14	04:42	1.95±0.09	04:23±00:07	0.926	2.1×10^6	7.3×10^3	6.0×10^{-2}
93	13-Jul-2004 01:34	1.0×10^{-3}	17-Jul-2004 03:49	1.12	01:17	2.37±0.12	00:34±00:10	0.905	4.3×10^4	2.4×10^0	$<7.0 \times 10^{-1}$
94	22-Jul-2004 17:33	2.0×10^{-3}	25-Jul-2004 16:19	1.10	17:16	1.34±0.17	14:30±00:13	0.784	3.3×10^5	6.6×10^2	7.0×10^{-1}
95	25-Jul-2004 16:19	3.0×10^{-3}	06-Aug-2004 09:16	1.09	16:02	2.30±0.20	15:10±00:18	0.735	1.2×10^7	4.1×10^4	5.0×10^{-2}
96	01-Nov-2004 06:15	1.0×10^{-1}	07-Nov-2004 16:54	1.13	05:57	1.60±0.07	05:50±00:06	0.914	2.1×10^6	3.7×10^2	1.3×10^{-1}
97	07-Nov-2004 16:54	$>2.0 \times 10^{-2}$	09-Nov-2004 18:43	1.08	16:37	4.70±0.14	14:44±00:12	0.953	1.1×10^7	5.3×10^4	6.0×10^{-2}
98	09-Nov-2004 18:43	5.0×10^{-3}	10-Nov-2004 02:46	1.03	18:28	7.94±0.27	16:08±00:30	0.746	7.0×10^5	1.2×10^3	4.0×10^{-2}
99	10-Nov-2004 02:46	$>5.0 \times 10^{-2}$	30-Nov-2004 18:45	1.03	02:31	3.25±1.66	04:34±02:10	0.198	2.2×10^7	9.6×10^4	7.0×10^{-2}
100	15-Jan-2005 06:59	7.0×10^{-3}	15-Jan-2005 23:35	1.04	06:43	1.43±0.07	06:31±00:05	0.961	3.3×10^5	1.7×10^2	1.1×10^{-1}
101	15-Jan-2005 23:35	5.0×10^{-2}	15-Feb-2005 16:37	1.07	23:19	4.24±0.11	22:04±00:09	0.980	6.6×10^7	5.7×10^5	1.0×10^{-1}
102	13-May-2005 18:43	5.0×10^{-3}	28-May-2005 11:39	1.10	18:26	1.47±0.07	17:18±00:06	0.958	1.4×10^7	5.8×10^4	1.8×10^{-3}
103	16-Jun-2005 20:35	1.0×10^{-1}	23-Jun-2005 13:35	1.08	20:18	1.97±0.05	19:59±00:04	0.979	N/A	N/A	N/A
104	13-Jul-2005 22:23	1.5×10^{-3}	14-Jul-2005 11:59	1.10	22:06	2.81±0.19	14:40±00:15	0.924	3.2×10^5	1.1×10^3	4.0×10^{-2}
105	14-Jul-2005 11:59	1.0×10^{-2}	17-Jul-2005 13:03	1.13	11:41	14.6±0.68	04:25±01:03	0.816	9.1×10^6	3.3×10^4	8.0×10^{-2}
106	17-Jul-2005 13:03	9.0×10^{-3}	24-Jul-2005 12:00	1.15	12:45	16.2±0.46	06:42±00:50	0.865	1.2×10^6	1.8×10^3	9.0×10^{-2}
107	22-Aug-2005 02:27	1.8×10^{-3}	22-Aug-2005 17:53	1.13	02:09	1.62±0.12	01:37±00:09	0.914	N/A	3.6×10^2	1.7×10^{-1}
108	22-Aug-2005 17:53	8.0×10^{-3}	29-Aug-2005 14:28	1.11	17:36	2.06±0.09	18:30±00:09	0.892	1.7×10^7	1.1×10^5	4.0×10^{-2}
109	29-Aug-2005 14:28	2.0×10^{-3}	01-Sep-2005 01:59	1.19	14:09	1.70±0.11	12:41±00:12	0.443	1.1×10^5	2.7×10^1	2.6×10^{-1}
110	01-Sep-2005 01:59	3.0×10^{-3}	04-Sep-2005 12:00	1.13	01:41	2.70±0.20	01:38±00:21	0.394	1.2×10^5	1.8×10^1	$<9.3 \times 10^{-2}$

Paasilta et al.: Catalogue of 55–80 MeV Solar Proton Events

Table 3. continued.

