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Effect of Interplanetary Plasma Parameters and CMEs on Geomagnetosphere

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Abstract

In this study, we have taken yearly mean value of total interplanetary magnetic field B, solar wind speed (V), plasma electric field (V.B), geomagnetic index (Kp) and coronal mass ejection (Halo and Partial Halo) events, for the solar cycle 23 to ascending phase of recent solar cycle 24, (Years 1996 - 2013), 588 Halo events and 1021 partial halo events are identified and a correlative study has been performed. It has been found that the positive correlation between total interplanetary magnetic field B, solar wind speed (V), plasma electric field (V.B), geomagnetic index (Kp) with coronal mass ejection (Halo and Partial Halo) events, which clearly indicate a good positive correlation r = 0.807 (Halo event with IMF B), r = 0.81 (Partial Halo event with IMF B), are calculated for the solar cycle 23, which is occurred during 1996 to 2009. We found that the plasma electric field (V.B) is the most effective parameter for producing larger geomagnetic disturbances.

Keywords : Solar Wind Velocity, CMEs, Interplanetary Magnetic Field, Geomagnetic Index.

Introduction

Coronal mass ejections have been recognized as the most energetic phenomenon in the heliosphere driving their energy from the stressed magnetic fields on the Sun. CMEs are associated with erupting prominences throughout the solar activity cycle and may act as a solar activity index. CMEs appear to surround the occulting disc of the observing white light coronagraph in the sky plane projection and expands rapidly are known as halo CMEs which may be backside or front side. These consequences of CMEs in the interplanetary medium have been discussed in detail (Kane 2005).

It is well known that high-speed solar wind streams are associated with coronal mass ejections (CMEs). These CMEs can have magnetic structures that are geoeffective in terms of leading to enhanced geomagnetic activity. The main cause of intense GMSs is believed to be large IMF structures, which have an intense, long duration and south ward magnetic field component Bz (Gonzalez, et. al 1999). They interact with the Earth's magnetic field and facilitate the transport of energy into the Earth's atmosphere through the reconnection process. In order to understand the response of the magnetosphere to IP conditions, interplanetary magnetic field strength (B) and (Bz) are investigated (Feldman, et at., 1978, Bieber, et al., 1993).

The solar – Terrestrial relationship includes the effect of solar output and its variations. It also includes propagation effects in the interplanetary medium, which ultimately produces disturbance in geomagnetic field. As such, the near earth interplanetary plasma and fields are expected to have a direct relationship with geomagnetic disturbance indices. The data have also been examined for their Long Term variability in terms of the eleven – year solar cycle component (Feldman, et at., 1978, Bieber, et al., 1993). Therefore, the characteristic variations of V, B, as well as of product V.B (plasms electricfieled) have been examined in the understand their effect on the geomagnetic filed disturbances on statistical basis over a long period covering four solar activity cycles 20 to23 (Dwivedi, et al, 2010,Singh et al 2013).

In this paper we have obtained CMEs (Halo and P Halo) events and their relation with solar wind velocity V, Kp index and IMF B for the period 1996 to 2013.

Data Analysis

In our analysis the daily value and annual average of Interplanetary magnetic field B, solar wind speed (V), geomagnetic index (Kp), Plasma electric field (V.B) and CMEs (Halo and Partial Halo) events, have been used over the periods 1996 to 2013, covering solar cycles 23 to ascending phase of current solar cycles 24. The daily value of solar and geomagnetic

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disturbance parameters have been taken from solar geophysical data books and data has been taken from the website www.ominwebgsfc.noaa.gov. Similarly, the geomagnetic index (Kp) have been downloaded from www.ngdc.noaa.gov. We have also used coronal mass ejection CMEs, data from solar heliosphericobservatory (SOHO) and large angle and spectrometric coronagraph (LASCO) CMEs catalogue (http://cdaw.gsfc.hass.gov/CME_list). We have used all the halo CMEs data observed by SOHO/LASCO from 1996 to 2013 taken from the SOHO/LASCO halo CMEs and partial halo CMEs catalog.

