

Interplanetary Coronal Mass Ejections (ICMEs) from *Wind* and ACE Data during 1995 – 2009

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In order to survey the ICMEs as completely as possible, we have used ACE data when the Wind data were unavailable or noisy and when Wind was near or within the magnetosphere.

The ICMEs are identified based by inspection of a combination of signatures: a stronger than ambient magnetic field, relatively quiet and smooth magnetic field rotations, a low proton temperature, a higher density ratio of alpha particles to protons, an enhancement of total perpendicular pressure (Pt), a declining solar wind speed, etc. At least three of the above features are required to identify an ICME, with careful consideration of ambient solar wind. The boundaries of ICMEs are identified from a consensus of available features, usually delimited by sharp changes in plasma and magnetic field properties. For ambiguous events, we have checked the SOHO LASCO CME catalog and STEREO SECCHI observations. When there is a clear magnetic obstacle (flux rope) in an ICME, we give the start time of the magnetic obstacle as well.

1. Jian et al (Solar Physics, 239, 393-436, doi: 10.1007/s11207-006-0132-2, 2006) gives more details about the identification criteria and also the ICME list of 1995 – 2004.
2. The ICME list of 1995 – 2006 is an appendix of Lan Jian's 2008 PhD thesis from UCLA.
3. Jian et al. (Solar Physics, 274, 321-344, doi: 10.1007/s11207-011-9737-2, 2011) updates the results to 2009.
4. The solar cycle variation from 1995 to 2011 is published in Jian et al. (Amer. Inst. Phys. Proceedings of Solar Wind 13, 1539, 195-198, doi: 10.1063/1.4811021, 2013), where STEREO A/B is used for 1-AU observation beyond 2009.

For more information and extensive use of the survey, please contact Lan Jian at lan.jian@nasa.gov

#	Start UT [mm/dd hhmm]	Start UT of Magnetic Obstacle ¹ [mm/dd hhmm]	End UT [mm/dd hhmm]	Disconti- nuity UT [mm/dd hhmm]	F/R ¹ Shock	P _{tmax} [pPa]	V _{max} [km/s]	V _{min} [km/s]	ΔV^2 [km/s]	B _{max} [nT]	Group ³	Comments
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1995

1*	02/08 0310	02/08 0310	02/09 0200			88	444	376	-68	12.8	1	clear B rotations
2*	02/09 0200		02/10 1000			65	420	340	-80	10.5	3	
3	03/04 0037	03/04 1142	03/05 0000	03/04 0037	F	95 (110) ⁴	470	428	-58	13.2	2	V _p , Pt irregular, T _p low, after SIR
				03/04 2000	/							
4*	03/23 0938	03/24 0000	03/25 2100	03/23 0938	F	85 (100)	340 (347)	295	-45	12	2	followed by an SIR
5*	04/03 0100	04/03 0100	04/04 1230			58	356	260	-96	11	2	Pt, B weak
6	05/13 1024		05/14 0515	05/13 1024	/	120	355	315	40	14.6		complex, Pt irregular, like in an SIR
7	06/30 1850	06/30 1850	07/02 1013			80	500	343	-157	11.3	1	V _{th} ~ 25km/s, weak, related to flux rope
8	08/22 1257	08/22 1927	08/23 2100	08/22 1257	F	82	383	333	-50	11.8	1	weak, Pt plateau, followed by an SIR
9*	10/18 1900	10/18 1900	10/20 0137	10/19 1751	F	410	437	378	-59	29	1	V _p irregular and noisy, in an SIR, shock in the center
10	10/24 0745	10/24 0745	10/25 0804			42	453	340	-113	8	1	weak, T _p not so low, but B clear rotations
11 *	12/16 0450	12/16 0450	12/16 1900	12/15 0437	F	100	420	385	-35	12.5	2	B maximizes during five days, in an SIR
				12/15 1457	/							
				12/16 0450	/							

1996

1*	05/27 1434	05/27 1434	05/29 1120			200	415	340	-75	16.5	1	following an SIR
2 *	07/01 1220	07/01 1220	07/02 1435	07/01 1220	/	110	370	340	-30	14	1	irregular Pt, following an SIR

irregular T_p , following an SIR

07/01 1417 /

3 08/07 0600 08/07 1100 08/08 0500 50 368 335 -33 8.2 2

weak, slow ICME

4 12/24 0300 12/24 0300 12/25 1130 12/24 1629 / 100 400 309 -91 13.4 1

Wind impacted the Earth bow shock several times; T_p irregular

1997

1* 01/10 0050 01/10 0430 01/11 0300 01/10 0050 F 380 480 410 -70 20.5 1

$N_p > 100 \text{ cm}^{-3}$, T_e was low, actual pressure may not be well estimated by P_t , followed by SIR; but it seems unlike filament, because T_p and T_e from CDAWeb did not decrease in that hole