ID	SOHO/ERNE 55–80 MeV proton flux			Proton TSA (67.7 MeV)		Proton VDA			Fluence [cm ⁻² sr ⁻¹]		Fe/O ratio
	Onset	I_{\max} [pfu MeV ⁻¹]	End	L [AU]	$t_{\text{ret}} +$ 500 s	s [AU]	$t_0 +$ 500 s	R^2	p^+ >10 MeV	O 5–15 MeV/n	
111	06-Jul-2006 09:37	3.0×10^{-3}	11-Jul-2006 03:45	1.09	09:20	2.38 ± 0.10	08:42±00:08	0.970	1.8×10^5	6.9×10^1	8.0×10^{-2}
112	13-Dec-2006 02:59	2.0×10^{-1}	14-Dec-2006 23:08	1.04	02:43	2.93 ± 0.40	03:06±00:30	0.756	1.6×10^7	5.0×10^4	5.0×10^{-1}
113	14-Dec-2006 23:08	8.0×10^{-2}	26-Dec-2006 14:35	1.01	22:53	4.30 ± 0.45	21:59±00:37	0.812	1.7×10^6	3.8×10^2	3.8×10^{-1}
114	14-Aug-2010 10:41	7.0×10^{-3}	17-Aug-2010 19:35	1.17	10:22	1.23 ± 0.08	10:13±00:06	0.933	4.0×10^5	3.9×10^0	4.7×10^{-1}
115	28-Jan-2011 01:56	3.5×10^{-3}	31-Jan-2011 02:17	1.24	01:36	1.96 ± 0.11	01:12±00:08	0.951	1.2×10^5	1.1×10^1	$< 1.6 \times 10^{-1}$
116	15-Feb-2011 03:39	1.2×10^{-3}	18-Feb-2011 08:00	1.11	03:22	3.23 ± 0.24	01:55±00:21	0.917	1.0×10^5	3.3×10^1	2.0×10^{-1}
117	07-Mar-2011 21:06	8.0×10^{-3}	14-Mar-2011 23:45	1.16	20:48	1.77 ± 0.11	20:37±00:08	0.944	5.2×10^6	1.1×10^4	1.0×10^{-2}
118	21-Mar-2011 03:27	1.1×10^{-2}	27-Mar-2011 11:01	1.19	03:08	2.41 ± 0.09	02:39±00:07	0.978	8.1×10^5	5.2×10^2	2.5×10^{-1}
119	05-Jun-2011 05:10	4.5×10^{-3}	07-Jun-2011 07:36	1.12	04:53	2.84 ± 0.34	02:58±00:27	0.751	3.4×10^5	2.5×10^2	3.6×10^{-1}
120	07-Jun-2011 07:36	9.0×10^{-2}	23-Jun-2011 16:58	1.18	07:17	4.62 ± 0.45	06:47±00:33	0.863	4.4×10^6	1.8×10^3	1.2×10^{-1}
121	02-Aug-2011 06:55	2.9×10^{-3}	04-Aug-2011 04:40	1.13	06:37	1.64 ± 0.07	06:16±00:06	0.970	1.2×10^5	5.9×10^0	2.8×10^{-1}
122	04-Aug-2011 04:40	8.5×10^{-2}	08-Aug-2011 18:28	1.22	04:20	1.78 ± 0.09	04:22±00:08	0.853	8.9×10^6	2.4×10^4	2.0×10^{-1}
123	08-Aug-2011 18:28	3.1×10^{-3}	09-Aug-2011 08:22	1.09	18:11	1.67 ± 0.08	18:04±00:06	0.963	4.4×10^4	2.2×10^2	2.7×10^{-1}
124	09-Aug-2011 08:22	1.0×10^{-1}	15-Aug-2011 05:54	1.09	08:05	1.79 ± 0.05	07:52±00:04	0.988	9.9×10^5	5.5×10^2	3.1×10^{-1}
125	06-Sep-2011 02:21	4.5×10^{-3}	06-Sep-2011 23:27	1.15	02:03	1.68 ± 0.09	01:49±00:07	0.956	9.6×10^4	$< 1.1 \times 10^0$	N/A
126	06-Sep-2011 23:27	1.8×10^{-2}	14-Sep-2011 09:25	1.16	23:09	1.85 ± 0.21	23:24±00:16	0.819	5.2×10^5	1.1×10^1	6.0×10^{-1}
127	22-Sep-2011 N/A	3.5×10^{-3}	13-Oct-2011 22:07	1.17	N/A	N/A	N/A	N/A	5.0×10^6	5.7×10^3	3.0×10^{-2}
128	03-Nov-2011 23:39	5.5×10^{-3}	13-Nov-2011 12:56	1.20	23:20	2.83 ± 0.14	22:24±00:10	0.962	2.6×10^5	1.9×10^1	6.9×10^{-1}
129	26-Nov-2011 08:25	2.5×10^{-3}	30-Nov-2011 14:43	1.14	08:07	2.42 ± 0.14	06:53±00:11	0.943	4.3×10^6	8.8×10^3	9.0×10^{-2}
130	23-Jan-2012 N/A	$> 1.0 \times 10^{-3}$	27-Jan-2012 18:48	1.12	N/A	N/A	N/A	N/A	N/A	N/A	N/A
131	27-Jan-2012 18:48	1.4×10^{-1}	15-Feb-2012 00:18	1.07	18:32	3.26 ± 0.12	17:59±00:10	0.953	N/A	N/A	N/A
132	05-Mar-2012 09:57	1.0×10^{-3}	07-Mar-2012 02:11	1.18	09:38	N/A	N/A	N/A	N/A	3.9×10^2	3.0×10^{-2}
133	07-Mar-2012 02:11	$> 2.0 \times 10^{-1}$	13-Mar-2012 17:53	1.15	01:53	3.84 ± 0.69	03:09±00:50	0.637	5.7×10^{7S}	6.4×10^5	9.0×10^{-2}
134	13-Mar-2012 17:53	3.3×10^{-1}	25-Mar-2012 00:00	1.07	17:37	1.86 ± 0.09	17:25±00:07	0.963	1.1×10^7	1.5×10^4	1.3×10^{-1}
135	17-May-2012 01:54	1.1×10^{-1}	26-May-2012 14:27	1.21	01:34	2.93 ± 0.17	00:48±00:14	0.893	N/A	N/A	N/A
136	08-Jul-2012 N/A	$> 1.0 \times 10^{-2}$	11-Jul-2012 16:52	1.17	N/A	N/A	N/A	N/A	N/A	N/A	N/A
137	12-Jul-2012 N/A	4.5×10^{-2}	17-Jul-2012 15:05	1.16	N/A	N/A	N/A	N/A	5.0×10^{6S}	4.2×10^3	3.0×10^{-2}
138	17-Jul-2012 15:05	7.5×10^{-3}	19-Jul-2012 06:27	1.13	14:47	1.73 ± 0.03	14:30±00:03	0.983	6.1×10^6	9.3×10^3	9.0×10^{-2}
139	19-Jul-2012 06:27	5.0×10^{-2}	23-Jul-2012 05:57	1.17	06:08	3.32 ± 0.08	05:27±00:10	0.725	6.9×10^6	5.8×10^3	2.7×10^{-1}
140	23-Jul-2012 05:57	4.5×10^{-2}	13-Aug-2012 15:23	1.15	05:39	2.85 ± 0.29	05:39±00:22	0.841	3.0×10^6	1.1×10^3	6.0×10^{-2}
141	08-Sep-2012 11:35	1.2×10^{-3}	15-Sep-2012 08:22	1.18	11:16	3.34 ± 0.12	10:01±00:12	0.875	5.6×10^4	8.8×10^0	$< 1.9 \times 10^{-1}$
142	28-Sep-2012 N/A	$> 5.0 \times 10^{-3}$	09-Oct-2012 20:41	1.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A
143	08-Nov-2012 N/A	$> 1.5 \times 10^{-3}$	16-Nov-2012 01:00	1.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A
144	16-Mar-2013 02:51	1.1×10^{-3}	22-Mar-2013 03:32	1.12	02:34	2.09 ± 0.11	00:33±00:14	0.493	2.6×10^4	6.0×10^3	3.0×10^{-2}
145	11-Apr-2013 08:10	9.0×10^{-2}	21-Apr-2013 00:00	1.16	07:52	2.03 ± 0.09	07:22±00:07	0.969	5.4×10^6	1.3×10^3	3.9×10^{-1}
146	24-Apr-2013 22:53	2.5×10^{-3}	30-Apr-2013 01:13	1.16	22:35	1.33 ± 0.03	22:30±00:04	0.833	5.4×10^4	1.2×10^0	$< 1.4 \times 10^0$
147	15-May-2013 10:19	3.5×10^{-3}	22-May-2013 13:47	1.19	10:00	3.21 ± 0.33	06:56±00:28	0.852	6.6×10^6	8.7×10^3	4.0×10^{-2}
148	22-May-2013 13:47	1.2×10^{-1}	02-Jun-2013 21:37	1.15	13:29	1.70 ± 0.04	13:18±00:04	0.969	3.0×10^7	1.2×10^5	5.0×10^{-2}
149	30-Sep-2013 N/A	4.0×10^{-3}	22-Oct-2013 23:27	1.36	N/A	N/A	N/A	N/A	N/A	N/A	N/A
150	22-Oct-2013 23:27	1.1×10^{-3}	25-Oct-2013 13:49	1.19	23:08	2.18 ± 0.20	22:08±00:18	0.886	N/A	1.1×10^1	3.1×10^{-1}
151	25-Oct-2013 13:49	1.2×10^{-3}	28-Oct-2013 06:19	1.22	13:29	5.15 ± 0.18	09:54±00:22	0.693	7.9×10^4	1.9×10^1	6.3×10^{-1}
152	28-Oct-2013 06:19	1.8×10^{-3}	28-Oct-2013 18:49	1.31	05:57	6.22 ± 0.36	02:17±00:44	0.453	9.9×10^4	1.1×10^2	5.6×10^{-1}
153	28-Oct-2013 18:49	$> 4.5 \times 10^{-3}$	05-Dec-2013 21:03	1.29	18:28	N/A	N/A	N/A	N/A	N/A	N/A
154	28-Dec-2013 18:32	1.2×10^{-2}	04-Jan-2013 20:08	1.19	18:13	2.06 ± 0.01	17:55±00:01	0.995	N/A	N/A	N/A
155	06-Jan-2014 N/A	9.2×10^{-2}	07-Jan-2014 19:25	1.16	N/A	N/A	N/A	N/A	N/A	N/A	N/A
156	07-Jan-2014 19:25	2.0×10^{-1}	27-Jan-2014 06:21	1.15	19:07	3.71 ± 0.02	18:10±00:03	0.990	1.3×10^7	2.1×10^1	3.8×10^{-1}
157	20-Feb-2014 08:10	6.0×10^{-2}	25-Feb-2014 03:05	1.06	07:54	1.03 ± 0.03	07:54±00:03	0.888	2.1×10^5	N/A	N/A
158	25-Feb-2014 03:05	2.5×10^{-2}	19-Mar-2014 08:19	1.12	02:48	4.23 ± 0.10	01:55±00:11	0.872	8.1×10^6	N/A	N/A
159	29-Mar-2014 18:34	4.0×10^{-3}	02-Apr-2014 12:00	1.14	18:16	1.77 ± 0.05	17:56±00:04	0.942	4.1×10^4	3.5×10^0	$< 4.7 \times 10^{-1}$
160	18-Apr-2014 13:42	1.5×10^{-2}	27-Apr-2014 23:21	1.13	13:24	2.35 ± 0.09	12:47±00:07	0.976	1.7×10^6	2.7×10^3	1.4×10^{-1}
161	09-May-2014 04:27	7.5×10^{-4}	12-May-2014 16:57	1.20	04:08	1.99 ± 0.12	03:12±00:10	0.936	2.6×10^4	3.5×10^0	$< 4.7 \times 10^{-1}$
162	25-Aug-2014 17:05	8.5×10^{-4}	28-Aug-2014 20:09	1.38	16:41	2.89 ± 0.17	15:38±00:13	0.943	4.7×10^4	$< 1.1 \times 10^0$	N/A
163	01-Sep-2014 20:41	1.3×10^{-2}	10-Sep-2014 19:28	1.17	20:22	9.20 ± 0.27	17:39±00:31	0.786	1.6×10^{6H}	8.1×10^2	4.0×10^{-2}
164	10-Sep-2014 19:28	4.6×10^{-2}	21-Sep-2014 00:00	1.20	19:09	1.90 ± 0.16	19:44±00:14	0.918	2.5×10^{6H}	1.9×10^3	8.0×10^{-2}
165	22-Sep-2014 07:28	2.0×10^{-3}	24-Sep-2014 00:05	1.14	07:10	2.35 ± 0.09	06:31±00:07	0.975	4.1×10^{4H}	1.2×10^0	$< 1.4 \times 10^0$
166	25-Sep-2014 00:05	1.3×10^{-3}	10-Oct-2014 00:00	1.14	23:47 ⁺	6.05 ± 0.25	22:25±00:36	0.336	N/A	8.6×10^0	3.9×10^{-1}

