Distribution of solar flares around the sun and their association with Forbush decreases

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Abstract

Solar flare is a gignatic discharge of lighting and solar mass due to abrupt release of the energy stored in the magnetic fields in the zone around the sunspots. In this work we have studied the relation of occurrence of solar flares in different hemispheric zones and cosmic ray Forbush decreases for the period of 1986 to 2000. It is investigated that the flares having the optical importance $\geq$ 2B might be the reason for Fobush decreases. Northern zone between 15° to 30° and southern zone between 0° to 30° are found most effective to produce Forbush decreases.

1. Introduction

It is generally accepted that reconnection processes that depend on magnetic topology the flare region cause bigger solar flare. The majority of transient decreases in the galactic cosmic ray intensity have been generally connected with solar flares. However, their source is not yet established beyond doubt, past studies revealed the significance of helio-longitudinal position of the solar flares, which are more geo-effective. (Agrawal and Singh 1976; Garde *et al.* 1983; Shrivastava *et al.* 1983). Duggal and Pomerantz 1977 tried to show that the majority of Forbush decreases are related to the passage of active centre and can not be assigned directly to the specific solar flares. On the other hand, Iucci *et al.* 1977, found that the Forbush decrease in cosmic ray intensity are produced by solar flares associated with type IV burst.

Recently, Shrivastava, 2001 and Shrivastava and Singh, 2002 have reported that the association of B-type solar flares with coronal mass ejection might be one of the major cause for producing geomagnetic disturbances as well as Forbush decreases.

In this work, an attempt has been made to find a relationship between occurrence of solar flares and their association with Forbush decreases.

pp. 3593–3596

Table 1. East-West and North-South distribution of solar flares for the period 1986 to 2000.

Solar flares	East	West	A = 2 (E–W) / (E+W)	North	South	A = 2 (N–S) / (N+S)
Flares for Imp. = 1	41	41	0.0	38	43	-0.12
Flares for Imp. = 2	37	24	0.42	35	27	0.25
Flares for Imp. = 3	14	8	0.54	15	7	0.72
Flares for Imp.≥2B	41	28	0.37	46	23	0.16

2. Methods

For the present study, we have chosen major solar flares as categorised in solar geophysical prompt report for the interval 1986 to 2000. We have noted all the major flares which have optical importance ≥ 1 and associated with Forbush decrease events only those major solar flares have been considered which occurred three days prior to the onset of the Forbush decrease.

3. Results

We have identified 165 solar flares having the optical importance $\geq$ 1 and associated with Forbush decreases. Table 1, shows the helio-latitudinal and helio-longitudinal distribution of solar flares in different categories. It is apparent from the table that the flare distribution pattern is almost same in both the hemisphere for the flare importance $\geq$ 1, 2. However, we can observe larger number of flares in northern and eastern zones. Fig. 1, shows the frequency distribution of solar flares ($\geq$ 2B) and associated with Forbush decreases for different helio-latitudinal zones. The flare location has been summed over 15 heliographic longitude interval. It is observed from Fig. 1 that large number of flares in association with Fds occur in northern zone. Zone between 15° north to 30° north is found most effective in producing Forbush type decreases in cosmic rays. Similar analysis has been done for solar longitudinal zone. Fig. 2 shows that frequency of occurrence of solar flares with different longitudinal zones. It is observed that eastern flares and zone between 0° east to 30° east are most effective in producing Forbush decreases.

It is noted that the flares having the optical importance $\geq$ 2B seems to be greater role in producing cosmic ray Forbush decreases. We have further derived the north-south and east-west asymmetries. In both the cases asymmetries of solar flares increases with flare importance.

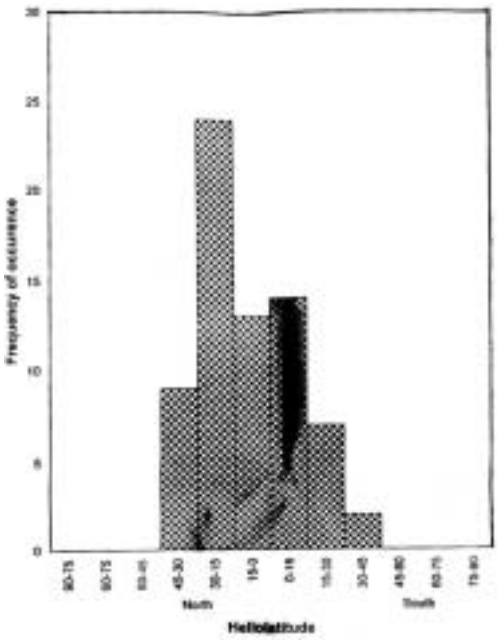

Fig. 1. Shows the histogram of the frequency of occurence of solar flares (> 2B) associated with Fds for different Heliolatitudinal zones.

