Relationship of Coronal Mass Ejections and high speed solar wind streams with geomagnetic activity

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Abstract

It is well known that the Coronal Mass Ejections and high speed solar wind streams are the causes of perturbation in interplanetary magnetic field. 74 events of high speed solar wind streams are identified during the period of 1998 to 2002, using the space craft data near 1 AU. From this study, high speed solar wind streams are found to be responsible in producing geomagnetic disturbances. It has been demonstrated that high speed solar wind streams in association with major solar flares and CMEs are much more effective in producing geomagnetic disturbances.

Introduction

It is well known that one of the most dynamical features in interplanetary medium is high speed solar wind stream. Solar terrestrial relationship is definitely on the propagation of solar wind stream into interplanetary space. Earlier, a number of research works have studied the various characteristics of solar wind streams near earth, using the space craft data (Gosling et al 1976; Iucci et al 1979; Chree method of superposed epoch has been adopted to derive the effects of HSSW streams Shukla et al 1979; Mavromichalaki et al, 1988.1998). A new updated reference catalog of high speed solar wind streams for the period of 1996 to 2002 is provided in this work. In earlier events of solar ejecta are named as Coronal Mass Ejections (Krieger et al 1973). Burlaga et al (2001) used the term “ejecta” for the interplanetary flows and CME for Coronal Mass Ejections that can be moving from corona. However, high speed solar wind streams are different from these ejecta. In this work, an attempt has been made to investigate the effects of high speed solar wind streams and CMEs on geomagnetic activity.

Data and Method of analysis.

Generally, period of enhanced solar wind speed lasting of several days (> 2 days) is known as event of high speed solar wind stream. In the present study, a high speed solar wind stream is defined as a period of one having a rapidly rising increase in the solar wind speed over a short period (> 250 km per second, which persist at high values for at least 5 days after the increase. We
have selected 74 solar wind high speed streams satisfying the above conditions, starting from the year 1998 to 2002. Our criteria for stream identification is easier than others, in which taking the maximum value of stream is 550 km per second. Chree method of superposed epoch has been adopted to derive the effects of HSSW streams and ICMEs on geomagnetic field.

**Results and discussion.**

In recent years, it is suggested that geomagnetic disturbances are governed by the various solar features such as solar wind streams (Mavromichalki et al. 1998; Shrivastava and Shukla, 1994), Coronal Mass Ejections (Gosling et al. 1991; Shrivastava and Singh 2002), Coronal transients (Kausik and Shrivastava, 1989). The relationship between solar activity and geomagnetic activity is still a problem for new research in solar terrestrial physics. To observe the influence of major solar flares together with HSSWS, 26 events of HSSWS are sorted out from the listings of solar wind velocity.

![Figure-1](image-url)  
**Figure-1.** Shows the results of chree analysis of Ap index with solar flare associated high speed solar wind streams for the period of 1998 to 2002
Figure–2. The result of three analysis for -5 to +10 day with respect to zero epoch days. The variation of mean Ap values are shown in the figure HSSWS events associated with CME and SF are considered. Zero days correspond to the starting day of HSSWS events.

In this analysis, only those major solar flares events have been considered, which have optical importance \( \geq 1 \) for the entire faint. Normal and bright categories. The results of three analysis for days -5 to 10 days have been plotted in figure 1 for the rime interval of 1998 to 2002. Figure 1 shows the effect of this solar flare associated high speed solar wind streams on geomagnetic activity. Higher increase in geomagnetic activity is clearly seen for the entire interval. For the further analysis, CMEs are also considered in association with solar flares and HSSWS. Figure 2 shows the effects of these solar flares and CME associated high speed solar wind streams on geomagnetic activity for the period of 1998 to 2002. High geomagnetic activity is clearly seen for the entire interval. Results of Figure 2 indicate that solar wind streams produce slight larger geomagnetic disturbances in comparison to that of without CME associated streams.

On the basis of this study of high speed solar wind streams and Ap-index data, it can be explained that the collision between a fast solar wind stream and lower solar wind stream produces an unstable stream interface. This interface consists of two compressional shock waves separated by tangential velocity discontinuity. This velocity is continuity produce irregularities in interplanetary magnetic field resulting an increase in geomagnetic activity. It has been observed that CMEs play an important role in interplanetary disturbances and can be responsible for non recurrent geomagnetic storms (Gosling, 1993).
The geoeffective solar wind structures include long intervals of large southward interplanetary magnetic field (Tsurutani and Gonzalez, 1997). That there is a solar cycle effect thus suggest that almost all full halo CMEs during the rising phase can produce southward magnetic field.

References: