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A COMPARATIVE STUDY OF HELIO-LATITUDINAL DISTRIBUTION OF B-TYPE AND N-TYPE Hα-SOLAR FLARES IN ASSOCIATION WITH CORONAL MASS EJECTION OR FORBUSH DECREASES

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Abstract: Major B-type and N-type Hα solar flare event of optical imp ≥1 have been utilized to study the solar latitudinal frequency distribution around the Sun for the period 1996 to 2010, which cover complete period of solar cycle 23. A statistical analysis was performed to obtain in relationship with halo/partial-halo CMEs (±1day window) and Forbush decreases of cosmic ray intensity. Our analysis clearly indicates that more than 50% of both B-type and N-type solar flare association with halo/partial-halo CMEs occur in northern hemisphere and less than 46.9% of both B-type and N-type solar flare association with halo/partial-halo CMEs occur in southern hemisphere. Similarly, we found that more than 50% B-type and N-type solar flare association with Forbush decreases occur in northern hemisphere and less than 48.4% occur in southern hemisphere. Finally, we conclude that the both B-type and N-type solar flare frequency distribution around the Sun association with halo CMEs in northern hemisphere is capable in producing Fds.
Keywords: Interplanetary coronal mass ejection, cosmic rays, solar flare.

INTRODUCTION

A solar flare is a sudden brightening observed over the solar limb, which interpreted as a large energy burst up to 6×10^{25} joules. These are mainly followed by coronal mass ejection (CME) (Kopp et al, 2005). The frequency of occurrence of solar flares varies from several days when the sun is particularly active to less than one every week when the Sun is quiet following the 11-year cycle. They are classified as A, B, C, M and X according to peak flux energy measured by GOES spacecraft (Tumrazyan, 1968). According to spectral intensity observation solar flare are classified as faint (F), normal (N) and brilliant (B) (Tandberg et al, 1988). The solar flare with their release of vast amount of matter and radiation in a short time are of importance to solar physics as well as to the study of cosmic ray modulation. The modulation of cosmic ray is produced by the solar output in the form of out flowing solar

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plasma and magnetic field throughout the heliosphere. Earlier observation of solar flare indicated that their occurrence is not uniform in the northern and southern hemisphere. A number of investigators have studied the distribution of solar flares around the sun and some reported the combined effect of bright solar flares and CMEs responsible for short term decrease in galactic cosmic ray intensity (Duggal et al 1997, Hatton 1980, Badruddin and Yadav, 1983). One of the solar flare related sporadic variation in cosmic ray intensity is called FD; a sudden cosmic ray intensity decrease followed by gradual recovery. The FD in cosmic ray intensity is often associated with CME and interplanetary CME (Parker 1963, Can et al, 1997). The longitudinal distribution of solar flare has been investigated by (Badaruddin and Yadav, 1982) and found an almost equal distribution in both eastern hemisphere and western hemisphere. The latitudinal distribution of solar flare has been investigated by (Howard, 1974) and found about 95% of total solar flare are confined to latitude below 40^0 in both the hemisphere of sun. The maximum cosmic ray modulation is observed by (Iucci et al, 1986) below 40^0 of the meridian in plane crossing the flare site. The north-south distribution of solar flare solar flare during solar cycle 23 studied by (Joshi et al, 2006) and found that solar flare activity during solar cycle 23 is low compared to previous solar cycle indicating the violation of Gnevyshev-Ohl rule. Recently, (Shrivastava et al, 2011) investigated longitudinal distribution of major solar flare and their association with CME and FD for the period of 1996 to 2010. These studies reveal that 63% of halo CME and FD associated solar flare occur in western hemisphere and 37% of these occur in eastern hemisphere.

Here, we have carried out a comparative study of helio-latitudinal distribution of B-type and N-type major solar flare in association with CME's and FD's. The CME and FD associated solar flare are studied to investigate their impact on cosmic ray intensity variation.

DATA ANALYSIS

The data used in present study have been collect form major solar flare list published in the SGD (Solar Geophysical Data Prompt Report) during the period of 1996 to 2010 covering complete period of solar cycle 23. All the major solar flare which has optical imp ≥ 1 has been noted. Since the number of solar flares above 50^0 latitude are very few are merged in one group. Only those Hα solar flares which are found to be associated in time either with halo/partial-halo CMEs or Fds have been taken in account for this study. The association of solar flares and CME_S responsible for cosmic ray intensity decreases by magnitude ≥ 3.5% during the period 1996 to 2010 has also been investigated. All Fds events with magnitude ≥

3.5% are recorded by (Moscow Neutron Monitor Station, cut off rigidity 2.43GV). The concerning data from Moscow are not available; we used that data from another station, which have nearly the same cut off rigidity as the Moscow station. We have considered the onset data/time and the magnitude (in %) of FD_S.

