RESEARCH PAPER | Physics | Volume : 3 | Issue : 5 | May 2013 | ISSN - 2249-555X

Solar Features and Solar Wind Plasma Parameters with Geomagnetic Storms During The Period of 2002-2006

KEYWORDS: Coronal mass ejections, X-ray solar flares, solar wind plasma parameters and geomagnetic storms.

Omkar Prasad Tripathi	P. L. Verma
Research Scholar Govt.P.G.College Maihar Satna M.P.India Department of Physics Govt.Vivekanand P.G.College Maihar Satna M.P.India.	Govt.Vivekanand P.G.College, Maihar Satna, M.P., India

ABSTRACT *We have studied geomagnetic storms (Dst ≤ - 80nT) observed during the period of 2002-2006 with halo and partial halo coronal mass ejections ,X-ray solar flares and disturbances in solar wind plasma parameters . We have found that 69.39 % geomagnetic storms are associated with halo and partial halo coronal mass ejections. The association rate of geomagnetic storms with halo and partial halo coronal mass ejections are found 67.65% and 32.35 % respectively. Further we have observed that geomagnetic storms are also associated with X ray solar flares of different categories. The association rate of B-class, C-class and M-class and X-class X-ray solar flares are found 18.25 %, 25.00% and 39.58 % and 16.67% respectively. From the study of geomagnetic storms with storms in solar wind plasma parameters, We have determined positive co-relation between magnitude of geomagnetic storms and magnitude of associated storm in solar wind plasma parameters with co-relation co-efficient, 0.61 between magnitude of geomagnetic storms and magnitude of associated jump in interplanetary magnetic field, 0.45 between magnitude of geomagnetic storms and magnitude of associated jump in solar wind plasma temperature,.0.32 between magnitude of geomagnetic storms and magnitude of associated jump in solar wind plasma pressure and 0.46 between magnitude of geomagnetic storms and magnitude of associated jump in solar wind plasma velocity .*

1-Introduction

The geospheric en-vironment is highly affected by the solar active regions associated solar features and interplanetary parameters such as solar flare (SFs), active prominences disappearing filaments (APDFs), coronal holes, magnetic clouds , coronal mass ejections (CMEs), radio bursts, interplanetary shocks and disturbances in solar wind plasma parameters . The active regions and related major classes of solar activity tend to track the sunspot number during the cycle, including, radio burst, calcium plages, solar flares, filaments, and coronal mass ejections (CMEs) (Webb and Howard, 1994). This activity is transmitted to earth through the solar corona and its expansion into the heliosphere as the solar wind. Among all these solar features radio burst, solar flares and coronal mass ejections are most energetic solar events in the heliosphere and are widely recognized as being responsible for production of large disturbances in solar wind, transient interplanetary shocks and geomagnetic disturbances in geomagnetic field of the geomagnetosphere. It is generally believed that long intervals of enhanced southward interplanetary magnetic field (IMF) and the high solar wind speed are the primary causes of intense geomagnetic disturbances in geomagnetic field of geomagnetosphere and that the solar sources of such geoeffective solar wind structures are usually CMEs (Webb et al. 2001).

