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Halo Coronal Mass Ejections and their geoeffectiveness

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Recently a new concept has been developed that CME are the driving agents, which produce large geomagnetic disturbances. A relationship have been examined between the halo CMEs and geomagnetic storms for the period of 1996 to 2003. Results of this analysis indicate that the large geomagnetic storms are generally associated with halo CMEs. It is investigated that the geomagnetic storms occur with days from 2 to 5 days from the onset of CME events.

1. Introduction

Coronal Mass Ejections (CMEs) involve the expulsion of substantial quantities of plasma and magnetic field from large region of corona, although denser and cooler material expected to come from chromosphere. CMEs appear to be bright loop like structure followed by a dark cavity and bright core. The onset of CME can be associated with both solar flares and filament eruption [1]. It is now believed that the sun generates magnetic flux tubes of the base of convection zone and transports them to the surface via the mechanism of buoyancy. A build of magnetic flux in the corona is an avoidable, unless all of the magnetic flux brought to the surface is some how returned below the photosphere. This magnetic flux expands outward in the form of prominences and sometimes it disappears from corona in an explosive manner. By these process sun expels magnetic flux into interplanetary space and 10^{13} kg of solar plasma is suddenly propelled out into interplanetary space. Thus, CMEs eject both Mass and Magnetic flux in interplanetary space. The leading edges of CMEs are close to the sun and compress the ambient interplanetary magnetic field and drop the southward component (Bs) over the ecliptic field component and produce large sudden commencement geomagnetic storms [2]. Several attempts have been made to relate the occurrence of CMEs with geomagnetic activity [3]. In a recent study, CMEs in association with B–type solar flares are investigated as one of the factor in geomagnetic disturbances [4]. It is often assumed that any limb CME would become a halo CME if there source region were located near disk centre, so that a front side halo CME is generally be called an earth– directed CME. In this work, we have examined the association of halo CMEs with geomagnetic storms for the period of 1996 to 2003.

2. Discussion

In this study we have taken CME events recorded by LASCO Coronograph Halo CME events have been taken from CME mail archive website http://lasco6.nascom.nasa.gov/pub/lasco/status/LASCO_CME_List. Coronal Mass Ejections detected in white light observations of the LASCO coronagraphs only those geomagnetic storms have been considered which are associated with Dst decrease of more than 60nT. Geomagnetic storms are recognised as an abrupt change in the general level of geomagnetic field, which may be as large as several percent of the undisturbed value measured at the surface. Solar cycle depends of geomagnetic storms has been proved beyond any doubt [5]. Fig. 1 shows the relationship of occurrence of geomagnetic storms with halo CMEs. Zero line denote the onset of halo CME events and bar diagrams for 0 to 96 hours show the frequency distribution of magnetic storms during the period of 12 hours interval. It is noted that generally geomagnetic storms stated to be occur after the 24 hours of onset of halo CMEs.

Maximum number of storms occur during 48 to 72 hours after the occurrence of halo CME events. Some CMEs are also followed by geomagnetic storms, which indicates the role of some other solar sources in producing the geomagnetic storms. It is believed that large geomagnetic storms are often associated with large interplanetary disturbances. In a further analysis, we described a geomagnetic storms observed during 20.09.99 to 26.09.99. This storm is sudden commencement type having peak magnitude – 100 nT and also associated with a halo CME events. The association of this storm with different interplanetary parameters are plotted in Fig. 2. During the main phase of this storm solar wind speed and IMF magnitude peaking around 600 km/s and 25 nT respectively. From this plot we notice that the initial phase of geomagnetic storm starts when IMP B has low magnitude and IMF Bz is initially northward. Main phase of geomagnetic storm starts after increasing in IMF B magnitude and Solar Wind speed and turning of IMF Bz from northward to southward. Southward IMF Bz provides an opportunity to make strong magnetic reconnection between IMF and earth is magnetic field.

