Interplanetary Drivers of Major Geomagnetic Storms, With Examples
Ian Richardson, GSFC, Rev. 3/01/05

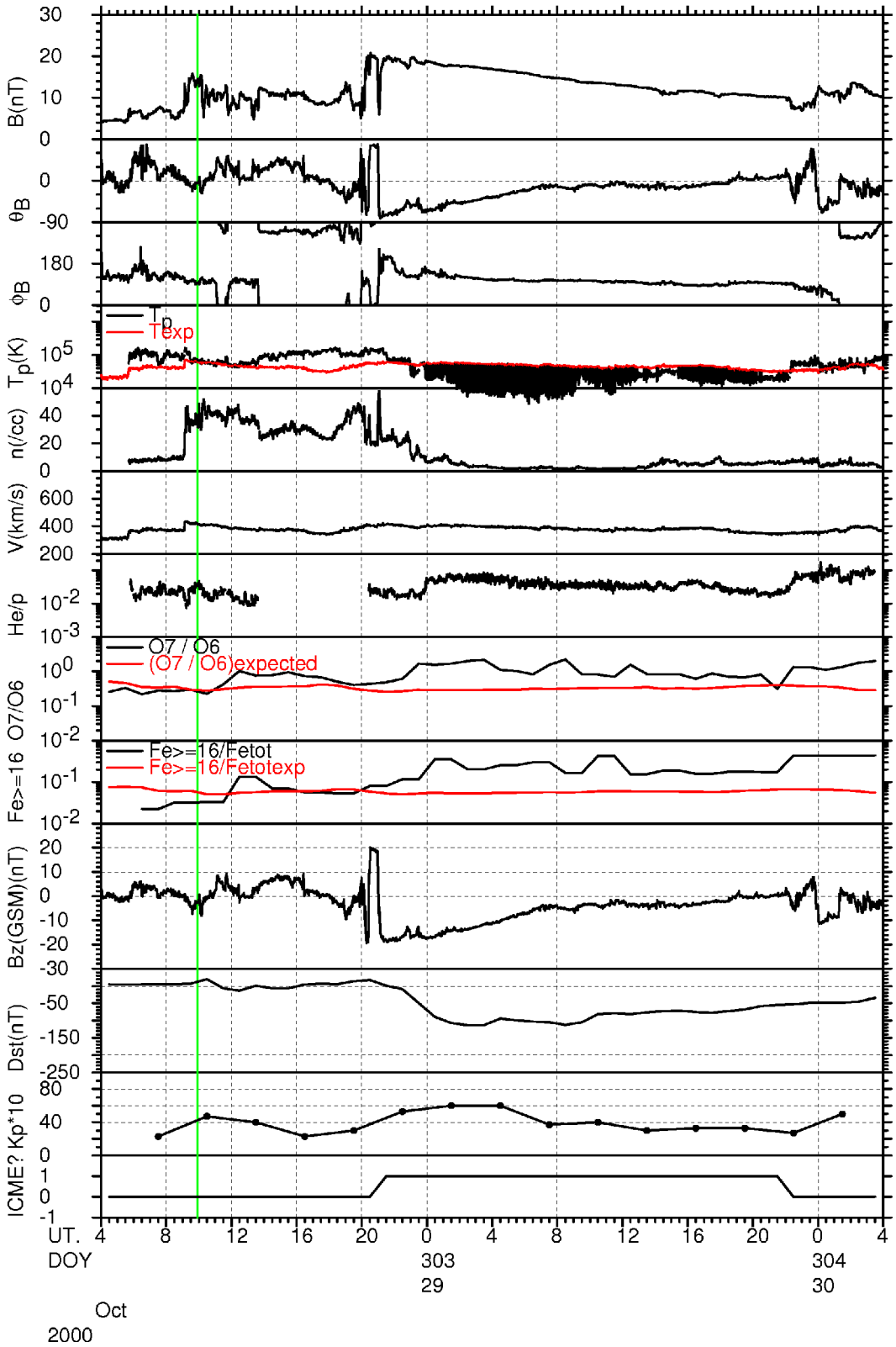
1=ICME; 2=Sheath;
3=Shock Compression of Bs in Preceding ICME
4=Complex

Date	IGR	Huttunen et al.*	Notes
97/10/11	1	1	Magnetic Cloud (Huttunen)
97/11/07	2	2	Magnetic Cloud (Huttunen)
97/11/23	1(Primary),2	1	Magnetic Cloud (Huttunen)
98/02/18	1	1	Magnetic Cloud (Lepping/Huttunen)
98/03/10	CIR		
98/05/04	3		
98/06/26	1,3		Magnetic Cloud (Lepping)
98/08/06	3		Magnetic Cloud (Lepping)/CIR
98/08/07	4		Same origin as 08/06; complicated
