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CMEs And Solar Radio Burst With Shock Related Geomagnetic Storms

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Abstract
In this investigation we have studied coronal mass ejections (CMEs) and radio burst of shock related geomagnetic storms (GMS) for the time period 1997-2012. For this period we have found 54 shock related geomagnetic storms out of which 48 are associated with coronal mass ejections of different categories. Majority of shock related geomagnetic storms are related to halo coronal mass ejections. Further we have found the weak positive correlation with correlation coefficient 0.26 between the magnitude of geomagnetic storms and speed of associated coronal mass ejections (CMEs). Furthermore we have found out of 54 shock related geomagnetic storms, 28 are found to be associated with radio burst of different categories. Out of 28 shock related geomagnetic storms 8 geomagnetic storms are found to be associated type II radio bursts, 5 geomagnetic storms are found to be associated with type IV radio bursts, and 15 geomagnetic storms are found to be associated with type II and type IV radio bursts.
Keywords: - *Coronal mass ejections, radio burst, geomagnetic storms.*

1- INTRODUCTION

The Sun is the source of severe space weather. Large, violent eruptions of plasma and magnetic fields from the Sun‘s corona, known as coronal mass ejections (CMEs), are the origin of geomagnetic storms (National Academy of Sciences [NAS], 2008). Coronal mass ejections (CMEs) are associated with a whole host of radio bursts caused by nonthermal electrons accelerated during the eruption process. In ground-based observations radio region plays a significant role due to a wide range of coverage with different type of bursts. Solar radio bursts are considered to be a significant characteristic of solar activity because they are generally attributed to a sudden acceleration of particles from the SunThree types of radio bursts are prominent at low frequencies: type III, type II, and type IV bursts, all due to nonthermal electrons accelerated during solar eruptions. The radio emission is thought to be produced by the plasma emission mechanism [Ginzburg and Zheleznyakov, 1958]. Type II bursts were first identified by Payne-Scott et al. [1947], who recognized the importance of mass motion for these bursts. Wild and McCready [1950] classified them as type II bursts to distinguish from the fast-drifting type III bursts. Uchida [1960] suggested that the type II bursts are produced by MHD shocks in the corona. The origin of shocks responsible for type II bursts has been controversial: flare blast waves or CME-driven shocks [Gopalswamy, 2006].

2- DATA SOURCES

The data of CMEs was collected from SOHO – large angle spectrometric, coronagraph (SOHO/LASCO) and extreme ultraviolet imaging telescope (SOHO/EIT) data. The data of radio bursts and other solar data which include, solar geophysical data report from the U.S. Department of commerce, NOAA monthly issue and solar STP data (http:

//www.ngdc.noaa.gov/stp/solar/solardatase rvices.html.) were used.

Table- CMEs and solar radio burst with geomagnetic storms.

