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A study of the role of the coronal index of solar activity in Long–term cosmic ray modulation

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We have analysed the relationship between cosmic rays and coronal index of solar activity (CI) for the periods of negative (A < 0), Mix and Positive (A > 0) polarities of the general magnetic field of sun. In cosmic ray modulation sunspot numbers are being generally used as a reliable solar parameter. In this analysis, we have used coronal index as a new solar parameter for long–term cosmic ray modulation. Negative and high correlations are found between CI and cosmic rays for the A > 0 epochs and A < 0 epochs of solar magnetic field. However, significant differences are found between A > 0 and A < 0 epochs. Correlations are found poor during the mix polarity years.

1. Introduction

Sunspot number, a reliable parameter of solar activity is being used in cosmic ray modulation studies since last five decades. Besides the sunspot number, many other solar indices such as grouped solar flares, solar radio flux (2800 MHz), area of coronal holes, tilt angle have been used to explain the characteristics of long–term cosmic ray modulation [1–3].

It is uncertain about the appropriate parameter of solar activity, which can be considered as a reliable solar parameter in cosmic ray modulation studies. First time in 2001, Shrivastava et al. [4] have investigated CI as a useful and appropriate solar parameter in cosmic ray modulation. In this work, we have performed a correlative analysis between CI and cosmic rays during the period of different epochs of solar magnetic field.

2. Discussion

We have taken the monthly mean values of coronal index of solar activity (CI) from the solar geophysical data books. The intensity of green corona line (Fix XIV 5303 Aº) is routinely measured at several coronal stations around the world. Each set of measurement includes a series of limb observations with a log of 5º in the positional angle, beginning from the north solar pole (0º) and proceeding counter clockwise around the solar disk. These data sets from measurements are used for calculating the coronal index of solar activity [5]. We have correlated the monthly mean values of CI against monthly mean values of Rz and CI vs CR for A > 0, A < 0 and mix polarity of solar magnetic field.

Figure 1 shows the five blocks of correlation results between CI and sunspot number Rz for the periods of 1971–1979 and 1991–1999 when A > 0 and 1981–1989 when A < 0. Years of 1980 and 1990 are the period of polarity reversal of solar magnetic field. Both of solar parameters show positive and high correlation for all the A > 0 and A < 0 epochs of solar magnetic field. It moves that the CI is also a reliable solar parameter and varies similar to sunspot numbers. Further, we have correlated CI against the CR for all the A > 0, A < 0 and mix polarity years as shown in Fig. 2. It is seen from the Fig. 2 that CI of solar activity shows negative and high correlation with cosmic rays. However, then coefficients changes from period to period.