Table 1: North-South heliographic distribution of solar flares in different categories.

Combination	NORTH	SOUTH	TOTAL	%NORTH	%SOUTH	ASYMMETRY
B-TYPE SF	129	112	241	53.5	46.4	0.14
B-TYPE SF + HCME	55	41	96	57.2	42.7	0.29
B-TYPE SF + PHCME	48	42	90	53.3	46.6	0.13
B-TYPE SF + FD	12	11	23	52.1	47.8	0.08
N-TYPE SF	257	229	486	52.8	47.1	0.11
N-TYPE SF + HCME	78	59	137	56.9	43	0.27
N-TYPE SF + PHCME	103	91	194	53	46.9	0.12
N-TYPE SF + FD	17	16	33	51.5	48.4	0.06

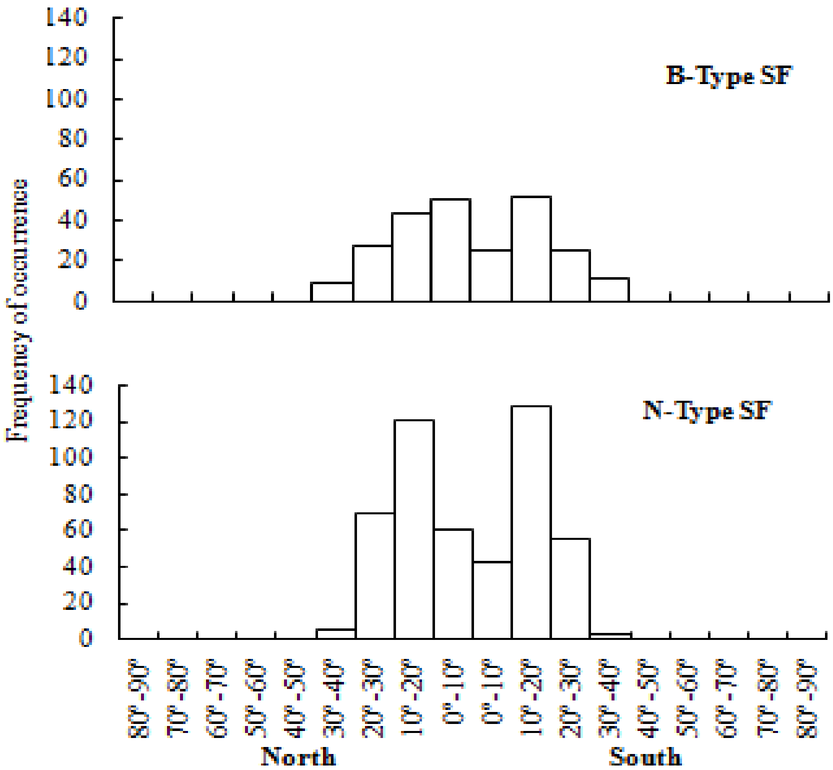

Fig. 1: A Helio-latitudinal distributions of B-type & N-type solar flares (1996-2010).

