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Forbush Decreases Related with Halo CMEs and Interplanetary Magnetic Field

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ABSTRACT: In this paper we have considered odd magnitude ≥ 3% of Forbush decreases (Fds) related with Halo CMEs and X-class solar flares during the period of 2004-2014. From the study of Halo CMEs and X-class solar flare related Forbush decreases (Fds) with parameters of magnetic fields (IMF & IMFBz), we have determined significant positive correlation between odd magnitude of Forbush decreases and peak values of associated parameters of magnetic fields with co-relation co-efficient 0.62 between odd magnitude of Forbush decreases and peak values of associated IMF, 0.70 between odd magnitude of Forbush decreases and peak values of associated IMFBz and significant positive correlation with co-relation co-efficient 0.71 is found between odd magnitude of Forbush decreases and speed of associated coronal mass ejections (CMEs).

Keywords: - Forbush decreases, Halo CMEs and Interplanetary Magnetic Field.

I. INTRODUCTION

Solar discharge and their variations are responsible for producing changes in the intensity of cosmic ray on short-term basis as well as on long-term basis. The short-term changes in cosmic ray intensity are known as Forbush decreases. Forbush decreases (Fds) is a transient and rapid decreases in the observed cosmic rays intensity followed by a gradual recovery typically lasting several days [1, 2]. Majority of transient decreases in the galactic cosmic ray intensity have been generally connected with solar flares. These decreases are most likely produced by perturbations in the interplanetary magnetic field and particle flow which propagate away from the Sun [3,4], which are strongly related to coronal mass ejections and their interplanetary counter parts [5,6,7,8,9,10]. [11]Belov et al have studied Forbush decreases with interplanetary disturbances. They have concluded that magnitude of Forbush decreases are directly proportional to Hm (maximum disturbances value for the interplanetary magnetic field strength) and Vm (maximum solar wind velocity). [12]Singh and Verma have been studied Forbush decreases to be associated with halo and partial halo coronal mass ejections and it is also concluded that disturbances in solar wind temperature and velocity are closely related to Forbush decreases. [13]Robert et al have investigate the relation between Forbush cosmic ray decrease recovery time and coronal mass ejection transit time between the Sun and Earth. [14]Mishra et al have concluded that the average solar magnetic field and solar wind velocity are found as a necessary condition for producing Forbush decreases. [15]Jothe and Shrivastava suggested that a strong solar flare alone is capable of producing Forbush decreases. [16]Kharyat et al suggests that CMEs adds magnetic flux to the interplanetary magnetic field which also produces Forbush decreases in cosmic ray intensity and produces major disturbances in the interplanetary medium. In this investigation we have determine the role of Halo CMEs in producing Forbush decrease and to correlate the odd magnitude of Fds with peak values of associated interplanetary magnetic fields (IMF) and south world components of interplanetary magnetic fields (IMFBz).

II. EXPERIMENTAL DATA

In this investigation hourly count rate of cosmic ray, recorded by Oulu neutron monitor over the period of 2004-2014 has been used to determine Forbush decreases (Fds). In this work we have selected only those Fds, which have decreased greater than 3.0%. The hourly data of interplanetary magnetic fields (IMF) and south world components of interplanetary magnetic fields (IMFBz) have been used over the period 2004-2014 to determine peak values of IMF & IMFBz. These data have been taken from the NSSDC Omani web system. The data of CMEs have been taken from SOHO, LASCO, CME catalogue, which consists all CMEs manually, identified since 1996 from large angle and spectrometric coronagraph (LASCO) on board the solar and

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heliospheric observatory mission (SOHO) and the data of X-ray solar flare are taken from STP solar data.

III. ANALYSIS AND RESULTS

The statistical analysis we have considered only those Forbush decreases (Fds), which have odd magnitude ≥ 3% related with Halo CMEs (which have speed ≥1000 km/s) and X-class solar flares. We have found only 07 Halo CMEs and X-class solar flares related Forbush decreases (Fds) during the period of 2004-2014. All Forbush decreases are associated with interplanetary magnetic fields (IMF) and south world components of interplanetary magnetic fields (IMFBZ). From the study of Forbush decreases with interplanetary magnetic fields (IMF) and south world components of interplanetary magnetic fields (IMFBZ), it is inferred that Forbush decreases of higher magnitudes are found to be associated with peak value of considered IMF & IMFBz.We have determined significant positive correlation between odd magnitude of Forbush decreases and peak values of associated IMF & IMFBz with co-relation co-efficient 0.62 between odd magnitude of Forbush decreases and peak values of IMF(in fig.1), 0.70 between odd magnitude of Forbush decreases and peak values IMFBz (in fig.2). We have also determined significant positive correlation between odd magnitude of Forbush decreases and speed of CMEs with co-relation co-efficient 0.71 between odd magnitude of Forbush decreases and speed of CMEs (in fig.3).

