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# Long term evolution of geomagnetic activity under the influence of 11 year cyclic variations in solar activity during solar cycle 23 and 24

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**ABSTRACT**: The solar activity follows an eleven year cyclic variability. The long term changes in the solar activity have a direct impact on the geomagnetic activity. In the present study, we have investigated the geomagnetic response of solar activity. To describe the long term variations of the solar activity we have selected two solar activity indices namely Sunspot Number (Rz) and solar radio flux (F10.7). Similarly to describe the level of geomagnetic activity we have taken four geomagnetic indices namely Dst, Kp, Aa and Ap. The study is carried out for the solar cycle 23 and minimum of solar cycle 24. From our study we found that long term changes in the geomagnetic activity follow a synchronous variation with the corresponding changes in the solar activity. We performed correlation analysis between solar activity and geomagnetic activity indices to access the magnitude of association between them. From correlation analysis we found that both the solar activity indices exhibit a strong correlation with all the four geomagnetic indices. The correlation coefficients of Rz with Dst, Kp, Aa and Ap are 0.78, 0.83, 0.81 and 0.86 respectively while those of F10.7 index with the same indices in the same order are 0.77, 0.83, 0.81 and 0.88.

**KEYWORDS**: Solar Cycle, Solar Indices, Geomagnetic Indices, Plasma.

## I. INTRODUCTION

The solar activity has long been recognized to be the origin of the geomagnetic activity. The geomagnetic activity is the result of variable current systems formed in the magnetosphere and ionosphere as a consequence of the interaction of the solar wind with the magnetosphere in addition to the dynamo operating inside the earth. The magnetic fields play a determining role in the dynamics of solar activity. The solar activity follows a regular periodic variation with eleven year periodicity, commonly known as solar cycle. The solar cycle is the periodic occurrence of sunspots at sun's surface. The changes in the solar activity can have a significant impact on the geomagnetic activity. Even small changes in solar activity can impact earth's magnetic field in significant and surprisingly complex way. Since the solar activity follows a periodic variability we can expect some kind of periodicity in the geomagnetic activity.

The association of 11-year solar cycle variability with the variability of electromagnetic environment of Earth has been studied in the last decades[1, 2, 3]. A long term correlation study between solar and geomagnetic activity has been reported, using annual averages of the aa index and of the sunspot number Rz as well as Dst and AE geomagnetic indices and solar wind speed data are used for more recent periods, during 1868-2000[4]. It has been found that the geomagnetic and solar activity correlation has decreased since the end of the 19th century, and the lag between them has increased. The variations of Rz and aa were in phase in the early period (solar cycles 11-14), and became out of phase in later periods (with a lag of 2 years in solar cycle 22)[4].

Apart from the geodynamo the solar activity is also recognized as one of the prominent sources of geomagnetic activity[5, 6, 7]. During the solar wind magnetoshperic interaction a variable current system is developed in the magnetosphere-ionosphere system which contributes to the geomagnetic activity[1, 8]. The geomagnetic activity has been found to be well correlated with the solar wind speed (v), the southward component (Bz) of the interplanetary magnetic field (IMF) and the product $BzV^2$[5, 9, 10, 11]. The solar sources of geomagnetic activity are generally thought to be of two categories[12,13]. One source, Coronal Mass Ejections (CMEs), has a frequency of occurrence