98/08/27	1		Magnetic Cloud (Lepping)
98/09/25	2	2	Magnetic Cloud (Huttunen)
98/10/19	1,2	1	Magnetic Cloud (Huttunen)/CIR
98/11/08	1		
98/11/09	1	1	Magnetic Cloud (Huttunen)
98/11/13	1	1	Magnetic Cloud (Huttunen)
99/01/14	1		ICME in CIR
99/02/18	2	2	Magnetic Cloud (Huttunen)
99/09/23	1	1	
99/10/22	1+CIR		
99/11/13	3		
00/02/12	1	2	
00/04/07	2		
00/05/24	CIR?		Complicated!
00/07/16	1	1	Magnetic Cloud (Huttunen)
00/08/11	1	1	Magnetic Cloud (Lepping/Huttunen)
00/08/12	1,2	1	Magnetic Cloud (Huttunen)
00/09/18	2?	2	Magnetic Cloud (Huttunen)
00/10/05	1,3		
00/10/14	1	1	Magnetic Cloud
00/10/29	1	1	Magnetic Cloud (Huttunen)
00/11/06	1,2	2	Magnetic Cloud (Huttunen)
00/11/29	1		
01/03/20	1	1	Magnetic Cloud (Huttunen)
01/03/31	2,1		
01/04/12	2	2	Magnetic Cloud (Huttunen)

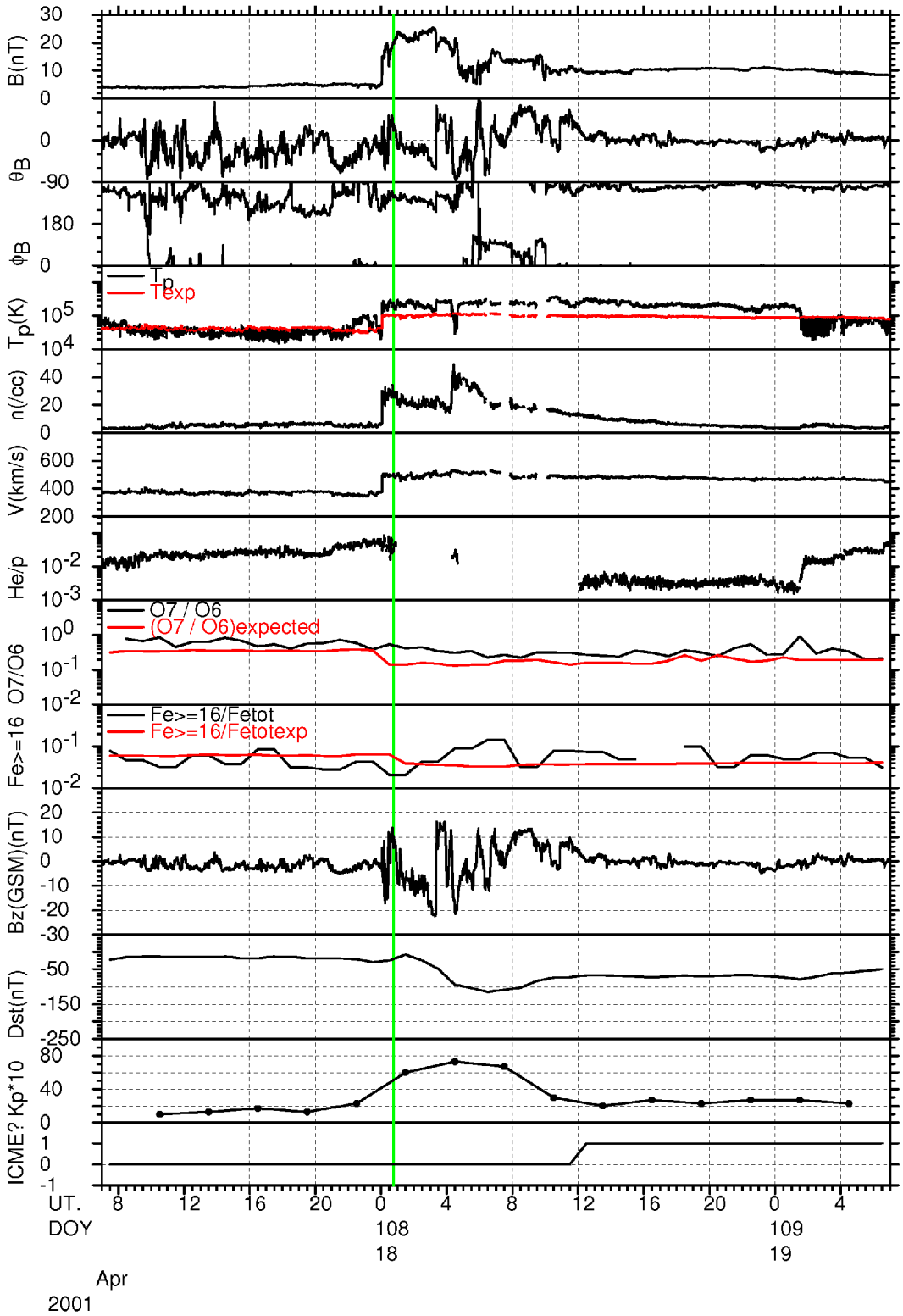
01/04/18	2		
01/04/22	1	1	Magnetic Cloud (Huttunen)
01/08/17	2		
01/09/26	2		
01/10/01	2?		
01/10/03	1	1	Magnetic Cloud (Huttunen)
01/10/21	2		
01/10/28	3		
01/11/06	3		
02/03/24	1,4	2	
02/04/18	1,2	1	Magnetic Cloud (Huttunen)
02/04/20	1,2?	2	Magnetic Cloud (Huttunen)
02/05/11	2/CIR?		
02/05/23	2	?	Magnetic Cloud (Huttunen)
02/08/02	2,3?	2	Magnetic Cloud (Huttunen)
02/08/21	1,4		
02/09/04	CIR?		
02/09/08	2,3		
02/10/01	1	1	Magnetic Cloud (Huttunen) in CIR
02/10/04	1		Magnetic Cloud (Lepping)
02/10/07	CIR		
02/10/14	CIR		
02/11/21	CIR		
03/05/30	3,2		Dense
03/06/18	3,CIR		
03/07/12	CIR		
03/07/16	CIR		In fast SW
03/08/18	1,2	1	Magnetic Cloud (Huttunen)
03/10/30a	1,2	1	Magnetic Cloud (Huttunen)
03/10/30b	2		
03/11/20	1	1	Magnetic Cloud (Huttunen)
04/01/22	1		Magnetic Cloud
04/02/11	CIR		
04/04/04	2,1?		Magnetic Cloud
04/07/23	1		
04/07/25	1		Magnetic Cloud
04/07/27	1,2		Magnetic Cloud
04/08/30	1		Magnetic Cloud
04/11/08	1,2		Magnetic Cloud
04/11/10	1,2		Magnetic Cloud

*** Properties and geoeffectiveness of magnetic clouds in the rising, maximum and early declining phases of solar cycle 23**
K. E. J. Huttunen, R. Schwenn, V. Bothmer, and H. E. J. Koskinen,
Annales Geophysicae (2005) 23: 1–17

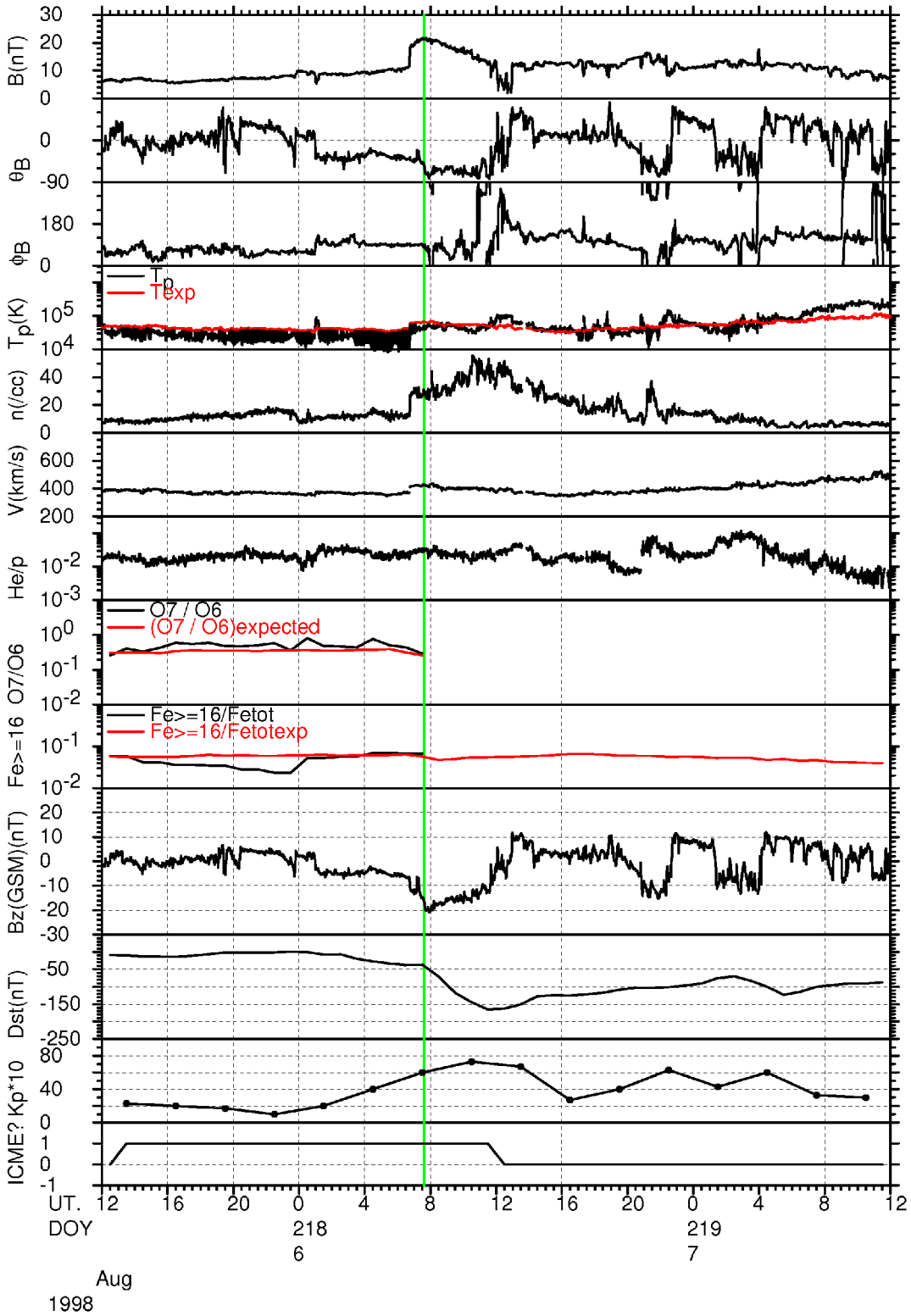
ICME (1) contributes in	~41/75 events
Sheath (2) contributes in	~30/75 events
Preceding ICME+shock compression (3):	~12/73 events
CIR (4) contributes in	~12/73 events



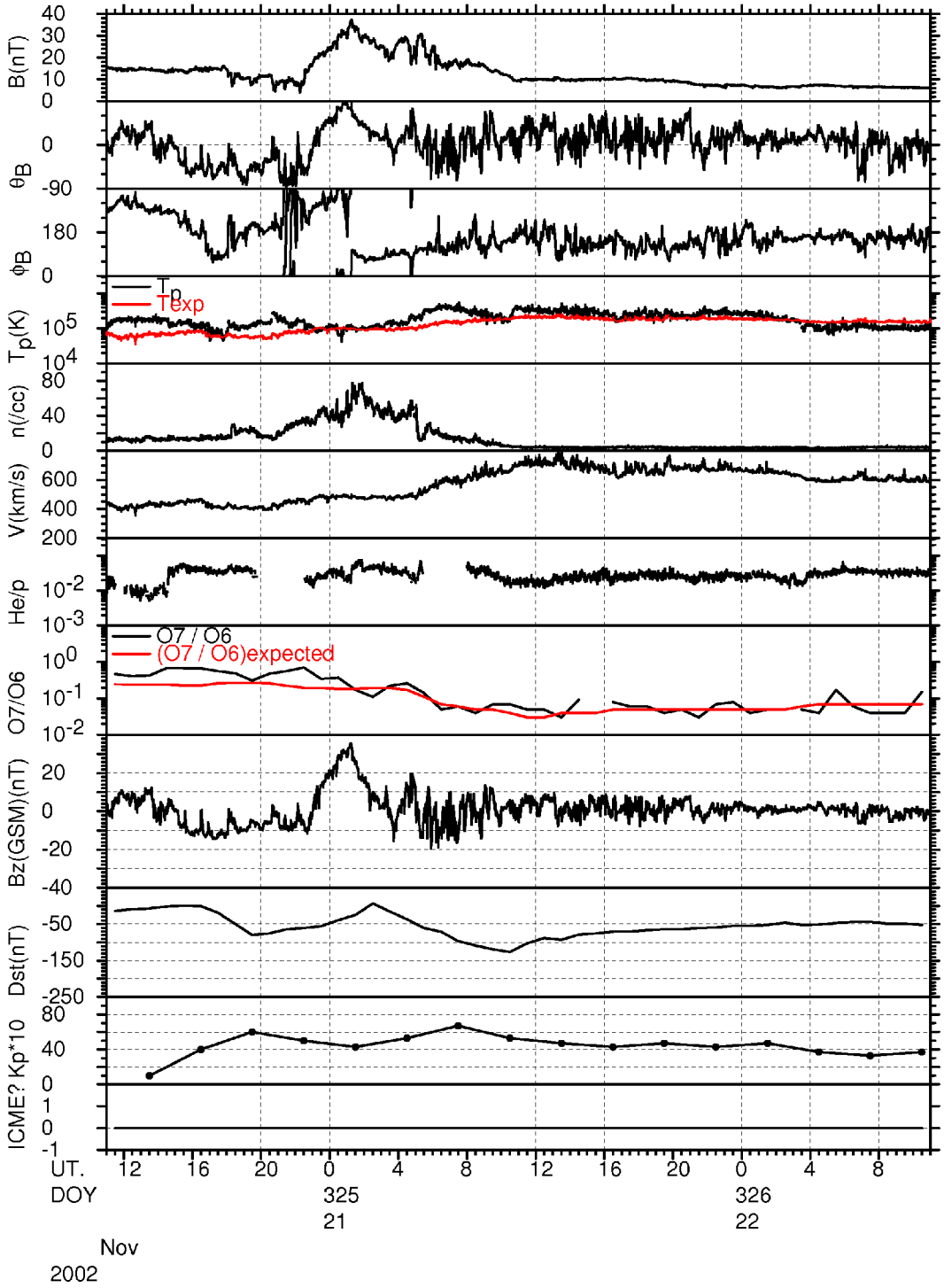
Example of Storm Predominantly Associated With an ICME (In This Case a Magnetic Cloud).



