29th International Cosmic Ray Conference Pune (2005) **1**, 273-276

Identification of Solar Features causing Geomagnetic Storms during 1978-95

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One hundred and seventy six geomagnetic storms (GMSs) of Severe (H≥400γ), Moderately Severe (250 γ <H<400 γ) and Moderate (H≤250 γ) with planetary index, Ap ≥20 have been investigated during the period 1978-95 and their possible interplanetary and solar causes are looked upon. It is observed that planetary index Ap increases after the occurrence of GMSs and acquires its maximum value on the day of maximum activity. Solar features like Hα, Xray – solar flares, active prominences and disappearing filaments (APDFs) have occurred more in lower heliographic latitudinal /longitudinal zones and produces large no of GMSs. Polar coronal hole intensity founded to be more dominant feature in producing the GMSs. The statistical sampling of four putative solar causes of GMSs at the earth is identified leading magnetic disturbances with Ap ≥20.

1. Introduction:

Geomagnetic disturbances are generally represented by geomagnetic storms. The geospace environment is dominated by disturbances directly by the Sun, such as Solar Flares, APDFs, Coronal Holes and Coronal Mass Ejections which are responsible for some large geomagnetic storms or else by disturbances, e.g. sub storm, occurring with in the magnetosphere that are ultimately caused by solar wind variations[1]. The intense disturbances in geomagnetic field are known as geomagnetic storms. The disturbances due to geomagnetic storms and substorms together are termed as geomagnetic activity. The geomagnetic planetary index Ap represents the degree of global geomagnetic variability of each day and widely used to define the state of geomagnetic field. By looking into the different phases of geomagnetic storms, it is observed that the increase in the solar wind velocity causes the increase in the value of Ap index leading to increase the level of geomagnetic disturbance. The large variations in the geomagnetic field are mostly caused by the disturbances on the solar atmosphere, which reaches on the Earth in the form of plasma and field through interplanetary medium. There are many solar activities eg, solar flares, active prominences and disappearing filaments, coronal holes, coronal mass ejections etc in the solar atmosphere, so a unique solar source for these geomagnetic activities [2].

2. Data Analysis

The Solar causes of Severe (H <400nT) Moderately Severe (250 ≤H ≤ 400nT) and Moderate (H < 250 nT) geomagnetic storms with Ap≥20 during the period 1978-1995 total 176 GMSs have been investigated. For this solar wind plasma (SWP) Interplanetary magnetic field (IMF) data compiled by King and Louzens in different volumes of interplanetary medium data book from NSSDC and polar coronal hole intensity data compiled by A. Sanchez, Sonora Mexico were used. For association of GMSs with solar features Solar Geophysical Data is being used (1978-1995).

3. Results and Discussion

The correlation coefficient between the yearly occurrence of GMSs and Solar features such as Hα, X-ray Solar flares, Hα+Xray Solar flares, APDFs and Coronal Hole Intensity has been calculated and found to be 0.82,0.96,0.94,0.95 and 1. The solar feature maximum coronal hole intensity is found to posses a very good correlation. Frequency histogram of Hα-, X-ray Solar flares have been plotted in Fig 1 and 2. It is observed that no Hα-, X ray Solar flares have occurred beyond 40^0 N and 40^0 S [3] . However the distribution of Hα-, X ray Solar flares has been observed through out from 0^0 to 90^0 East to 0^0 to 90^0 West. Flare events in the northern hemisphere are larger then the southern hemisphere. Similarly flare events in the western hemisphere to the eastern hemisphere are little larger. This shows N-S and E-W asymmetry. It is observed from the Fig 3 (a) and (b) that maximum number of GMSs are associated with importance of SF, SN, 1N, 1B of each Hα and X ray solar flares. Importance of SB of X ray solar flares cannot be ignored. Importance of SF is more associated with GMSs. No significant correlation between magnitude (Intensity) of Total GMSs and importance of Hα, X ray solar flares have been observed. It is statistically found that 65.14%, 56.00%, 72.17% and 100% Total (S+MS+M) GMSs are associated with Hα, X ray Solar flares, APDFs and polar coronal hole maximum intensity. It is statistically observed that polar coronal hole intensity founded to be more dominant feature in producing the GMSs. It is observed that the correlation coefficient is better in the case of Severe GMSs(.99) followed by Moderate (.97) and Moderately Severe (.94) GMSs.

4. Conclusions:

1. Hα solar flares have occurred with in lower Helio graphic latitude (0-40^0) N and (0-40^0) S and Helio longitude $(0\text{-}60)^0$ E and $(0\text{-}60)^0$ W are associated with large number of GMSs. No Hα, X ray solar flares have occurred beyond 40^0 N and 40^0 S. The distribution of Hα and X ray solar flares has been observed spread through out from 0^0 to 90^0 east to 0^0 to 90^0 west.
2. The APDFs observed to be more effective when located at the extremes Helio longitudinally i.e. 80^0 to 90^0 East and West.
3. Hα-, X-ray Solar flares and APDFs are accompanied by polar coronal hole maximum intensity.
4. Maximum number of GMSs is associated with importance of SF, SN, 1N, 1B of each Hα and X-ray Solar flares. Importance of 1B cannot be ignored. No significant correlation between magnitude (intensity) of GMSs and importance of Hα, Xray Solar flares have been observed.
5. Maximum no of GMSs occurred during the entire period of consideration ie, 1978-95 has occurred during the year 1989 only.
6. 65.14%, 56%, 72.17% and 100% of Total (S + MS + M) type GMSs are associated with Hα, X ray solar flares, APDFs and polar coronal hole maximum intensity.
7. Total GMSs are closely associated with polar coronal hole maximum intensity
8. Some how the solar feature maximum coronal hole intensity is found to posses a very good correlation (1) with the occurrence frequency of GMSs.

