Ultra Scientist Vol. 24(1)B, 81-84 (2012).

Impact of high and low diurnal wave train events on geomagnetic disturbance

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(Acceptance Date 23th January, 2012)

Abstract

Cosmic ray intensity shows significant diurnal variation of day to day basis with wave trains of high amplitude anisotropic events (HDW) and low amplitude anisotropic events (LDW). Using the pressure corrected data of neutron monitor at Kiel (2.36 GV) for Solar cycles 22 & 23, harmonic analysis was performed to obtain harmonics. Trends were removed by subtracting 24 hours running average from the hourly values. The events of high & low amplitude wave trains were sorted out, total 54 events was selected for solar cycle 22, and 63 events were selected for solar cycle 23. On the basis of geomagnetic disturbance index Ap group (0-5, 6-10, 11-14, 15-18,>19) events were again sorted out of different durations.

It is concluded that low diurnal amplitude wave train event of different durations does not exhibit any effect on geomagnetic disturbances, while high diurnal amplitude wave train event of all durations, equally, are effecting geomagnetic disturbances.

Introduction

It is well known that cosmic-ray diurnal anisotropy is caused by the co-rotation of galactic cosmic-ray particles with the magnetic field of the solar system. However, the neutron monitor observations indicate that the anisotropy vector exhibits a significant variability in amplitude and time of maximum, when considered on a long-term basis. The studies of the long-term behaviour of diurnal anisotropy[1,3,4,6] have indicated that the anisotropy consists of two components, one related to the 22-year solar cycle and the other related to the 11-year solar activity cycle. Further, Agrawal & Bercovitch[1] have also shown that the direction of the 22-

year component is perpendicular to the diurnal anisotropy vector. As reported by earlier workers, the statistical relationship between Ap and diurnal amplitude and also with phase of the diurnal variation on a day-to-day basis was found to change drastically, during the period[2] 1968 to 1973, as well as during the period[8] 1989-04. In fact, it has been demonstrated that the Ap index is highly correlated with the mean fluctuation in the amplitude of the interplanetary magnetic field, which in turn is related to the diffusive component in the convection-diffusion theory of daily variation[7]. Further, we have studied the behaviour of the enhanced and low amplitude diurnal wave train events and tried to establish the relationship between High/Low diurnal amplitude wave train events (HDW and LDW) and geomagnetic disturbances. Moreover, Ap has also been found to be related to the solar wind velocity, which is related to the convective component[5]. It is therefore, natural to further examine the relationship between Ap and the diurnal variation.

Data and Method of Analysis:

In the analysis cosmic ray intensity data for Kiel neutron monitor station and geomagnetic disturbance index Ap data has been taken from NSSDC OMNI Web data explorer.

In the further investigation, events of high and low amplitude were sorted out on the basis of following strict selection criteria, for the period of 1986 to 2008 (solar cycle 22 & 23). Based on the observed diurnal variation vectors at Kiel neutron monitor, the individual days are classified into two groups as follows:

(i) Four (or more) consecutive days with 0.5% diurnal amplitude or more amplitude are taken as high amplitude wave train events (HDW).

(ii) Four (or more) consecutive days with 0.2% diurnal amplitude or less than 0.2%, are taken as low amplitude wave train events (LDW). For each event, the average diurnal variation is determined by vector averaging of the diurnal variation derived for each individual day of the events. The daily geomagnetic disturbance index Ap of geomagnetic field have been taken for the same time period of analysis *i.e.* from 1986 to 2008. The days are then divided into five groups according to increasing value of Ap index. Higher Ap groups are an indicator of more disturbed interplanetary medium.

Discussion and Results

Kiel neutron monitor data have been used to derive the daily vector of cosmic ray anisotropy.

We have made detail investigation of geomagnetic disturbance relationship with cosmic ray intensity I^{st} harmonic amplitude over the complete time period of two solar cycles 22 & 23 from 1986-2008 and tried to interpret the behaviour of diurnal anisotropy and their effect on geomagnetic field.

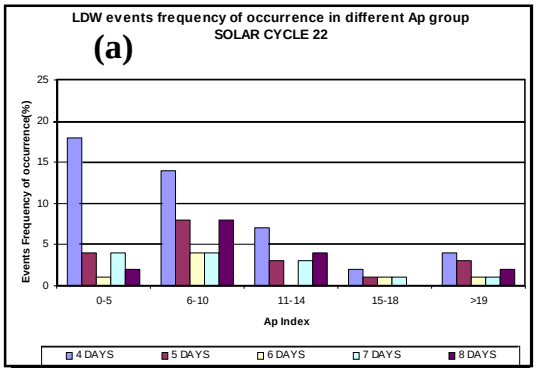
In figure 1(a), we show the percentage of occurrence of Low diurnal amplitude wave train events (LDW) in different groups of Ap for the period 1986-1996, which covers complete solar cycle 22.

