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Study of wave train events of cosmic rays on different phases of solar cycles 22 & 23

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Abstract

The average characteristics of diurnal variation have been found to vary with solar cycle different phases, where the variation is much larger at higher energies. A number of investigators have reported short as well as long term characteristics of the daily variation, To observe the impact of solar cycle variations (22 and 23) on high as well as low amplitude wave train events (LDW and HDW), the events were classified on the basis of different phases of solar cycles, *i.e*. the minimum solar activity time period, the maximum solar activity time period, the declining phase of solar cycle. It was observed that low amplitude wave train events are dominant in every phase of solar cycle except in the time period of maximum solar activity time period, where the high amplitude diurnal wave train events are dominant. In the minimum solar activity time period only low amplitude wave train events are observed in both solar cycles.

Introduction

The existence of consecutive days having abnormally high & low diurnal amplitude in the daily variation has been reported several time before[2,5,6] with the explanation of source and sinks in anti garden-hose and garden-hose direction; though low amplitude wave trains events were not explainable in terms of co rotation. The average daily variation of cosmic ray intensity generally consists of diurnal variation, Semi-diurnal variation & Tri-diurnal variation with significant amplitudes, the amplitude of the diurnal variation (Ist harmonic) at a high/middle latitude station has been found to be of the order of 0.3 to 0.4 %, whereas the amplitude of two higher harmonics is found to be of the order of 0.08% and 0.02% respectively (Pomerantz *et.al.*,1960) the average characteristics have also been found to vary with the solar cycle. The diurnal variation might be influenced by the polarity of the magnetic field[4],

so that the largest diurnal variation is observed during the days when the daily average magnetic field is directed outward from the sun. A number of investigators have reported the short term characteristics of the daily variation. Where they have selected continually occurring days of high amplitude and low amplitudes of diurnal variation[1,6,7].

Method of Analysis :

The pressure corrected hourly neutron monitor data of Kiel neutron monitor station (54.3^0N, 10.1^0E, cut-off rigidity 2.36 GV) has been used for the whole analysis time period (solar cycle 22 and 23). To study the characteristics of low amplitude wave Train (LDW) and high amplitude wave Train events (HDW) during solar cycle 22 and 23, the hourly cosmic ray data (Kiel neutron monitor) has been subjected to harmonic analysis after removing long term trend (using 24 hr moving average) and days having UT effect has also been removed, further the LDW and HDW events were selected under strict selection criteria[6], as follows:

(i) Four (or more) consecutive days with observed diurnal amplitude ≥ 0.6% or five (or more) consecutive days with observed diurnal amplitude ≥ 0.6% in which a day in between is having amplitude<0.6% but not <0.4% is also included, these are taken as high amplitude wave train events (HDW).

(ii) Four (or more) consecutive days in which the observed diurnal amplitude is ≤ 0.2%; are taken as the low amplitude wave train events (LDW). From the classification we obtained 36 high amplitude wave trains and 83 low amplitude wave trains events occurring during complete solar cycle 22 and 23 (total number of events 119).

The high and low amplitude wave train events (solar cycle 22 and 23) so far obtained were further classified in different groups on the basis of their time duration, the individual events for each solar cycle were classified into five groups, 4 days, 5 days, 6 days, 7 days, 8 days and 9 days/ or of longer duration. The occurrence of high amplitude days is found to be positively correlated with the sunspot cycle.

Result and Discussion

The average characteristics of diurnal variation have been found to vary with solar cycle different phases, where the variation is much larger at higher energies. A number of investigators have reported short as well as long term characteristics of the daily variation, where they have selected continually occurring days of high and low amplitudes of diurnal variation[1,6,9,3].

To observe the impact of solar cycle variations on high as well as low amplitude wave train events (LDW and HDW), the events were further classified on the basis of different phases of solar cycle, *i.e.* the minimum solar activity time period, the maximum solar activity time period, the declining phase of solar cycle.

Figure 1 shows frequency of occurrence of low amplitude wave train events and high amplitude wave train events (LDW and HDW) from 1985 to 2008,in different phases of solar cycles, *i.e.* for complete solar cycle 22 and 23 (maximum and minimum solar activity time period). From the figure it is clearly evident

