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Comparative study of diurnal anisotropy in CR intensity on quiet days and all days

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Abstract. A comparative study of diurnal variation has been performed on geomagnetically quiet days (QD) and all days (AD) using the data of neutron monitor for the year 1987. It is observed that even though there are significant differences on individual days but the QD have been found to be more informative as compared to AD. Further, on long term basis the phase of the diurnal anisotropy has acquired its usual corotational direction in 1980. It is observed to remain constant for the later period up to 1990 adding further to the hypothesis of 22-year periodic variation of diurnal anisotropy. Thus, the diurnal anisotropy is observed to be consistent with the convection-diffusion model.

Key words : solar activity—neutron monitor—cosmic rays

1. Introduction

A study of diurnal variation of CR intensity using data of Deep River and Tokyo Neutron monitors is performed to investigate the detailed characteristics of diurnal anisotropy. Agrawal *et al.* (1981) has reported that on a day to day basis the coherence for CR anisotropy is better for days of low to average solar wind speed (also, geomagnetically quieter days; Kumar *et al.* 1981). Further, Badruddin *et al.* (1985) have analysed the neutron monitor data for geomagnetically quiet days each year during 1964-1979 to obtain the perpendicular gradient and compared the results with the north-south asymmetry in the solar activity deduced from solar flares (Yadav *et al.* 1980; Badruddin *et al.* 1988). In the present work, we have made a comparison between these two sets of averages for the year 1987 and tried to understand the differences, if any, in the characteristics of the diurnal variation. The experimental data and analysis are used as discussed earlier (Kumar & Gulati 1991).

2. Results, discussion and conclusions

The day to day values of phase and amplitude of diurnal anisotropy of CR intensity on QD and on AD have been plotted on histograms in figures 1(a) and 1(b) for the year 1987. It is apparent from figure 1 for phases that the peak of the histograms for quiet days is very narrow as compared to all days; which is true for other years as well (Kumar *et al.* 1987).

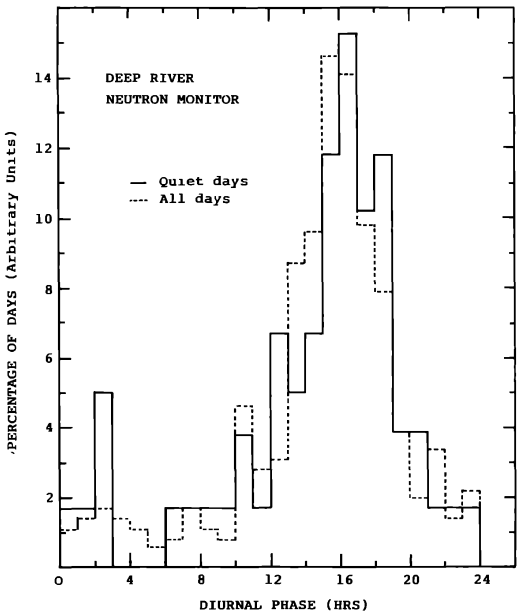

Figure 1(a). Histogram plotted on day to day basis for diurnal phase (hrs) of cosmic ray intensity on QD and AD; recorded by neutron monitoring station at Deep River for the year 1987.

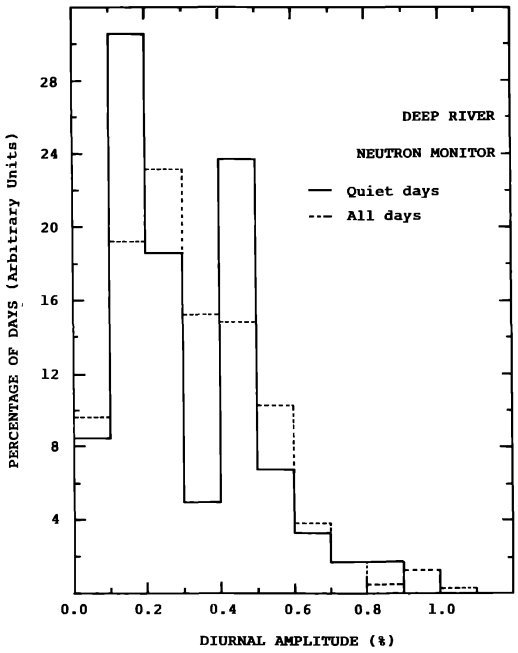

Figure 1(b). Histogram plotted on day to day basis for diurnal amplitude (%) of cosmic ray intensity on QD and AD; recorded by neutron monitoring station at Deep River for the year 1987.