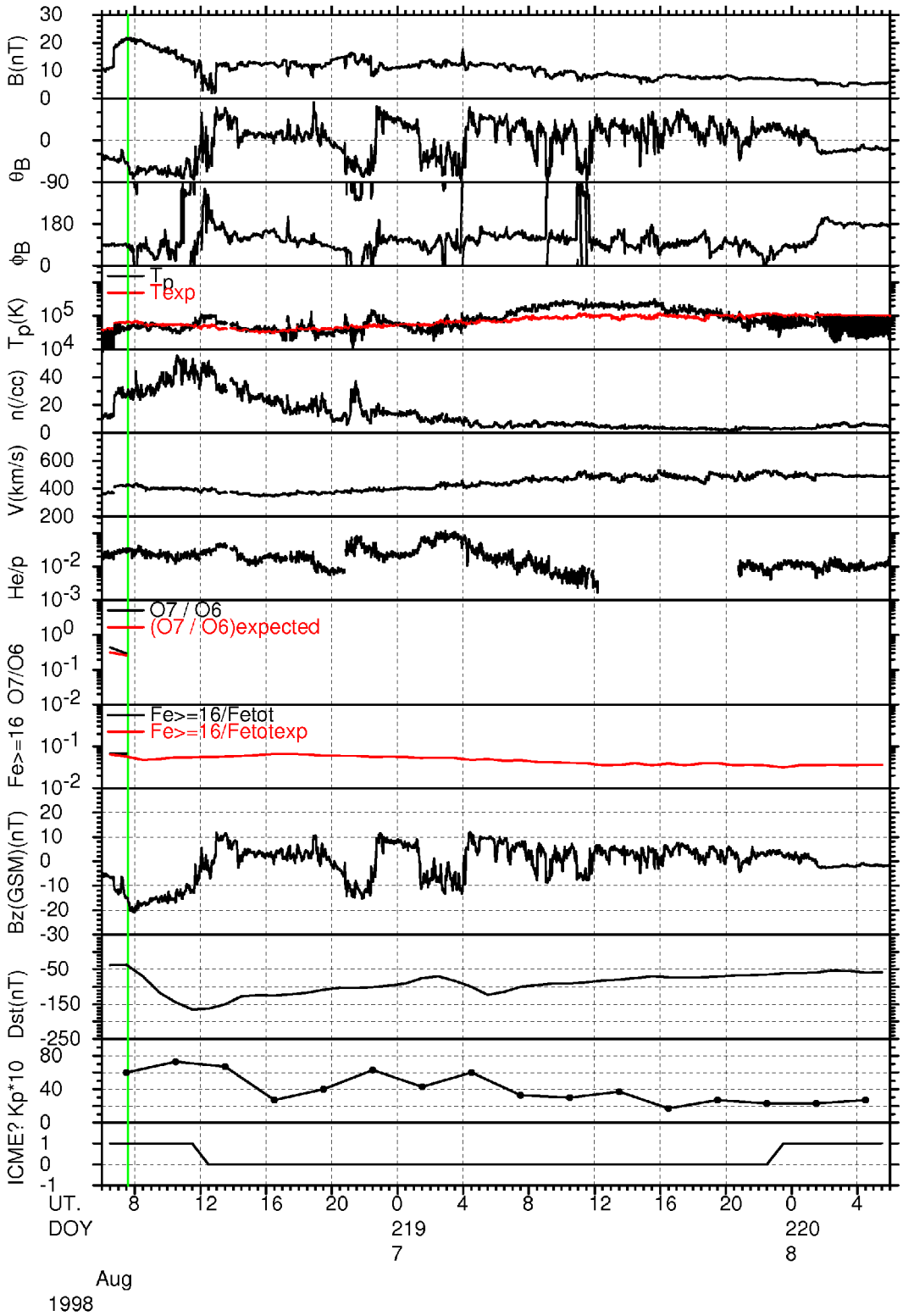
Example of Storm Predominantly Associated With Sheath.



Example of Storm Associated With Shock Compression of Preceding ICME Magnetic Field, Enhancing Bs.



Example of Storm Associated With CIR.



Example of Storm Associated With Complicated IP Structure (Complex ICME?).