Results and Conclusions

Using the daily value of interplanetary magnetic field (B), solar wind speed (V), electric magnetic field (V.B), annual mean value of geomagnetic index (Kp), and annual number of CMEs (Halo and Partial halo) events during 1996 to 2013, following results are drawn-

1. We have observed 588 numbers of CMEs (Halo) events and 1021 number of CMEs (Partial halo) events for the study period out of which 63.45% P Halo CMEs and 36.54 is Halo CMEs events have occurred. These CMEs are positively correlated with IMF (B) with correlation coefficient r = 0.587 (B with Halo CMEs) and r = 0.409 (B with P Halo CMEs) as shows in figure 1 to 5.
2. It is found that geomagnetic index Kp is positive correlated with V and B separately.It is also found that geomagnetic index Kp is also highly positive correlated with product of V and B i.e. plasma electric fields (V.B) with correlation coefficient r = 0.973 as shows in figure (6 to 7).
3. CMEs (Halo and P Halo) are strongly positive correlated to interplanetary magnetic field B during 23, recent solar cycle 24 sunspot cycle.

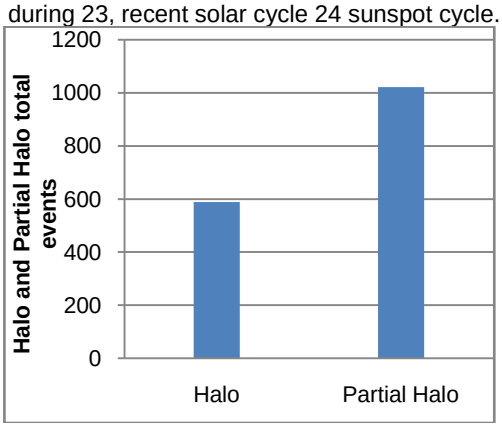

Figure 1:-
Shows the Curve Between Annual Number of Cmes (Halo and Partial Halo) Total Event During Solar Cycle 23 to Ascending Phase of Recent Solar Cycle 24, (1996 to 2013).

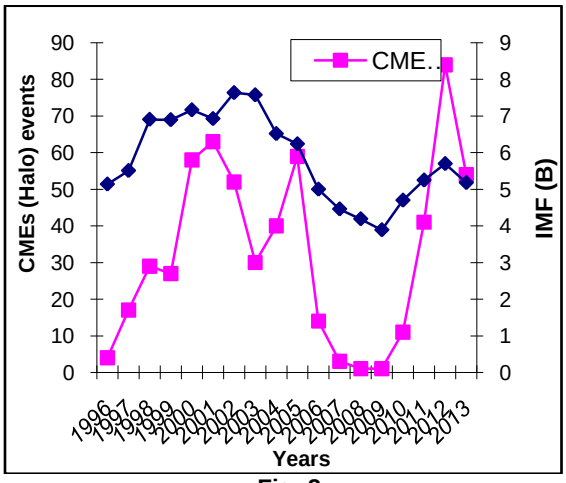

Fig: 2
Shows Linear-Plot Curve Between Yearly Mean Value of Cmes (Halo) Events and Interplanetary Magnetic Field (B) for the Period 1996 to 2013.

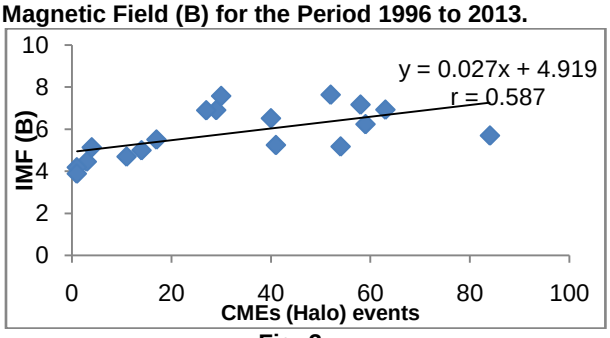

Fig: 3
Shows Correlation Curve Between Yearly Mean Value of Cmes (Halo) Events and Interplanetary Magnetic Field (B) For the Period 1996 To 2013.

