Influence of the Solar sources and Geomagnetic Disturbances for Intense Geomagnetic storms Occurred between 2003-2008

Abstract

Geomagnetic storms are intervals of time when a sufficiently intense and long-lasting interplanetary convection electric field leads, through a substantial injection of energy into the magnetosphere-ionosphere system, to an intensified ring current, strong enough to exceed some key threshold of the quantifying storm time Dst index. We have studied all the 23 intense geomagnetic storms (peak Dst ≤ -100 nT) observed during the January 2003 to December 2008. Solar activity plays a major role in the average intensity of geomagnetic storms. Some results were found as follows, (1) The intensity of a geomagnetic storm in a solar active period is significantly stronger than in a solar quiet period. (2)The magnitude of negative Bzmin is larger in a solar active period than in a quiet period. (3) Solar wind speed in an active period is faster than in a quiet period. (4) V Bmax in an active period is much larger than in a quiet period. (5) Solar wind parameters, Bzmin, Vmax and V Bmax are well correlated with geomagnetic storm intensity.

Keyword: Solar Sources,Geomagnetic, Dicturbance

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Introduction

On one hand we have the solar wind plasma constantly flowing out of the Sun throughout interplanetary space at typical speeds of the order of 400-500 km/s, carrying the Sun's magnetic field frozen into it, given its high conductivity . Superposed on this ambient plasma there are transient injections of material, often faster than the solar wind, and also carrying strong magnetic field, the so called coronal mass ejections [1]. To complete the set of structures present in the interplanetary medium, we can find the high speed solar wind streams, which have lower density than the solar wind, and travel with speeds of the order of 800 km/s, coming from the coronal holes [2]. On the other hand, we have the Earth's magnetic field, shielding Earth from the variety of interplanetary structures mentioned above, forming the cavity known as magnetosphere. If the solar wind magnetic field is such that its direction points anti-parallel to the Earth's magnetic field, energy can be injected into the magnetosphere, increasing the equatorial ring current, causing a geomagnetic storm. [3] found that a dawn-dusk convection electric field greater than 5 mV/m, which means 10 nT magnetic field and 420 km/s speed, lasting for at least 3 hours, is the minimum interplanetary condition for the occurrence of an intense geomagnetic storm, i.e. storm-time Dst index less than -100 nT.

Results and Discussion

An overview of the 23 storm events with Dst ≤-100nT, that occurred in the interval January first 2003 to December 31st 2008 has been studied . The solar wind plasma field measurement sand Dst data with 1 h time resolution were obtained from the OMNI website as: http://omniweb.gsfc.nasa.gov. Table 1 gives a summary of some representative parameters for the 23 storms events. They are the selected time interval for the study of Dst growth the peak Dst value, and the average value of B, the southward component of magnetic field Bz, of the solar wind speed is 'V'. From the table 1 following results are concluded;

1. For all geomagnetic storms IMF turns southward.
2. For 87% geomagnetic storms Bz < -10 nT.
3. For all 23 geomagnetic storms B >12 nT.
4. Solar wind speed for geomagnetic storms Dst ≤ -100 nT is greater than 450 km/sec.
5. The total number of geomagnetic storms in 2004 and 2005 are more as compare to the other years.

Table 1. Shows intense storm events (2003-2008).

Day	Dst(nT)	Bz(nT)	B(nT)	Speed (km/s)
18/06/2003	-141	-17.2	19.8	626
18/08/2003	-148	-17.4	22.2	522
30/10/2003	-383	-30.9	38.1	1084
20/11/2003	-422	-45.9	55.8	703
22/01/2004	-149	-15	25.4	666
11/02/2004	-109	-11.3	16.5	451
04/04/2004	-112	-9.3	12.4	515
24/07/2004	-101	-15.5	18.9	672
26/07/2004	-148	-21.9	21.5	692
28/07/2004	-197	-17.7	25.3	890
30/08/2004	-126	-14.3	15	444
18/11/2004	-373	-44.6	47.8	730
22/11/2004	-109	-4.7	37.7	667
18/01/2005	-121	-16.8	21.8	957
22/01/2005	-105	-6.9	29.5	950
08/05/2005	-127	-11.9	16	804
15/05/2005	-263	-41.2	54.7	955
30/05/2005	-138	-16	17	469
13/06/2005	-105	-16.9	24.2	503
24/08/2005	-216	-40.9	52.2	720
31/08/2005	-128	-16.9	18.6	493
14/04/2006	-111	-12.2	19.8	540
15/12/2006	-146	-15.6	17.9	894

A geomagnetic storm is a multi-faceted phenomenon that owes its origin to physical processes in which energy transferred from the solar wind to the Earth magnetosphere is redistributed in the magnetosphere-ionosphere coupled system in the form of electric currents. The primary causes of geomagnetic storms are strong dawn-to-dusk electric fields generated by the interplanetary magnetic field (IMF) transition to a southward direction and lasting for sufficiently long intervals of time. In this configuration the IMF is coupled with the Earth's magnetic field and allows solar wind energy transfer into the Earth's magneto-tail / magnetosphere. It was established that (i) IMF B has a minimum at solar minimum (ii) maximum in V occurs during the declining phase and (iii) density and pressure have minima during solar activity maximum [4].