2 02/09 1340 02/10 0245 02/10 1900 02/09 1340 / 35 (85) 570 (660) 403 -167 9 1

3 02/11 0415 02/11 0415 02/12 0544 103 452 360 -92 7.2 1

4* 04/11 0552 04/11 0552 04/11 1752 235 490 420 -70 22.8 1

V_p irregular

5 04/21 1200 04/21 1200 04/23 0400 120 430 320 -110 14.5 2

T_p is not low, weak rotations of \mathbf{B} , P_t plateau

6* 05/15 0120 05/15 2325 05/15 0120 F 280 (360) 500 420 80 26 3

V_p increases, in an SIR

7 06/07 2330 06/07 2330 06/10 2300 115 415 347 -68 14.3 1

V_p irregular, only a short interval of low T_p

8 06/19 0012 06/19 0530 06/21 0400 06/19 0012 F 52 377 (395) 283 -94 9 2

plateau, and B_{\max} for two days, weak \mathbf{B} rotations

9	07/15 0905	07/15 0905	07/16 1105			100	380	330	-50	13	2	noisy
10	08/03 1350	08/03 1350	08/04 0200	08/03 1350	/	140	500	400	-100	17		a concave in Pt
11*	09/03 1320	09/03 1320	09/03 2230			175	530	380	150	18	1	in an SIR, <i>Wind</i> passed by the side of ICME
12	09/18 0400	09/18 0400	09/20 1200	09/18 0031	F	110	420	270	-150	13.5	1	T_p not low, V_p decreases and then increases
13*	09/21 2205	09/21 2205	09/22 1727	09/21 2205	/	183	490	355	-135	18.5	1	in an SIR, T_p and V_p increases following the declines
14	10/01 1710	10/01 1710	10/02 2310			65	487	407	-80	10.6	2	weak, Pt plateau, B_{max} for over one day, noisy data before it
15	10/11 0000	10/11 0000	10/12 0230			95	435	345	-90	13.5	1	T_p is not low, data gap before it
16	10/27 0620	10/27 0620	10/28 0720			50	555	408	-147	8.8	1	weak, two hours data gap, after a big SIR
17	11/06 2220	11/07 0630	11/08 1430	11/06 2220	F	150 (270)	470 (480)	330	-140	18.5	1	plasma data gap at around 11/06 2220, but strong FF ⁵ from the recovered data ⁶
18	11/22 0910	11/22 1850	11/23 1250	11/22 0910	F	340 (520)	530	480	-50	26 (31)	2	
19	12/10 0430		12/12 0000	12/10 0430	F	225	430	310	-120	16	3	ICME meets solar wind and probably magnetic reconnects
20	12/30 0114	12/30 0947	12/31 0647	12/30 0114	F	110 (155)	410	315	95	14		V_p too irregular, two streams with different plasma properties

1998

1	01/06 1330	01/07 0250	01/08 0728	01/06 1330	F	170 (190)	435	350	-85	19	1	followed by an SIR
2	01/28 1557	01/29 2010	01/30 2310	01/28 1557	F	80	400 (415)	347	-53	9.3	2	followed by another ICME
3	02/04 0435	02/04 0435	02/05 2200			115	360	290	-70	14.5	1	
4*	02/17 0900	02/17 0900	02/20 0036	02/18 0749	F	280	470	360	110	22	1	T_p enhances at the interface, heated by reconnection? irregular V_p , big deflection of V_p , shock at the center
5*	03/04 1437	03/04 1437	03/06 0200	03/04 1103	F	120	395	310	-85	13	1	
6*	03/06 1100	03/06 1100	03/07 2120			65	340	300	-40	8		
7	05/01 2121	05/02 0900	05/03 1702	04/30 0843	F	120 (320)	640 (670)	425	-215	14 (22)	2	irregular Pt
				05/01 2121	F							
				05/03 1702	F							
8	05/04 0203		05/05 0200	05/04 0203	F	220 (800)	770 (860)	540	-230	19 (42)	3	weak rotations of \mathbf{B}
				05/04 0230	/							
9	06/02 1028	06/02 1028	06/02 1900			80	440	370	-70	12.3	1	
10*	06/24 1300	06/24 1300	06/26 1900	06/25 1543	F	178	535	395	-140	18		ACE ⁷ , ICME + ICME, shock at the center
							505	460	-45			
11*	07/10 1939	07/10 1939	07/12 0514			150	405	333	72	17.3		ACE
12*	07/12 0514	07/12 0514	07/13 1828			90	450	340	-110	14		ACE, closely following an ICME
13	08/10 0031	08/10 1320	08/12 1530	08/10 0031	F	100	455 (510)	350	-95	12.2	2	V_p irregular
14	08/19 1840	08/20 0900	08/21 1900	08/19 1840	F	135	350	287	-63	16.5	1	V_p irregular
15	08/26 0640	08/27 0530	08/28 0100	08/26 0640	F	110 (400)	710 (850)	530	-180	16 (25)	2	T_p high, weak rotation of \mathbf{B}

16	09/23 0400		09/23 1500			62	500	375	-125	9	3	weak rotations of B
17	09/24 2321	09/25 0600	09/26 1142	09/24 2321	F	160 (815)	860	580	-280	20 (40)	1	
18	10/02 0654		10/04 0900	10/02 0654	F	220	720	440	-280	19.6	3	ACE, weak rotations of B
19	10/18 1929	10/19 0425	10/20 0800	10/18 1929	F	280 (390)	435	360	-75	26	2	before an SIR
20	10/23 1235		10/24 1800	10/23 1235	F	100	610	445	-165	13.2	3	ACE
21	11/07 2200	11/07 2200	11/10 2130	11/08 0422	F	580	640	400	-240	36.3	1	ACE, ICME + ICME, shock at the center
							450	370	-80			
22	11/13 0000	11/13 0000	11/14 0700	11/13 0054	/	215	420	350	-70	20.5	2	ACE, slow
23	11/30 0418	11/30 0900	12/01 0254	11/30 0418	F	140 (150)	490 (500)	420	-70	16.5	2	ACE, slow
24 *	12/26 0956		12/27 0009	12/26 0956	F	110	550	400	-150	13	3	after an SIR
25	12/28 1735	12/29 0530	12/31 0100	12/28 1735	/	75 (130)	450	370	-80	12 (15.2)	2	ACE, slow, BDE

1999

1	01/22 1948	01/22 2330	01/23 1500	01/22 1948	F	190	680 (685)	540	-140	19 (20)	2	ACE, BDEs
2*	02/18 0210	02/18 1000	02/20 1700	02/18 0210	F	320 (385)	680	400	-280	26 (29)	2	ACE
3	04/16 1036	04/16 1800	04/17 2000	04/16 1036	F	260	460 (470)	380	-80	24.6	1	ACE, <i>classic</i>
4	04/21 0423	04/21 0423	04/22 1823			50	560	430	-130	9.3	2	ACE, <i>Wind</i> was in Earth's magnetosheath

