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Relationship of Dst with Solar Flares and Coronal Mass Ejections during intense Geomagnetic Storms

KEYWORDS: X-ray Solar Flares, Coronal Mass Ejection , Geomagnetic Storms, CMEs speed.

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ABSTRACT *From the study of 110 observed intense geomagnetic storms (dst ≤ - 110 nT) in relation with X-ray solar flares and coronal mass ejections (Halo & Partial halo) for the solar cycle 22,23 and rising phase of 24, it is concluded that intense geomagnetic storms are closely related to different classes of X-ray solar flares. It is also observed that majority of the intense geomagnetic storms (78 %) are associated with coronal mass ejections in which 75 % geomagnetic storms are associated with full Halo type CMEs and 25 % storms are associated with partial Halo type CMEs. A positive correlation has been found between magnitude of intense geomagnetic storms and speed of associated CMEs.*

Introduction- A geomagnetic storm is a major component of space weather and provides the input for many other components of space weather. A geomagnetic storm is caused by a solar wind shock wave or cloud of magnetic field which interacts with the Earth's magnetic field. The disturbance in the interplanetary medium which drives the geomagnetic storm may be due to a solar coronal mass ejection (CME) or a high speed stream of the solar wind originating from a region of weak magnetic field on the Sun's surface. A solar flare is a sudden brightening observed over the Sun surface which ejects clouds of electrons, ions, and atoms through the corona into space. Solar flares were one of the first strong disturbances discovered on the Sun and they were considered as the important source of almost all interplanetary and geomagnetic disturbances but another powerful solar processes coronal mass ejections (CMEs) were discovered by Gosling (2007) which is considered as the main cause of all interplanetary and geomagnetic disturbances (Schwenn et al 2005, Yermolaev et al 2005). Actually CMEs are eruptions into interplanetary space of as much as a few billion tons of plasma and embedded magnetic fields from the Sun's corona. The majority of large and major geomagnetic storms are generated by the encounter with both the interplanetary shock and the CME that drives it. The "geoeffectiveness" of CMEs i.e. their ability to disturb the Earth's magnetosphere is a function of their speed, the strength of their magnetic field, and the presence of a strong southward magnetic field component (Webb,1994,Gopalswamy et al 2007,Yashiro et al 2005,Cane 2003). In this paper, I have presented the analysis and results of solar flares and coronal mass ejections with geomagnetic storms Dst ≤-110 nT during the period of solar cycle 22, 23 and rising phase of 24.

2. Data analysis

For geomagnetic storms, disturbance storm time (DST ≤ - 110 nT) index was obtained from site http:// omniweb.gsfc.nasa.gov. Solar flare data available from the NOAA National Geophysical Data Center and collocated World Data Center for Solar-Terrestrial Physics have been used. We have used the CMEs data from large angle spectroscopic coronagraph (LASCO) on the solar and Heliospheric observatory (SOHO). In the present study, we have studied the total CMEs, full halo and partial halo CMEs . A CME is said to be partial halo for which MPA ≥ 120^0 and a CME is said to be a full for which MPA is equal to 360^0 which is based on the azimuthal extent of CMEs in LASCO field of view .

3. Results and discussion

We have analyzed intense geomagnetic storms magnitude ≤-110 nT with X ray solar flares of different categories, observed during the period of solar cycle 22, 23 and rising phase of 24.It is observed that all 110 intense geomagnetic storms have been identified which are associated with X ray solar flares of different categories. Out of 110 intense geomagnetic storms 15 (14 %) geomagnetic storms are found to be associated with X- class X-ray solar flares, 60 (54 %) geomagnetic storms are found to be associated with M- class X-ray solar flares,28 (25 %) geomagnetic storms are found to be associated with C class X-ray solar flares and 07(7 %) are found to be associated with B- class X-ray solar flares. From these results it is concluded that intense geomagnetic storms magnitude ≤-110 nT are closely related X-ray solar flares solar flare.

It is observed that majority of the intense geomagnetic storms has been identified as being associated with coronal mass ejections .We have 110 geomagnetic storms in which 87 intense geomagnetic storms (78 %) has been found to be associated with coronal mass ejections in which 75 % geomagnetic storms are associated with full Halo type CMEs and 25 % storms are associated with partial Halo type CMEs. A positive correlation has been found between magnitude of intense geomagnetic storms and speed of associated CMEs.

These results suggest that the coronal mass ejections associated with X-ray solar flares are very much effective in producing major geomagnetic storms.

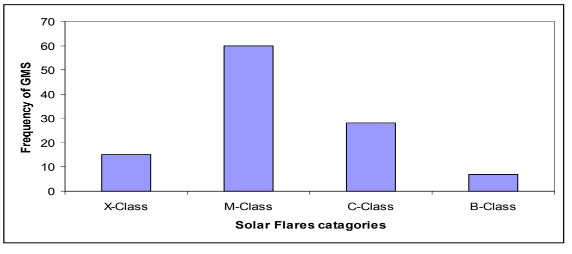

Figure 1-Shows association of Solar Flares with intense geomagnetic storms.

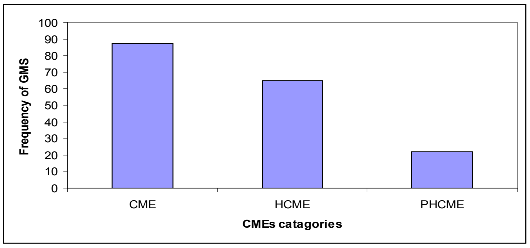

Figure 2 - Distribution of intense geomagnetic storms with coronal mass ejections.

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