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EFFECT OF SOLAR AND INTERPLANETARY DISTURBANCES ON SPACE WEATHER

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ABSTRACT

The environment of interplanetary medium near earth is dominated by the disturbances originating directly from the solar and interplanetary medium, such as solar flares, X-rays flares, coronal holes, CMEs and interplanetary magnetic field. Space-weather is significantly controlled by coronal mass ejections (CMEs), which can affect the earth in different ways. Moreover, the influence of solar phenomenon and associated interplanetary disturbances provide a unique opportunity to understand the correlation between solar, interplanetary and geomagnetic activity. The study of solar, interplanetary and geomagnetic parameters make possible to know the disturbances and impact on space weather interaction in the interplanetary magnetic field. In the present paper, we have analyzed the effect of solar and interplanetary plasma and field in relation to geomagnetic activity. The driving forces which are responsible to create disturbances in the space-weather have been investigated.

KEYWORDS: Space weather, interplanetary medium and coronal mass ejections

The Sun's influence on the Earth can be seen via the interplanetary magnetic field and the solar wind. The magnetic field on the Sun is the root cause of the emission structures and their variation. The plasma from the Sun's corona, called the solar wind rushes out into interplanetary space, which contains an imprint of the Sun's magnetic field. Mainly magnetic field of the Sun are responsible for changes of environment of Earth. A significant advance in space weather monitoring can be achieved if CME's and other solar wind features with a potential impact on the near-earth environment, are tracked with good enough angular and time resolution to determine their characteristics and evolution while they propagate through the interplanetary medium. The capability to track solar disturbances through interplanetary space, to determine the three-dimensional structure of the solar wind in the inner heliosphere has been a crucial component in the development of any reliable space weather forecast system. The speed of a CME"s determines how geoeffective it will be, but not because of speed itself particularly geoeffective (Tsurutani et al., 1992). Speed is the factor in a solar wind electric field, which controls the merging rate at the boundary of the magnetosphere, but its overall contribution to storm strength as an electric field factor is not large. CMEs which are faster than the ambient solar wind are more geoeffective because they compress southward fields in the vicinity of their leading edges. It is now well known that the CMEs are responsible for the most geoeffective solar wind disturbances but an ultimate goal of solar-terrestrial physics is to be able to predict when a CME will arrive at earth and whether or most it will be geoeffective (Web, 1995; Gopalswamy, 2006 and Creooker, 2000).

Big geomagnetic storms are usually caused by large disturbances of strong southward interplanetary magnetic field (IMF) impinging on the earth's magnetosphere. These features are effective in causing geomagnetic disturbances (Tripathi et al., 2006). Coronal mass ejections (CMEs) also trigger aurora and other electromagnetic disturbances which affect space weather. CMEs originating from close to the disk centre significantly perturb Earth's environment and they directly impact on the Earth (Gopalswamy, 2006). Each CMEs generally drain the solar mass in the range of 10^{10} Kg (Webb, 1995). A detail review of interstellar environment dealing with the Heliospheric Magnetic Fields, Energetic Particles, and the Solar Cycle has been discussed in the literature (Creooker, 2000). Coronal mass ejections rising from the solar limbs have been observed directly and routinely with white light

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chronographs since the yearly 1970s, the ability to detect at earth is a recent development. Strong interaction of CMEs with Earth's environment causes serious space weather effect through the coupled magnetosphere-ionosphere system. Geomagnetic storms are a global disturbance of the earth's magnetic field (Akasofu and Chapman,1963). These emissions and their entry into Earth's environment results various changes in space weather.

DATA AND RESULTS

Magnetic cloud is a large interplanetary structure produced due to transient injection in the ambient solar wind. Burlaga et al., (1981) reported the characteristics of magnetic cloud which is peculiar type of interplanetary structure. The decrease in the equatorial magnetic field strength, measured by the Dst index, is directly related to the total kinetic energy of the ring current particles; thus the Dst index is a good measure of the energetic of the magnetic storm. The Dst index itself is influenced by the interplanetary parameters. A superposed epoch analysis shows a decrease in the rate of development of Dst index with substorm occurrence, contrary to the view that substorm contribute to the build-up of the ring current as measured by Dst index (Iyemori and Rao, 1996).

