

# Heliosphere and Cosmic Rays Modulation Due to Solar Outputs

**B. K. Tiwari**

*Assistant Professor  
Department of Physics  
A.P.S.University, Rewa(M.P.)*

**B. R. Ghormare**

*Assistant Professor  
Department of Physics  
Rewa Engineering College, Rewa(M.P.)*

## Abstract

Based on the observation from Omniweb data centre for solar- interplanetary data and monthly mean count rate of cosmic ray intensity (CRI) variation data from Oulu / Moscow neutron monitors during 23/24 solar cycle. It is observed that Solar variability controls the structure of the heliosphere and produces long-term as well as short-term changes in cosmic ray intensity, during minimum solar activity period the sun is remarkably quiet and the strength of the interplanetary magnetic field has been falling off to new low levels, reduces the GCR entering inner- heliosphere and it is high anti-correlation between sunspot number & GCR flux. It is also found that 10.7 cm solar radio flux, velocity of solar wind and the strength and turbulence of the interplanetary magnetic field with count rate of cosmic ray intensity are inverse correlated.

**Keywords:** Interplanetary magnetic field (IMF), Galactic Cosmic ray (GCR), solar activity.

## I. INTRODUCTION

The Solar minimum between cycles 23 and 24 to be extremely interesting, the sun is remarkably quiet and the strength of the IMF has been falling off to new low levels. The dependence of the heliosphere and cosmic ray modulation due to solar activity supported by space and ground based experiments<sup>1, 2</sup>. In order to study the cosmic ray modulation , in early times and solar activity has been proven during this period of very low solar activity , sunspot nearly disappeared and solar magnetic field is reduced, are about half as those observed during the previous minimum period and the mean value of the IMF was recorded between 2007-2009 falling off to new low levels as compared with 1985-1987 and in 1995-1997 .This decrease in IMF is due to either weaker input of solar polar magnetic flux or less input from the ICME. Changes in the solar winds magnetic field over the solar cycle affect GCRs, in the inner solar system. Higher solar activity (when sunspot number are large) is correlated with increased IMF strength ,which in turn reduces the GCR entering the inner heliosphere and it is strong & steady anti-correlated between sunspot number and GCR flux. Modulation in the solar wind plasma and its fluctuation flows through the interplanetary medium creates weaker solar magnetic field and the tilt of the heliospheric current sheet is also responsible drift effect on GCR<sup>3</sup>. At the end phase of solar cycle 23, the strength of IMF and solar wind density were lower than observed in solar cycle 22/23<sup>4</sup>, whereas solar wind speed remained unchanged as compared with previous solar minimum<sup>5, 6</sup>.

## II. DATA ANALYSIS

In this study yearly mean data of solar activity and heliosphere indices data with count rate of cosmic ray intensity as observed by Oulu / Moscow ( $R_c=0.80\text{GV}$  &  $R_c=2.42\text{GV}$ ) neutron monitors and Solar-interplanetary data from Omni web data base were used.