Several scientists have tried to establish relation between properties of solar active regions, associated solar features, their interplanetary manifestations and their interplanetary and geomagnetic effects. Some of them have reported that the properties of the earth-directed CMEs, such as the internal structure of the magnetic field may determine whether or not a geomagnetic storm subsequently occurs (Burton et al. 1975; Cane et al.2000).This suggests that the magnetic field serves as a link between flares, CMEs, and geomagnetic storms in geomagnetic field of geomagnetosphere. Liu, et al (2006) have analyzed active regions to explore the relationship between magnetic configurations of active regions and geomagnetic storms. Each active region was found to be associated with multiple full-halo coronal mass ejections (CMEs). This study demonstrates that although full-halo CMEs may originate from the same active region but it is not necessary for them to have similar geoeffectiveness, depending on the magnetic configurations actually involved in the corresponding flare activities. This implies that the flares, CMEs, and geomagnetic storms are closely related magnetically as already suggested by many others scientists (Webb et al. 2000; Zhao & Webb 2003).The main cause of intense geomagnetic storms is believed to be the large IMF structure which has an intense and long duration southward magnetic field component, Bz (Tsurutani,et al 1988 , Echer,et al 2004). They interact with the earth's magnetic field and facilitate the transport of energy into the earth's atmosphere through the reconnection process. Earth-directed CMEs are likely to impact the magnetosphere to cause geomagnetic storms in geomagnetosphere (N Gopalswamy, 2006, Manoharan 2006). The intensity of geomagnetic storms is primarily decided by the speed of CME and strength of magnetic field it contains (Cane, et al 2000) whereas according to Manoharan(2006), primary factors determining the geoeffectiveness are the direction of propagation of CMEs, its speed, size, density, orientation and strength of the magnetic field at the near earth space. Intense geomagnetic storms are found to be mainly caused by CMEs (Zhang, et al 2003, Gopalswamy 2002, Cid, et al 2004, Gopalswamy, 2007). From the numerous studies it has been found that CMEs are associated with a number of phenomena like radio bursts, prominence eruptions (PEs), solar energetic particles (SEPs) etc. Several scientist have investigated relation between solar features and interplanetary parameters Leamon et al. (2004), Bothmer and Schwenn(1994), Marubashi (1997), Zhao and Hoeksema(1998), Crooker (2000), McAllister and Martin (2000), Yurchyshyn et al. (2001), Luhmann et al. (2002) and Zhao and Webb (2003) and suggested that there is a straightforward relationship between the solar features and interplanetary parameters and it is inferred that geomagnetosphere is highly effected by solar active regions associated solar features and interplanetary parameters.

2-Experimental Data

In this investigation hourly Dst indices of geomagnetic field have been used over the period 2002 through 2006 to de-

Volume : 3 | Issue : 5 | May 2013 | ISSN - 2249-555X

termine onset time, maximum depression time, magnitude of geomagnetic storms. This data has been taken from the NSSDC omni web data system which been created in late 1994 for enhanced access to the near earth solar wind, magnetic field and plasma data of omni data set, which consists of one hour resolution near earth, solar wind magnetic field and plasma data, energetic proton fluxes and geomagnetic and solar activity indices. The data of coronal mass ejections (CMEs) have been taken from SOHO – largeangle spectrometric, coronagraph (SOHO / LASCO) and extreme ultraviolet imaging telescope (SOHO/EIT) data. To determine disturbances in interplanetary magnetic, hourly data of average interplanetary magnetic field has been used, these data has also been taken from omni webdata(http;//omniweb.gsfc.nasa.gov/form/dxi.html)). The data of X ray solar flares radio bursts, and other solar data, solar geophysical data report U.S. Department of commerce, NOAA

Monthly issue and solar STP data (http://www.ngdc.noaa.gov/stp/solar/solardatase rvices.html.) have been used. . Interplanetary shocks data are taken from the list of the shocks derived by PM group

Table –1-Geomagnetic storms, Associated Solar Features and Interplanetary Parameters During The Period of 2002-2006