2 . 1 Statistical relation between *Dst* index , IMF and solar wind parameters

In the present work an effort has been made to achieve a better understanding of the geomagnetic indices and their relationships with various plasma and field parameters during different geomagnetic storms. The main conclusions can be summarized as following.

- Peak values of Dst index are well correlated (r = -0.7) with peak values of B, (Figure 1)
- Peak values of Dst index are well correlated (r = 0.8) with peak values Bz, (Figure 2)
- There is good corelation between peak Dst and peak solar wind velocity (r = - 0.6), (Figure 3)
- Peak values of Dst index are well correlated (r = 0.7) with V*Bz, (Figure 4)

Wu and Lundstedt [5] and Wu and Lepping [6] studied the correlations of Dst with the maximum of solar wind speed V and Bz component of IMF and found that Bz component is essential for determining the magnetospheric activity. Our result is in agreement with the results by Kane and Echer [7] in the sense that for intense storms the larger negative Bz gives the stronger negative Dst and the solar wind velocity possibly does not play a significant geo-effective role. Recently Echer et.al.[8] confirmed that peak Dst is correlated to the maximum negative Bz component of the IMF better than the maxima of solar wind number density D and solar wind speed V. Previous results on the correlation between Dst and V were also similar [9].

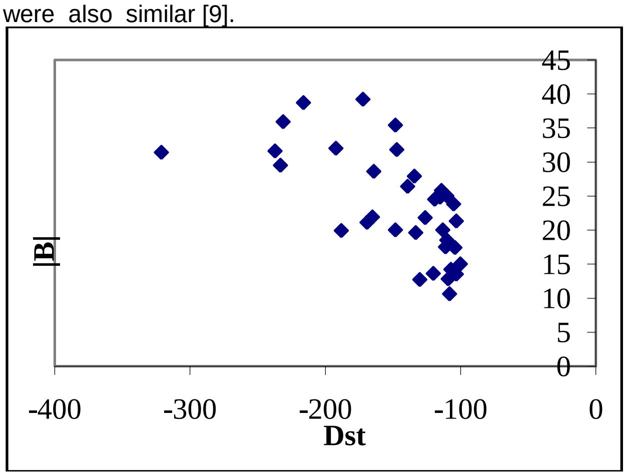

Figure 1. Graph between Dst and | B | r = -0.7

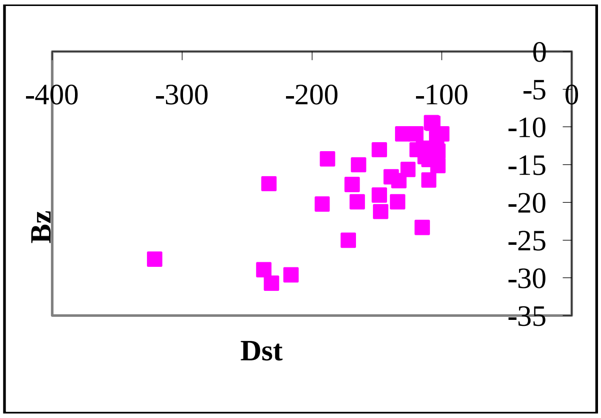

Figure 2. Graph between Dst and Bz . r = 0.8

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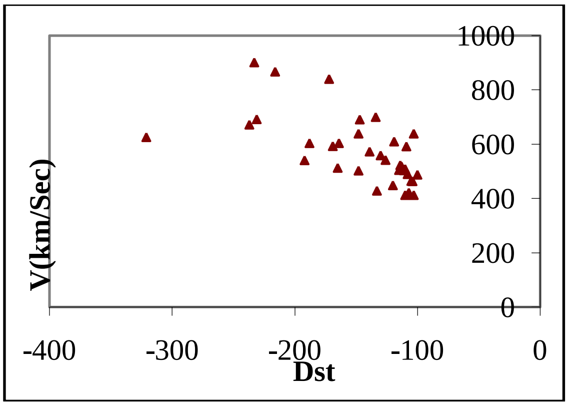

Figure 3. Graph between Dst and V . r = -0.6

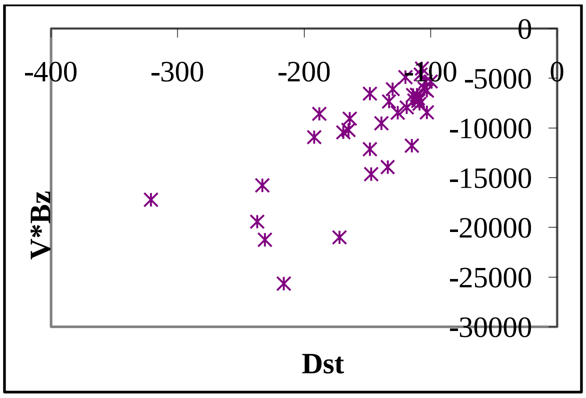

Figure 4. Graph between Dst and V*Bz . r = 0.7

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