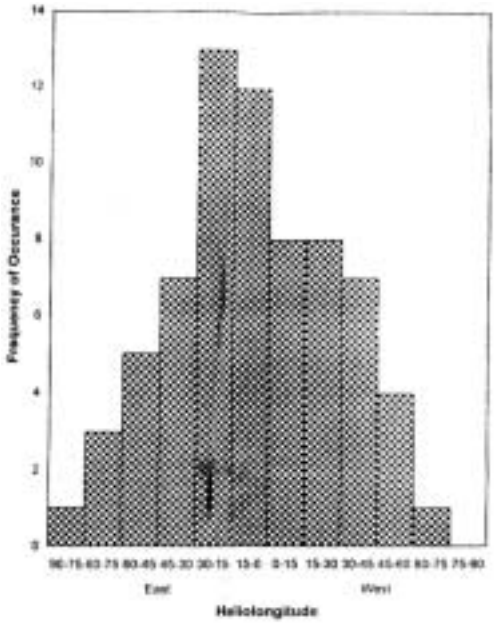

Fig. 2. Shows the histogram of the frequency of occurence of solar flares (> 2B) associated with Fds for different Heliolongitudinal zones.

4. Discussion

It is observed that the larger number of solar flares observed in northern/eastern hemisphere is probably associated with the preponderance of the sunspot numbers in that hemisphere. 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 (Hansen, 1973). It is noted that solar flares occurring near the centre of visible disk are most efficient in producing the Forbush decreases. It is observed that the more than 60% Forbush decreases are produced by a selective zones of northern and eastern hemisphere.

Results of analysis indicate that the magnetic of cosmic ray Forbush decrease is depend upon the importance of pattern flares in general. The average magnitude of Forbush decreases is maximum for the importance of $\geq$ 2B solar flares as would be expected of the plasma and fields evolve to generate shock waves somewhere in between sun and earth whose size and strength depend upon the importance of solar flares. We significantly observed N-S and E-W asymmetry for Forbush decreases, though it is more pronounced for flares having higher optical importance. This asymmetry is mainly due to a asymmetrical distribution of solar flares.

5. Conclusions

(i) Solar flares $\geq$ 2B are found most effective in producing Forbush decreases.

(ii) It is concluded that the flares and zones between 15° north to 30° north and 0° east to 30° east are found most effective in producing Forbush decreases.

(iii) It is observed that north-south and east-west asymmetries of solar flares rapidly increases with flare importance.

Acknowledgement

Author thanks the world data centre — A for providing the data. Author is also grateful to Dr. Prashanti Shrivastava for suggestions and helpful discussion.

References

1. Agrawal, S. P., Singh, R. L. 1976. *Indian J. of Radio & Space Physics.* **5**, 330.
2. Duggal, S. P., Pomeretz, M. A. 1977. *J. Geophys. Res.* **82**, 2170.
3. Garde, S. K., Jain, A. K., Pandey, P. K., Shrivastava, P. K. 1983. *Proc. 18th Int. Cos. ray conf.* Vol. **3**, 278.
4. Hanseen, E. T. 1973. *Rev. Geophys. Space Phys.* **11**, 469.
5. Iucci, N., Parisi, M., Storini, M., Villoresi, G. 1977. *Proc. 15th Int. Cos. Ray Conf.* **3**, 329.
6. Shrivastava, P. K., Tiwari, A. K., Awasthi, D. S. 1983. *Proc. National Space Science Symposium*, Poona. 352.
7. Shrivastava, P. K. 2001. *Proc. 27th Int. Cos. Ray Conf.* **9**, 3481.
8. Shrivastava, P. K., Singh, G. N. 2002. *Earth, Moon and Planet.* **91**, 1.