Geomagnetic Storms Dst≤-80nT				IMF	Temperature	Velocity	Pressure	CMEs		Shocks	Solar flare
S. No.	Date	Onset time in dd(hh)	Magnitude in nT	Magnitude in nT	Magnitude in degree kelvin	Magnitude in km/s	Magnitude in npa	Speed in km/s	Type	Time in hours (hhss)	Class
1	01-02-02	01(23)	-91	3.8	102363	104	4.55	1136	H	na	M-36
2	23-03-02	23(14)	-107	9.8	82810	114	4.58	1750	H	1137	M-16
3	17-04-02	17(11)	-149	25.1	19374	286	1.23	720	H	1107	M-37
4	11-05-02	11(13)	-103	7.3	230600	181	2.85	614	H	1014	B-98
5	18-05-02	18(21)	-84	16.1	222176	150	0.77	600	H	2008	M-10
6	23-05-02	23(11)	-172	33.4	1201690	473	1.97	853	P	1050	X-21
7	01-08-02	01(10)	-98	9.9	110074	157	7.05	360	P	105	M-48
8	12-08-02	12(18)	-100	2.1	128931	39	0.05	401	H	na	C-20
9	04-09-02	04(01)	-179	4.1	234281	121	2.5	na	na	na	C-67
10	30-09-02	30(01)	-179	18.3	98361	80	1.91	178	P	815	M-18
11	20-04-03	20(20)	-85	7.6	207502	93	4.85	na	na	na	M-11
12	09-05-03	09(08)	-88	7	62590	145	7.51	na	na	na	C-57
13	21-05-03	21(14)	-148	8.2	272887	184	3.53	na	na	na	B-98
14	16-06-03	16(05)	-152	8	208048	86	3.35	875	P	na	X-13
15	10-07-03	10(17)	-128	9.3	50406	56	6.06	na	na	na	M-20
16	17-08-03	17(14)	-175	17	216610	105	7.48	378	H	1421	C-77
17	15-09-03	15(20)	-102	16.4	166127	108	9.23	na	na	na	C-22
18	13-10-03	13(19)	-86	13.8	243085	219	7.23	na	na	na	B-44
19	28-10-03	28(05)	-382	10.9	1042274	373	6	1322	P	206	X-12
20	04-11-03	04(06)	-83	13.6	860792	266	15.06	2598	H	625	X-83
21	20-11-03	20(02)	-417	53.3	455915	262	15.68	1660	H	803	M-42
22	11-02-04	11(09)	-109	17.9	423873	300	6.74	na	na	na	C-96
23	09-03-04	09(11)	-92	10.8	536116	448	7.46	395	P	na	M-13
24	03-04-04	03(14)	-113	11.1	71817	143	9.78	na	na	1410	C-74
25	16-07-04	16(22)	-84	2.5	288238	176	0.4	409	P	2155	X-18
26	22-07-04	22(18)	-115	14.2	167781	312	5.56	710	H	1036	M-86
27	24-07-04	24(10)	-201	16.3	447032	110	12.69	899	P	613	M-91
28	30-08-04	30(05)	-116	12.7	72912	63	6.13	na	na	1005	B-18
29	07-11-04	07(19)	-415	45	694860	418	33.19	653	H	1827	M-54
30	07-01-05	07(12)	-94	18.3	101870	84	24.57	735	H	922	B-85
31	16-01-05	16(20)	-117	31.9	1059288	286	51.9	2049	H	748	M-18
32	16-02-05	16(11)	-87	2.2	147620	75	1.67	584	P	na	X-26
33	11-04-05	11(16)	-89	13.1	273505	202	7.36	514	P	na	B-82
34	07-05-05	07(19)	-275	10.7	793666	472	13.21	1180	H	1916	M-13

Volume : 3 | Issue : 5 | May 2013 | ISSN - 2249-555X

35	28-05-05	28(11)	-155	17	195777	185	10.28	586	H	436	M-11
36	12-06-05	12(16)	-110	18.6	218359	199	2.38	na	na	745	B-87
37	22-06-05	22(23)	-92	17.5	231268	153	17.02	na	na	na	C-21
38	09-07-05	09(04)	-85	10.3	47361	58	8.08	683	H	na	C-59
39	10-07-05	10(11)	-100	2.2	271207	148	5.95	1540	H	337	M-49
40	17-07-05	17(05)	-82	10.6	90599	99	3.68	2115	H	134	X-12
41	24-08-05	24(06)	-248	48.7	2640465	309	30.14	2378	H	613	M-56
42	31-08-05	31(11)	-155	9.8	167775	155	10.35	1600	H	1908	M-16
43	31-10-05	31(04)	-84	10.9	94715	61	2.57	na	na	na	NA
44	04-04-06	04(07)	-106	7.2	13486	65	4.53	na	na	na	B-67
45	14-04-06	14(00)	-111	15.8	350243	165	6.97	183	P	na	C-23
46	07-08-06	07(01)	-82	15.5	405487	294	12.18	na	na	35	B-18
47	19-08-06	19(10)	-82	16.2	148850	132	12.54	563	H	1131	C-36
48	09-11-06	09(16)	-87	17.3	391291	326	7.72	1994	H	1650	C-88
49	14-12-06	14(12)	-155	14.3	194741	333	12.81	1774	H	1414	X-34

