International Journal of Science, Environment and Technology, Vol. 4, No 3, 2015, 753 – 758

ISSN 2278-3687 (O)
2277-663X (P)

STUDY OF SOLAR FLARES AROUND THE SUN AND THEIR ASSOCIATION WITH FORBUSH DECREASES AND CORONAL MASS EJECTIONS FOR THE PERIOD 2000 TO 2010

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Abstract: Coronal Mass Ejections (CME) are usually associated with a decresase in cosmic ray intensity (CRI) called forbush decreases (FDs). A statistical analysis has been made to obtain the association of solar flares with Forbush Decreases and Coronal Mass Ejections for the period of 2000 to 2010 covering the solar cycle 23 and recent period of solar cycle 24. It is investigated that the flares in Southern Zone between 10^o to 20^o are found most effective to produce Forbush Decreases. Solar flares in association with Coronal Mass Ejections in the Northern Hemisphere are found to be more effective in producing Forbush Decrease events. Major solar flares in association with Forbush decreases are found to be almost equally distributed all over the helio-longitude. Similarly the solar flares associated with Forbush Decreases and Coronal Mass Ejections are equally distributed in the Eastern and Western hemisphere for the period 2000 to 2010.
Keywords: Solar flares, Coronal Mass Ejection, Forbush Decrease.

1. Introduction

A solar flare is a short-lived sudden increase in the intensity of radiation emitted in the neighborhood of sunspots. The majority of transient decreases in the galactic cosmic ray intensity have been generally connected with solar flares. Distribution of solar flares around the sun and their association with various interplanetary and cosmic ray decreases has been studied by several workers from time to time [1, 3,11,12,14]. It is generally believed that the majority of Forbush decreases (Fds) in galactic cosmic ray intensity have been connected with occurrence of bigger solar flares [10]. Recently it has been reported that Coronal Mass Ejections, not solar flare alone may produce cosmic ray intensity variation [13]. In this analysis we calculated the relation between solar flare, Coronal Mass Ejections and Forbush Decrease for the period 2000 to 2010.

The majority of transient decreases in the galactic cosmic ray intensity have been generally connected with solar flares. Result of our analysis suggests that these Coronal Mass Ejections produce geomagnetic disturbances. Coronal Mass Ejection (CME) was first discovered

*Received April 23, 2015 * Published June 2, 2015 * www.ijset.net*

in1971 using the seventh Orbiting Solar Observatory (OSO-7) coronagraph [15]. Coronal Mass Ejections are dynamic large scale events in the solar corona that expels plasma and magnetic field through the solar wind [5]. The Coronal Mass Ejections initiated by the solar flares was emitted at very high speed and was directed towards the Earth and resulting Forbush Decrease occurred in cosmic ray intensity [7].

2. Data and method of analysis

For the purpose of this study, we have selected most of the solar flares during the interval 2000-2010 with optical importance ≥ 1. The selection was made from the routine list published in solar Geophysical Data Book. The data of Coronal Mass Ejections were taken from SOHO/ LASCO. Only those solar flares have been considered which are found to be associated in time either with Forbush Decreases alone or with both Coronal Mass Ejections and Forbush Decreases. Coronal Mass Ejections and Forbush Decrease considered to associated with a flare if it occurs between 3 days after and before the event because it is expected that the event near the earth will occur with certain delay compared to the time of the flare due to the finite time taken by the solar wind and the associated magnetic field to propagate to the earth neighborhood. We have identified 378 solar flares with optical importance ≥ 1 and associated with Forbush decrease and 128 solar flares with optical importance ≥ 1 and associated with Forbush Decrease and Coronal Mass Ejections.

3. Result and Discussion

Major solar flares having optical importance ≥ 1 and associated with Forbush decrease and Coronal Mass Ejections are identified.

Fig.1shows the frequency of occurrence of solar flares associated with Forbush decreases (Fds) for different helio-latitudinal zone. The flare location has been summed up 10^o helio-latitudinal interval. It is observed from the graph that large number of solar flares in association with Forbush decrease (Fds) occur in Southern Zone. Zone between 10^oSouth to 20^o South is found most effective in producing Forbush type decrease in cosmic rays. Similar analysis has been done for solar longitudinal Zone.