5	05/28 2140	05/28 2140	05/30 1046			43	415	365	-50	8.5	2	strong rotations of \mathbf{B} , V_p irregular and noisy
6*	06/26 0547		06/28 0600	06/26 0232	F	460	910	307	603	25		ICME+SIR, V_p peaks in the center
				06/26 1932	F							
7	07/02 0026		07/05 1346	07/02 0026	F	93	680	380	-300	11.7	3	long, ACE
8	07/06 1417		07/07 1655	07/06 1417	F	75	510	400	-110	12	3	ACE, possibly several flux ropes nearly in contact
9*	07/07 2132	07/07 2132	07/09 0544	07/08 0400	F	73	450	320	-130	12	1	
10	07/12 0122		07/13 1345	07/12 0122	F	130	322	282	-40	12.2	3	T_p not low
11*	07/30 1910		08/02 0600			285	670	420	-250	18.3 (24)		ACE, might associated with the interaction of two CMEs from the Sun, causing compressions of \mathbf{B} and T_p
12	08/04 0117		08/05 1230	08/04 0117	F	120	383	325	-58	14	3	ACE
13*	08/09 1018	08/09 1018	08/10 1840			103	385	314	-71	13.8	1	strong rotations, ICME+SIR
14*	08/21 1600		08/23 1035			50	510	380	-130	9.2		closely followed by an SIR
15	09/15 0720	09/15 0720	09/15 1942	09/15 0720	F	115	680	550	-130	16	1	ACE
16*	09/22 1146		09/23 2042	09/22 1146	F	520	600	500	-100	31.3	3	ACE, with SIR
17*	10/21 0221	10/21 0436	10/22 0650	10/21 0221	F	610	590	347	373	38		ICME+SIR, Pt trough in the center, concave
18	11/12 1820	11/12 1820	11/14 0930	11/13 1214	F	120	487	400	-87	16	1	ACE
19*	11/22 0156		11/24 0640	11/21 1713	/	200	510	410	-100	16.3		T_p, V_p irregular, SIR+ICME

20	12/12 1655	12/12 1655	12/13 1630	12/12 1515	F	105	760	440	-320	15	1	ACE
21	12/14 0340	12/14 0340	12/16 0200			80	490	340	-150	11.5	2	ACE, slow
22	12/26 2128		12/28 0447	12/26 2128	F	95	460	360	100	9.3 (13)	3	ACE

2000

1	01/22 0023	01/22 1700	01/25 0820	01/22 0023	F	220	440	330	-110	18.6	1	ACE, BDEs, slow ICME, T_p not low
2	02/11 0213		02/11 2300	02/11 0213	F	120	550	400	-150	12.5	3	ACE, BDE
3	02/11 2319	02/12 0715	02/13 0015	02/11 2319	F	280 (380)	600	510	-90	22.4 (25)	1	ACE, BDE
4	02/14 0657		02/15 1530	02/14 0657	F	93	690	480	-210	11	3	ACE
5	02/20 2100	02/21 0500	02/22 1200	02/20 2100	F	225	468	320	-148	18	2	
6	03/01 0330	03/01 0330	03/02 0300	03/01 0152	/	55	542	440	-102	10.5	2	
7	03/29 2330	03/29 2330	03/31 2000	03/31 0316	/	86	528	370	-158	9	1	followed by SIR, weak but is Group 1
8	04/03 1356	04/04 0142	04/05 2035	04/03 1356	/	86	430	355	-75	12	1	ACE, slow ICME, BDE
9	04/06 1632	04/06 1632	04/08 0600	04/06 1632	F	520	630	515	-115	34	1	low T_p region after high Pt and B rotation region
			04/07 0912	/								
10	05/07 0000	05/07 0000	05/08 2110			110	430	330	-100	15	1	V_p gradually declines, T_p not low
11	06/04 1450	06/05 0600	06/06 1630	06/04 1450	/	210	498 (550)	418	-80	17.5	1	not smooth
12	06/08 0905		06/09 1600	06/08 0905	F	450	800	590	-210	26	3	
13	06/12 2200		06/14 0615	06/12 2200	/	150	580	415	-165	9.7	3	weak
14	06/23 1228		06/25 1922	06/23 1228	F	310	600	405	-195	23	3	ACE, BDE
15	07/01 0100	07/01 0100	07/02 1829			70	440	360	-80	9.7	1	ACE, no BDE

16	07/11 1124		07/13 0222	07/11 1124	F	310	540	465	-75	22	3	ACE, <i>Wind</i> was around bow shock
17	07/13 0919		07/14 0400	07/13 0919	F	420	680	580	-100	27	3	ACE, <i>Wind</i> was in the magnetosheath, small $ \Delta V $
			07/13 0936	/								
18	07/14 1500	07/14 1500	07/15 1400	07/14 1500	F					18		plasma data gap from ACE, data gap (07/14-07/17) of <i>Wind</i>
19	07/15 1416	07/15 1900	07/17 0100	07/15 1416	F					58		plasma data gap, LARGE B
20	07/19 1449		07/21 1927	07/19 1449	F	120	650	460	-190	13.8	3	ACE
21*	07/26 1755		07/27 1953	07/26 1755	F	130	400	330	-70	11	3	ACE, several ICMEs nearby
22*	07/28 0543		07/29 0910	07/28 0543	F	460	485	390	-95	26	3	ACE
			07/28 0910	F								
23*	08/10 0408	08/10 1920	08/11 1800	08/10 0408	F	80 (125)	445	390	-55	13.5 (15)	2	ACE, weak
24*	08/11 1812	08/12 0446	08/13 2210	08/11 1812	F	475	630 (680)	537	-93	35	1	ACE
25	09/02 1200	09/02 1200	09/03 1215			68	460	400	-60	11	1	ACE, weak, BDE in first half day of 09/03
26	09/04 1245	09/04 2145	09/06 0043	09/04 1245	F	60	430 (490)	350	-80	10.5	2	ACE, BDE
27	09/06 1615	09/06 2300	09/10 0400	09/06 1615	F	280	520	360	-160	20	3	ACE
28	09/17 1409	09/17 2320	09/19 0625			710	870	625	-245	41	3	ACE, noisy <i>Wind</i> data
29	10/03 0102	10/03 1700	10/04 1230	10/03 0102	F	190	442 (488)	385	-57	18	1	irregular Pt
30	10/05 0329	10/05 1100	10/06 0600	10/05 0329	F	420	535	500	-35	29	3	fast ICME

