ORIGINAL RESEARCH PAPER

Physics

ASSOCIATION OF INTENSE GEOMAGNETIC STORMS WITH INTERPLANETARY MAGNETIC FIELD AND KP INDEX FOR SOLAR CYCLE 24

KEY WORDS: Geomagnetic storms, Interplanetary magnetic field

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ABSTRACT

The study has been carried out to find the association of intense geomagnetic storms (GSs) with interplanetary magnetic field (IMF B) and the Kp index for Solar 24. In order to study such variations, we incorporate the analysis technique by superposed epoch method. The current analysis depict that IMF B has a strong impact as the cause of GSs. We have obtained high value of correlation coefficient between Dst index and IMF B(r= -0.7). The correlation coefficient between Dst and Kp index is found to be −0.8. Furthermore, we observed that IMF B is highly and positively correlated with kp index (r = 0.9). This study proves that IMF B is a geo-effective parameter. Our study gives a statistical proof of the occurrence of intense geomagnetic storms mainly depends upon the interplanetary magnetic field (IMF B). Moreover, the time delay analysis has also been performed by the method of correlation and observed a time delay of 0 to 5 hour between the extreme value of IMF B, Kp index and least value of Dst index.

1. INTRODUCTION

A geomagnetic storm is a significant disruption of Earth's magnetosphere that happens when there is a very powerful exchange of energy between the solar wind and surrounding space environment **(Gonzalez et al., 1994)**. In our study, we used Dst index as an indicator of geomagnetic storm. Geomagnetic storms are categorized as severe storm (Dst ≤ -200nT), intense storm (-200nT < Dst ≤ -100nT) and moderate storm (-100nT < Dst ≤ -50nT). In order to study the association of intense geomagnetic storms with IMF B, the occurrence hour of GSs is used as a zero epoch with criteria -200nT < Dst ≤ -100nT for intense geomagnetic storm for Solar Cycle 24.

Several scholars **Tsurutani et al. 1988, Kane 2014, Singh and Mishra 2015** have addressed a number of geomagnetic storms and their manifestations, arguing that the geomagnetic storms plays an extensive role in space weather phenomena by transmitting increased energy from solar wind to the magnetosphere.

Interplanetary magnetic field (IMF B) is a constituent of the sun's magnetic field that is fetch in to interplanetary space by the solar wind. IMF B plays a significant role in how the solar wind interacts with the Earth's magnetosphere and affects auroral activity on earth. When the charged particles from the sun hit to the upper atmosphere it results to the coloured light in the sky known as auroras **(Tsurutani and Gonzalez, 1997)**. A number of investigations have been conducted to find the association of geomagnetic indices with interplanetary parameters and it is observed that interplanetary parameters are geo-effective **(Kumar et al., 2008, Joshi et al., 2011, Pande et al., 2017, Rathore et al., 2014)** while interplanetary magnetic field (IMF B) is not a CR-effective parameter **(Mathpal et al., 2018).**

2. Data and Method

In order to understand the dependence of intense geomagnetic storms on interplanetary magnetic field during solar cycle 24, we have represented a statistical correlative study between geomagnetic activity indices (Dst index and Kp index) and interplanetary magnetic field IMF B by the incorporation of the analysis technique by superposed epoch method (Chree analysis). The hourly (5 hour) mean values of interplanetary magnetic field (IMF B), dst index and kp index are taken from the Omni web data center (omniweb. gsfc.nasa. gov/form/dx1.html) for the studied period 2009-2017 (Solar Cycle 24). Furthermore, we calculated the average correlation coefficient of dst index with respect to these introduced parameters. The hourly mean values are selected for our findings of the accurate result and its physical interpretations.