Fig.2 shows that frequency of occurrence of solar flares associated with Forbush decreases (Fds) in different longitudinal zone. It is noted that almost equal number of solar flares occurred in both the Eastern and Western hemisphere. However slight large numbers of flares are found in Western hemisphere. Results of analysis indicate that mechanism of cosmic ray Forbush Decrease is depends upon the importance of solar flare in general.

Fig.3 shows the frequency of occurrence of solar flares associated with Forbush Decrease (Fds) as well as Coronal Mass Ejections during the period 2000 to 2010 in helio- latitude. It is noted that the number of flares occurring 10^0 to 20^0North and between 0^0 to 20^0 South are more effective in producing Forbush Decrease as well as Coronal Mass Ejections.

Fig. 4 shows longitudinal frequency distribution for those solar flares which are associated with Forbush Decreases and Coronal Mass Ejections. It is now observed that almost equal numbers of solar flares are found in Eastern and Western hemisphere in the case of solar flares associated with Forbush Decrease and Coronal Mass Ejections for the period 2000 to 2010.

It has been reported in earlier studies that solar activity could move in one or the other hemisphere depending upon the phase of the 22 year magnetic cycle [4]. Forbush Decrease in cosmic ray intensity has generally been explained due to the shielding of cosmic ray particles by shock fronts produced by an intense flare [6,9] proposed the shock wave production of a magnetic link or blast wave as a mechanism to reduce the cosmic ray intensity at earth during Forbush Decreases. Some authors reported a quantitative correlation between Forbush Decrease and passage of shock fronts followed by disturbance represented by enhanced by solar wind velocity and reduced field aligned diffusion coefficients [2, 8].

4. Conclusions

1. It is concluded that the flares and zone between 10^oSouth to 20^o South are found most effective in producing Forbush decreasess.
2. Major solar flares in association with Forbush decreases are found to be almost equally distributed all over the helio-longitude. However slight large number of solar flares is evident in western hemisphere.
3. Slightly higher solar flares in southern hemisphere are found to be associated with Forbush Decreases.
4. Solar flares in association with Coronal Mass Ejections and Forbush Decreases are found to be equally distributed in the Eastern and Western hemisphere for the period 2000 to 2010.
5. Solar flares in association with Coronal Mass Ejections in the Northern Hemisphere are found to be more effective in producing Forbush Decrease events.
6. A large number of solar flares are in association with Coronal Mass Ejections and Forbush Decrease occurring in the zone 10^0North and 20^0 South.
7. Coronal Mass Ejections produce significant decrease in cosmic ray intensity.

8. Coronal Mass Ejections are found responsible in geomagnetic disturbances.

5. Acknowledgement

Authors thank World Data Centre-A for providing the data.