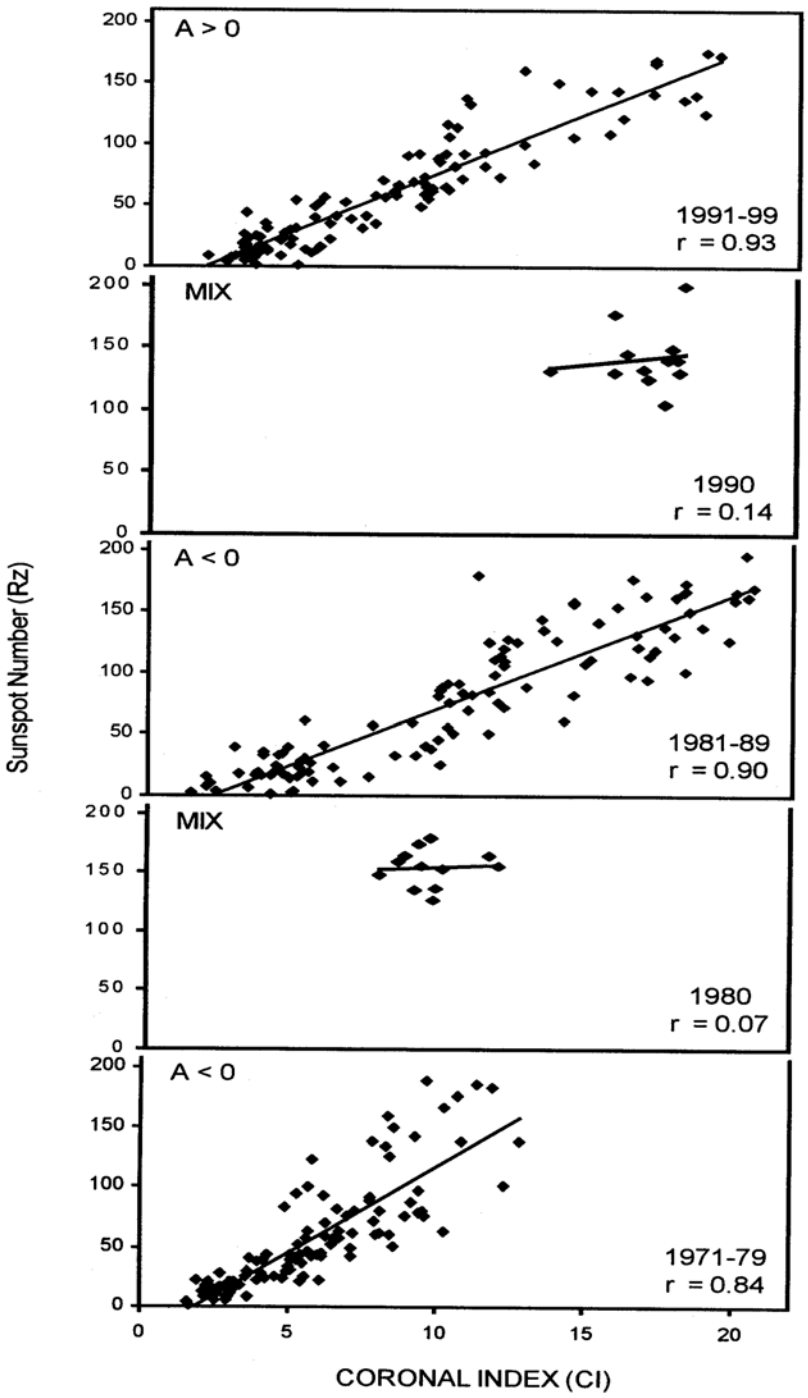

Figure 1. Shows the correlation between the CI and Rz for the epochs of (i) A > 0 (ii) A < 0 and mix polarity reversal periods.

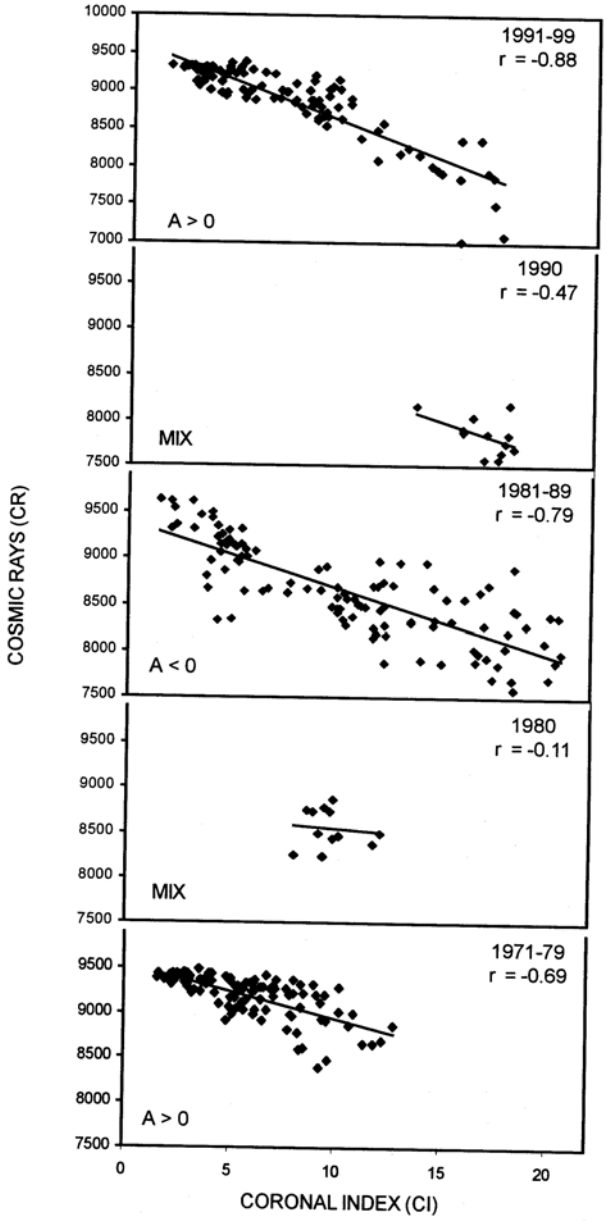

Figure 2. Shows the correlation between the CR and CI for the epochs of (i) A > 0 (ii) A < 0 and mix polarity reversal periods.

We looked into problem in more detail and evaluated the correlation coefficients between (i) CR vs Rz (ii) CR vs CI. This correlation analysis has been done for solar cycles 21, 22 and solar cycle 23 (upto 2002). Each of the solar cycles divided into three parts : ascending, high and low on the basis of their sunspot number. We observed almost similar correlation in both the pairs.

Table 1. Correlation coefficient for different period of two pair of values (i) Rz vs CR (ii) CI vs CR

Period	Solar cycle A = Ascending H = High D = Descending	Correlation coefficients	
		Rz vs CR	CI vs CR
1976-1986	21	-0.62	-0.84
1986-1996	22	-0.90	-0.89
1996-2002	23	-0.46	-0.27
1976-1978	A21	-0.79	-0.70
1979-1981	H21	0.11	-0.41
1982-1986	D21	-0.77	-0.84
1986-1988	A22	-0.84	-0.83
1989-1991	H22	-0.22	-0.08
1992-1996	D22	-0.92	-0.91
1996-1999	A23	-0.77	-0.20
2000-2002	H23	0.13	0.44

3. Conclusions

It is concluded from the analysis that correlation coefficients between the both of the pairs (i) CR vs Rz (ii) CR vs CI are found negative and high for $A > 0$ and $A < 0$ epochs of solar magnetic field. Poor correlations are found during the period of mix polarity years. Similar and high correlations are also noticed during the solar cycles 21 and 22 and also for ascending and descending phases of solar cycles. It is found that the use of coronal index of solar activity in cosmic ray modulation studies is reasonable due to its direct influence in interplanetary medium.

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