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# Comparative study of semi-diurnal anisotropy on days having different selection criterion

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**Abstract.** Variation of semi-diurnal anisotropy of cosmic ray intensity has been studied using Deep River neutron monitor data for the period 1985-95, on four different groups of days selected using different selection criterion. These are 60 quietest days (60QD), selected by taking 5 quietest days from each month, 120 quiet days (120QD) selected by taking 10 quietest days from each month, Continuous quiet days (CQD) are groups of days having Ap values less than the mean Ap value for all days for 3 continuous days and lastly all days (AD). The distributions of semidiurnal anisotropy values within each group of days have also been considered. The annual average values of semi-diurnal phase and amplitude are observed to show quite similar variations within the statistical errors. The statistical errors are although slightly higher in case of 60QD. The distributions of values are observed to be more regular in case of CQD & 60QD.

## 1 Introduction

The anisotropic modulations in the cosmic ray (CR) intensity on long/short term basis have been studied for diurnal variations as well as for higher harmonics on days satisfying different selection criteria , Kumar et al (1981) have preferred to perform the annual analysis considering 60 geomagnetically quiet days which will be refereed to as 60QD, by choosing 5 quietest days from each month. Rao (1972), Agrawal (1983), Bieber and Evenson (1997) have preferred to perform the analysis on all days in a year. Agrawal et al (1979) considered to perform study over continuos periods where the monthly mean values of diurnal amplitude and/or phase or significantly different to annual average values of these quantities.

A compression study has been performed by evaluating amplitude and phase of semi diurnal anisotropy on 4 different groups of days These groups are firstly 60QD as discussed earlier, secondly 120QD selected by considering 10 quiet most days from each month in a year. Thirdly, continuous quiet days, for this purpose only those days are considered where Ap value remains less than mean annual average Ap value for atleast 3 continuous days, these days have been reffered as CQD and lastly all the 365/366 days of a year referred to as AD.

The comparative study has been performed over the data for Deep River neutron monitor for the period 1985-1995, covering a complete 11-year period.

## 2 Data Analysis

The pressure corrected neutron monitor data has been subjected to Fourier analysis so as to obtain daily values of amplitude and phase of semi diurnal anisotropy.

The daily values of amplitude as well as and phase have been group in different amplitude and phase intervals and histrographic plots for semi-diurnal phase and amplitude for different years have been plotted.

The daily values of semi-diurnal amplitude and phase have been used to estimate the annual average value of amplitude and phase of semi diurnal anisotropy. The statistical errors in these quantities have also been estimated.

## 3 Result And Discussions

The daily values of phase and amplitude of semi-diurnal anisotropy have been grouped in to different equal intervals. The right half of Fig. 1. show the histographic plot of phase of semi-diurnal anisotropy and left half show the histographic plot of amplitude of semi-diurnal anisotropy for four groups of days, for the year 1987, which is the period of minimum solar activity of solar activity cycle (SAC) –22.

The amplitude hystograph shows a peak in the interval of

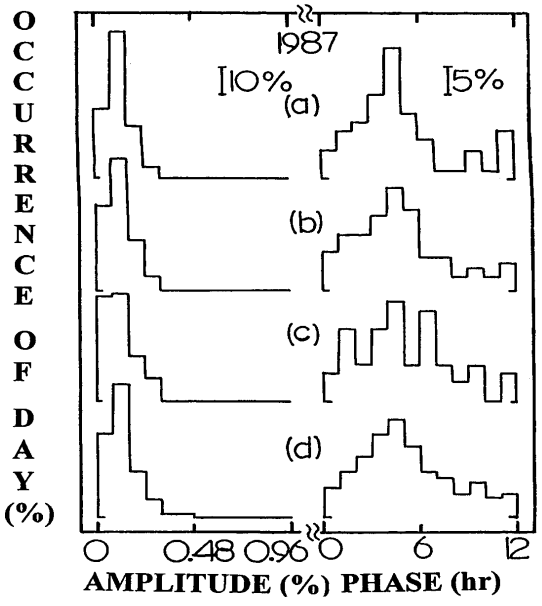


Fig. 1. The histographic plots of ocurrence of days (%) for amplitude (%) and phase (hr) of the semi-diurnal anisotropy in CR intensity during 1987 for (a) 60QD (b) 120QD (c) CQD and (d) AD

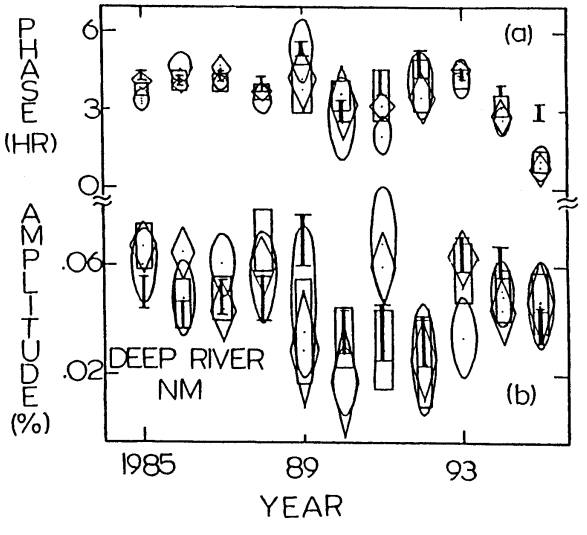


Fig. 2. The annual averag values of (a) phase (hr) in LT (b) amplitude (%) at ground for the semi-diurnal anisotropy during the period 1985-95 for (a) 60QD (O) (b) 120QD (□) (c) CQD (◆) and AD (I). Height of legend represents twice the error contained in the value.