Table 3. continued.

ID	SOHO/ERNE 55–80 MeV proton flux			Proton TSA (67.7 MeV)		Proton VDA			Fluence [cm ⁻² sr ⁻¹]		Fe/O ratio
	Onset	I_{\max} [pfu MeV ⁻¹]	End	L [AU]	$t_{\text{rel}} +$ 500 s	s [AU]	$t_0 +$ 500 s	R^2	p ⁺ >10 MeV	O 5–15 MeV/n	
167	13-Dec-2014 N/A	2.0×10^{-4}	16-Dec-2014 20:12	1.07	N/A	N/A			4.5×10^4	N/A	N/A
168	12-May-2015 04:04	2.4×10^{-3}	16-May-2015 04:36	1.22	03:44	2.10 ± 0.15	03:28±00:12	0.917	1.5×10^{5H}	1.2×10^1	$< 1.4 \times 10^{-1}$
169	18-Jun-2015 04:39	1.0×10^{-3}	21-Jun-2015 00:00	1.16	04:21	1.29 ± 0.14	02:36±00:11	0.837	5.6×10^{5H}	6.1×10^2	1.0×10^{-2}
170	01-Jul-2015 15:32	7.5×10^{-4}	05-Jul-2015 18:55	1.18	15:13	1.41 ± 0.05	15:02±00:04	0.980	N/A	N/A	N/A
171	20-Sep-2015 18:37	9.0×10^{-4}	23-Sep-2015 05:21	1.09	18:20	1.91 ± 0.08	17:54±00:06	0.971	N/A	N/A	N/A
172	29-Oct-2015 02:59	4.9×10^{-2}	03-Nov-2015 07:47	1.25	02:39	0.48 ± 0.04	02:58±00:04	0.393	N/A	N/A	N/A
173	09-Nov-2015 N/A	2.8×10^{-3}	13-Nov-2015 00:00	1.08	N/A	N/A	N/A		N/A	N/A	N/A
174	01-Jan-2016 23:49	5.0×10^{-3}	05-Jan-2016 08:40	1.11	23:32	1.08 ± 0.05	23:31±00:05	0.660	2.8×10^{5H}	N/A	N/A
175	16-Mar-2016 08:22	1.2×10^{-3}	18-Mar-2016 16:04	1.10	08:05	1.23 ± 0.03	07:12±00:04	0.980	1.6×10^{4H}	N/A	N/A

(*) The time given refers to the previous calendar day.

(+) The time given refers to the following calendar day.

(?) Result or identification is uncertain.

(H) Fluence given for ≥ 13.8 MeV protons.

(S) Value is uncertain/unreliable due to saturation of ERNE/HED during the event.

Notes. Items marked with "N/A" or "No data!" could not be determined due to insufficient or completely missing data, respectively. Values preceded by the tilde (~) are approximate. The notation "saturated" in the maximum proton intensity column signifies that ERNE became saturated during the event to such an extent that no estimate for the maximum intensity is feasible. All times UT. Unless otherwise noted, proton fluence is given for the energy range > 10 MeV, and the oxygen fluence and the iron/oxygen ratio for 5–15 MeV/nucleon.

Table 4. Electron events, soft X-ray flares, and CMEs associated with the 55–80 MeV proton events in 1996–2016.