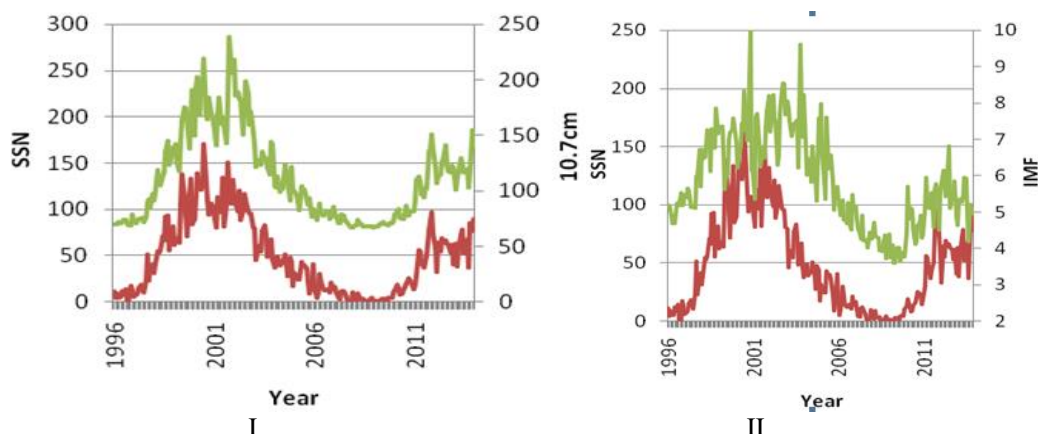
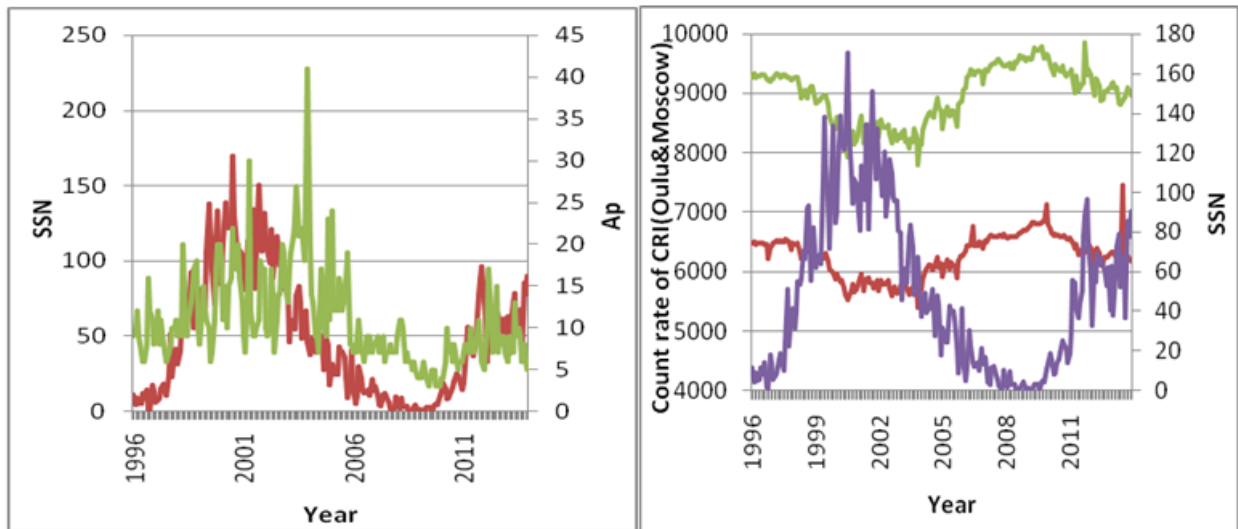
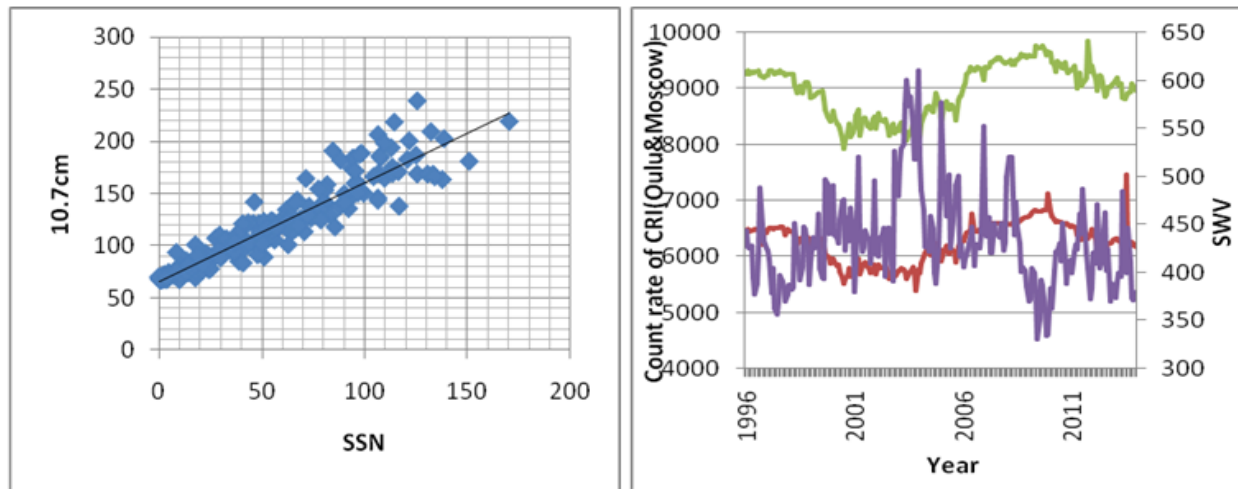