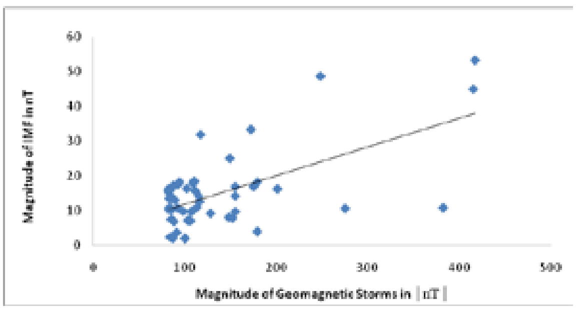

Fig-1-Scatter plot between magnitudes of geomagnetic storms and magnitudes of jump in interplanetary magnetic fields during the period of 2002-2006

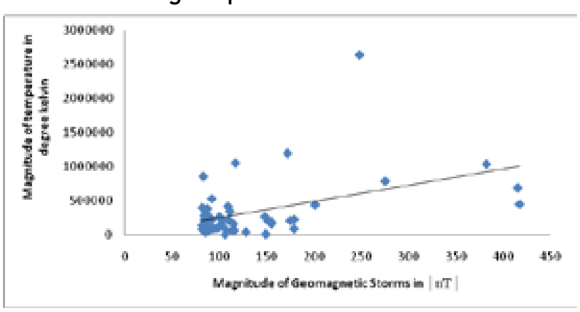

Fig-2-Scatter plot between magnitudes of geomagnetic storms and magnitude of jump in solar wind plasma temperature during the period of 2002-2006

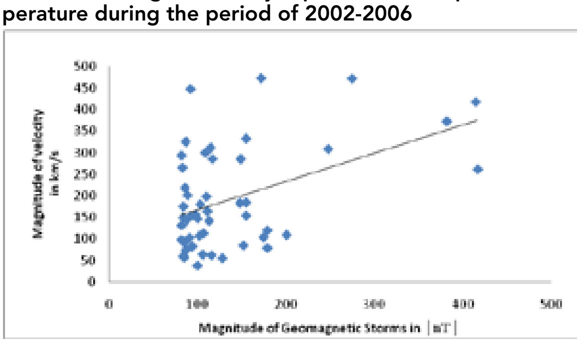

Fig-3-Scatter plot between magnitudes of geomagnetic storms and magnitudes of jump in solar wind plasma velocity during the period of 2002-2006

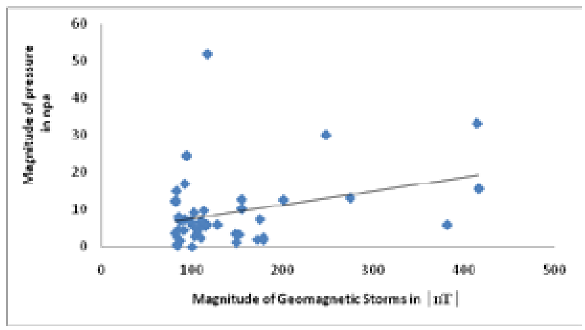

Fig-4-Scatter plot between magnitudes of geomagnetic storms and magnitudes of jump in solar wind plasma pressure during the period of 2002-2006

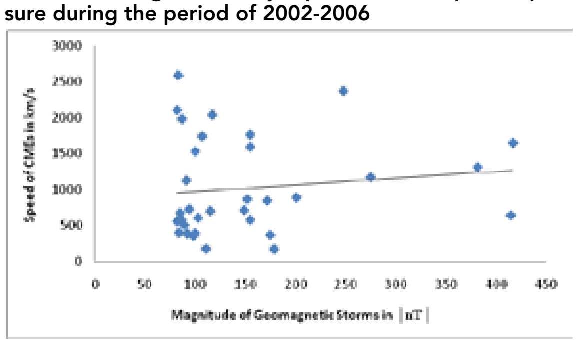

Fig-5-Scatter plot between magnitudes of geomagnetic storms and speed of associated CMEs during the period of 2002-2006