	Geomagnetic Storms Dst≤-90nT				Coronal mass Ejections				Radio Bursts	
S. No.	Date	Day	Hour	Magnitude	Date	Time	Type	Speed	Date	Type
1	10.01.1997	10	2	-101	06.01.1997	15:10:42	Halo	136	na	na
2	10.04.1997	100	19	-102	07.04.1997	14:27:44	Halo	878	07.04.97	II,IV
3	15.05.1997	135	5	-115	12.05.1997	5:30:05	Halo	464	12.05.97	II,IV
4	03.09.1997	246	15	-108	30.08.1997	1:30:35	Halo	371	na	na
5	30.12.1997	364	2	-95	26.12.1997	2:31:54	Partial	197	na	na
6	17.02.1998	48	11	-114	na	na	na	NA	na	na
7	02.05.1998	122	9	-203	29.04.1998	16:58:54	Halo	1374	29.04.98	II,IV
8	07.11.1998	311	11	-139	04.11.1998	7:54:06	Halo	523	05.11.98	II,IV
9	28.02.1999	59	17	-94	na	na	na	na	24.02.99	II
10	16.04.1999	106	15	-156	na	na	na	na	na	na
11	12.09.1999	255	7	-103	10.09.1999	7:54:05	Partial	1467	08.09.99	II,IV
12	22.09.1999	265	19	-191	20.09.1999	6:06:05	Halo	604	na	na
13	21.10.1999	294	23	-257	19.10.1999	5:50:05	Partial	753	17.10.99	II
14	22.01.2000	22	14	-98	18.01.2000	17:54:05	Halo	739	18.02.00	II,IV
15	15.07.2000	197	15	-308	14.07.2000	10:54:07	Halo	1674	12.07.00	II,IV
16	15.09.2000	259	19	-221	12.09.2000	17:30:05	Halo	1053	12.09.00	II
17	13.10.2000	287	14	-100	11.10.2000	6:50:05	Partial	799	09.10.00	II,IV
18	28.10.2000	302	20	-142	25.10.2000	8:26:05	Halo	770	na	na
19	04.11.2000	309	3	-194	01.11.2000	16:26:08	Halo	801	na	na
20	10.11.2000	315	7	-102	08.11.2000	4:50:23	Halo	474	08.11.00	IV
21	27.03.2001	86	19	-123	25.03.2001	17:06:05	Halo	677	na	na
22	31.03.2001	90	3	-413	29.03.2001	10:26:05	Halo	942	na	na
23	18.04.2001	108	1	-106	15.04.2001	14:06:31	Partial	1199	na	na
24	17.08.2001	229	12	-149	15.08.2001	23:54:05	Halo	1575	na	na
25	25.10.2001	298	10	-162	22.10.2001	15:06:05	Halo	1336	na	na
26	05.11.2001	309	18	-314	04.11.2001	16:35:06	Halo	1810	na	na
27	24.11.2001	328	6	-223	22.11.2001	23:30:05	Halo	1437	na	na
28	29.12.2001	363	22	-91	28.12.2001	20:30:05	Halo	2216	na	na
29	23.03.2002	82	14	-107	22.03.2002	11:06:05	Halo	1750	20.03.02	II
30	17.04.2002	107	11	-149	15.04.2002	3:50:05	Halo	720	15.04.02	II,IV
31	11.05.2002	131	13	-103	08.05.2002	13:50:05	Halo	614	07.05.02	IV
32	23.05.2002	143	11	-172	21.05.2002	21:50:05	Partial	853	21.05.02	II
33	8/1/2002	213	10	-98	######	23:30:05	Partial	360	29.07.02	II,IV
34	30.09.2002	273	1	-179	26.09.2002	1:31:44	Partial	178	27.09.02	II
35	17.08.2003	229	14	-175	14.08.2003	20:06:05	Halo	378	na	na
36	20.11.2003	324	2	-417	18.11.2003	8:50:05	Halo	1660	18.11.03	II,IV
37	03.04.2004	94	14	-113	na	na	na	na	na	na
38	22.07.2004	204	18	-115	20.07.2004	13:31:52	Halo	710	20.07.04	II,IV
39	30.08.2004	243	5	-116	na	na	na	na	na	na
40	07.11.2004	312	19	-415	04.11.2004	9:54:05	Halo	653	04.11.04	II,IV
41	28.05.2005	148	11	-155	26.05.2005	15:06:05	Halo	586	26.05.05	IV
42	12.06.2005	163	16	-110	na	na	na	na	na	na