In the present work we have studied 10 IP shocks observed in the year 2006. Here, we have considered hourly averaged data of IP parameters (i.e. Total average interplanetary magnetic field B along with its components Bx, By, Bz components, solar wind velocity (Vsw), solar wind density (Nsw), solar wind dynamic pressure (Pdsw) solar wind temperature (Tsw) and the geomagnetic indices (Dst, Kp and Ap). These data are available from the omini web data center, national geophysical data centre and SOHO LASCO/C2. Through averaging procedure on the 10 shock events, we have tried to establish relationships among various parameters. Such quantitative relationships are invaluable for modeling studies and space weather phenomena. There is a defined relationship between the changes in the interplanetary parameters and geomagnetic indices Dst, Kp and Ap. Solar wind speed and total average magnetic field B (IMF) is clearly related to changes in Kp, Ap and Dst indices (fig.1). We have analyzed geomagnetic storms which is associated with Dst decreases of less than -100nT during the period 11 April to 17 April 2006 and a partial halo CME's on 10/04/2006 at 06:06UT. Position angle of partial halo CME's is 312^0, angular width 251^0, linear speed 183km /s and measurement position angle is 313 degree. Solar wind Speed is 666km/s. The association of geomagnetic storm with different interplanetary parameters is plotted in figure (1). It is evident in figure 1 that on 14 April 2006 at 00:00 UT, Dst is 0 nT but Dst suddenly decreases at 09:00 UT which became -111nT within 09 hours. Solar wind temperature is showing increase alongwith decreases in Dst.

The space craft observations of interplanetary magnetic field strength B provides an opportunity to make correlative study between interplanetary magnetic field B (IMF) and geomagnetic activity. Variability of the solar cycle has been statistically described using a proxy parameter, total interplanetary magnetic field IMF (B) with Dst, Kp and Ap indices respectively. Figure (2) respectively shows the correlation of Dst, Kp and Ap indices with total interplanetary magnetic field IMF (B) measured at 1AU by ACE satellite. From figure (2) it is apparent that total magnetic field (B) has good correlation with Kp, Correlation Coefficient r = (0.59), Ap, r = (0.58) and negative correlation with Dst, (-0.11).

There are few cases in CME's where moderate to severe deceleration process happens before their arrival at 1AU; this may result into no apparent effect on the geomagnetic field and its indices. The statistical results reported here are in good agreement with earlier finding which showed that most of the CME having an initial speed greater than ambient solar wind are decelerated.