31	10/12 2233	10/13 0600	10/14 0716	10/12 2233	F	290	490	385	-105	20	1	
32	10/28 0932	10/28 2230	10/29 2330	10/28 0932	F	190 (250)	415	342	-73	18.2	3	
33	11/06 0930	11/06 2230	11/08 0325	11/06 0930	F	264	615	430	-185	25	1	
			11/08 1404		R							
34	11/10 0620		11/10 1800	11/10 0620	F	2100	960	860	-100	32	3	too high T_p and P_t , big CME from the Sun, data gap of ACE, BDEs
35	11/11 0413		11/11 2100	11/11 0413	F	140	970	730	-240	12	3	
36	11/28 0458	11/28 1131	11/30 0800	11/28 0458	F	143	497	460	-37	16.3	1	
			11/29 0307		F							ACE, complex, shock around the center
			11/29 0523		F							
37	12/03 0321		12/05 0800	12/03 0321	F	90	497	320	-177	12.7	3	ACE, weak, five-hour BDE

2001

1	01/13 0227		01/14 0000	01/13 0227	F	123	450	378	-72	16	3	BDE from 01/13 0900
2	01/23 1007		01/26 0748	01/23 1007	F	160	565	338	-227	13.5	3	ACE, BDEs
3	01/31 0837		02/01 1530	01/31 0837	F	155	485	395	-90	14.5	3	
4*	03/04 0500	03/04 0500	03/05 0140			83	470	400	-70	13		in an SIR, no BDE
5	03/19 1134	03/19 1900	03/22 0000	03/19 1134	F	175 (218)	465	290	-175	20 (21)	1	classic
6	03/27 0202		03/27 1009	03/27 0202	/	183	445	390	-55	18	3	data gap around 03/27 0202, followed closely by another ICME
7	03/27 1807	03/27 2257	03/28 1345	03/27 1807	F	180 (410)	650	565	-85	19 (28)	2	V_p irregular

8	03/31 0023		03/31 2138	03/31 0023	F	2100	770	500	-270	70	3	
9*	03/31 2140	04/01 0421	04/03 0310	03/31 2140	/	50 (460)	830	515	-315	10 (35)		ACE, no BDE, closely following an ICME
				03/31 2256	R							
10	04/04 1423	04/04 1800	04/05 0545	04/04 1423	F	275	800	650	-150	23	3	Wind data gap (04/06 - 04/30), ACE, BDE
11	04/07 1700		04/08 0551	04/07 1700	F	160	560	460	-100	15.5	3	ACE, BDE, T_p not low
12	04/08 1032		04/10 0900	04/08 1032	F	345	800	520	-280	22	3	ACE, BDE
13	04/11 1315	04/11 2212	04/13 0446	04/11 1315	F	550 (950)	740	600	-140	35 (41)	1	ACE, half period with high T_p , two shocks close to each other
				04/11 1453	/							
				04/11 1528	F							
14	04/13 0707	04/13 1030	04/14 1010	04/13 0707	F	105	830	600	-230	15		ACE, BDE
15	04/18 0005		04/20 1100	04/18 0005	F	360	530	370	-160	25	3	ACE, BDE
16	04/21 1508	04/21 2335	04/23 0030	04/21 1508	F	120	390	330	-60	15.5	1	ACE, no obvious BDE
17	04/28 0432	04/28 1550	04/29 1400	04/28 0432	F	170 (400)	720 (750)	560	-160	19 (25.5)	2	ACE, V_p classic, short interval of BDE
18	05/27 1447	05/28 0430	05/29 1030	05/27 1447	F	106	560 (640)	415	-145	10 (15)	1	
19	06/27 0300	06/27 0300	06/28 1700			24	480	363	-117	3.5		ACE, P_t very small, in a declining stream
20	07/09 0300	07/09 0300	07/12 0300			73	482	320	-162	9.2		P_t trough, slow, before an SIR
21	08/03 0719		08/03 1815	08/03 0719	F	210	465	410	-55	12	3	a short interval with BDEs

