

Long-term modulation of Cosmic ray Intensity in relation to Solar Parameters

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Abstract: The cosmic rays and solar parameters for the period 1996 to 2008 have been analyzed. The most of the solar parameters have been found to be related with sunspot numbers. The high events are found in maximum number during the maximum solar activity period and in the declining phase of solar activity, both are low. For the R_z high peaks are seen during the years 1989, 1990 and 1991. The high peaks events are found in the maximum number during the maximum solar activity period and in the declining phase of the solar activity.

Key words: Cosmic ray variation, sunspot number and geomagnetic parameters.

I. Introduction

Solar modulation of the cosmic ray has been a interest field since last four to five decades. The propagation and transport of high energy cosmic rays within the heliosphere and the surface of the earth studied since a long–time[1-2]. Long–term cosmic ray modulation and its association with solar activity were studied by a number of cosmic ray researchers (Rao, 1972, Venkatesan and Badruddin, 1990, Krimsky et al 2003, Burlaga, 1993, Singh and Badruddin 2007, Dwivedi et al 2009)[3-6]. It was understood that solar flares and Sunspots were the active regions responsible for sporadic variation in cosmic ray intensity. Several energy sources such as solar flares, coronal holes, solar wind, coronal mass ejection etc. As Sunspots are considered a reliable index of solar activity and key source of solar outputs as therefore, it is essential to find correlation between cosmic rays and Sunspot numbers.

II. Data and Methods

In the present analysis, the data of various solar parameters has been giving us a good comparative study. The other solar activity indices should also be used to obtain the best solar activity parameter for the periods of our investigation (solar cycle 23). In this paper we have collected the data of solar activity parameters for the period 1976 – 2010 covering the odd and even solar cycles. The daily values of solar parameters have been taken from Solar Geophysical Data Books.

III. Results and Discussion:

The cosmic ray particles are affected by the electromagnetic disturbances while transporting from galactic space to earth. It has been well known that cosmic ray intensities are modulated by solar activity cycle from one to another. To show the long–term cosmic ray intensity variation along with sunspot numbers we have plotted the yearly mean values of the cosmic rays and solar parameters for the period of 1960 to 2008 as shown in figure 1 which cover the solar cycle 19 to 23. In figure 1 yearly mean values of Kiel cosmic ray counts rates are plotted against the yearly mean values of Sunspot numbers. We show the yearly average values of the cosmic ray intensity (I) for near about four solar cycles of Sunspots number R_z . The 11 / 22 years cosmic ray intensity cycles in anti-relationship with Sunspot cycles are clearly seen for all the four successive solar cycles 19 to 23. The scales for the values of R_z decreases but cosmic ray intensity (I) increases.

