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Physics

CO-RELATIONAL ANALYSIS OF SWP PARAMETERS WITH GEOMAGNETIC FIELD DISTURBANCES DURING GROWING STAGE OF SOLAR CYCLE 24

Omkar Prasad Tripathi — Department of Physics, AKS University, Satna (M.P.) India

Varinder Pandey* — Research Scholar, Department of Physics, APS University, Rewa (M.P.) India
*Corresponding Author

P. L. Verma — Department of Physics, Govt. Vivekananda P. G. College Maihar (M.P.) India

ABSTRACT Disturbances in geomagnetic field are extremely affected by sun's behavior like solar and interplanetary parameters. For this, we have studied **38** geomagnetic storms (DST ≤ - 75nT) and observed that the more effective events of solar wind plasma parameters during growing stage of solar cycle 24. In present study, we have found positive correlation between the magnitude of geomagnetic storms and initial value of solar wind plasma parameters corresponding to the onset time of initial phase with correlation coefficient **0.56** between magnitude of geomagnetic storms and onset value of solar wind plasma temperature, **0.54** between magnitude of geomagnetic storms and onset value of solar wind plasma density, **0.68** between magnitude of geomagnetic storms and onset value of solar wind plasma velocity, **0.75** between magnitude of geomagnetic storms and onset value of solar wind plasma pressure, **0. 59** between magnitude of geomagnetic storms and onset value of interplanetary magnetic field (B). We have also determined the positive co-relation between geomagnetic storms and onset value of Ap-index and Kp-index at a time of initial phase of geomagnetic storms with correlation co-efficient **0.88** and **0.78** respectively.

KEYWORDS : Geomagnetic Storms (GMs), Solar Wind Plasma (SWP) Parameters, Disturbance Storm Time (Dst), Solar Cycle.

INTRODUCTION

The Sun is a huge, glowing ball at the middle of our solar system. The sun provides light, heat and other energy to Earth. The sun is made up entirely of gases like- hydrogen and helium etc. The sun also emits particle radiation consists of protons and electrons. Solar wind is magnetized plasma in which, throughout most of the solar system, the magnetic and plasma pressures are analogous. Often our perception, trained on the behavior of gases, magnetic fields and fluids in a vacuum, does not strictly apply in plasma like solar wind. We have studied geomagnetic storms (DST ≤ - 75 nT) and observed that disturbances in solar wind plasma parameters during solar cycle 24 are more effective events. In this investigation we have studied geomagnetic storms (Dst ≤ - 75 nT) observed during solar cycle 24 with solar wind plasma parameters like- solar wind plasma temperature, solar wind plasma density, solar wind plasma velocity, solar wind plasma pressure and interplanetary magnetic field to know the role of these parameters to produce geomagnetic storms. We have found that **38** geomagnetic storms which are associated with interplanetary magnetic field, solar wind plasma temperature, density, velocity, pressure and also two other geomagnetic indices Kp-index and Ap-index.

EXPERIMENTAL DATA

In this investigation we have used hourly Dst indices of geomagnetic field during the period of solar cycle 24 to determine onset time, maximum depression time and recovery time of magnitude of geomagnetic storms. In the study we have used hourly Dst indices of geomagnetic field from Omni web data system to measure geomagnetic storms. This information of data has been taken from the NSSDC Omni web data system which have been created in late 1994 for enhanced access to the near earth solar wind, magnetic field and plasma data of Omni data set, which consists of one hour resolution near earth, solar wind magnetic field and plasma data, energetic proton fluxes and geomagnetic and solar activity indices. The data of interplanetary magnetic field; Omni web data system has been used, these data has also been taken online from Omni web data explorer (http//omniweb.gsfc. nasa.gov/form/dxi.html).

DATA ANALYSIS AND OBSERVATION

Figure shows the scatter plot between magnitude of geomagnetic storms and different storms associated solar wind plasma parameters like-interplanetary magnetic field, solar wind plasma temperature, solar wind plasma density, solar wind plasma velocity, solar wind plasma pressure, Ap and Kp indices. In this analysis we have observed good positive correlation of magnitude of geomagnetic storms with different solar wind plasma parameters and also with different geomagnetic indices Ap and Kp.

