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Results of diurnal anisotropy in cr intensity on different geomagnetic conditions

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Abstract. Cosmic Ray intensity data for a period of eleven years (1985-95; which covers descending phase of the 21st solar cycle and ascending phase of the 22nd solar cycle alongwith the maximum and minimum solar activity periods), have been analysed using four different criteria for selection of days for such analysis. Study of diurnal anisotropy on different criteria shows that the phase of diurnal anisotropy during 1985-91, remains constant within the statistical error limits and in the later period it shifts to early hours in 1992-93 and then it shifts further to earlier hours in 1994 and 95. It is also found that the characteristics of daily variation in cosmic ray intensity are quite comparable for all the four different groups of days, during the period of investigation.

1 Introduction

Association between the Cosmic Ray (CR) intensity and solar transients are well established and effects of changing interplanetary conditions in the interplanetary space are reflected in spatial distribution of CR intensity which also affect geomagnetic activity index Kp or Ap. The anisotropic modulation in CR intensity on long/short term basis has been studied for diurnal anisotropy and for higher harmonics in CR intensity, satisfying different criteria. Kumar et al (1981; 87; 93; 98) studied the diurnal anisotropy on geomagnetically quietest days (60 QD); Whereas, Rao (1972), Agrawal (1983); Bieber and Evanson (1997); Ahluwalia (1999) have opted All Days (AD) for such analysis. Agrawal (1981) considered to perform study over continuous periods, where the monthly mean values of diurnal amplitude and/or phase are significantly different as compared to the annual average values.

This situation led to a search for the most suitable criteria for selection of days for analysis of CR intensity data. In the present paper, an attempt has been made to study the CR diurnal variation on the basis of different criteria.

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2 Data Analysis

Days with lowest values of Ap and Kp are identified as geomagnetically quietest days (QD) and taking five most quiet days from each month of a year, group of days are termed as 60 QD; ten quiet days on monthly basis have been recognised as 120 QD; continuous quiet days, selected on yearly average values of Ap-index (discussed in accompanying paper, Kumar et al, 2001) have been taken as CQD; and where all the days of the year have been taken for studies, the group of days is termed as to 'All Days' (AD).

The Pressure corrected CR intensity data for Deep River neutron monitor (NM) (Cutoff rigidity: 1.02 GV; Lat.: 46.1^{o}N; Long.: 282.5^{o}E; Alt: 145m), during these selected groups of days, has been used to perform the Fourier Analysis to obtain the amplitude and the phase of the diurnal anisotropy in CR intensity. Days with any abnormal behaviour are not considered. Data analysis has been performed for a period of eleven years (1985-95), which covers all the phases of solar activity in a cycle (descending period of 21st solar cycle and ascending period of the 22nd solar cycle alongwith minimum and maximum periods).

3 Results and Discussion

The phase (Hrs) and amplitude (%) at ground on different criteria for Deep River neutron monitoring station have been plotted in Fig. 1, for the period 1985-95, alongwith their respective errors on the particular criteria, calculated on yearly average basis. These errors have been taken into account while drawing conclusions from this analysis. The phase of diurnal anisotropy during this period on different criteria is shown in these plots in Fig. 1, have values atleast partially coinciding; when taken with their respective errors under

the particular criteria, and it may be thus concluded that the time of maximum (LT, Hrs) remains constant within the statistical error limits; during 1985-91, and later to it the phase shifts to early hours in 1992 and 93. It shifts further to earlier hours in 1994 and 95. However, errors under all four groups of days have been found to be greater in 1989 and 1991, but average picture may be worked out using points of coincidence.

We find a sharp decrease in diurnal amplitude in year 1986 as compared to that in 1985. This amplitude value further decreases on the following year; i.e., 1987, and then remains almost constant on a higher value for the period 1988-90. It again falls to lower value in 1991 and gradually attains higher values in 1992, 93 and 94. Once again it decreases in 1995. As it is apparent from Fig. 1 the error in the amplitude is larger on all groups of days during 1989, 90 and 91.

These observations are very clearly depicted in Fig 2, which shows the vector addition diagram of diurnal anisotropy in CR intensity recorded with Deep River neutron monitoring station during the period 1985-95 on different groups of days. It is apparent from these plots that the characteristics of daily variation of CR intensity are quite comparable in all the cases during the period of investigation. Thin dashed lines indicate the average diurnal direction during the period 1985-95 for each individual group of days and thick arrow lines represent the overall diurnal vectors for the same period. Average diurnal vectors for all the groups of days are also quite comparable for period of investigation.

4 Conclusions

Our study of variation of diurnal anisotropy for the period 1985-95 may be summarised as follows:

1. The diurnal vector has remained statistically constant in corotational direction during 1987-91.
2. The time of maximum of diurnal anisotropy remained in the corotational direction during 1986-87; i.e., during period of minimum solar activity.
3. The direction of diurnal anisotropy is observed to shift to early hours during 1992 and onwards which is maximum during 1995.