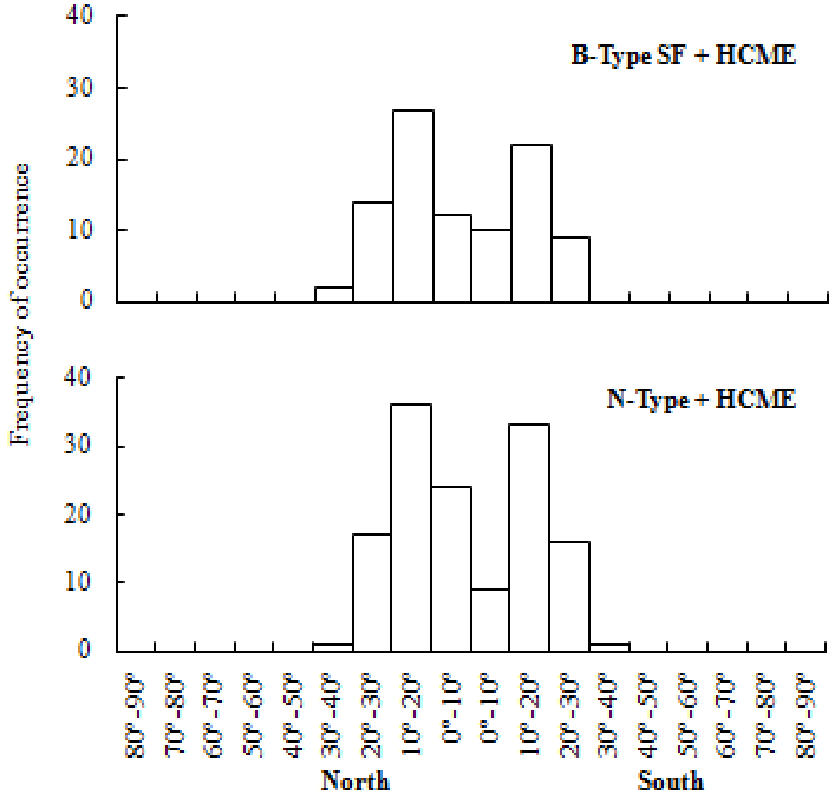

Fig. 2: A Helio-latitudinal distributions of B-type & N-type in association with halo CMEs solar flares (1996-2010).

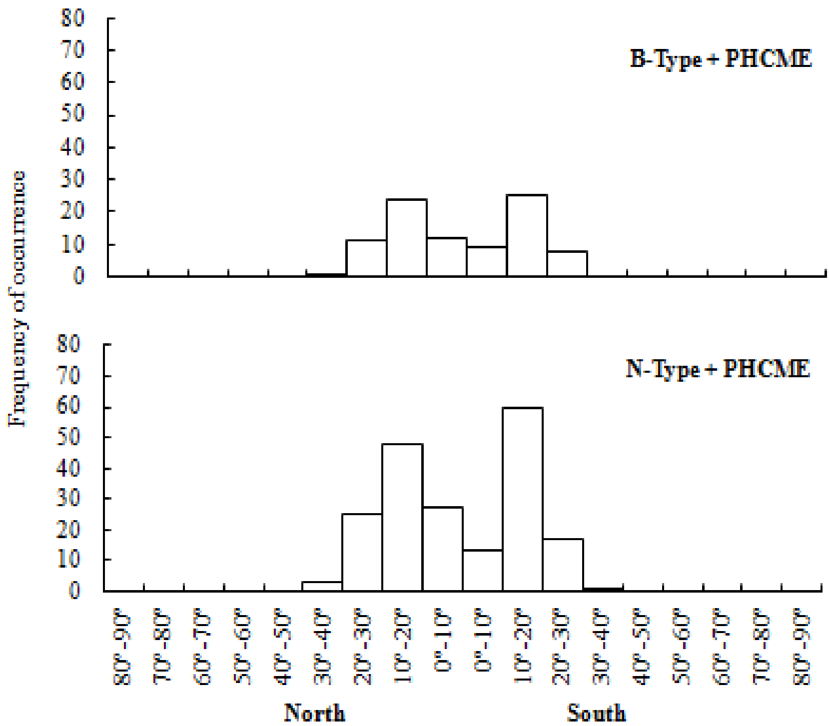

Fig. 3: A Helio-latitudinal distributions of B-type & N-type in association with partial halo CMEs solar flares (1996-2010).