ID	ACE/EPAM 0.18–0.31 MeV electron flux			SOHO/EPHIN 0.7–3.0 MeV electron flux		X-ray flare			CME		
	Date	Onset	I_{\max} [pfu MeV ⁻¹]	$t_0 + 500$ s	Onset	Max. dl/dt	Class	Location	1st obs.	v [km/s]	Width/PA [°]
0	24-Sep-1997	03:43	2.5×10^1	03:37	03:14	02:46	M5.9	31S 19E	03:38	532	76/137
1 ^L	07-Oct-1997	13:41	3.0×10^1	13:32	13:23		No GOES flare		13:30 ^{C3}	1271	167/246
2	04-Nov-1997	06:20	2.5×10^3	06:14	06:16	05:56	X2.1	14S 33W	06:10	785	360/halo
3	06-Nov-1997	12:24	3.9×10^4	12:18	12:23	11:53	X9.4	18S 63W	12:11	1556	360/halo
4	13-Nov-1997	21:43	5.3×10^2	21:37	21:47		No GOES flare		22:26	546	288/328
5	14-Nov-1997	13:54	1.9×10^2	13:48	13:46		No GOES flare		13:37	702	217/320
6	20-Apr-1998	10:35	7.0×10^4	10:29	10:33	09:59	M1.4	long. ≥ 90	10:07	1863	>243/284
7	02-May-1998	13:47	1.3×10^4	13:43	13:47	13:39	X1.1	15S 15W	14:06	938	360/halo
8	06-May-1998	08:08	5.5×10^4	08:03	08:05	08:05	X2.7	11S 65W	08:29	1099	190/309
9	09-May-1998	04:17	5.1×10^2	04:12	04:20	03:26	M7.7	long. ≥ 90	03:36	2331	178/262
10 ^L	16-Jun-1998	19:58	1.3×10^2	19:50	19:03	18:16	M1.0	long. ≥ 90	18:27	1484	281/341
11	18-Oct-1998	21:41	5.2×10^3	21:35	21:32		No GOES flare			No data!	
12	14-Nov-1998	05:27	1.4×10^4	05:22	05:47		No GOES flare			No data!	
13	22-Nov-1998	07:17	1.0×10^2	07:12	07:00	06:39	X3.7	27S 82W		No data!	
14	24-Nov-1998	03:35	1.9×10^2	03:30	03:07	02:14	X1.0	long. ≥ 90	02:30	1798	360/halo
15	24-Apr-1999	13:40	5.7×10^2	13:35	13:47		No GOES flare		13:31	1495	360/halo
16	09-May-1999	18:19	3.7×10^2	18:13	18:17	18:00	M7.6	long. ≥ 90	18:28	615	172/296
17	27-May-1999	11:03	4.3×10^2	10:58	11:00		No GOES flare		11:06	1691	360/halo
18	01-Jun-1999	19:31	1.2×10^3	19:25	19:20		No GOES flare		19:38 ^{C3}	1772	360/halo
19	11-Jun-1999	00:57	2.4×10^2	00:52	00:55		No GOES flare		01:27	719	101/288
20	09-Jan-2000	N/A	N/A	N/A	complex		No GOES flare			No data!	
21	18-Jan-2000	18:25	1.1×10^2	18:19	17:59	17:17	M3.9	19S 11E	17:54	739	360/halo
22	12-Feb-2000	04:59	1.4×10^2	04:55	04:51	03:57	M1.7	26N 23W	04:31	1107	360/halo
23	17-Feb-2000	21:04	1.4×10^2	20:59	21:01	20:26	M1.3	29S 07E	21:30	728	360/halo
24	18-Feb-2000	09:34	9.3×10^3	09:28	09:33	09:23	C1.1	16S 78W	09:54	890	118/286
25	02-Mar-2000	08:43	2.3×10^2	08:38	08:43	08:25	X1.1	14S 52W	08:54	776	62/231
26	03-Mar-2000	02:33	1.8×10^2	02:28	02:31	02:12	M3.8	15S 60W	02:30	841	98/233
27	04-Apr-2000	15:27	6.1×10^2	15:21	15:25	15:19	C9.7	16N 66W	16:33 ^{C3}	1188	360/halo
28	23-Apr-2000	14:07	7.0×10^1	14:02	13:32		No GOES flare		12:54	1187	360/halo
29	06-Jun-2000	18:38	5.2×10^2	18:33	16:43	15:05	X2.3	20N 18E	15:54	1119	360/halo
30	10-Jun-2000	17:08	6.7×10^3	17:03	17:08	16:54	M5.2	22N 38W	17:08	1108	360/halo
31	18-Jun-2000	02:18	7.5×10^2	02:10	02:15	01:57	X1.0	23N 85W	02:10	629	132/307
32	14-Jul-2000	10:33	8.1×10^5	10:28	10:16	10:18	X5.7	22N 07W	10:54	1674	360/halo
33	22-Jul-2000	11:51	1.6×10^3	11:46	11:55	11:25	M3.7	14N 56W	11:54	1230	>229/259
34	27-Jul-2000	00:34 ⁺	8.1×10^2	00:28 ⁺	23:43		No GOES flare		19:54	905	360/halo
35	12-Sep-2000	12:44	6.1×10^3	12:38	12:36	11:43	M1.0	17S 09W	11:54	1550	360/halo
36	16-Oct-2000	07:35	3.4×10^2	07:31	07:48	07:08	M2.5	long. ≥ 90	07:27	1336	360/halo
37	25-Oct-2000	11:28	6.0×10^2	11:23	11:02	09:49	C4.0	long. ≥ 90	08:26	770	360/halo
38	08-Nov-2000	23:00	1.9×10^5	22:55	22:58	23:12	M7.4	10N 77W	23:06	1738	>170/271
39	24-Nov-2000	05:59	4.2×10^3	05:53	05:32	04:59	X2.0	20N 06W	05:30	1289	360/halo
40	05-Jan-2001	18:53	1.7×10^2	18:36	17:44		No GOES flare		17:06	828	360/halo
41 ^L	21-Jan-2001	04:17	2.0×10^2	04:08	$\geq 21:49$		$t_p - t_x > 6$ h		19:32 [*]	839	360/halo
42	28-Jan-2001	16:40	2.0×10^3	16:34	16:28	15:48	M1.5	04S 59W	15:54	916	360/halo
43	29-Mar-2001	10:23	3.7×10^3	10:18	10:23	10:07	X1.7	20N 19W	10:26	942	360/halo
44	02-Apr-2001	12:05	6.8×10^2	12:00	N/A	11:26	X1.1	16N 62W	11:26	992	80/270
45	02-Apr-2001	22:03	5.5×10^4	21:58	N/A	21:47	X20.0	17N 78W	22:06	2505	244/261
46	09-Apr-2001	16:22	9.1×10^2	16:18	16:11	15:27	M7.9	21S 04W	15:54	1192	360/halo
47	10-Apr-2001	07:19	3.2×10^3	07:14	07:09	05:18	X2.3	23S 09W	05:30	2411	360/halo
48	12-Apr-2001	N/A	N/A	N/A	complex	10:20	X2.0	19S 43W	10:31	1184	360/halo
49	15-Apr-2001	14:03	3.0×10^4	13:59	14:02	13:47	X14.4	20S 85W	14:07	1199	167/245
50	18-Apr-2001	02:39	7.3×10^3	02:34	02:35	02:12	C2.2	long. ≥ 90	02:30	2465	360/halo
51	07-May-2001	12:48	2.6×10^2	12:42	10:03		No GOES flare		12:06	1223	205/286
52	20-May-2001	06:40	3.5×10^2	06:34	06:30	06:01	M6.4	long. ≥ 90	06:26	546	179/227
53	04-Jun-2001	16:53	1.1×10^2	16:48	16:50	16:26	C3.2	24N 59W	16:30	464	89/299
54	15-Jun-2001	15:40	1.6×10^3	15:35	15:53		No GOES flare		15:56	1701	360/halo

Table 4. continued.