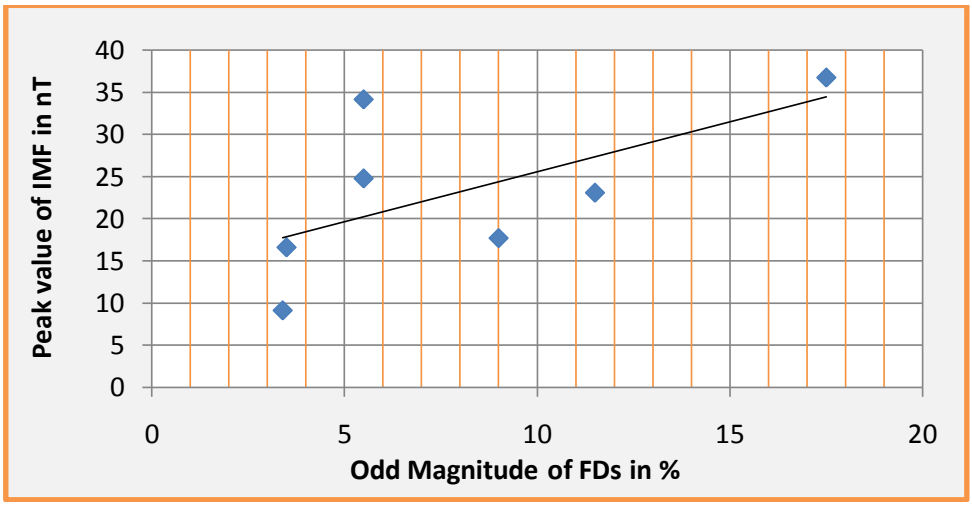

Fig.1. Shows the scatter plot between odd magnitudes of Forbush decreases and peak values of IMF, showing positive correlation with correlation coefficient 0.62.

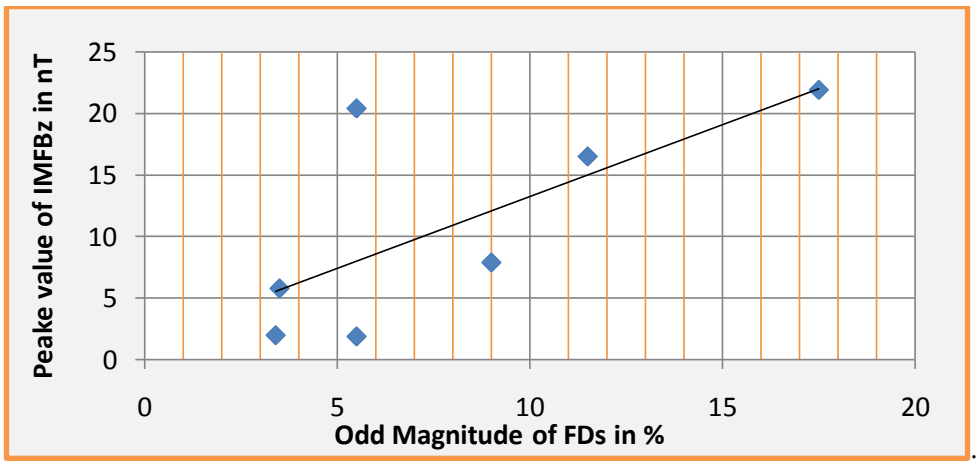

Fig. 2. Shows the scatter plot between odd magnitudes of Forbush decreases and peak values of IMFBz, showing positive correlation with correlation coefficient 0.70.

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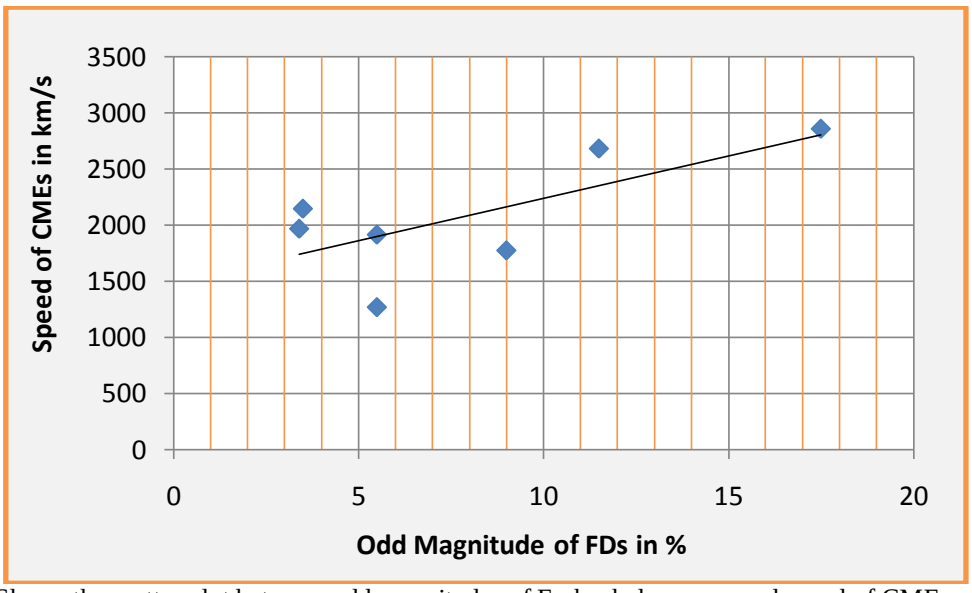

Fig. 3. Shows the scatter plot between odd magnitudes of Forbush decreases and speed of CMEs, showing positive correlation with correlation coefficient 0.71.

IV. CONCLUSION

In this study we have found the most significant positive correlation between odd magnitude of Forbush decreases (Fds) and speed of CMEs. We have concluded that Halo CMEs are the most important events in which large amount of solar plasma materials are expelled from the solar corona into interplanetary space then other CMEs which are responsible to generate storms in parameters of magnetic fields and Forbush decreases. The significant positive correlation between odd magnitude of Forbush decreases and peak values of IMF and IMFBz suggests that magnitude of Forbush decreases depends upon the peak values of IMF and IMFBz.

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