Moreover, the peak on quite days is also quiet prominent. This type of comparison brings out the fact that the quiet days are better suited for the daily variational studies of CR intensity on long term as well as short term basis because of the interplanetary medium to be in quiet and stable condition.

It is quite apparent from figure 2 that the phase of the diurnal anisotropy on QD is observed to remain constant during 1964-70. However, the systematic change in diurnal phases on QD is in agreement with time invariant hypothesis on yearly average basis for all days in a year (Rao *et al.* 1972). Further, the diurnal phase on QD has shifted towards earlier hours at all stations from 1970-71 (Kumar *et al.* 1981). The diurnal phase on QD has shifted to earlier hours till 1976 except during 1974. Later to 1976 a recovery in the phase shifting to its usual corotational direction has been observed. It has completely recovered to 18 hour direction during 1980 (Kumar & Gulati 1991) and has remained constant till 1990.

It is also observable from figure 2 that the diurnal amplitude is almost constant from 1964-70. Though there is a decrease in 1964-65 which is attributed to the decrease in the value of upper cut-off rigidity (Ahluwalia & Erickson 1971). During 1977 there is a sharp increase in the value of diurnal amplitude on QD to early hours. Later to 1971, it continuously decreased till 1976 which is a year of minimum solar activity except 1974. The amplitude of diurnal anisotropy on QD has shown exceptionally large value during 1985 and small value in 1987 which is a period of minimum solar activity.

Therefore, it has been well established with the present results that there is a 22 year periodicity in the diurnal anisotropy of CR intensity on QD which is applicable during both minimum as well as maximum solar activity periods.

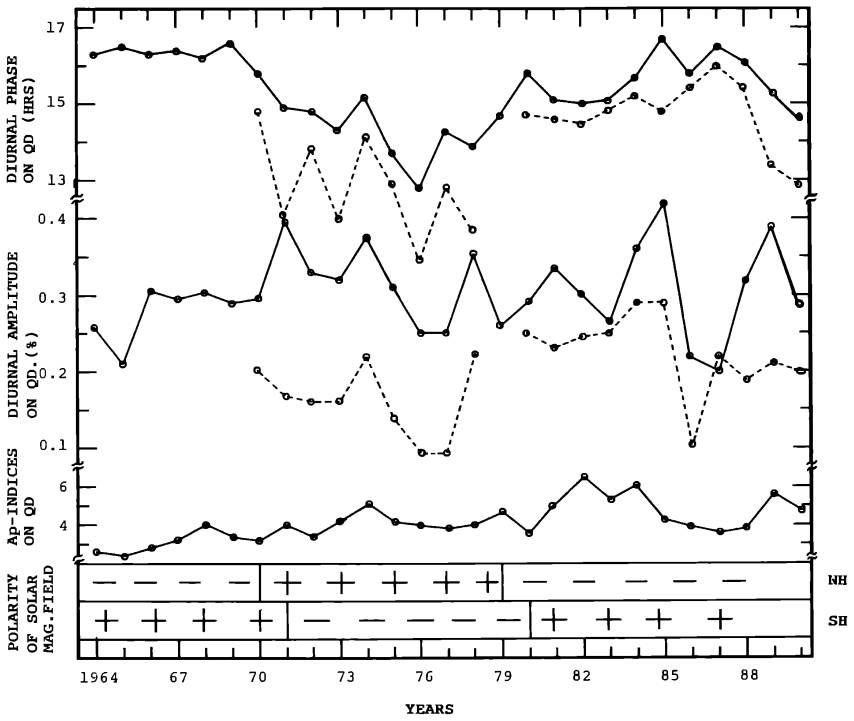

Figure 2. Variation of amplitude and phase of the diurnal anisotropy for Deep River (—) and Tokyo (---) neutron monitoring stations; Ap-index on quiet days and polarity of the solar magnetic field in the northern and southern hemispheres.

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