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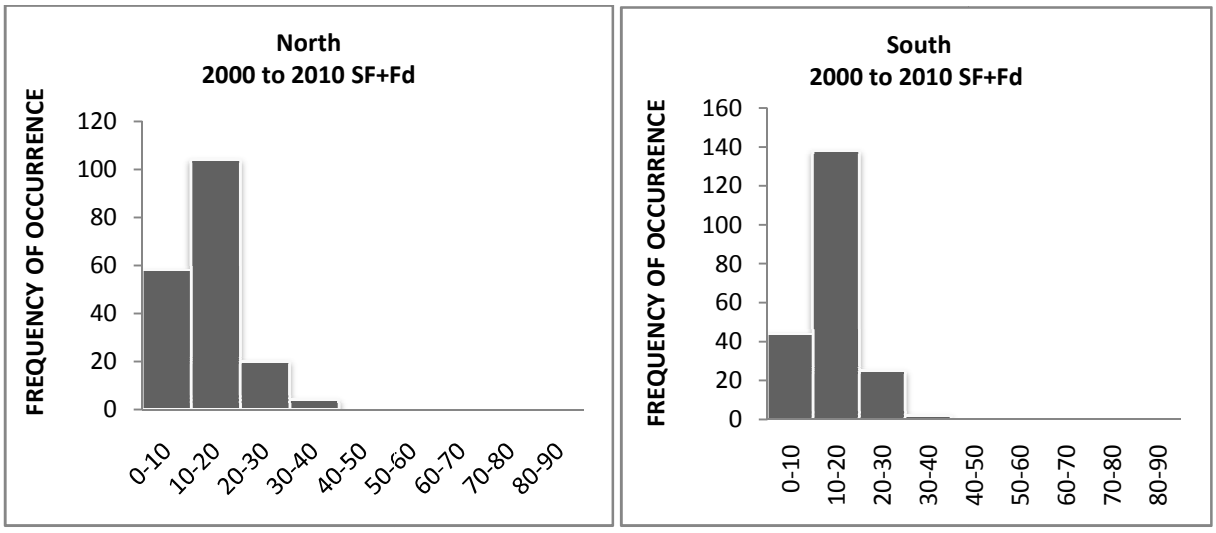
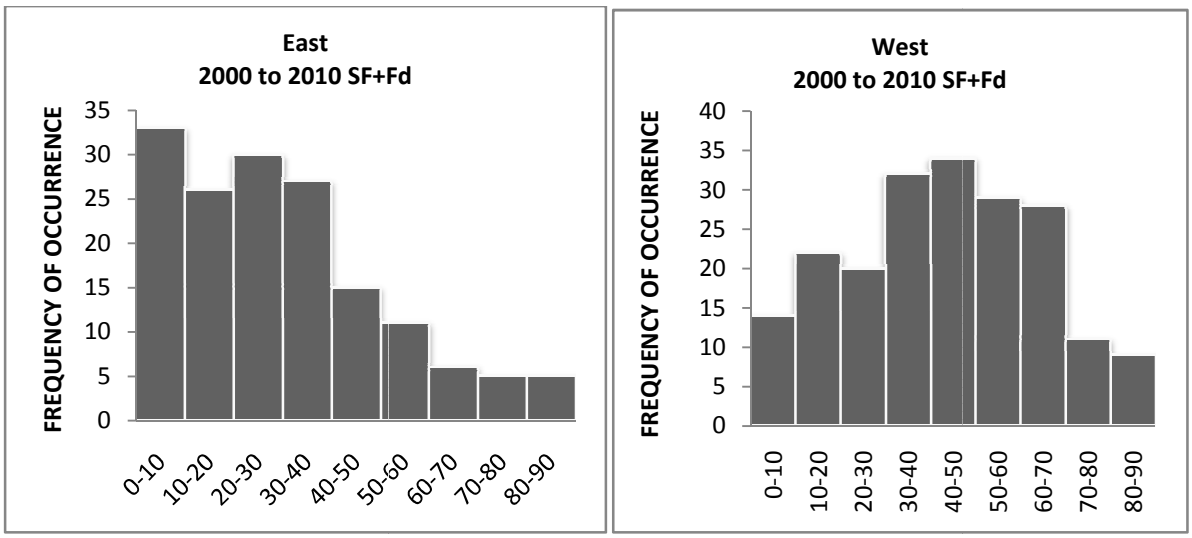