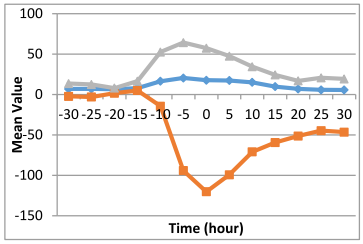
3. RESULTS AND DISCUSSION

We study the correlative importance of interplanetary magnetic field (IMF B) influencing the geomagnetic activity for Solar Cycle 24. Beside these variations in GSs with respect to the introduced parameter, we also study the variation of Kp index with Dst index.

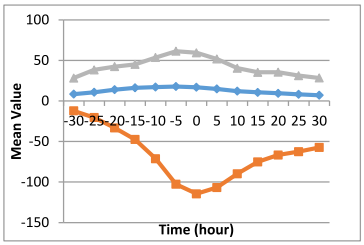
3.1. Dst index, IMF B, Kp index

In Figure 1, we have compared the profiles of Dst index, IMF B and kp index for solar cycle 24 and concluded that dst index is highly anti-correlated with kp index. The correlation coefficient of IMF B with dst index is found to be -0.7, which indicates that IMF B is a geo-effective parameter. Our outcome is in good agreement with the findings of **Pande et al., 2007.** The correlation coefficient of IMF B with kp index is found to be 0.9, which indicates that IMF B is highly and positively correlated with kp index. The correlation coefficient between Dst index and kp index is found to be -0.8. Our outcome is in good agreement with the findings of **Snyder et al., 1963 and Pokharia et al., 2018** . Furthermore, we observed a time delay of 0 to 5 hour between the extreme value of IMF B, kp index and least value of dst index for most of the year of Solar Cycle 24 except 2014 and 2016. No time delay is observed between the extreme value of IMF B, kp index and least value of dst index for the year 2014 and 2016. The time delay between the extreme value of IMF B , kp index and least value of dst index indicates the type of the mechanism operating in the given process.

2011



2012



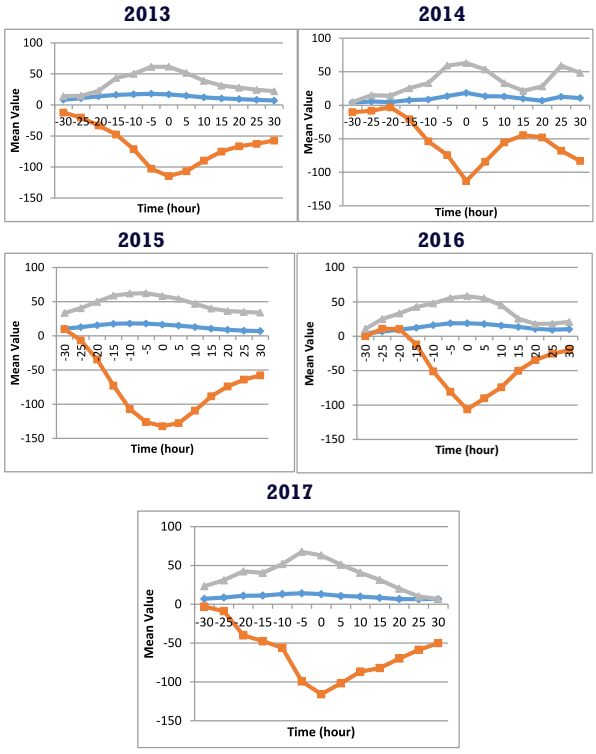


Figure 1: The conclusion of superposed epoch analysis with respect to the happening day of GSs (zero epoch). The discrepancy of average values of IMF B in blue, dst index in red and kp index in green colour are demonstrated for the intense geomagnetic storms.

4. CONCLUSIONS

After the detailed analysis of our study various conclusions has been observed that are discussed below-

1. The correlation coefficient between IMF B and dst index is found to be -0.7 while the correlation coefficient between IMF B and Kp index is found to be 0.9, which indicates that IMF B is a geo-effective parameter.
2. Dst index and kp index is found to be highly correlated with each other, which indicates that kp index is an indicator of geomagnetic storm.
3. Time delay of 0 to 5 hour is found between the extreme value of IMF B, kp index and least value of dst index.

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