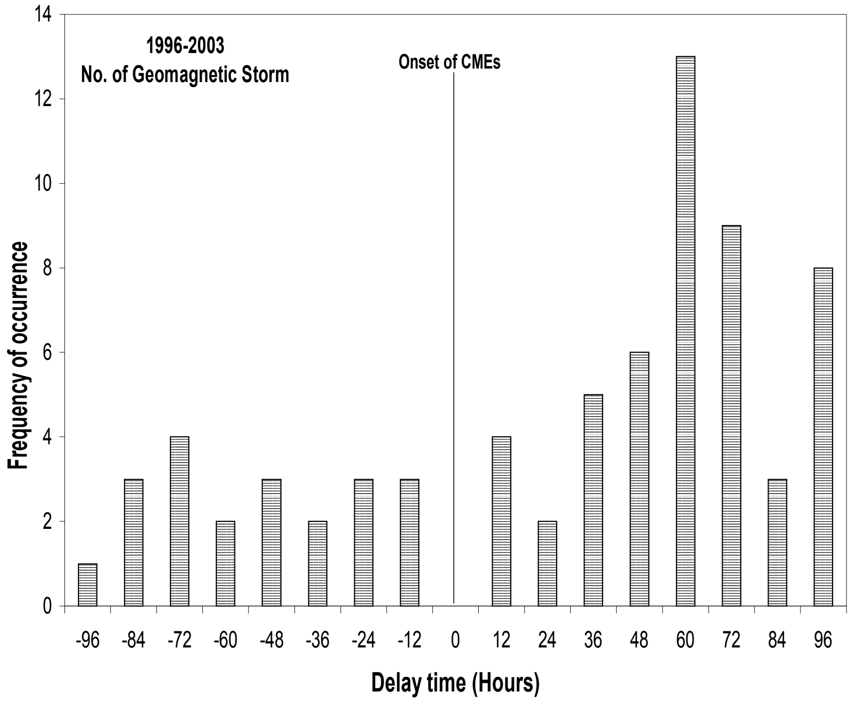

Figure 1. Frequency distribution of geomagnetic storms in association with halo CMEs for the period of 1996 to 2003.

3. Conclusions

Geomagnetic storms occur normally 36 to 72 hours after the onset of halo CME. Whereas majority of geomagnetic storms observed within 60 to 70 hours range. Main phase of geomagnetic storm start with sudden change of interplanetary magnetic field from northward to southward. Solar wind speed, IMF B start increasing during the main phase of storm.

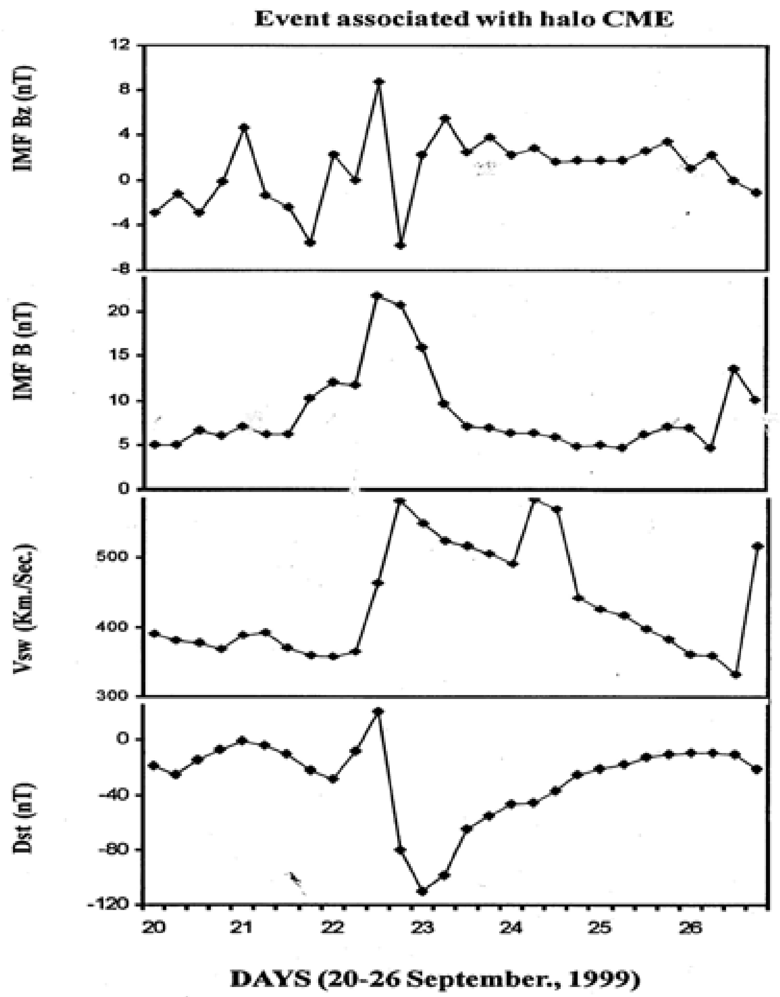

Figure 2. Shows the association of geomagnetic storm with solar wind speed. Interplanetary Magnetic Field B and IMF Bz observed during 20.09.1999 to 26.09.1999.

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