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Oscillatory nature of diurnal anisotropy in cr intensity as an effect of spmf inversion

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Abstract. The Cosmic Ray intensity data recorded with Deep River neutron monitor has been investigated for a period from 1981-95 on 60 Quiet Days (QD), 120 QD, Continuous QD and All Days (AD) in a year. The Phase of the diurnal anisotropy has been found to remain in corotational direction during the period 1985-91. Afterwards, a shift towards earlier hours continuously till 1995 has been observed in the phase of diurnal anisotropy on QDs. Further, the diurnal anisotropy vectors on QDs have been observed to have shifted to earlier hours for the positive polarity (1992-95) of Solar Poloidal Magnetic Field (SPMF) in Northern Hemisphere (NH) whereas, it remains in later hours for the negative polarity (1981-90) of SPMF in NH.

1 Introduction

In addition to 11-year modulation; several new features in diurnal anisotropy of cosmic ray (CR) intensity have been suggested to probe into the 22-year periodic variation.The cumulative effects of Forbush decreases (FD) may account for the long term variation in CR intensity (Lockwood and Webber, 1984). Sharma and Yadav (1993) supporting the results of Lockwood and Webber (1984), indicate that in addition to the cumulative effect of FDs, some other mechanism, having a natural dependence on the magnetic field polarity, may also be responsible for the long term variation in CR intensity. It is well known that the polarity of the solar poloidal magnetic field (SPMF) reverses sign about every 11/22 years near the time of maximum solar activity or minimum CR intensity (Webber and Lockwood, 1988). An attempt has been made to study the long term trend in diurnal anisotropy with variation in SPMF during the period 1964-95. The trend is viewed critically to interpret the existence of 22-year modulation as the results of SPMF polarity reversal.

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2 Data Analysis

Days with low values of Ap and Kp are identified as geomagnetically quiet days (QD) and taking five quietest days in each month of a year, group of days are termed as 60 QD. The pressure corrected CR intensity data for Deep River neutron monitor (Cutoff rigidity: 1.02 GV; Lat.: 46.1^{o}N; Long.: 282.5^{o} E; Alt: 145m) during 1964-95 has been used to perform the Fourier Analysis to obtain the amplitude and the phase of the diurnal anisotropy in CR. Days with abrupt changes, if any, are not considered.

3 Results and Discussion

The values of diurnal anisotropy vectors are plotted on a harmonic dial for the period 1964-95 in Fig.1a. This vector addition diagram also shows that the diurnal vectors constantly lie in the same direction; i.e.,~16 Hrs in LT at ground during the period 1964-70 and then shows a wave like nature afterwards. The vectors are seen almost in 12-Hrs direction during 1975-76 and in 1995 and possibly onwards. Further, the phase during 1979-80 is in the same direction as it is observed during the period of maximum solar activity; i.e., 1957-58 (Kumar et al, 1981). During the period 1979-80 the phase of the diurnal anisotropy, as observed on QD is recovering after 1976 to its corotational direction are similar to that observed during the period 1957-58, later to 1954 as discussed earlier (Kumar et al, 1981). It is to be noted that the polarity of the solar magnetic field has changed from positive to negative in the northern hemisphere (NH) of the Sun and from negative to positive in the southern hemisphere (SH) during period 1957-58 as well as in 1979-80.

Fig. 1b shows the plots of diurnal anisotropy vectors on QD for four different groups of periods. On the basis of SPMF, the entire period of investigation has been divided into four groups; when the SPMF in the NH is negative; i.e., during the periods 1964-70 & 1981-90 and when the SPMF in the NH is positive; i.e., during the periods 1972-79 & 1992-95.

The average diurnal anisotropy vector has also been plotted on the same harmonic dial in the same figure. It is quite apparent from the Fig. 1b that during the period 1964-70 the phase of the diurnal anisotropy is found in corotational direction. When the polarity of the SPMF has changed from negative to positive during the period from 1972-79; the phase of the diurnal anisotropy on QD has shifted towards earlier hours. Further, when the polarity of the SPMF has changed from negative to positive during the period from 1981-90; the phase of the diurnal anisotropy on QD recovers to its usual direction of corotation, again during the period 1992-95 on positive polarity of NH the diurnal anisotropy has shifted to early hours with respect to the average diurnal vector for the entire period of investigation; similar to the shift during 1972-79. Thus, an oscillatory nature of diurnal vector is clearly evident with the change in SPMF, from this study for the period 1964-95.

