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ORIGINAL PAPER

Distribution of intense, moderate and weak geomagnetic storms over the solar cycle

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Abstract: The geomagnetic storms observed during different phases of a solar cycle have distinct primary solar sources. Therefore, we have statistically examined, in the present study, how the geomagnetic storms of different intensities are distributed over a solar cycle. We have considered previous four cycles, viz. cycle 21, 22, 23 and 24. We selected all the storms which were observed during these cycles and classified them into three categories as: intense (Dst ≤ -100 nT), moderate ($-100 \leq$ Dst ≤ -50) and weak ($-50 \leq$ Dst ≤ -30). We found that geomagnetic storms are distributed in such a way that maximum number of intense storms occur around peak phase of a solar cycle, while maximum number of weak storms occur during the starting and ending phases of a cycle. About 73.20% of intense storms, 58.07% and 47.93% of moderate and weak storms occurred around the peak of a cycle. Therefore, it was concluded that peak phase is dominated by intense and very intense storms due to increase in frequency of occurrence of coronal mass ejections during such periods. At the same time, the ending phase of solar cycle is dominated by the occurrence of weak storms due to the frequent occurrences of fast solar wind streams during such periods. Moreover, the total number of storms occurring during the descending phase is greater than those observed during the ascending phase. The storms with peak Dst ≤ -200 nT were classified as very intense and designated as outstanding Sun–Earth connections. It was found that 90% of such events occur around the peak phase of solar cycle. Therefore, it was concluded that the high-risk events occur during the peak phase of a solar cycle. Therefore, extreme care must be taken while launching new space missions and operating the existing ones, during this period.

Keywords: Solar cycle; Geomagnetic storms; Outstanding Sun–Earth connections

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1. Introduction

It is now established that geomagnetic storms are caused either by coronal mass ejections (CMEs) or by fast solar wind streams emanating from coronal holes [1, 2]. The most intense or the great geomagnetic storms are usually caused by CMEs, while moderate storms and weak storms may be caused by coronal holes or CIRs. It is much known that frequency of occurrence of CMEs is usually very high near the peak of solar cycle because around the peak of solar cycle the maximum numbers of active regions or sunspots appear on the sun. However, coronal holes are frequent during the low solar activity or around the minimum of solar cycle. Therefore, it is expected that the distribution of geomagnetic storms during the solar cycle will be such that more number of intense geomagnetic storms will occur during the peak of solar cycle, while least numbers will be observed during the solar minimum. However, it has been found that the maximum number of intense storms do not occur exactly at the peak phase of solar cycle, but a couple of years away from the peak [3, 4]. About 90% of the intense storms occur in the interval "2 years before and 3 years after" the peak point [5]. Moreover, the percentage of intense storms observed during the declining phase of solar cycle is significantly larger as compared to occurrences during the ascending phase. This kind of distribution has been found to be highly

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