43	10.07.2005	191	11	-100	09.07.2005	22:30:05	Halo	1540	07.07.05	IV
44	24.08.2005	236	6	-248	22.08.2005	17:30:05	Halo	2378	22.08.05	II,IV
45	14.04.2006	104	0	-111	10.04.2006	6:06:04	Partial	183	na	na
46	14.12.2006	348	14	-155	13.12.2006	2:54:04	Halo	1774	13.12.06	IV
47	05.08.2011	217	19	-142	04.08.2011	4:12:05	Halo	1315	na	na
48	09.09.2011	252	13	-109	07.09.2011	18:48:05	Partial	924	na	na
49	17.09.2011	260	7	-94	15.09.2011	0:00:06	Partial	530	na	na
50	26.09.2011	269	13	-136	24.09.2011	12:48:07	Halo	1915	na	na
51	24.10.2011	297	21	-157	22.10.2011	10:24:05	Halo	1005	na	na
52	07.03.2012	67	0	-140	05.03.2012	4:00:05	Halo	1531	05.03.12	II
53	23.04.2012	114	15	-119	19.04.2012	15:12:09	Partial	540	19.04.12	II
54	17.06.2012	169	0	-151	14.06.2012	14:12:07	Halo	987	14.06.12	II,IV

3- RESULTS AND DISCUSSION

In this study we use statistical method association and correlation for data analysis of the observed shock related geomagnetic storms with CMEs and solar radio bursts. We have identified 54 shock related geomagnetic storms during the period of 1997-2012, out of which 48 (88.09%) shock related geomagnetic storms have been associated with coronal mass ejections. Out of 48 associated geomagnetic storms 36(75.00%) geomagnetic storms have been found to be associated halo coronal mass ejections and 12(25.00%) with partial halo coronal mass ejections (Figure-1).

To know the statistical behavior of shock related geomagnetic storms and CMEs we have plotted a scatter plot between magnitude of geomagnetic storms and speed of CMEs and the resulting plot is shown in fig-2. The trend line of the plot shows weak positive correlation between magnitude of geomagnetic storms and speed of associated CMEs. Positive co-relation with correlation coefficient 0.26 has been found between magnitude of geomagnetic storms and Speed of associated coronal mass ejections.

Further we have observed that 54 geomagnetic storms have been identified as being associated with shocks and 28 (51.85%) shock related geomagnetic storms have been found to be associated with radio bursts. Out of 28 geomagnetic storms 08(28.57%) geomagnetic storms are found to be associated type II radio bursts. 05 (17.86%) geomagnetic storms are found to be associated with type IV radio bursts, and 15 (53.57 %) geomagnetic storms are found to be associated with type II and type IV radio bursts (figure-3).

From this analysis we have concluded that most of the geomagnetic storms for this duration are well correlated with coronal mass ejections and more than 50% geomagnetic storms which are shock related are associated with radio bursts.

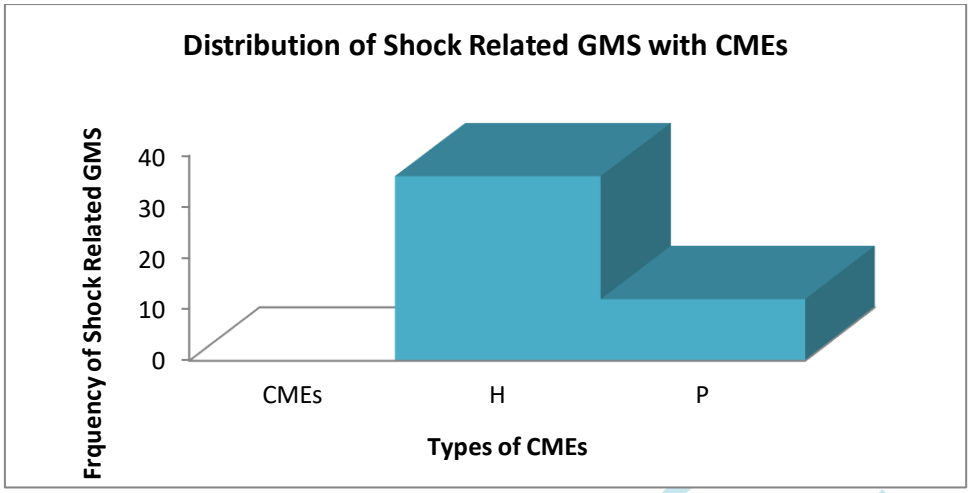

Figure-1 -Distribution of shock related geomagnetic storms with coronal mass ejections