ID	ACE/EPAM 0.18–0.31 MeV electron flux				SOHO/EPHIN 0.7–3.0 MeV electron flux		X-ray flare			CME	
	Date	Onset	I_{\max} [pfu MeV ⁻¹]	$t_0 + 500$ s	Onset	Max. dI/dt	Class	Location	1st obs.	v [km/s]	Width/PA [°]
55	19-Jun-2001	03:57	2.7×10^2	03:51	03:48			$t_p - t_x > 6$ h	22:47*	1301	59/217
56	10-Aug-2001	N/A	N/A	N/A	15:54			N/A		N/A	
57	15-Sep-2001	12:06	3.2×10^2	12:01	12:08	11:09	M1.5	21S 49W	11:54	478	130/263
58	24-Sep-2001	10:53	6.7×10^5	10:48	10:52	10:23	X2.6	16S 23E	10:31	2402	360/halo
59	01-Oct-2001	13:18	4.2×10^4	13:13	complex	05:10	M9.1	long. ≥ 90	05:30	1405	360/halo
60	19-Oct-2001	01:57	4.5×10^2	01:50	01:49	01:00	X1.6	16N 18W	01:27	558	360/halo
61	19-Oct-2001	17:17	5.2×10^2	17:11	17:12	16:24	X1.6	15N 29W	16:50	901	360/halo
62	22-Oct-2001	15:46	1.4×10^3	15:41	15:33	14:58	M6.7	21S 18E	15:06	1336	360/halo
63	04-Nov-2001	16:32	7.9×10^5	16:26	16:33	16:13	X1.0	06N 18W	16:35	1810	360/halo
64	22-Nov-2001	20:52	1.2×10^5	20:47	20:52	20:26	M3.8	25S 67W	20:31	1443	360/halo
65	26-Dec-2001	05:34	1.4×10^4	05:29	$\geq 22:33$	05:18	M7.1	08N 54W	05:30	1446	>212/281
66	10-Jan-2002	11:15	1.1×10^4	11:10	09:18			N/A		N/A	
67	14-Jan-2002	07:44 [?]	2.0×10^3	07:39 [?]	09:20	06:00	M4.4	long. ≥ 90	05:35	1492	360/halo
68	27-Jan-2002	13:12	3.4×10^2	13:07	13:21			No GOES flare	12:30	1136	360/halo
69	20-Feb-2002	06:04	9.5×10^3	05:59	06:02	06:09	M5.1	12N 72W	06:30	952	360/halo
70	18-Mar-2002	05:22	3.4×10^3	05:15	12:11	02:24	M1.0	long. ≥ 90	02:54	989	360/halo
71	17-Apr-2002	$\geq 09:08$	7.1×10^3	$\geq 09:03$	08:45	08:04	M2.6	14S 34W	08:26	1240	360/halo
72	21-Apr-2002	01:34	3.7×10^4	01:29	01:34	01:29	X1.5	14S 84W	01:27	2393	360/halo
73	22-May-2002	04:29	1.8×10^5	04:23	$\geq 00:19$	03:34	C5.0	22S 53W	03:50	1557	360/halo
74	07-Jul-2002	11:53	1.9×10^3	11:48	11:48	11:23	M1.0	long. ≥ 90	11:31	1423	>228/277
75	16-Jul-2002	08:00	2.0×10^4	07:54	04:43			$t_p - t_x > 6$ h	20:30*	1151	360/halo
76	14-Aug-2002	01:57	3.3×10^3	01:52	01:57	01:59	M2.3	09N 54W	02:30	1309	133/297
77	18-Aug-2002	21:34	1.4×10^3	21:29	21:36	21:20	M2.2	12S 19W	21:54	682	140/203
78	20-Aug-2002	08:41	1.4×10^4	08:36	08:31	08:24	M3.4	10S 38W	08:55	1099	>122/237
79	22-Aug-2002	02:18	2.2×10^3	02:13	02:15	01:53	M5.4	07S 62W	02:06	998	360/halo
80	24-Aug-2002	01:24	7.4×10^3	01:18	01:02	01:02	X3.1	02S 81W	01:27	1913	360/halo
81	06-Sep-2002	03:52	2.4×10^3	03:47	00:00			$t_p - t_x > 6$ h	16:54*	1748	360/halo
82	09-Nov-2002	13:57	9.2×10^3	13:51	13:49	13:16	M4.6	12S 29W	13:32	1838	360/halo
83	19-Dec-2002	21:58	1.0×10^3	21:54	21:58	21:42	M2.7	15N 09W	22:06	1092	360/halo
84	23-Apr-2003	01:18	6.6×10^1	01:13	01:21	01:03	M5.1	22N 25W	01:27	916	248/271
85	28-May-2003	01:05	4.4×10^3	01:01	01:00	00:23	X3.6	08S 22W	00:50	1366	360/halo
86	31-May-2003	02:39	1.1×10^4	02:35	02:35	02:21	M9.3	07S 65W	02:30	1835	360/halo
87	26-Oct-2003	17:51	1.9×10^4	17:46	17:45	17:36	X1.2	02N 38W	17:54	1537	>171/270
88	28-Oct-2003	11:20	3.0×10^5	11:16	12:00	11:05	X17.2	16S 08E	11:30	2459	360/halo
89	02-Nov-2003	09:49	9.6×10^2	09:45	10:01			No GOES flare	09:30	2036	360/halo
90	02-Nov-2003	17:34	2.3×10^4	17:29	17:15	17:18	X8.3	14S 56W	17:30	2598	360/halo
91	20-Nov-2003	$\geq 07:27$	7.9×10^3	$\geq 07:23$	$\geq 06:50$	07:42	M9.6	01N 08W	08:06	669	360/halo
92	11-Apr-2004	04:38	1.6×10^3	04:33	04:43	04:15	C9.6	16S 46W	04:30	1645	314/203
93	13-Jul-2004	01:13	8.0×10^1	01:08	00:48	00:15	M6.7	14N 45W	00:54	409	201/253
94	22-Jul-2004	17:35	3.3×10^3	17:30	$\geq 09:54$			$t_p - t_x > 6$ h	08:30	899	132/193
95	25-Jul-2004	15:23	1.2×10^5	15:18	15:21	14:46	M1.1	08N 33W	14:54	1333	360/halo
96	01-Nov-2004	06:01	3.7×10^3	05:56	06:04			No GOES flare	06:06	925	146/266
97	07-Nov-2004	16:49	5.9×10^3	16:45	complex	15:57	X2.0	09N 17W	16:54	1759	360/halo
98	09-Nov-2004	17:41	5.3×10^3	17:37	18:00	17:13	M8.9	08N 51W	17:26	2000	360/halo
99	10-Nov-2004	02:39	1.3×10^4	02:35	complex	02:09	X2.5	09N 49W	02:26	3387	360/halo
100	15-Jan-2005	06:46	2.1×10^2	06:42	06:46	06:17	M8.6	16N 04E	06:30	2049	360/halo
101	15-Jan-2005	23:14	1.4×10^4	23:10	00:02 ⁺	22:47	X2.6	15N 05W	23:07	2861	360/halo
102	13-May-2005	17:34	1.9×10^5	17:29	17:28	16:45	M8.0	12N 11E	17:12 ^{C3}	1689	360/halo
103	16-Jun-2005	20:30	3.6×10^3	20:26	20:25	20:11	M4.0	08N 90W			No data!
104	13-Jul-2005	14:29	1.6×10^3	14:24	14:36			$t_p - t_x > 6$ h	14:30	1423	360/halo
105	14-Jul-2005	11:05	4.2×10^3	11:00	11:42	10:21	X1.2	11N 90W	10:54	2115	360/halo
106	17-Jul-2005	13:07	2.1×10^3	13:02	13:23			No GOES flare	11:30	1527	360/halo
107	22-Aug-2005	01:16	8.7×10^2	01:11	01:11	01:00	M2.6	11S 54W	01:32	1194	360/halo
108	22-Aug-2005	17:23	1.4×10^4	17:18	17:27	16:57	M5.6	13S 65W	17:30	2378	360/halo
109	29-Aug-2005	12:56	1.5×10^2	12:50	12:02			No GOES flare	10:54	1600	360/halo
110	01-Sep-2005	01:39	2.9×10^2	01:34	00:16			No GOES flare	22:30*	1808	360/halo
111	06-Jul-2006	09:29	1.1×10^2	09:24	09:25	08:23	M2.5	09S 34W	08:54	911	360/halo