22*	08/05 0115	08/05 0115	08/05 2345	08/05 1156	F	95	500	370	-130	13.7		ACE, with an SIR, BDE
23	08/17 1102	08/17 2000	08/18 2000	08/17 1102	F	430 (500)	600	470	-130	31	2	
24	08/27 1938		08/28 1650	08/27 1938	F	300	600	500	-100	19	3	BDE
25	09/17 2145		09/19 1747			110	480	400	-80	12		ACE, plot of Pt looks like SIR, big deflection of V_p , BDE occurred during a part of the interval
26	09/25 2018		09/27 0400	09/25 2018	F	550	740	460	-280	32.6	3	data gap of ACE
27*	09/29 0906	09/29 1130	09/30 1600	09/29 0906	F	110	725	460	-265	14.5	1	ACE
28*	09/30 1847	09/30 2200	10/01 1600	09/30 1847	F	175 (200)	560	440	-120	20	3	ACE
29*	10/02 2324	10/02 2324	10/03 1630	10/03 0807	F	240	600	460	140	23.8	1	ACE, followed by another ICME
30*	10/03 2200		10/04 0700			85	590	470	120	12	3	ACE, following a leading ICME
31	10/21 1614	10/22 0043	10/22 2310	10/21 1614	F	160 (500)	680	500	-180	18 (30)	2	ACE, low T_p , B irregular and noisy, BDE for whole interval
			10/22 0013		R							
32	10/28 0243		10/31 1254	10/28 0243	F	230	525	325	-200	22	3	ACE
33	10/31 1348	10/31 2100	11/02 1200	10/31 1348	F	93 (113)	400	305	-95	13.6	1	V_p noisy and irregular
34	11/05 1931		11/06 2017							80		ACE, plasma data gap, same to <i>Wind</i>
35	11/14 0800		11/15 0900							4.6		ACE, plasma data gap, same to <i>Wind</i>
36	11/15 1800	11/15 1800	11/16 1030			180	380	325	55	16.3		ACE, plasma data gap (11/14 1200 - 11/15 1700)

37	11/19 1736		11/20 1700	11/19 1736	F	140	580	405	-175	13.5	3	some data gaps during 11/01-11/16, taking five days off, ACE, BDE
38	11/24 0552	11/24 1545	11/25 1638	11/24 0552	F	210 (1900)	970	600	-370	23 (58)	2	very strong, ACE data gap (11/24 0420- 1730)
				11/24 1400	R							
39*	12/29 0449	12/30 0021	12/30 1820	12/29 0449	F	200 (460)	430 (510)	350	80	20.8 (24.7)	2	ACE, followed by another ICME
40*	12/30 1933		12/31 0747	12/30 1933	F	440	700	510	190	27	3	ACE, weak rotations, BDE

2002

1	02/28 0507	02/28 1835	03/01 0900	02/28 0507	F	140	420	360	-60	14.6	1	V _p irregular
2	03/18 1315		03/20 0938	03/18 1315	F	600	480	330	-120	22.5	3	T _p not low
3	03/20 1320		03/22 0300	03/20 1320	/	350	616	415	-201	21	3	
4*	03/23 1125	03/24 1200	03/25 2100	03/23 1125	F	180	490 (520)	410	-80	21	1	V _p irregular, followed by an SIR
				03/25 0115	F							
5	04/14 1149	04/14 1149	04/15 1800	04/14 1149	/	90	440	332	-108	11	2	ACE, BDE
6	04/17 1102		04/19 0825	04/17 1102	F	900	640	430	-210	33	3	followed by another shock
7	04/19 0827	04/20 0045	04/21 1630	04/19 0827	F	200 (265)	650	440	-210	21.5 (23.7)	1	
8	04/23 0415		04/24 1700	04/23 0415	F	310	650	472	-198	17	3	ACE, T _p high, partial DG
9	05/10 1114		05/11 1000	05/10 1114	/	180	418	330	-88	15.5	3	
10*	05/11 1030		05/11 2350	05/11 1030	F	320	470	400	-70	23	3	ICME (05/11 1618~05/12 0100, T _p not low) + SIR
				05/12 0234	/							

11	05/18 1920	05/19 0240	05/20 0257	05/18 1920	F	208 (370)	475 (500)	380	-95	20	2	ACE
12	05/20 0335		05/21 2100	05/20 0335	F	148	533	370	-163	16	3	
13	05/23 1016		05/25 1820	05/23 1016	F	1400	975	360	-615	54	3	ACE, strong, BDE
14	07/17 1526		07/19 0730	07/17 1526	F	260	540	408	-132	19.5	3	ACE, BDE
15*	07/19 0932	07/19 0932	07/21 1108	07/19 0932	F	200	925	480	-445	20	1	classic SIR+ICME, ACE, BDE, V _p big deflections
			07/19 1443	F								
16	07/25 1300		07/26 1830	07/25 1300	F	100	550	420	-130	13.8	3	ACE, T _p not low, BDE
17	07/29 1242		07/30 1800	07/29 1242	F	150	570	400	-170	17.5	3	ACE
18	08/01 0425	08/01 0425	08/01 2220	08/01 0425	F	120	463	430	-33	15	1	ACE, followed by another ICME
19	08/01 2220	08/02 0422	08/03 0526	08/01 2220	F	80 (130)	525	407	-118	13.5 (16)	1	ACE
20	08/18 1810		08/21 2115	08/18 1810	F	200	600	370	-230	16.7	3	ACE
21	08/26 1115		08/26 2300	08/26 1115	F	230	430	355	-75	17	3	
			08/26 1121	SF ⁸								
22*	09/07 1622		09/08 2000	09/07 1622	F	290	620	450	-165	23	3	ICME + ICME
23*	09/08 2225	09/08 2225	09/10 2000			60	552	385	-167	10	2	
24	09/19 0617		09/20 2235	09/19 0617	/	90	780	370	-410	10.2	3	
25*	09/30 0755	09/30 2200	10/01 1430	09/30 0755	F	300	430	350	80	26.5	1	ICME in SIR

26	10/02 2241	10/02 2241	10/04 1900	10/02 2241	F	100	543	370	-173	14	2
27	11/16 2304	11/17 0722	11/18 2346	11/16 2304	F	90	510	380	-100	11.3	2
28	11/26 2110		11/27 2015	11/26 2110	F	510	600	500	-100	29	3

