Role of ambient solar wind conditions in CME evolution

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Abstract. A large variety of solar events are held responsible for producing geoeffective magnetic storms at the Earth. Besides Coronal Mass Ejection (CME), high speed streams emanating either from coronal hole or flare region are also held responsible for events at the Earth even during the period of positive Interplanetary Magnetic Field (IMF) i.e. during October-November 2004. CMEs and other Solar events occurred during 1998-2004 are studied. The effects produced at the Earth during the same period are considered and an attempt has been made to associate them with solar counterparts. This is to draw some conclusion about how some of the events become geoeffective.

Index Terms. Coronal mass ejection, geoeffective storm, space weather.

1. Introduction

The sun with variety of activities has been a major research topic since centuries. The earth and its terrestrial atmosphere are no doubt greatly affected by solar activities. Recently, study of the Sun - Earth relationship, called Space Weather, has become very important as particle emission from the solar corona called Coronal Mass Ejection (CME) is disturbing and sometime destroying Terrestrial Satellites, producing magnetic storms and also affecting life on ground.

Recent studies (e.g. McAllister et al., 1996; Richardson et al., 2000; Jadav et al., 2005) has identified the role of CME parameters like initial speed, ram pressure in producing magnetic storm at the Earth. Local Solar Wind conditions also play a key role in CME evolution during its passage from the sun to the Earth. We have attempted to correlate CME parameters with the magnetic storm index (Dst) with an aim to identify the role of ambient solar wind conditions in either helping the CME to bang on the magnetosphere or checking it.

2. Results

One of the most important parameter of a CME is its initial speed and a lot of research has been done to correlate it with the effects at the Earth. However, it has been found that many Halo CMEs with speed ranging from 1000 to 2000 km/s do not result in a geomagnetic storm. When the CME driven solar wind interacts with the magnetosphere, ram pressure, which indicates combining effect of solar wind density and speed, is also an important contributor. However what happens to a CME during its journey from the Sun to the Earth has been an enigma. CME evolution, its speed and density profile are not yet properly understood. CMEs with varying initial speed interact with ambient solar wind conditions and that may be quite different for different CMEs. In this paper we have attempted to combine initial CME speed, ram pressure and previous day's (of CME occurrence) averaged solar wind speed representative of ambient solar wind. Fig. 1 is a plot of various solar wind parameters vs. magnetic storm index Dst (nT). Slope value (R) of linear fit to each plot is calculated. For CME initial speed V_{CME} and ram pressure the slope values were -0.101 and -0.163 respectively. It can be seen from the graph that for previous day average solar wind speed the value of slope R = - 0.011 which is comparatively very less. However, if we multiply all three

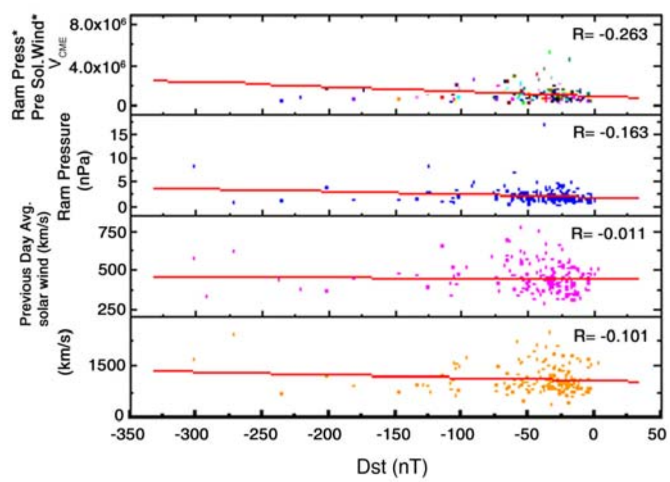

Fig. 1. Plot of various solar wind parameters vs. magnetic storm index Dst (nT). Figs. on top right indicates slope value (R) of linear fit to each plot. From bottom to top on Y-axis: Initial speed of CME, Previous day's average Solar wind, Ram Pressure and multiplication of all three parameters to emphasize the role of ambient solar wind condition in CME evolution.

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parameters (e.g. CME initial speed, previous day averaged solarwind speed and ram pressure) than the linear fit to the plot gives a slope value of R = - 0.263 which is far greater than other slopes.

3. Discussion and conclusion

Ambient solar wind condition plays a major role in CME evolution during its passage from the sun to the magnetosphere of the Earth. However, as per our knowledge not much research has been done to identify the role of ambient solar wind. The present study has revealed that when previous day average solar wind is taken into consideration, the value of slope (R) was doubled and hence the new parameter which is multiplication of initial CME speed, ram pressure and previous day average solar wind becomes better in predicting magnetic storm. It is the most probable thing that high speed Halo CME interacts with previous day's slow solar wind. The CME will not only push the preceding solar wind but will intertwined with it resulting into an interplanetary disturbance with new speed and density profile. Thus, it is fair to include CME's previous day solar wind as a parameter important in CME evolution.

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