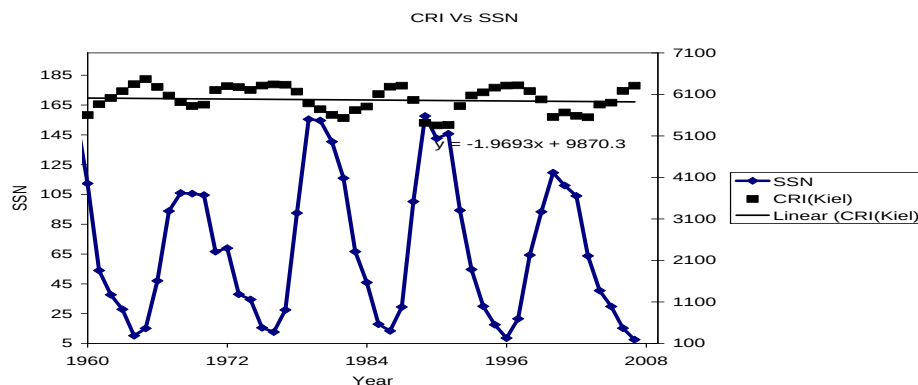


Figure 1: The annual mean values of CR intensity and R_z as shown in figure 1

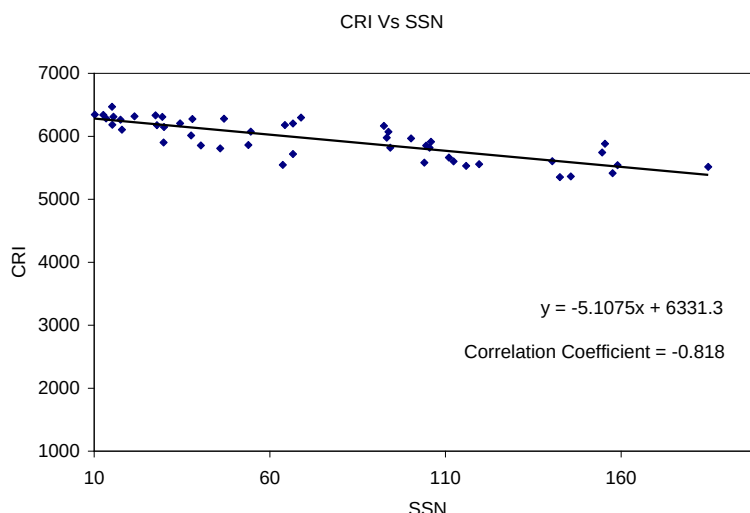


Figure 2: Shows the annual mean values of CR intensity and Rz

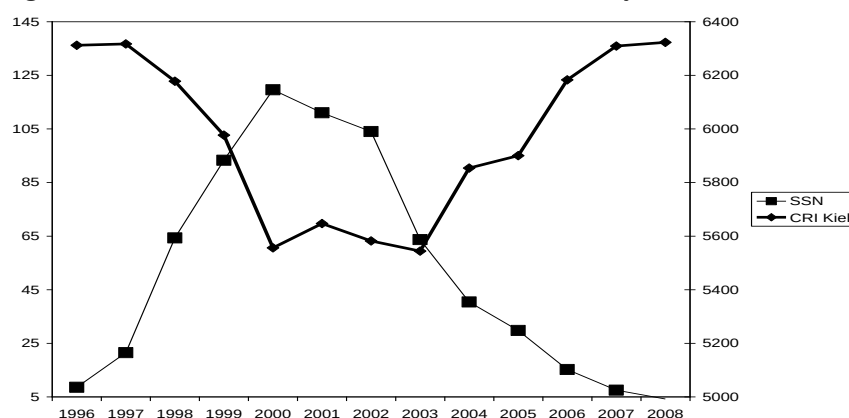


Figure 3: Shows the CRI and sunspot number for the interval 1996 to 2008

Figure 2 shows the annual mean values of CR intensity and Rz . This figure shows a high and positive correlation between Rz and CRI. In this way, it can be inferred from the analysis that the Rz and CRI are highly correlated during the period of solar cycle 23. Figure 2 shows a high and positive correlation between Rz and CRI. In this way, it can be inferred from the analysis that the Rz and CRI are highly correlated during the period of solar cycle 23. Similarly, the present variation of cosmic ray intensity for the Kiel station is plotted in figure 3 for the interval 1996-2008 (Solar cycle 23). The minimum intensity (in almost all the stations) is observed in the year 1996-2008, which is the period of maximum solar activity as observed and seen in figure 3. The sunspot number and the cosmic ray intensity, as expected, or anti correlated.

IV. Discussion

The statistical significance of the observed neutron monitor data for different periods averages have been clearly brought-out and discussed. The variation of both sunspot as well as cosmic ray intensity has been discussed on annual averages. The monthly averages of sunspot reaches to a peak value of about - 155 in the year 2000 and 2003 with a very fast rise within two years. A plateau is seen from 2001 to 2003 and then the Sunspot number declines with the minimum value reaching in 1996 and 2010. The sunspot number and the cosmic ray intensity anti correlated. The observational results presented in this paper are based on cosmic ray intensity data, where low and high latitude neutron monitor data has been used to confirm many of the findings reported here it is also necessary to use data of atleast one more low and high latitude station.

V. References

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