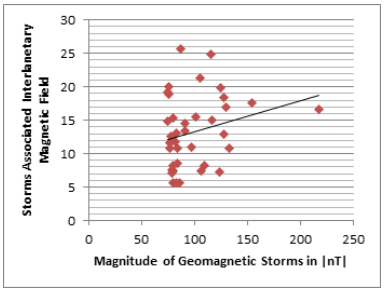

Fig.1-shows scatter plot between geomagnetic storms and storms associated interplanetary magnetic field

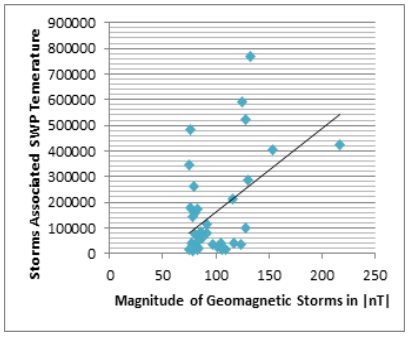

Fig.2-shows scatter plot between geomagnetic storms and storms associated solar wind plasma temperature

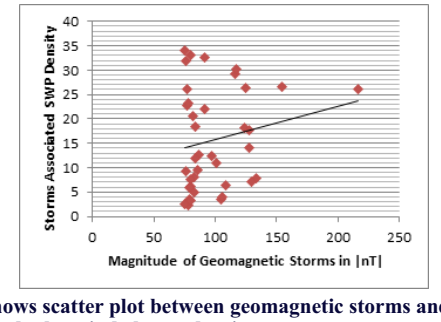

Fig.3-shows scatter plot between geomagnetic storms and storms associated solar wind plasma density

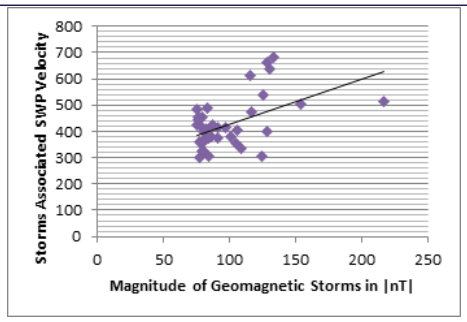

Fig.4-shows scatter plot between geomagnetic storms and storms associated solar wind plasma velocity

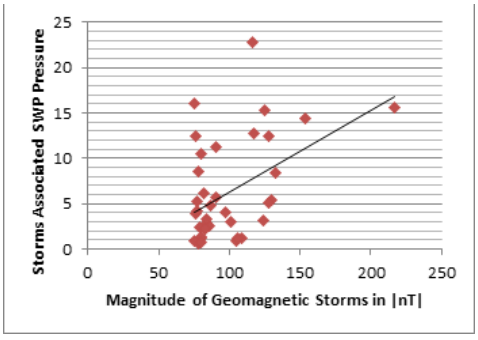

Fig.5-shows scatter plot between geomagnetic storms and storms associated solar wind plasma pressure