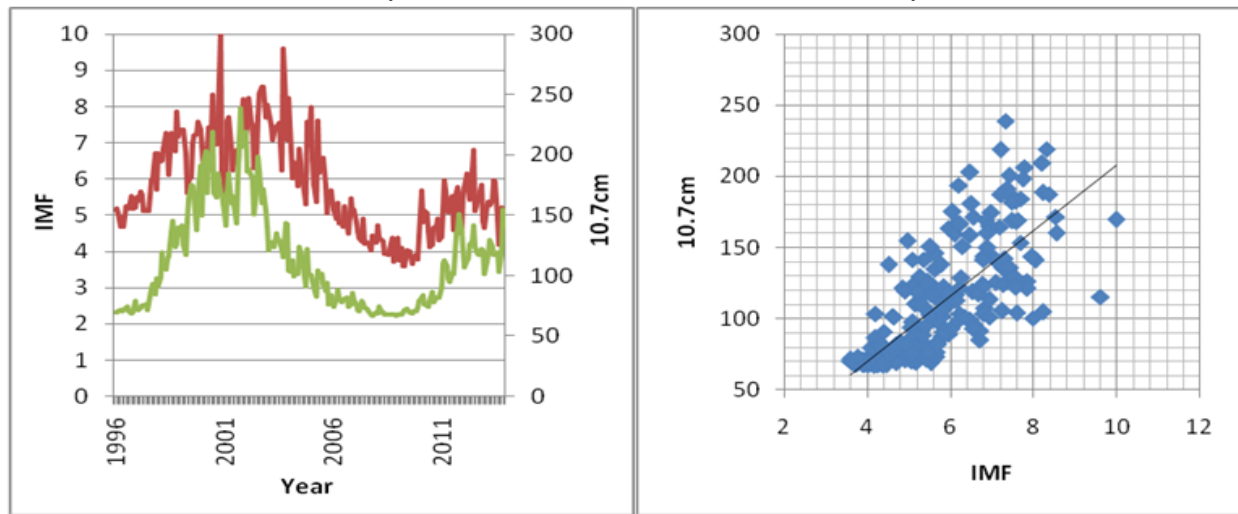
Fig. 1: Monthly mean sunspot number(SSN) with (i) 10.7 cm Solar radio flux (ii) and IMF .



III  
IV  
Fig. 2: (iii) Monthly mean sunspot number with monthly mean Ap and (iv) monthly mean count rate of CRI.



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Fig.3. (v) correlation between monthly mean sunspot number with 10.7 cm solar radio flux and (vi) linear plot between monthly mean count rate of CRI with solar wind velocity .



VII  
VIII  
Fig.4. (vii) linear plot between monthly mean IMF with 10.7 cm solar radio flux and (viii) their correlation.

### III. RESULT AND DISCUSSION

The changes in the solar winds magnetic field over the solar cycle, affect GCRs in the inner heliosphere, the sun is remarkably quiet, IMF strength reduces and the strength of IMF has been falling off to new low levels, which in turn reduces the GCRs entering the inner heliosphere, and a record high cosmic ray intensity observed during minimum period of solar cycle 23&24 and it is strength anti- correlation between sunspot number and GCR flux. Variation in cosmic ray intensity is a multi-valued function of the tilt of the heliospheric current sheet for ascending and descending both phases of the solar cycle is due to inadequacy of the tilt angle as a parameters for drift modulation and it is single –valued function of solar wind B within a given polarity epoch. The variation of cosmic ray intensity are inversely correlated with solar activity indices and these variations are produced by solar wind velocity (V) is related to convection, diffusion depends on the interplanetary field strength (B) and its fluctuations, and the tilt of the heliospheric current sheet. A record high cosmic ray intensity observed in 2009 due to reduction in B and tilt angle and there after an unusually rapid increase in the tilt angle is likely related to the weaker polar field.

### IV. CONCLUSION

Solar- interplanetary indices, tilt of the heliospheric current sheet and reduction in solar polar magnetic field and interplanetary magnetic field caused modulation in GCR in the inner heliosphere. The sun was remarkably quiet and strength of IMF has been falling off to new low level and record high CRI observed during the period of minimum solar activity. Changes in the solar winds magnetic field over the solar cycle, affect GCR in the inner heliospheric solar system and strong anti-correlation -0.78 found between SSN and GCR flux.

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