2003

1	02/01 1313	02/01 2131	02/03 0447	02/01 1313	/	120	700	470	-230	13.5	2	
2	02/17 2151		02/19 0044	02/17 2151	/	156	700	570	-130	16.2		ACE, high B in the leading region, no BDE, followed by an SIR
3	03/20 0421	03/20 0830	03/20 2230	03/20 0421	F	85 (120)	810 (840)	605	-205	12.8 (15.5)	2	ACE, no BDE
4	05/09 0456	05/09 0800	05/10 0600	05/09 0456	F	90 (120)	900	650	-250	12.2	2	ACE, no BDE
5	05/29 1152	05/29 1300	05/29 1830	05/29 1152	F	105	680 (690)	640	-40	16	2	ACE, BDE, closely followed by an ICME
6	05/29 1830	05/30 0119	05/30 1415	05/29 1830	F	450 (750)	665 (800)	550	-115	30 (36)	2	ACE, BDE
7	05/30 1553		05/31 1125	05/30 1553	/	250	850	660	-190	22	3	ACE, weak, large B in the leading part, BDE
8	06/15 0617	06/15 0617	06/16 2100			110	600	440	-160	15	1	ACE, weak rotations of B , Pt mimics SIR
9*	06/17 0030	06/17 0030	06/18 0900	06/18 0442	F	170	540	442	-98	19	1	closely followed by an ICME
10	07/06 1225		07/07 1142	07/06 1225	F	70	720	480	-240	9.5	3	ACE, no BDE, T_p not low
11	07/23 1400		07/24 1400			50	515	395	120	9		ACE, Pt irregular

12*	08/04 1930	08/04 1930	08/05 2300			95	512	410	-102	12.5	2	bad rotation, before an SIR
13	08/18 0113	08/18 0113	08/19 1623	08/17 1341	F	172 (240)	500 (530)	400	-100	20 (23)	1	ACE, T _p disturbance
14	10/21 2300	10/21 2300	10/24 0228	10/21 1938	/	95	760	410	-350	12	1	ACE
15	10/24 1449		10/25 1123	10/24 1449	F	670	605	510	-95	34	3	ACE, T _p not low, because of interaction of several ICMEs
16	10/26 0810		10/28 0130	10/26 0810	F	133	600	420	-180	17		ACE, Pt irregular
				10/26 1833	F							
17	10/29 0842	10/29 0842	10/30 1000							48		ACE, plasma data gap (10/28 1300 - 10/31 0100), Halloween event
18	10/31 0127	10/31 0127	11/01 1720			700	1200	600	-600	40		
19	11/04 0600		11/04 1530	11/04 0600	F	500	770	700	-70	27.5	3	ACE
20	11/06 1920		11/08 0430	11/06 1920	F	150	600	410	-190	14.5	3	ACE
21	11/15 0519		11/15 1700	11/15 0519	F	195	730	620	-110	14	3	ACE, BDEs
22	11/20 0728	11/20 1000	11/21 0615	11/20 0728	F	1250	720	520	-200	56	1	ACE, strong, <i>CLASSIC</i>

2004

1	01/09 1451		01/12 1300	01/09 1451	/	165	700	480	-220	15.5	3	ACE, 16-hour low T _p
2	01/22 0105	01/22 1000	01/23 0700	01/22 0105	F	420	700	520	-120	29	3	big shock, ACE, BDE
3	01/23 1421	01/23 1421	01/25 0300	01/23 1421	/	80	560	460	-100	13	2	ACE, small B , BDE, closely following an ICME
4*	04/03 0955	04/04 0110	04/05 1932	04/03 0955	/	170	525	370	-155	19.3	1	classic, followed by an SIR
				04/03 1422	/							

19	12/11 1257	12/12 2230	12/14 0238	12/11 1257	F	103 (120)	400 (590)	370	-30	15.7	2	ACE, BDE
20	12/27 0448		12/28 1800	12/27 0448	/	90	580	405	-175	10.3	3	ACE, BDE, Pt irregular, maybe a slow forward shock14 at 12/27 0448

2005

1	01/07 0838	01/07 1508	01/08 0707	01/08 0016	F	300	620	507	-113	22.5	1	shock in the center of magnetic obstacle, at 01/08 00:15:35; Vp irregular, low S in the obstacle, not well-organized rotations of B ; one B and S hole during 01/08 03:40 - 04:00, where the Pt was balanced
2	01/08 2013		01/09 1740			58	486	440	-46	9.9	2	filament? during 01/09 09:39-09:59, Np hump, T, B and S hole, Pt hump; following an ICME; but such structure was not prominent at ACE; B changes at that time looks like an IFE, associated with dust trails along the orbits of comets and asteroids
3	01/16 0927	01/16 1612	01/17 0713			70	570 (605)	495	-75	11	2	BDE, not well-organized B rotations, followed by another ICME, Np was very variable; B dip around 01/17 05:25; followed by 2 ICMEs
4	01/17 0715	01/17 1600	01/17 2300	01/17 0715	F	1000	700 (840)	600	-100	22 (42)	/	BDE, complicated B , maybe combined of several CMEs from the Sun, hard to separate every single one; several halo CMEs on 01/14-01/15 from SOHO observations, 2 with speed around 2000 km/s close to the Sun
5	01/18 0220	01/18 2227	01/20 0200			250	1000 (2000)	620	-380	18 (27)	2	BDE, very fast, 2 superfast halo CMEs on 01/17 from SOHO observations