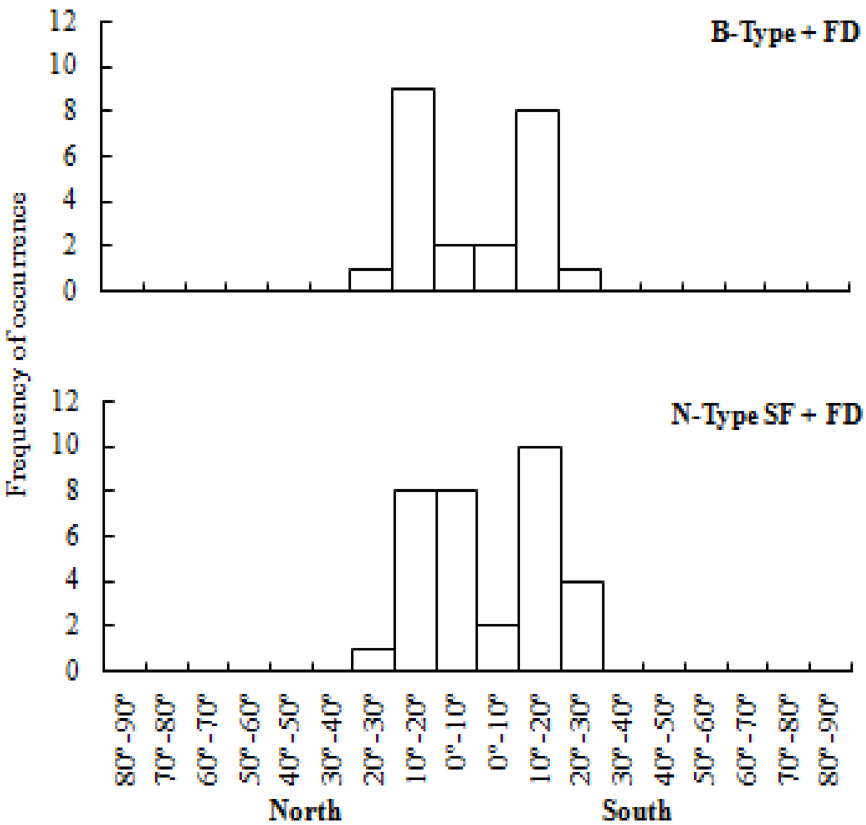

Fig. 4: A Helio-latitudinal distribution of B-type & N-type in association with Forbush decreases solar flares (1996-2010).

RESULT AND DISCUSSION

Solar active region were identified by location of major solar flare, which eject spacious amount of energy and matter from solar atmosphere and affected the cosmic ray intensity. A major solar flare having optical imp ≥ 1 in association with either with halo/partial-halo CMEs or only Fds are identified. The north south distribution of solar flare association with different solar activity is shown in table 1.We are interested in location of active regions producing major solar flare. Shrivastava and Singh (2005) report that the flares occurring between 0° W-40°W is found to more effective in producing Fds for solar cycle 22. Recently Shrivastava and Jothe (2011) for work on period 2001 to 2006 in solar cycle 23 found to the magnitudes of Fds higher when in association of halo CMEs. In this analysis, we have extended our previous work to recent period and adopting a slightly different approach then as used in earlier work of Shrivastava and Jothe (2011). Figure (1) shows that the heliographic distribution in latitudinal of all B-type and N-type major solar flares on solar disk for the period 1996 to 2010 in solar cycle 23.It is noted that an almost equal number of flares occurred in both the northern and southern hemisphere. In Figure (2) shows that the heliographic distribution in latitudinal of all B-type and N-type major solar flares association with halo CMEs on solar disk for the period 1996 to 2010 in solar cycle 23 equal number of flares occurred in both the northern and southern hemisphere. Similarly Figure (3) shows that the heliographic distribution in latitudinal of all B-type and N-type major solar flares association with partial halo CMEs on solar disk for the period 1996 to 2010 in solar cycle 23 are identical on the both the northern and southern hemisphere. However, slight increases are seen in the northern hemisphere.

Now all B-type and N-type major solar flares which is association with Fds shows in Figure (4) in case of B-type out of 23 such flare,12 are found in the northern hemisphere and 11 flares are found in the southern hemisphere. Similarly for N-type out of 33 such flare, 17 are found in the northern hemisphere and 16 flares are found in the southern hemisphere. The percentages of events associated with Fds are higher in the northern hemisphere, as given in table (1).On the basis of this analysis; we can infer that the majority of solar flares occurring in the northern hemisphere of the sun are more effective in producing Fds.

CONCLUSION

In this work, we have determined the distribution of Hα B-type and N-type solar flare on solar disk and their association with CMEs and Fds. The following conclusion can draw from our study.

i) Major Hα B-type solar flares distributed all over the heliographic latitude are found 0.7 % more in the northern hemisphere as compare to N-type solar flare.

ii) Major Hα B-type solar flare distributed all over the heliographic latitude which is association with halo/partial CMEs are found 0.3% more in the northern hemisphere as compare to N-type solar flare which is association with halo/partial CMEs.

iii) Major Hα B-type solar flare distributed all over the heliographic latitude which is association with Fds occurring in northern hemisphere are found 0.6% more in the northern hemisphere as compare to N-type solar flare which is association with Fds.

iv) Major Hα solar flare distributed all over the heliographic latitude. The northern hemispheres are more effective to produce forbush decreases in B-Types solar flare as compare to N-type solar flare. Over all northern hemispheres dominate for producing forbush decreases in both B-type and N-type solar flare.

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