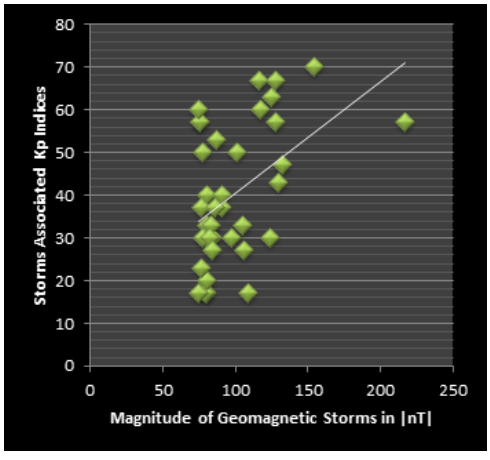

Fig.6-shows scatter plot between geomagnetic storms and Kp-index

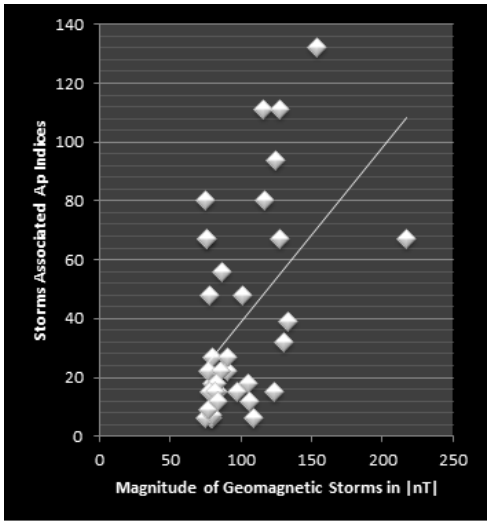

Fig.7-shows scatter plot between geomagnetic storms and Ap-index

RESULTS

Some scientists (Boteler et al. 1998; Kappenman 1996; Kappenman 2004 and Pirjola, 2002) have studied that the Geo-magnetically induced currents (GICs) are a type of natural hazard that can affect conducting infrastructures, such as power grids and pipelines damage. We have found that **38** geomagnetic storms which are associated with interplanetary magnetic field, solar wind plasma temperature, density, velocity, pressure, Kp and Ap index. In present study we have found positive correlation between the geomagnetic storms and initial value of SWP parameters corresponding to the exact time of initial phase with very good correlation coefficient like- **0. 56** between geomagnetic storms and storms associated solar wind plasma temperature, **0.54** between geomagnetic storms and storms associated solar wind plasma density, **0.68** between geomagnetic storms and storms associated solar wind plasma velocity, **0.75** between geomagnetic storms and storms associated solar wind plasma pressure, **0.59** between geomagnetic storms and storms associated interplanetary magnetic field (B). We have also determined the positive co-relation between geomagnetic storms and initial value of Ap-index observed at a time of initial time of geomagnetic storms with correlation co-efficient **0.88** and between geomagnetic storms and onset value of Kp-index observed at a time of initial phase of geomagnetic storms with correlation co-efficient **0.78**. The obtained result will provide new insight about the physical process mainly responsible for geomagnetic storms.

CONCLUSION

From our study 38 out of 38 IMFs are associated with magnitude of geomagnetic storms and correlation coefficient **0.59** is obtained between interplanetary magnetic field and associated geomagnetic storms during the solar cycle 24. These results are suggesting that the interplanetary magnetic fields are most effective event to produce major geomagnetic storms. In this investigation we have obtained very good correlation with geomagnetic storms and solar wind plasma temperature, solar wind plasma density, solar wind plasma velocity, solar wind plasma pressure, interplanetary magnetic field (B). We have also determined the positive co-relation between geomagnetic storms and initial value of Ap-index (another geomagnetic storms index) observed at a time of initial time of geomagnetic storms with correlation co-efficient **0.88** and between geomagnetic storms and onset value of Kp-index observed at a time of initial phase of geomagnetic storms with correlation co-efficient **0.78**. Furthermore, it is also concluded that in case of geomagnetic field disturbances interplanetary magnetic fields are more effective event and play crucial role to produce geomagnetic storms. Magnetic Clouds are produced in the solar wind when solar eruptions (flares and coronal mass ejections) carry material off of the Sun along with embedded magnetic fields. These magnetic clouds can be detected in the solar wind through observations of the solar wind characteristics - wind speed, density, and magnetic field strength and direction. These results are closely related with results obtained by previous investigators like- Dungey (1961); Perreault and Akasofu (1978); Tsurutani and Gonzalez (1997); Cane (2000); St. Cyr (2000); Webb (2000); Correiaa (2005); Gopalswamy (2006); Manoharan (2006); Michalek (2006); Verma et al (2009); Verma (2012). From the above results it is concluded that the disturbances in geomagnetic field due to solar activity and solar wind plasma parameters; and these solar and interplanetary parameters play crucial role to generate intense and severe geomagnetic storms. Geomagnetic storms are not injurious for human physiological state but they affect our modern technological system and hence there is a lot of future research scope in this area.

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