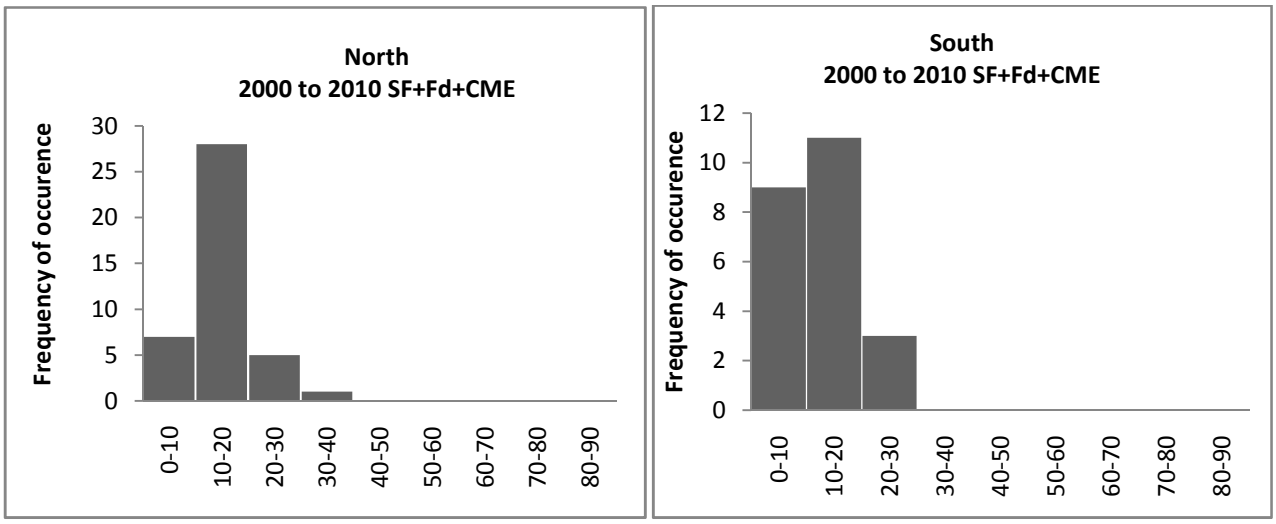
Helio- Latitude

Figure 1- Shows the frequency of occurrence of solar flares associated with Forbush Decreases with helio-latitude in interval of 10^{o} for the period of 2000 to 2010.



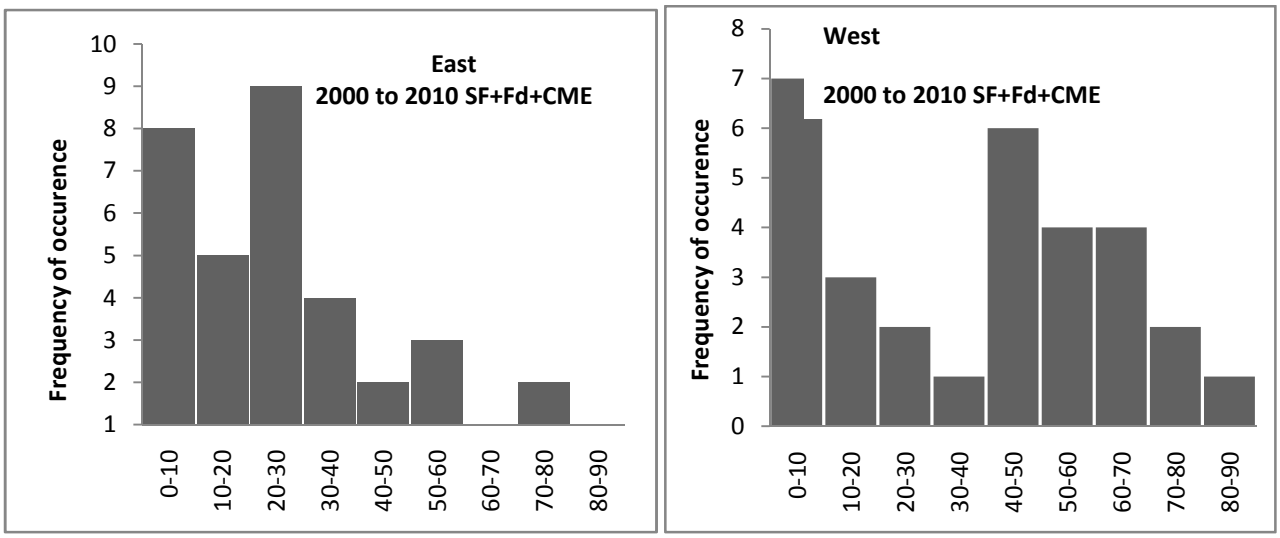
Helio- Longitude

Figure 2- Shows the frequency of occurrence of solar flares associated with Forbush Decreases with helio-longitude in interval of 10^{o} for the period of 2000 to 2010.



Helio-latitude

Figure 3- Shows the frequency of occurrence of solar flares associated with Forbush Decreases and Coronal Mass Ejections with helio-latitude in interval of 10^0 for the period of 2000 to 2010.



Helio-longitude

Figure 4- Shows the frequency of occurrence of solar flares associated with Forbush Decreases and Coronal Mass Ejections with helio-longitude in interval of 10^0 for the period of 2000 to 2010.