6	01/21 1648	01/21 2035	01/22 1700	01/21 1648	F	450 (900)	950	700	-250	27 (36)	/	BDE, ACE, DG at Wind
7	01/30 2301	01/31 1400	02/02 0910			30 (65)	680 (720)	460	-220	8.2 (10.8)	/	Pt concave
8	02/18 1500		02/19 0420			50	590	485	-105	9	2	a lot of disturbances in region before it, like from a streamer belt
9	02/21 0148		02/22 0733			38	460	360	-100	6.5	/	Pt was low and irregular, DG after that
10	02/22 1626		02/23 1820			200	400	355	45	13	1	ACE, BDE, low Tp and b
11 *	03/21 0615		03/23 1900	03/21 0615	F	80	660	300	-360	9	/	followed by a SIR, big plasma shear at the leading edge; partial halo CME on 3/18 observed by SOHO
12 *	05/07 1826	05/08 1701	05/10 0800	05/07 1826	F	80 (440)	775 (900)	500	-315	10 (19)	/	concave in Pt profile, ICME in fast stream, BDE, halo CME on 05/02 (662 km/s at 20 Rs) and on 05/05 (1174 km/s)
				05/08 1701	R							
13	05/15 0210	05/15 0545	05/17 0942	05/15 0210	/	1250	1000	480	-520	56	1	really strong, BDE, DG at the leading edge
14	05/20 0335	05/20 0645	05/21 0700	05/20 0335	F	125	490	414	-76	16	1	Tp is a little noisy, not clear BDE
15 *	05/29 0900	05/29 1447	05/31 0703	05/29 0900	F	240	550	430	-120	22.5	/	after a SIR, BDE, different interval in the ICME list by Richardson and Cane, discontinuities in the ICME
16	06/12 0649	06/12 1500	06/13 1400	06/12 0649	F	200 (380)	525	435	-90	20 (27)	3	occurred near a streamer belt
17 *	06/14 1756	06/15 0500	06/16 0809	06/14 1756	F	80 (140)	535 (570)	422	-113	12.5 (14)	2	between an ICME and a SIR
18 *	07/10 0242	07/10 1054	07/11 0619	07/10 0242	F	260 (470)	490	390	-100	25 (27)	2	end time differ from the ICME list by Richardson and Cane

19	07/16 0141	07/16 0141	07/16 1242	07/16 0141	F	80	430	382	-48	9.7	2	short, low Tp, BDE, some halo CME candidates from SOHO CME list
20	07/17 0053	07/17 1513	07/18 0255	07/17 0053	F	120 (138)	460 (510)	396	-64	15	2	another shock at 07/16 16:10 before the ICME, without clear driver, maybe associated with 07/14 super fast halo CME; not well-organized B rotations; BDE
21	08/08 2310		08/09 1200			23	560	460	-100	7	2	ACE, small Pt, BDE, lower Tp than expected, relatively high Na/Np
22 *	08/23 2247		08/24 1128	08/24 0535	F	1300	660	410	250	56	/	in a SIR; 2 fast halo CME on 08/22, one with 1127 km/s at 20 Rs, the other with 2585 km/s at 20 Rs
23	09/02 1350	09/02 1841	09/03 0300	09/02 1350	F	170 (220)	680	590	-90	15.2	2	
24 *	09/09 1333		09/10 0410	09/09 1333	F	330	500	420	-80	17	3	caught up by a fast stream
25	09/11 0058	09/11 0520	09/12 0600	09/11 0058	F	250 (600)	1800	700	-1100	18 (27)	3	a series of halo CMEs observed by SOHO
26	09/12 0603	09/12 2000	09/13 0900	09/12 0603	F	47 (73)	830 (1000)	700	-130	9.8 (11)	2	ACE, closely following previous ICMEs
27	09/13 0854		09/14 0800			43	780	565	-215	9.5	3	small Pt, relatively smooth B rotations at the last 6 hours, BDE
28	09/15 0836		09/16 0342	09/15 0836	F	220	930	680	-250	21.3	1	extremely low Np and Tp during 09/15 15:58 - 17:12, rare, almost Pt balance
29	10/31 0243		10/31 2100			107	405	355	-50	13	1	Vp irregular
30 *	12/30 2345		01/01 1000	12/30 2345	F	62	600	450	-150	11	2	cross year, a forward shock at the trailing edge, an interesting interval of Np enhancement as well as S and B dip (12/31 12:30-13:50)

2006

1 *	01/01 1326		01/02 0300	01/01 1326	F	195	520	430	-90	20	3	following an ICME, BDE, it could correspond to partial halo CME on 12/28/2005
2	02/05 1900		02/06 1245			82	356	310	-46	11.6	1	weak, Pt irregular
3 *	03/14 1130		03/15 0000			100	425	345	80	9	2	Np and Vp small, Pt irregular, in an SIR, S differed from the surrounding SIR, no BDE; maybe some processes close to the Sun opened the field line; a partial halo CME on 03/10
4 *	04/13 1112	04/13 1517	04/14 1100	04/13 1112	F	180	540	460	-80	20	1	ACE, about 4 hours sheath region; large-scale but noisy B rotations before the sheath region; probably an ICME interacted well with streamer belt during its eruption; need further study
5	06/17 2130		06/18 0800			30	580	530	-50	6.7	/	after a SIR, weak, nice rotations of B and BDE, S decreased within it
6 *	07/09 2040	07/10 2000	07/11 0527	07/09 2040	F	90	450	350	-100	10	2	closely followed by a SIR; BDE
7	08/19 1057		08/21 1600	08/19 1057	F	260	490	370	-120	21	3	2 halo CMEs on 08/16 from SOHO, Vp noisy, another FF at 15:52 on 08/18; low Tp and relatively smooth B during 08/20 13:20 - 08/21 16:00; Vp big deflection
8 *	09/30 0753		09/30 1943			190	460	360	-100	18.5	1	ACE, in a SIR, a reverse shock at 08:50:30 on 10/01

9	11/29 0500		11/30 0625			115	460	380	-80	16	1	classical, a partial halo CME on 11/15
10	12/08 0402		12/09 1424	12/08 0402	F	180	745	460	-285	15	3	maybe a pass-by of the flux rope (12/09 07:00 - 14:24)
11	12/14 1352	12/14 2234	12/15 1150	12/14 1352	F	140 (390)	875 (990)	650	-225	17.8 (18)	2	a discontinuity at 08:22 on 12/15
12	12/16 1734		12/17 1921	12/16 1734	F	73	680	500	-180	13	3	large Vp and Tp during 20:00 - 21:10 on 12/16