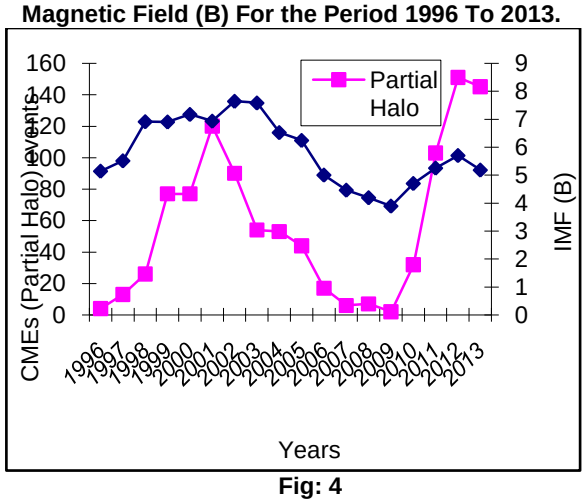

Fig: 4
Shows Linear-Plot Curve Between Yearly Mean Value of Cmes (Partial Halo) Events and Interplanetary Magnetic Field (B) For the Period 1996 To 2013.

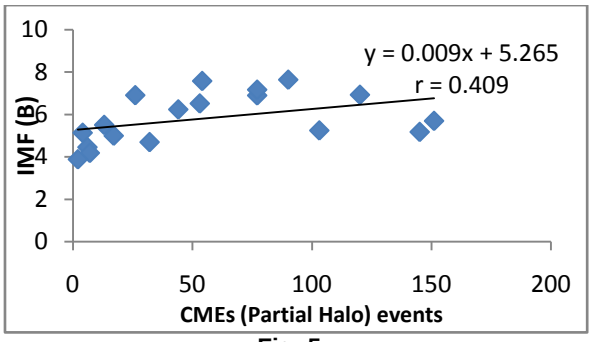

Fig: 5

Shows Correlation Curve Between Yearly Mean Value of Cmes (Partial Halo) Events and Interplanetary Magnetic Field (B) for the Period 1996 To 2013.

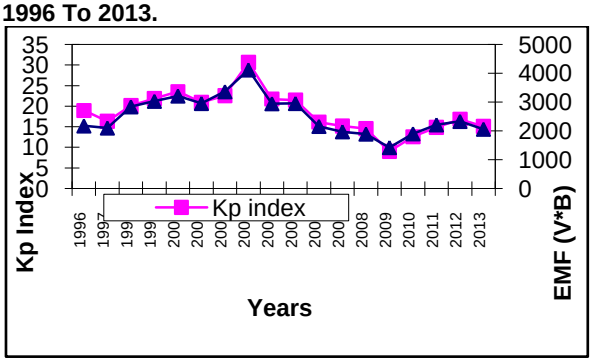

Fig: 6

Shows Linear-Plot Curve Between Yearly Mean Value of Geomagnetic Index (Kp) Electromagnetic Field (V.B) for the Period 1996 To 2013.

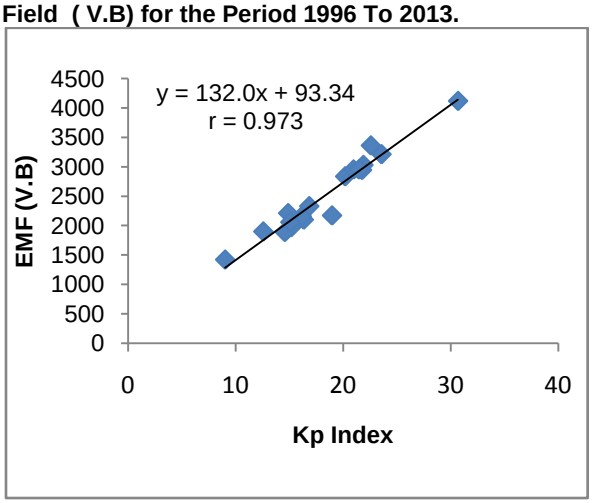

Fig: 7

Shows Correlation Curve Between Yearly Mean Value of Geomagnetic Index (Kp) With Electromagnetic Field (V.B) for the Period 1996 To 2013.

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