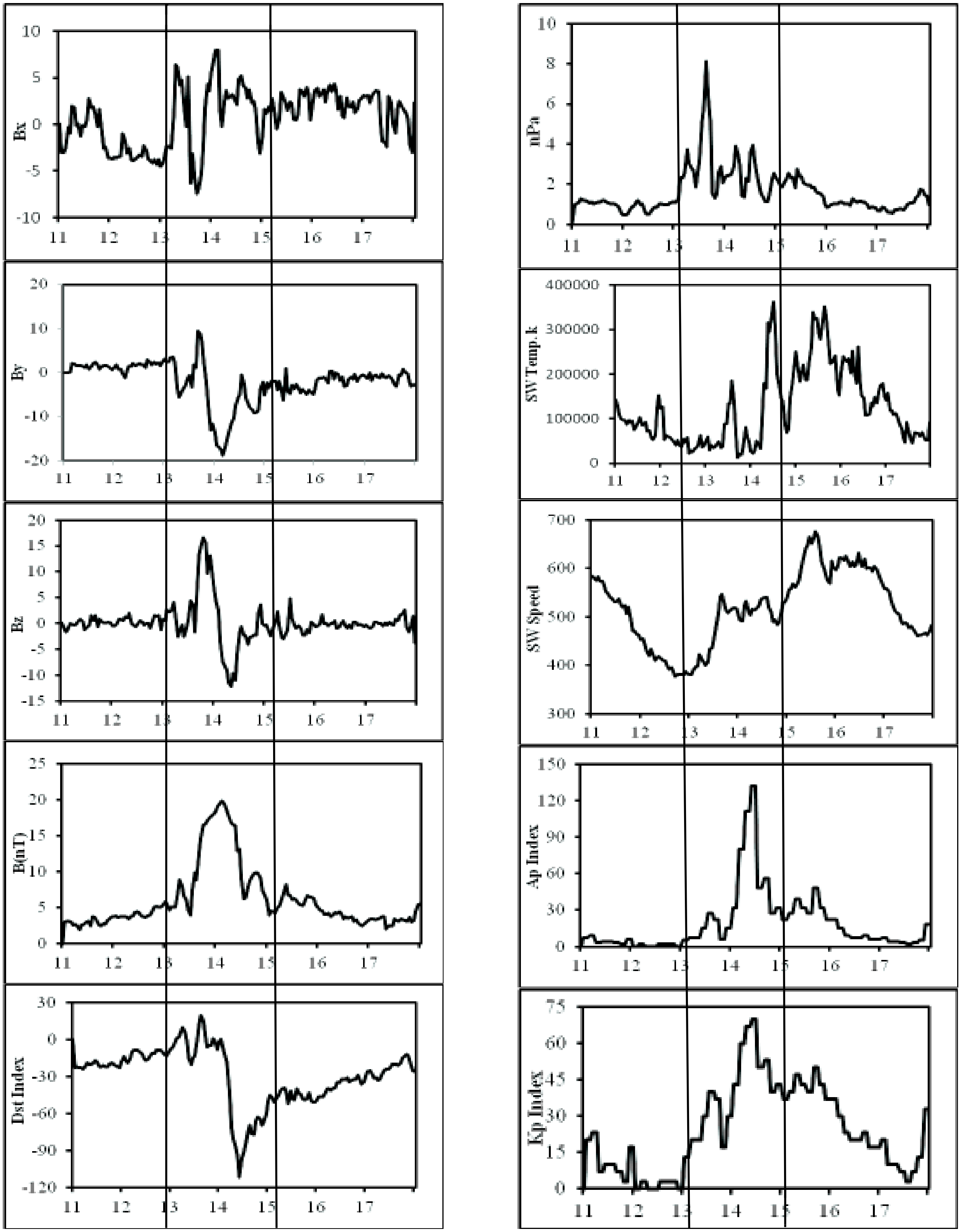

Figure1:Shows the variation of interplanetary parameters and geomagnetic parameters during the period 11-17 Apr'06

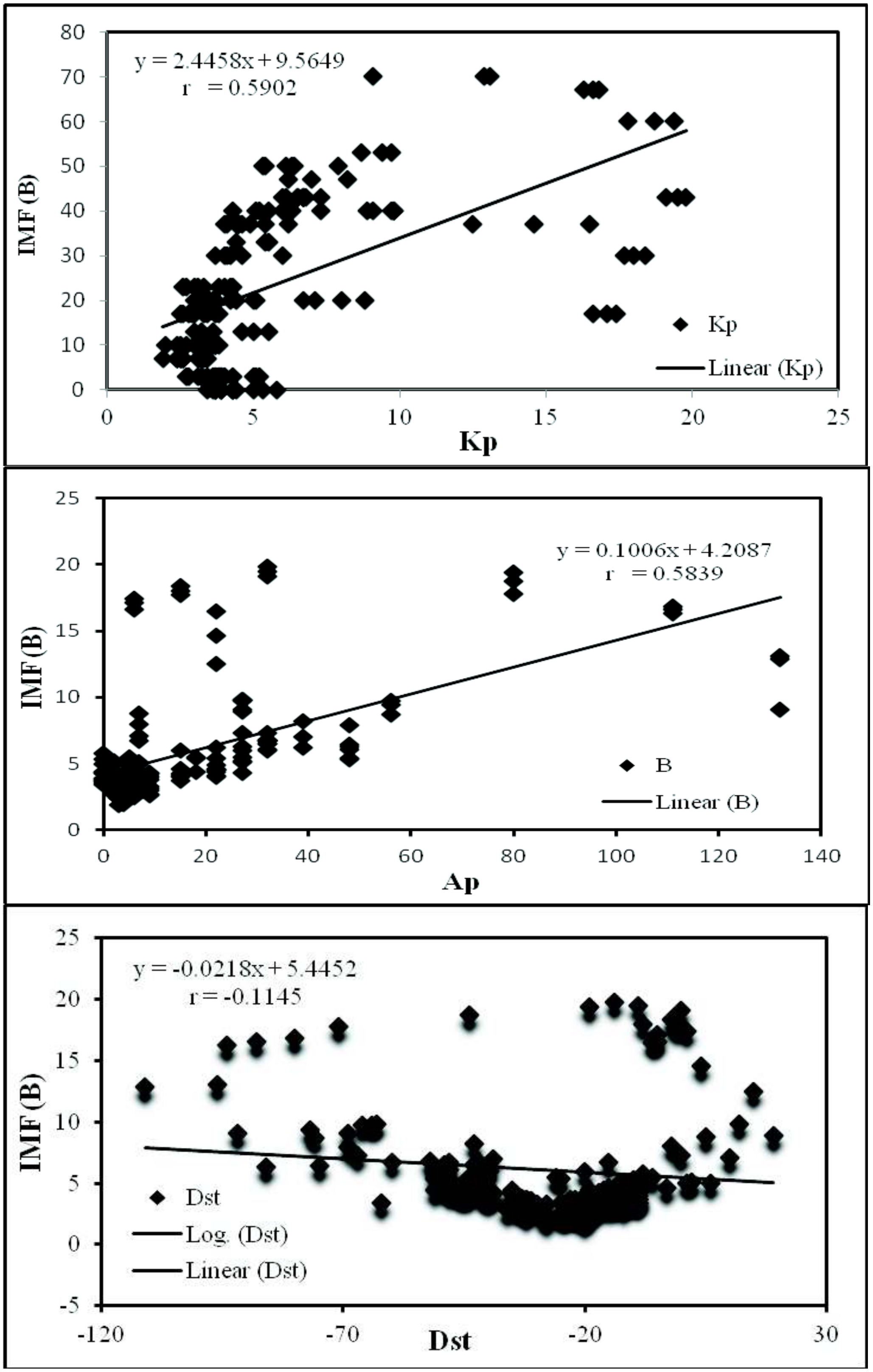

Figure 2: Correlation plots of geomagnetic indices Dst, Kp and Ap with interplanetary total magnetic field, IMF (B)

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