3-Results

The association between geomagnetic storms (Dst < –80nT) and coronal mass ejections (CMEs), interplanetary shocks and disturbances in solar wind plasma parameters for the period 2002-2006 are given in Table No.1. From the data analysis, it is observed that 34 out of 49(69.39%) geomagnetic storms are found to be associated with halo and partial halo coronal mass ejections. The association rate of halo and partial halo coronal mass ejections have been found 67.65% and 32.35% respectively. We have found positive correlation with correlation between magnitude of geomagnetic storms and speed of associated CMEs [Fig-5].We have also determined 48 out of 49 geomagnetic storms, are related to the X-ray solar flares of different categories.08(16.67%),X-class, 19(39.58%),M class, 12(25.00%)C-class and 09 (18.75%) B-class . From the study of geomagnetic storms with solar wind plasma parameters i.e. Jump in solar wind temperature (JSWT) jump in solar wind pressure (JSWP) ,jump in interplanetary magnetic field (JIMF) and jump in solar wind velocity (JSWV) , we have determined positive co-relation between magnitude of geomagnetic storms and magnitude of associated storm in solar wind plasma parameters with correlation co-efficient 0.45 between magnitude of geomagnetic storms and magnitude of associated jump in solar wind plasma temperature [Fig-2] , 0.61 between magnitude of geomagnetic storms and magnitude of associated jump in interplanetary magnetic field[Fig-1], 0.32 between magnitude of geomagnetic storms and magnitude of associated jump in solar wind plasma pressure [Fig-4]. 0.46 between magnitude of geomagnetic storms and magnitude of associated jump in solar wind plasma velocity [Fig-3].

4-Cconclusion

From our study 34 out of 49 geomagnetic storms < -80nT have been identified as being associated with coronal mass ejections ,48 out of 49 have been identified as being associated with solar flares . These results are suggesting that the coronal mass ejections associated with X-ray solar flares are very much effective in producing major geomagnetic storms. The positive correlation between magnitude of geomagnetic storms and magnitude of solar wind temperature, pressure, velocity and interplanetary magnetic fields suggest that disturbances in solar wind parameters play crucial role in producing geomagnetic storms.

REFERENCE Burton, R. K., McPherron, R. L., & Russell, C. T., J. Geophys. Res., 80, 4204, 1975 | Bothmer, V., & Schwenn, R., Space Sci. Rev., 70, 215, 1994. | Cane, H. V., Richardson, I. G., & St. Cyr, O. C., Geophys. Res. Lett., 27, 3591, 2000. | Crooker, N. U., J. Atmos. Sol.-Terr. Phys., 62, 1071, 2000. | C Cid, M A Hidalgo, E Saiz, Y Cerrato and J Sequeiros, Solar Phys. 223, 231, 2004. | Echer, E, M V Alves and W D Gonzalez, Solar Phys. 221, 361, 2004 | Gopalswamy, N, J. Astrophys. Astronomy 27, 243, 2006. | Gopalswamy, N S Yashiro and S Akiyama, J. Geophys. Res. 112, A06112, 2007. | Liu, Y. D. F. Webb, and X. P. Zhao The Astrophysical Journal, 646:1335Y1348, 2006. | Luhmann ,J.G.Y.Li C.N.,Arge,X.P.Zhao 200th AAS Meeting ,BAAS,34,06,731, 2002. | Manohar,an, P K, Solar Phys. 235, 345 2006. | Marubashi, K., N. Crooker, J. A. Joselyn, & J. Feynman (Geophys. Monogr. 99; Washington: AGU), 147, 1997. | Mc Allister,H,and S.F.Martin Adv. Space Res,26,469, 2000.a | Tsurutani, B T, W D Gonzalez, F Tang, S I Akasofu and E J Smith, J. Geophys. Res. 93, 8519 1988 | Webb, D.F. & Howard, R.A. J. Geophys. Res. 99, 4201, 1994. | Webb, D. F., Crooker, N. U., Plunkett, S. P., & St. Cyr, O. C., in Geophysics Monograph Ser. 125, Space Weather, ed. Song, P., Siscoe, G., & Singer, H., 123,2001. | Webb, D.F., E.W. Cliver, N.U. Crooker, O.C. St. Cyr & B.J. Thompson J. Geophys. Res.105, 7491, 2000. | Yurchyshyn, V. B., Wang, H., Goode, P. R., & Deng, Y., ApJ, 563, 381,2001. | Zhao, X. P., & Webb, D. F., J. Geophys. Res., 108, 1234, DOI: 10.1029/2002JA009606, 2003 | Zhang, J K P Dere, R A Howard and V Bothmer, The Astrophys. J. 582, 520 2003. | Zhao, X.P.and J.THoeksema J.Geophys.Res, 103, 2077. 1998. |