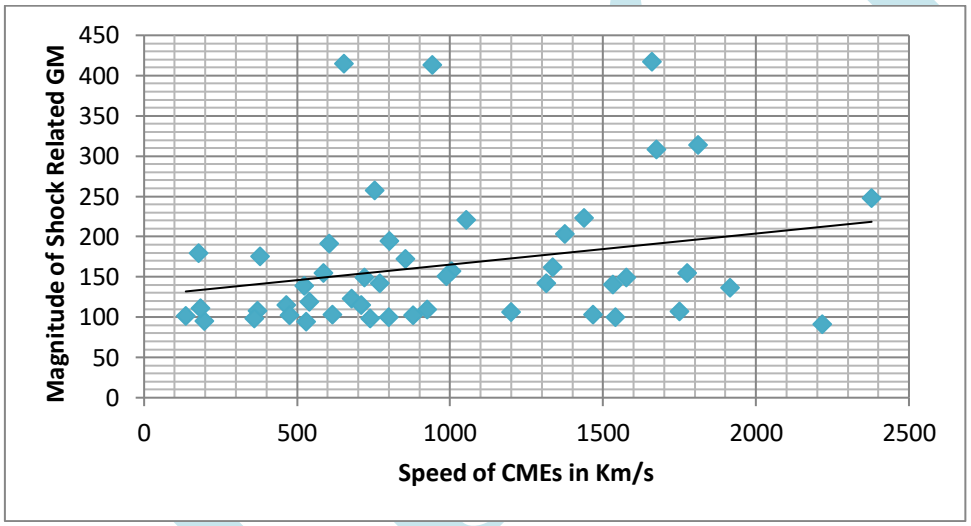

Figure-2- Scatter plot between speed of CMEs and magnitude of shock related geomagnetic storms.

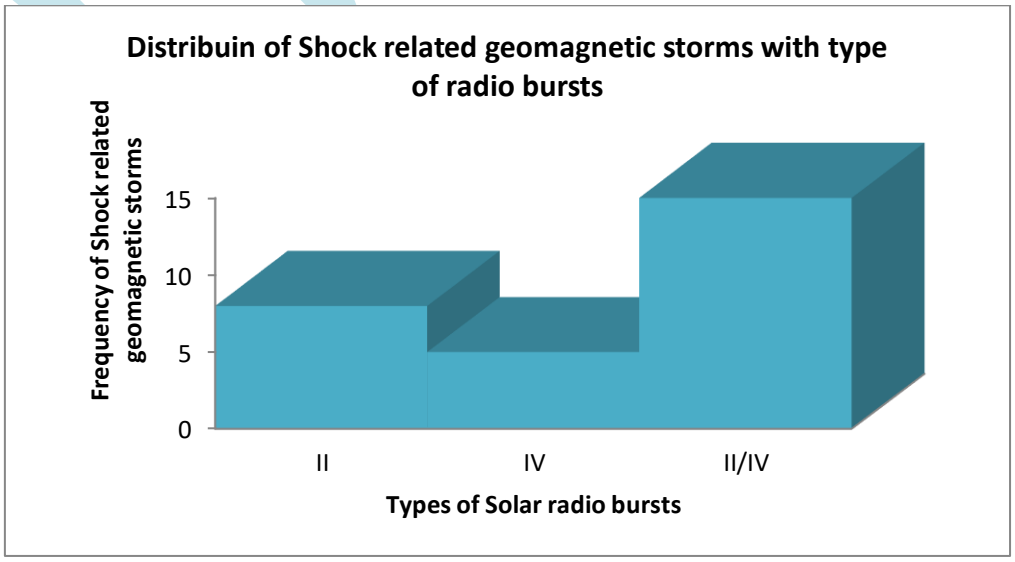

Figure-3 Distribution of shock related geomagnetic storms with solar radio bursts.

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