Table 4. continued.

ID	ACE/EPAM 0.18–0.31 MeV electron flux				SOHO/EPHIN 0.7–3.0 MeV electron flux		X-ray flare			CME	
	Date	Onset	I_{\max} [pfu MeV ⁻¹]	$t_0 + 500$ s	Onset	Max. dI/dt	Class	Location	1st obs.	v [km/s]	Width/PA [°]
112	13-Dec-2006	02:38	2.7×10^4	02:34	02:29	02:26	X3.4	06S 23W	02:54	1774	360/halo
113	14-Dec-2006	22:34	3.5×10^3	22:30	22:10	22:10	X1.5	06S 46W	22:30	1042	360/halo
114	14-Aug-2010	10:21	8.7×10^2	10:16	10:18	9:46	C4.4	17N 52W	10:12	1205	360/halo
115	28-Jan-2011	01:41	9.0×10^1	01:35	01:37	00:58	M1.3	16N 88W	01:26	606	119/288
116	15-Feb-2011	03:42	1.4×10^2	03:37	02:34	01:52	X2.2	20S 10W	02:24	669	360/halo
117	07-Mar-2011	21:07	2.3×10^3	21:02	21:02	22:35	M3.7	30N 48W	20:00	2125	360/halo
118 ^L	21-Mar-2011	03:41	3.1×10^2	03:17	03:13		No GOES flare		02:24	1341	360/halo
119	05-Jun-2011	N/A	N/A	N/A	02:43		No GOES flare		22:05*	2425	360/halo
120	07-Jun-2011	06:54	2.9×10^3	06:48	06:53	06:27	M2.5	21S 54W	06:49	1255	360/halo
121	02-Aug-2011	06:32	3.6×10^2	06:27	06:29	06:14	M1.4	14N 15W	06:36	712	268/288
122	04-Aug-2011	04:34	2.5×10^3	04:28	04:25	03:53	M9.3	19N 36W	04:12	1315	360/halo
123	08-Aug-2011	18:12	1.4×10^3	18:07	18:11	18:06	M3.5	16N 61W	18:12	1343	237/305
124	09-Aug-2011	08:08	5.4×10^3	08:01	08:11	08:02	X6.9	17N 69W	08:12	1610	360/halo
125	06-Sep-2011	02:08	1.2×10^2	02:03	02:05	01:45	M5.3	14N 07W	02:24	782	360/halo
126	06-Sep-2011	23:17	2.3×10^2	23:12	23:04	22:18	X2.1	14N 28W	23:06	575	360/halo
127	22-Sep-2011	14:17	N/A	14:12	$\geq 23:04^*$	10:44	X1.4	09N 89E	10:48	1905	360/halo
128	03-Nov-2011	23:23	1.9×10^2	23:17	23:04		No GOES flare		23:12	991	360/halo
129	26-Nov-2011	07:26	2.8×10^3	07:21	07:28	06:56	C1.2	11N 47W	07:12	933	360/halo
130	23-Jan-2012	03:59	1.5×10^5	03:54	04:00	03:49	M8.7	18N 25W	04:00	2175	360/halo
131	27-Jan-2012	18:44	8.0×10^3	18:40	18:30	18:26	X1.7	27N 71W	18:28	2508	360/halo
132	05-Mar-2012	N/A	N/A	N/A	07:46		$t_p - t_x > 6$ h		04:00	1531	360/halo
133	07-Mar-2012	00:42	2.5×10^5	00:24	02:02	00:18	X5.4	17N 27E	00:24	2684	360/halo
134	13-Mar-2012	17:39	1.0×10^4	17:35	17:38	17:24	M7.9	19N 59W	17:36	1884	360/halo
135	17-May-2012	01:46	6.0×10^3	01:40	01:52	01:36	M5.1	11N 76W	01:48	1582	360/halo
136	08-Jul-2012	17:43	1.4×10^3	17:37	$\geq 23:21^*$	16:29	M6.9	14S 83W	16:54 ^{C3}	1495	157/212
137	12-Jul-2012	16:55	1.7×10^3	16:50	N/A	16:32	X1.4	13N 15W	16:48	885	360/halo
138	17-Jul-2012	14:33	4.0×10^3	14:28	14:51	16:36	M1.7	23S 61W	13:48	958	176/255
139	19-Jul-2012	07:11	4.7×10^3	07:05	06:29	05:23	M7.7	13S 88W	05:24	1631	360/halo
140	23-Jul-2012	05:27	2.2×10^3	05:22	04:42		No GOES flare		02:36	2003	360/halo
141 ^L	08-Sep-2012	11:51	8.0×10^1	11:37	10:46		No GOES flare		10:00	734	360/halo
142	28-Sep-2012	00:19	2.2×10^3	00:13	N/A	23:43*	C3.7	09N 32W	00:12	947	360/halo
143	8-Nov-2012	11:53	6.6×10^1	11:48	N/A		No data!		11:00	972	360/halo
144	16-Mar-2013	N/A	N/A	N/A	N/A		No GOES flare			N/A	
145	11-Apr-2013	07:53	1.6×10^3	07:48	07:43	07:10	M6.5	09N 12E	07:24	861	360/halo
146	24-Apr-2013	22:31	1.3×10^2	22:26	22:08		No GOES flare		22:12	594	360/halo
147	15-May-2013	10:00	7.2×10^3	09:56	04:42		$t_p - t_x > 6$ h		01:48	1366	360/halo
148	22-May-2013	13:43	1.9×10^4	13:38	13:36	13:17	M5.0	18S 15W	13:26	1466	360/halo
149	30-Sep-2013	N/A	9.0×10^3	N/A	22:42*		N/A			N/A	
150	22-Oct-2013	22:21	7.9×10^1	22:15	21:53	21:17	M4.2	04N 01W	21:48	459	360/halo
151	25-Oct-2013	N/A	N/A	N/A	09:49	07:59	X1.7	08S 73E	08:12	587	360/halo
152	28-Oct-2013	05:14	4.4×10^3	05:07	05:16	04:38	M5.1	11S 46W	04:48	1201	156/315
153	28-Oct-2013	N/A	N/A	N/A	N/A	15:11	M4.4	08S 28E	15:36	812	360/halo
154	28-Dec-2013	18:34	3.7×10^2	18:28	18:18		No GOES flare		17:36	1118	360/halo
155	06-Jan-2014	08:07	2.0×10^3	08:02	N/A	07:42	C2.1	15S 89W	08:00	1402	360/halo
156	07-Jan-2014	19:13	3.9×10^4	19:08	18:56	18:18	X1.2	12S 08W	18:24	1830	360/halo
157	20-Feb-2014	07:56	5.2×10^3	07:52	07:56	07:46	M3.0	11S 43W	08:00	948	360/halo
158	25-Feb-2014	02:50	1.2×10^4	02:45	02:08	00:46	X4.9	12S 82E	01:26 ^{C3}	2147	360/halo
159	29-Mar-2014	18:04	6.2×10^2	17:59	18:05	17:46	X1.0	11N 32W	18:12	528	360/halo
160	18-Apr-2014	13:07	7.6×10^2	13:02	13:06	12:53	M7.3	20S 34W	13:26	1203	360/halo
161	09-May-2014	04:46	7.0×10^1	04:40	03:48		No GOES flare		02:48	1099	360/halo
162	25-Aug-2014	16:20	9.0×10^1	16:12	15:48	15:02	M2.0	05N 36W	15:36	555	360/halo
163	01-Sep-2014	19:18	7.0×10^2	19:12	15:46		No GOES flare		11:12 [?]	1901 [?]	360/halo [?]
164	10-Sep-2014	21:39	3.5×10^3	21:33	18:59	17:33	X1.6	14N 02E	18:00	1267	360/halo
165	22-Sep-2014	07:05	4.0×10^1	07:00	06:53		No GOES flare		06:12	618	252/342
166	25-Sep-2014	00:40	2.8×10^1	00:35	23:16* [?]		No GOES flare		21:30* ^{C3}	1350	360/halo
167	13-Dec-2014	15:30	8.0×10^1	15:26	N/A		No data!		14:24	2222	360/halo
168	12-May-2015	03:20	2.8×10^2	03:14	03:29	02:43	C2.6	21S 83W	2:48	772	250/286