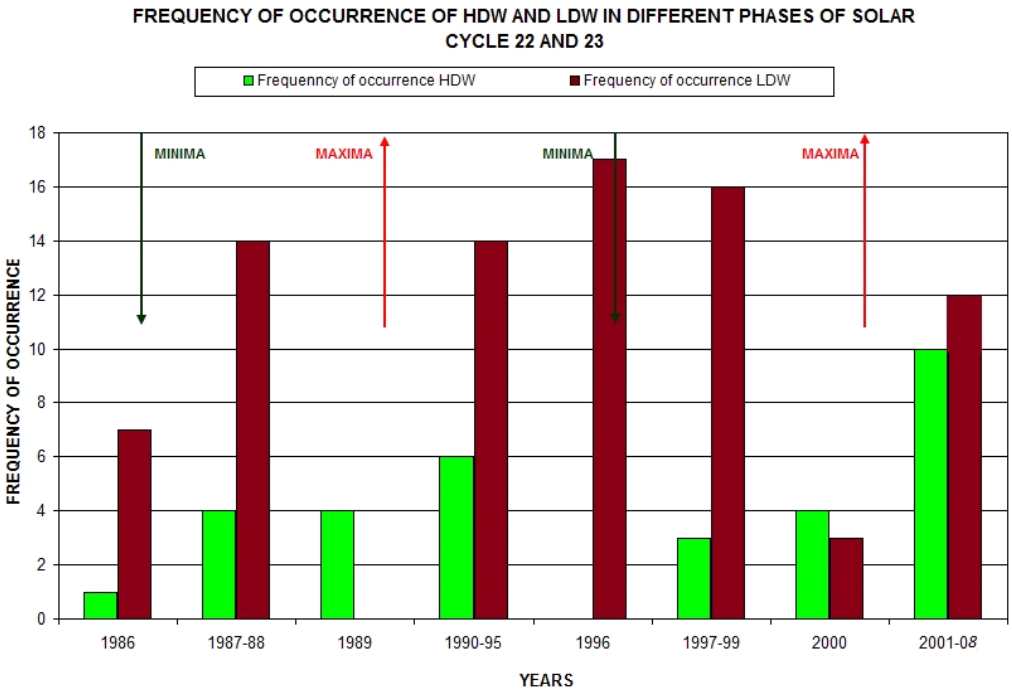

Figure 1. Shows the frequency of HDW and LDW in different phases for complete solar cycle 22 and 23 (1986-2008)

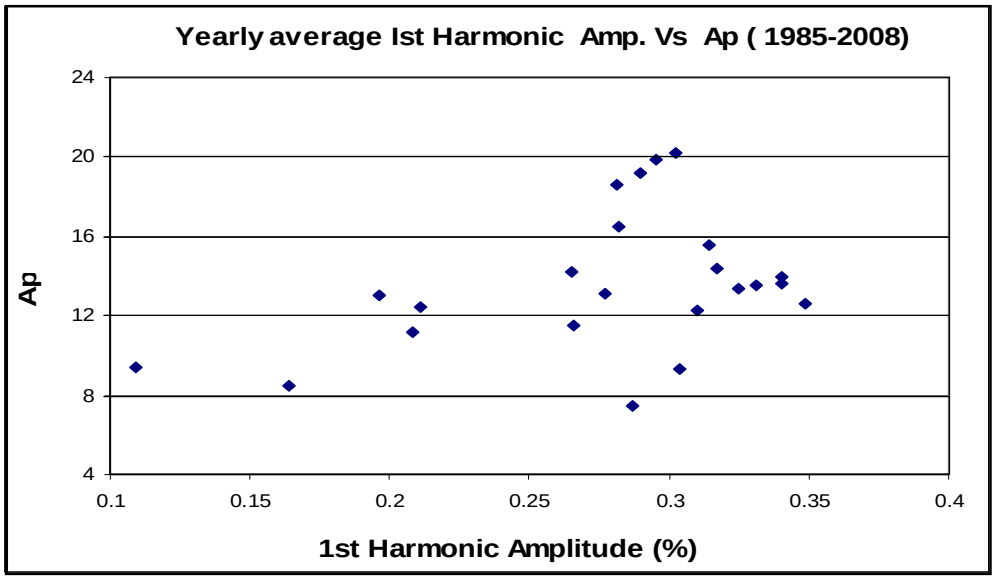

Figure 2. Shows the cross plot between annual average of first harmonic amplitude with geomagnetic disturbance index (Ap) from 1985-2008(solar cycle 22 and23)

that low amplitude wave train events are dominant in every phase of solar cycle except in the time period of maximum solar activity time period, where the high amplitude diurnal wave train events are much more than low amplitude wave train events in maximum solar activity time period[8]. In the minimum solar activity time period only low amplitude wave train events are observed in both solar cycles (years 1986-87,1996 -97, 2007-08).

Moreover, the low amplitude wave train events (LDW) are found to be maximum in minimum sun spot activity time period of solar cycle 22 and 23, which is found to be inversely correlated with solar activity.

Figure 2 shows the cross plot between annual average of geomagnetic disturbance index Ap with amplitude of diurnal amplitude for solar cycle 22 and 23. From the figure it is clearly evident that diurnal anisotropy do not reveal any significant correlation with the geomagnetic disturbance index (Ap) on annual average basis.

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