0.08% - 0.16%. The amplitude distribution is quite sharp for 60QD as compared to other groups of days. The amplitude distribution in case of 60QD, 120QD and CQD is confined only to the interval 0-0.32%. On the contrary in case of AD the spread is over a larger range of values.

The hystograph showing the distribution of phase shows a maxima lying in the interval of 4-5 hour. The sharpness of maximum is highest in case of 60QD as compared to other groups of days. The general trend of distribution is similar for all four groups of days.

Identical plots showing the confinement of amplitude and phase values of semi-diurnal anisotropy over a small range in case of 60QD as compared to other groups of days are observed for other years as well. The distribution shows a wide spread values in case of AD for amplitude as well as phase.

In Fig 2., the annual average values of the semi-diurnal phase (in hr) in local time (LT) and the amplitude at ground for the semi-diurnal anisotropy during the period 1985-95 are plotted for Deep River Neutron Monitor. The elliptical symbol ( 0 ) denotes the results for 60QD, the rectangular symbol ( □ ) shows results for 120 QD, the diamond shape symbol ( ♦ ) represents the results for CQD and vertical line ( I ) denotes the results for AD. In all the four cases the height of the legend represents twice the error contained in the values.

The general trend shown by phase of semi-diurnal anisotropy for all the four types of days are quite comparable. However, some statistically significant deviations irrespective of the level of solar activity during some of the years are noticeable, particularly on 60QD, 120QD and CQD when compared with AD. Which is more clearly observable during 1995 where the value of semi-diunal phase is high as compared to other groups of days.

The semi-diurnal amplitude plots also shows the same general trend within the statistical errors for all four types of days. However, the value of semi-diurnal amplitude in case of 120QD is statistically different from that obtained for AD.

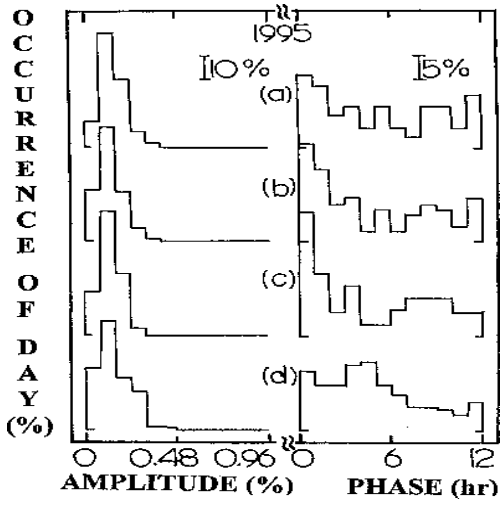


Fig. 1. The histographic plots of ocurrence of days (%) for amplitude (%) and phase (hr) of the semi-diurnal anisotropy in CR intensity during 1995 for (a) 60QD (b) 120QD (c) CQD and (d) AD

During 1991, the semi-diurnal amplitude in higher for 60QD & CQD as compared to 120QD & AD, whereas the semi-diurnal amplitude is low in case of 60QD for the year 1993.

The statistical errors for each type of days in case of phase as well as amplitude observed to increase with the increase in the level of solar activity. However, on the contrary during 1995 where the solar activity has decreased as compared to, the years 1993 and 1994, the statistical errors have relatively increased.

The distribution plots ( histographs ) of phase and amplitudes for the year 1995 are shown in Fig. 3. The amplitude distribution for all the four types of days is similar to that for other years. But the phase distribution is quite flat. The phase of the semi-diurnal anisotropy is spread over the entire range almost uniformly. This wide spread distribution over a wide range has given rise to increase in statistical errors.

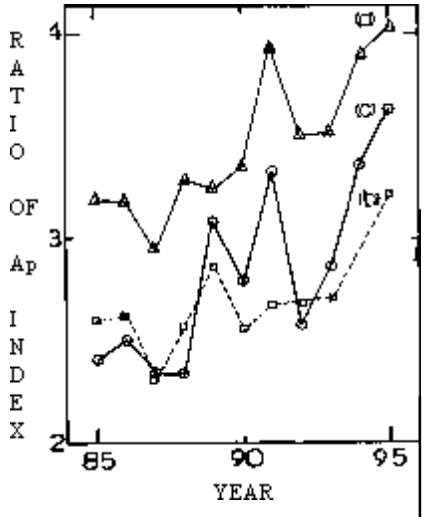


Fig. 4.Plots of the ratio of annual average values of Ap index on Ad with those for (a)60QD [Δ] (b) 120QD [□] ( (c) CQD ( O) during 1985-95.

Fig 4. shows the ratio of annual average values of Ap index on AD with those for other three groups of days. It is observed that a large ratio of Ap index for a particular group of day corresponds to the fact that the values of semi-diurnal amplitude/phase are observed to be different for that group of day as compared to AD. A large value of ratio of Ap index on AD with other groups of days implies that the number of disturbed days in the year is comparatively large. A large ratio of Ap index mean either the number of disturbed days is also large or their corresponding values are very high.

Thus, the distributed days changes the general trend of variation of semi-diurnal anisotropy and hence, it is suggested that for considering the annual average values of semi-diurnal anisotropy 60QD & CQD can be preferred over other two groups of days. The number of days under consideration in case of 60QD or 120QD decreases giving rise to increase in statistical errors. A large ratio of Ap index mean either the number of disturbed days is also large or their corresponding values are very high.

## 4 Conclusion

For long term study of semi-diurnal variations disturbed days must be removed from all days so as to read to better trend study alternatively 60QD, which are convenient for selection can be used for such study. However, the statistical errors are slightly higher due to reduction in number of days.

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