COSMIC RAY VARIATIONS WITH THE PERIOD CLOSE TO 27 DAYS AND THEIR CONNECTION WITH SOLAR ACTIVITY LONGITUDINAL DISTRIBUTION

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ABSTRACT

The amplitude and phase changes of the 27 day cosmic ray variation from 1958 to 1975 were studied. The comparison between cosmic ray intensity characteristics and longitudinal distribution of solar activity ones for different stages of the solar cycle were made.

1. Introduction

In some cases the longitudinal redistribution of the solar activity (SA) leads to the changes in 27 day cosmic ray (CR) variations connected with the solar rotation period / 1 /. The purpose of this paper is to analyse in detail the amplitude and the phase evolution of CR 27 day variations along with the longitudinal redistribution of SA. The neutron monitor data I of Thule and the sunspot group area Sp from 1958 to 1975 (except for 1964) were processed.

2. Method

As a result of the sunspot group area treatment for each solar rotation, the polar vector with the amplitude ρ_{SA} and the phase λ_{SA} was obtained, which characterized the non-uniformity of the sunspot longitudinal distribution / 2 /. Indeed, the existence of a longitudinal interval with increased activity means the increased value of ρ_{SA}, and the movement of this interval on the solar surface causes the changes of λ_{SA} from one rotation to another. The amplitude ρ_{CR} and the phase λ_{CR} of the first harmonic of the 27 day CR variation was used for comparison with ρ_{SA} and λ_{SA} of SA / 1 /. The 11-year CR variation, which plays a part of the trend for the present analysis was firstly withdrawn from the primary CR data.

3. Results

Fig. 1 shows the correlation coefficient values R (λ_{SA} , λ_{CR}) between time series of the phases of 27 day SA variations and CR ones with the zero shift between these two series. The horizontal bars correspond to the time intervals, for which these correlation coefficients were obtained. Fig. 1 shows R(λ_{SA}, λ_{CR}) keep the high values during the long time intervals; but for two time intervals from 1970 to 1973 correlation coefficient sharply fell. For these two time intervals (III 1970 - IX 1971, II 1972 - VIII 1973) R(λ_{SA} , λ_{CR}) were computed with the time shift between time series of the phases of 27 day SA variations and CR ones.

Fig. 2 shows the dependence of the R(λ_{SA} , λ_{CR}) on the time shift. It can be seen in Fig. 2 the R(λ_{SA}, λ_{CR}) reached the maximum value $R \approx 0.86$ for the time shift equal to about three months CR variations being prior to the SA ones. It should be noted that not far from 1970-1973 the polarity reversal of the Sun's general magnetic field took place / 3 /, thus we may expect the redistribution of solar magnetic fields among these the SA longitudinal redistribution. The corresponding changes of interplanetary magnetic fields and 27 day CR variations may be expected. To check this assumption we consider the 27 day variation cyclogram of sunspot group areas shown in Fig.3 / 4 /. As could be expected the SA amplitude of variations decreased and the phase became unstable (region A in the cyclogram). When SA is high the phase of variations is more stable, except for time intervals B and C which concerned with the polarity reversal of the Sun's general magnetic field. This result is confirmed by Table 1 where the parameter of the phase conservation is presented which is the relation $|\Sigma \vec{\rho}_i|/\Sigma|\vec{\rho}_i|$ in percent / 5 /. This parameter was more than 58% during the years of high SA except for XI 1959 - VIII 1960 and II 1970 - III 1972, when it fell abruptly.

Table 1

Year	$\lvert\Sigma\vec{\rho}_i\rvert/\Sigma\lvert\vec{\rho}_i\rvert$, %	Year	$\lvert\Sigma\vec{\rho}_i\rvert/\Sigma\lvert\vec{\rho}_i\rvert$, %
II-V 1958	85	VIII 1961 - IV 1962	89
VI-X 1958	95	VII 1966-V 1967	87
XI 1958-X 1959	65	VI 1967-II 1968	60
XI 1959-VIII 1960	58	III 1968-I 1970	58
IX 1960-VII 1961	76	II 1970-III 1972	5

4. Conclusion

The strong variability of the longitudinal distribution of SA took place near the polarity reversal of the Sun's general magnetic field. The disturbance of 27 day CR variations may be expected in turn.

Nevertheless from the point of view of current ideas about the solar modulation of CR intensities it is difficult to explain a high value of R(λ_{SA} , λ_{CR}) between the time series of the phases of 27 day SA variations and CR ones for 1970-1973 with CR variations being prior to the

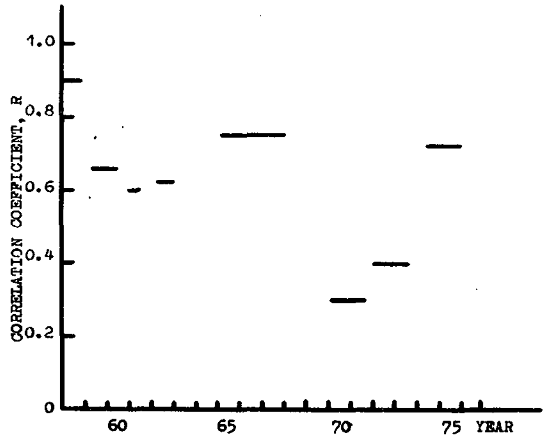

Fig. 1. Correlation coefficients between the 27 day variation phases of CR intensity and sunspot area with zero shift between time series.

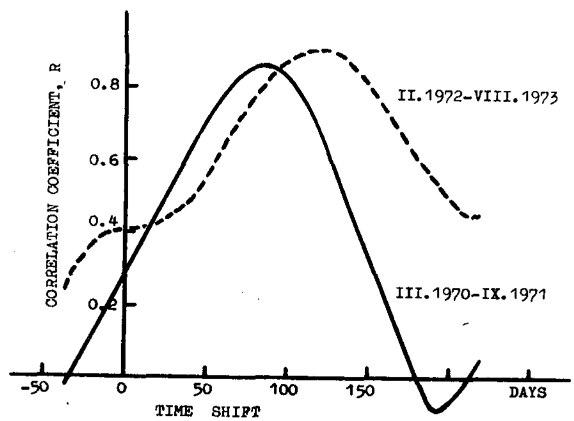

Fig. 2. Correlation coefficient R(λ_{SA} , λ_{CR}) versus the time shift between the series.

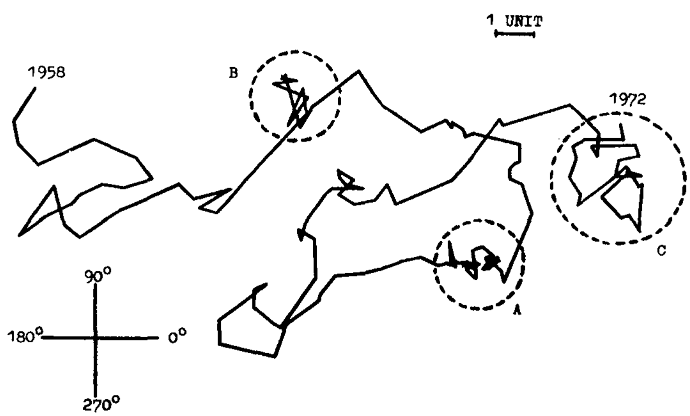

Fig. 3. The cyclogram of sunspot area for 1958-1972 (1 unit is equal to 20 000millionths of the solar hemisphere).

SA. At the same time it is unlikely to obtain such a high value of R(λ_{SA} , λ_{CR}) by chance because of rather long time intervals under consideration (each of them being of order 1.5 year).

5. References

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