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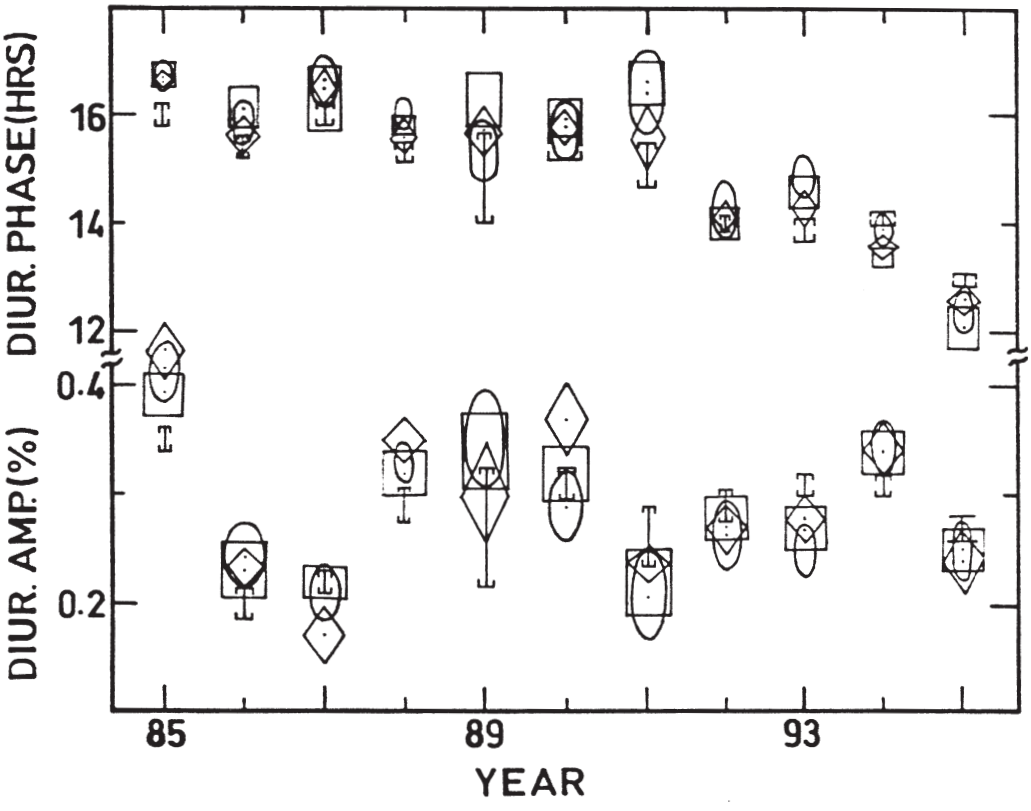

Fig 1. The annual average values of Phase (Hrs, LT) and Amplitude (%) at ground for the diurnal anisotropy during 1985-95 plotted for 60 QD (O), 120 QD (□), CQD (◇) and AD (I).

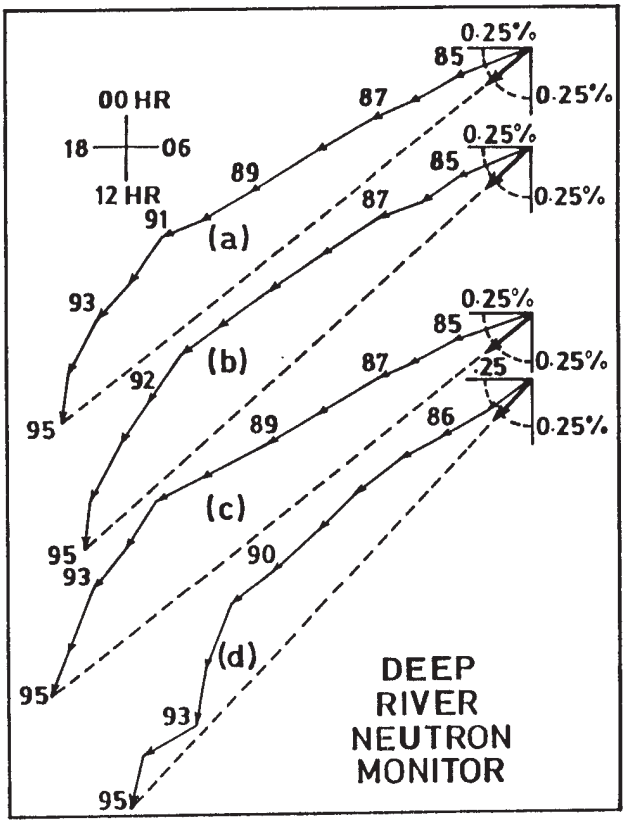

Fig 2. Vector addition diagram of the diurnal anisotropy for different types of days plotted for the period 1985-95.