4 Conclusions

The direction of diurnal anisotropy in CR intensity is found to change continuously either to early hours or to corotational direction for different solar conditions characterised by the polarity of SPMF. Thus, establishing the periodic behaviour of diurnal anisotropy in CR intensity caused by SPMF inversion.

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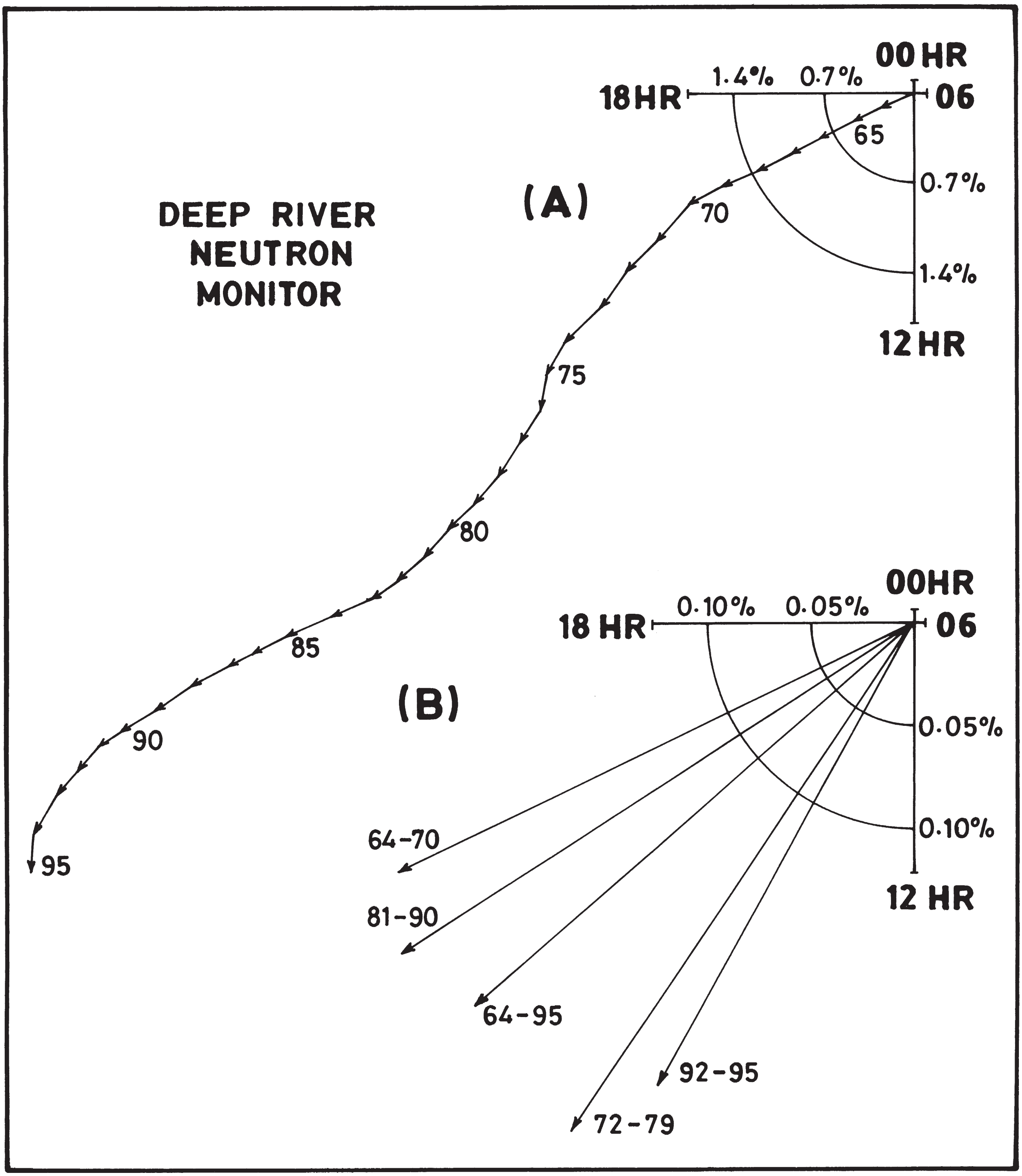

Fig 1. (a) Vector addition diagram for the diurnal anisotropy in CR intensity on QD, plotted for the period 1964-95; (b) Diurnal anisotropy vectors plotted for the negative polarity (1964-70 & 1981-90) and positive polarity (1972-79 & 1992-95) of SPMF in NH and also the average vector on harmonic dial; for the period1964-95. SH3.2