5. Acknowledgements

I am thankful to to Dr. Santosh Kumar, M.P. Yadav, Erik Gomez for encouragement and also to the anonymous referees for their valuable suggestions.

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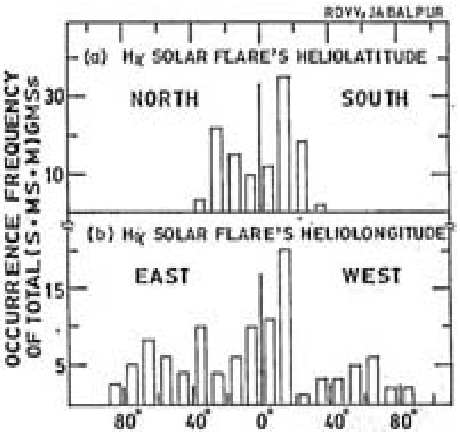

Figure 1. Occurrence frequency of Hα Solar Flares (a) Helio-latitude and (b) Helio- longitude associated with Total (S + MS + M) type GMSs during the period 1978-95.

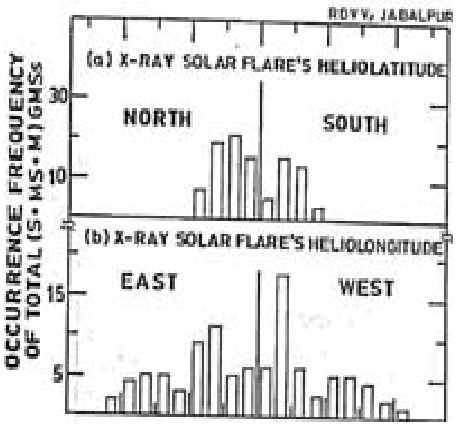

Figure 2. Occurrence frequency of X-ray Solar flares (a) Helio-latitude and (b) Helio-longitude associated with Total (S + MS + M) type GMSs during the period 1978-95.

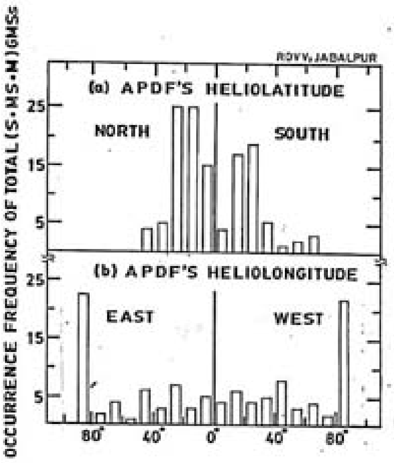

Figure3. Occurrence frequency of APDFs (a) Helio-latitude and (b) Helio-longitude associated with Total (S + MS + M) type GMSs during the period 1978-95.

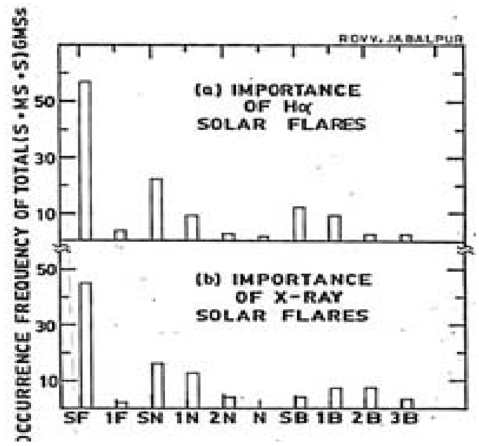

Figure4. The Occurrence frequency of the importance of (a) Hα Solar flares and (b) X-ray Solar flares associated with Total (S + MS + M) type GMSs during the period 1978-95.

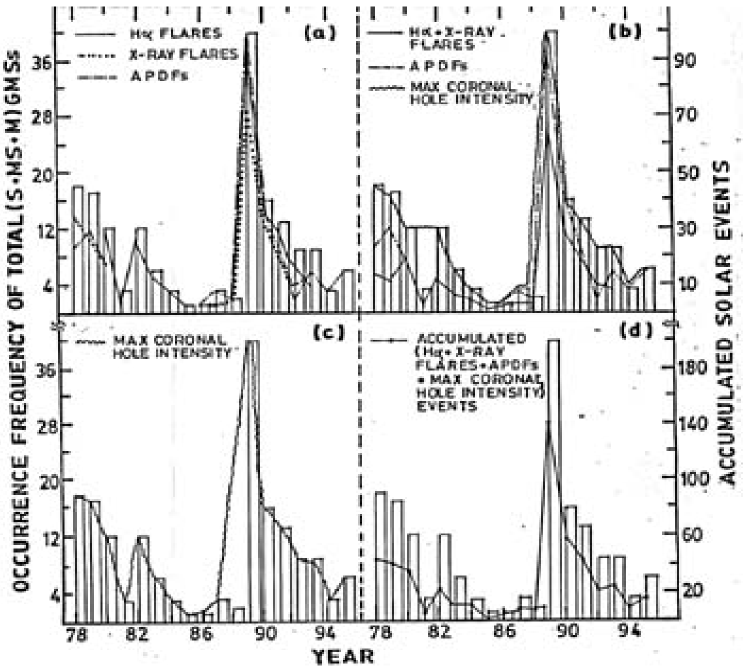

Figure5. Occurrence frequency of Total (S + MS + M) type GMSs with their associated Solar features such as Hα-, X-ray- Solar flares, APDFs, CHMI and their accumulated effects during the period 1978-95.