Similarly, figure 1(b) shows the percentage of occurrence of Low diurnal amplitude wave train events (LDW) in different groups of Ap for complete solar cycle 23.

In figure 2 (a), the percentage of occurrence of High diurnal amplitude wave train events (HDW) in different groups of Ap for the period 1986-1996 is shown (solar cycle 22).

Similarly, figure 2(b) shows the percentage of occurrence of High diurnal amplitude wave train events (HDW) in different groups of Ap for complete solar cycle 23.

The occurrence of High amplitude diurnal wave train events are found in maximum number during the maximum solar activity period and also in the declining phase of the solar activity.



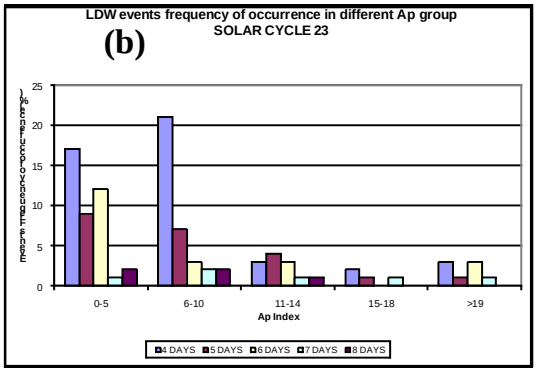
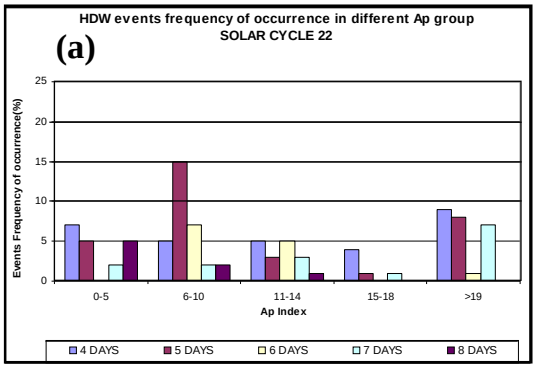


Figure: 1 (a) Shows the frequency of occurrence of Low Amplitude wave train events in different Ap groups of cosmic ray intensity 1st Harmonic for Solar Cycle 22.

Figure: 1 (b) Shows the frequency of occurrence of Low Amplitude wave train events in different Ap groups of cosmic ray intensity 1st Harmonic for Solar Cycle 23.



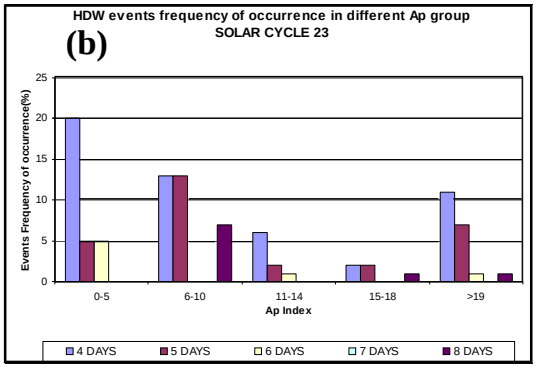


Figure: 2 (a) Shows the frequency of occurrence of high Amplitude wave train events in different Ap groups of cosmic ray intensity 1st Harmonic for Solar Cycle 22.

Figure: 2 (b) Shows the frequency of occurrence of high Amplitude wave train events in different Ap groups of cosmic ray intensity 1st Harmonic for Solar Cycle 23.

Conclusions

From the above observation we conclude that:

1. Most of the LDW events occur (On the basis of their duration) in 0-5 and 6-10 days geomagnetic disturbance index Ap group.

2. HDW events occurrence is wide spreaded in all geomagnetic disturbance index Ap group (Small as well as longer duration of events).

3. HDW events relationship is established with geomagnetic disturbance index Ap.

Acknowledgement

Authors are thankful to NASA officials for the OMNI web data provided in public domain. Authors are also thankful to the Principal, Govt. T.R.S. College, Rewa (M.P.) for providing research facilities in the institute.

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