Table 4. continued.

ID	ACE/EPAM 0.18–0.31 MeV electron flux				SOHO/EPHIN 0.7–3.0 MeV electron flux		X-ray flare			CME	
	Date	Onset	I_{\max} [pfu MeV ⁻¹]	$t_0 + 500$ s	Onset	Max. dI/dt	Class	Location	1st obs.	v [km/s]	Width/PA [°]
169	18-Jun-2015	01:57	7.5×10^2	01:52	01:53	01:08	M1.2	16S 81W	1:26	1714	195/279
170	01-Jul-2015	15:12	1.8×10^2	15:06	15:02		No GOES flare		14:36	1435	360/halo
171	20-Sep-2015	18:01	3.2×10^3	17:56	18:02	17:51	M2.1	20S 24W	18:12	1239	360/halo
172	29-Oct-2015	02:39	2.0×10^3	02:33	02:35	01:09 [?]	C1.1 [?]	18N 30W [?]	02:36	530	202/259
173	09-Nov-2015	16:48 [?]	8.0×10^1	16:44 [?]	14:26		N/A			N/A	
174	01-Jan-2016	23:41	5.9×10^2	23:36	23:38	23:40	M2.3	25S 82W	23:24	1730	360/halo
175	16-Mar-2016	07:28	9.6×10^1	07:23	07:03	06:39	C2.2	12N 88W	07:00	529	154/285

^(*) The time given refers to the previous calendar day.

⁽⁺⁾ The time given refers to the following calendar day.

^(?) Result or identification is uncertain.

^(L) The onset and maximum intensity were determined using the 0.10–0.18 MeV electron energy channel.

^(C3) The first observation of the CME occurred on the LASCO C3 coronagraph.

Notes. The number (ID) and date of the event (Date) refer to the proton event with which the electron, X-ray, and CME events listed here are associated. Onset times preceded by "≥" are the earliest possible estimates for events where several closely spaced intensity rises occurred. The notation "complex" for SOHO/EPHIN electron onset indicates a complicated intensity rise which did not allow a precise onset time to be determined. Items marked with "No GOES flare" are cases in which no GOES flare (on the visible solar disk or over the limb) reasonably likely associated with the proton/electron event could be identified; "long. ≥ 90" signifies a probable over-the-limb flare event; and " $t_p - t_x > 6$ h" refers to GOES flares that occurred more than 6 hours before the onset of the proton event at the spacecraft. Items marked with "N/A" or "No data!" could not be determined due to insufficient or completely missing data, respectively. Values preceded by the tilde (~) are approximate. All times UT.