2007

1	01/14 1148	01/14 1148	01/15 0710			95	385	325	-60	14.5	2	slow, low Tp, clear V deflection, flux rope, although the field rotations are not very smooth, a sharp increase of B at 01/14 19:30, followed by a fast wind
2	05/21 2223	05/21 2223	05/22 1340			100	480	440	-40	14	1	good BDE, followed by a fast wind, a r.s. at 05/24 2231, big V deflection
3	11/19 1722	11/19 2332	11/20 1146	11/19 1722	F	245	490	450	-40	20	1	nice MC, low Tp, suprathermal electron flux increases greatly, but BDE not clear, followed by faster solar wind
4	12/25 1600	12/25 1600	12/26 0743			31	380	330	-50	6.1	1	speed is declining, very cold plasma, field rotates little over the interval; STA likely encounters a part of the ICME

2008

1	07/25 1300	07/25 1300	07/25 2330			23	432	388	-44	5.4	2	ambiguous, weak, a little BDE
2	09/17 0400	09/17 0400	09/18 0804			31	470	365	-105	7.2	1	low Tp, clear B rotations, clear BDE
3	12/04 1120	12/04 1120	12/05 1038			46	450	360	-90	8.4	2	BDE, low Tp, STA saw the CME candidate

4	12/17 0327	12/17 0327	12/17 1600			40	348	316	-32	9.6	2	STA, STB saw the CME at right locations, nice field rotation, quiet mag field, low Tp, and noticeably different S within the mag obstacle, plasma before the event is hot and dense
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2009

1 *	01/26 0455	01/26 0455	01/26 1515			110	385	320	-65	11	/	strong and quiet B, without smooth field rotations, surprisingly lower B in front of the ICME, sharp B change in the center of the obstacle, Np and Tp are pretty variable in the ICME, causing irregular Pt; BDE exists but is very weak; STB saw the CME candidate on 01/21 17:52
2	02/03 1921	02/04 0300	02/04 1900	02/03 1921	F	106	400	340	-60	11.8	2	low Tp than expected, high Nalp/Np, field line is still noisy, one possible CME candidate: STA 01/29 which is not strong, HCS after the event
3 *	03/11 2200	03/12 0118	03/13 0133	03/11 2200	F	190	390	326	64	18.5	1	BDE, Tp low, nice B rotations, followed by a fast wind, good example, B slightly increases at f.s
4	06/27 1104.25	06/28 0130	06/28 1939	06/27 1104.25	F	87	430	350	-80	9.2	/	nice B rotations, Tp low, followed by a fast stream, merged with SIR
5	07/21 0100	07/21 0433	07/22 0515			200	345	297	-48	17	/	BDE, B rotations; Tp is lower than expected; Pt peaks at the trailing part due to the compression of the overcoming fast wind
6 *	08/05 1229	08/05 1229	08/06 0549			133	396	360	-36	13.6	1	high α particle abundance, no BDE, embedded within a SIR, followed by fast wind, STA HI saw the CME launched on July 29

7	09/30 0038	09/30 0070	09/30 1913			63	360	330	-30	9.5	1	low Tp, field rotations, stronger field than ambient, no BDE, no CME candidate found
8	10/16 2222	10/16 2222	10/17 1023			16.4	360	320	-40	3.9	1	Pt very weak, BDE, nice B rotations, 10/11 SOHO saw possible candidate
9	10/17 2124	10/17 2124	10/18 1520			23.6	324	290	-34	4.1	1	BDE, 2 flux ropes, Pt is very weak, B does not vary smooth, probably because it is too weak
10	10/29 0200	10/29 0200	10/29 2342			80	390	355	~ 0	11.3	1	BDE, nice field rotations, Vp is very variable
11	11/13 1700	11/14 1040	11/15 1150			50 (70)	376	313 (275)	~ 0	8.2	2	BDE, low Tp, CME candidate seen by STEREO on 11/09, not smooth B rotations; Vp does not vary monotonically so Vexp is set as 0
12	12/12 0439	12/12 1928	12/13 2239	12/12 0439	F	60	296 (300)	254	-42	8.2	1	very slow, partial BDE, STA/B COR2 saw CME candidates on 12/6 and 12/8, ACE data gap

¹ For most Group 3 ICMEs, the spacecraft do not traverse some part of magnetic obstacle, so that the start time of obstacle is not given for such events. The stop time of the magnetic obstacle, not given in the survey, is the same as the end time of the ICME event.

* Hybrid event consisting of not only one event.

¹ F/R Shock: forward/reverse shock. "/" means neither a forward shock nor a reverse shock.

² ΔV : change in solar wind velocity during one event; negative value indicates that the solar wind velocity declines through the event.

³ Group: classification of ICME into three groups depending on the time variation of Pt. Group 1: central maximum of Pt; Group 2: plateau-like profile of Pt; Group 3: gradual decrease after sharp increase at the leading edge. From Group 1 to Group 3, the relative impact distance between spacecraft and central flux rope approximately increases.

⁴ (): the value in the "magnetosheath" region.

⁵ FF: fast forward shock.

⁶ From Davin Larson's shock list (<http://sprg.ssl.berkeley.edu/~davin/IPShocks.html>).

⁷ ACE: from the ACE data.

⁸ From Kasper's shock list (<http://space.mit.edu/home/jck/shockdb/shockdb.html>).

⁹ Overexpansion: CME where the expansion is driven by a quite high initial internal pressure (Gosling *et al.* , 1994).

Record:

1. Revised on 25 Oct 2010. Change: update the events for 1996 and 2007 - 2009 following the study for Jian et al. (2011); the group classification is changed. In addition, Wind data gaps during 1995 - 1997 are filled up with OMNI data (1-min available), although no ICMEs are found with the filled data.
2. Reference information is updated on 18 Nov 2014.
3. Update Lan Jian's affiliation on 18 February 2021.