Research Journal of Physical Sciences _____ ISSN 2320–4796
Vol. **2(6),** 5-8, October **(2014)** *Res. J. Physical Sci.*

Solar Variability and their Impact on the Helioshphere and Cosmic Rays

B. K. Tiwari[1] and B.R. Ghormare [2]
[1]Department of Physics, A.P.S. University, Rewa, MP, INDIA
[2]Department of Physics, Rewa Engineering College, Rewa, MP, INDIA

Available online at: www.isca.in
Received 18th September 2014, revised 29th September 2014, accepted 2nd October 2014

Abstract

The structure of the heliosphere controls by the solar outputs and their variability, produce changes in cosmic ray intensity. Observation based on the data taken from Omniweb data centre for solar- interplanetary data and yearly mean count rate of cosmic ray intensity (CRI) variation data from Oulu, Moscow and Kiel neutron monitors during 1996-2014. It is observed that slow decline of solar cycle 23 and slow rise of solar cycle 24 resulted prolonged of low solar activity which lasted about 2006 to 2009 with 2008 and 2009 being sun is remarkably quiet, therefore solar minimum between cycle 23 and 24 was very extended and deep in contrast to previous solar minima's 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 and GCR flux. It is also found that correlation between the count rate of cosmic ray intensity with solar indices and heliospheric parameters.

Keywords: Interplanetary magnetic field (IMF), Cosmic ray intensity (CRI), Interplanetary Coronal mass ejections (ICMEs), Solar activity.

Introduction

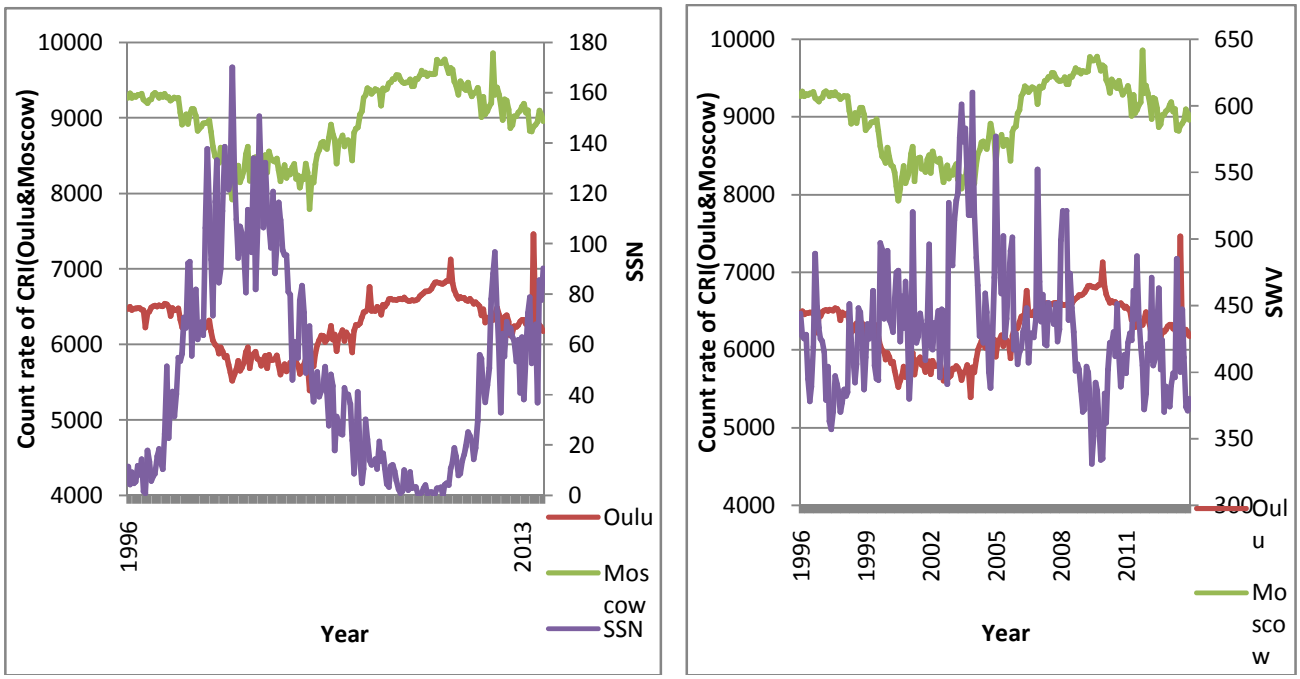
The slow decline of solar cycles 23 and slow rise of solar cycles 24 resulted prolonged and deep in contrast to previous solar minima. The sun is remarkably quiet and the strength of the IMF has been falling off to new low levels, the dependence of the helioshphere and cosmic ray modulation due to solar activity supported by space and ground based experiments[1, 2]. The mean sunspot number occurred minimum in August 2009 and maximum of cosmic ray intensity was observed in October 2009, dependence of the cosmic ray intensity time-lag behind the sunspot number about two months. In order to study the cosmic ray modulation 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 interplanetary magnetic field is due to either weaker input of solar polar magnetic flux or less input from the Interplanetary coronal mass ejection. The changes in the solar winds magnetic field over the solar cycle, affect GCRs, in the inner solar system. During 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 and 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 helioshperic current sheet is also responsible drift effect on GCR[3]. The slow decline of solar cycle 23 and slow rise of solar cycle 24 resulted prolonged of low solar activity which lasted about 2006 to 2009 with 2008 and 2009 being sun is remarkably quiet, therefore solar minimum between cycle 23 and 24 was very extended and deep in contrast to previous solar minima's with tens of months instead of few months. Solar cycle dependence of cosmic ray intensity time lag behind the sunspot number, for cycle 17-23, the mean value of this time lag is about 2.4± 1.9 months for even cycles and 12.4 ± 7.2 for odd cycles[3,4] . The strength of IMF and solar wind density were about reduces about 28% at the end phase of solar cycle 23 , whereas solar wind speed remained unchanged as compared with previous solar minimum[5, 6].

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 and Keil (R_c=0.80GV, R_c=2.42GV and R_c=2.39GV) neutron monitors and Solar-interplanetary data from Omni web data base were used.

Result and Discussion

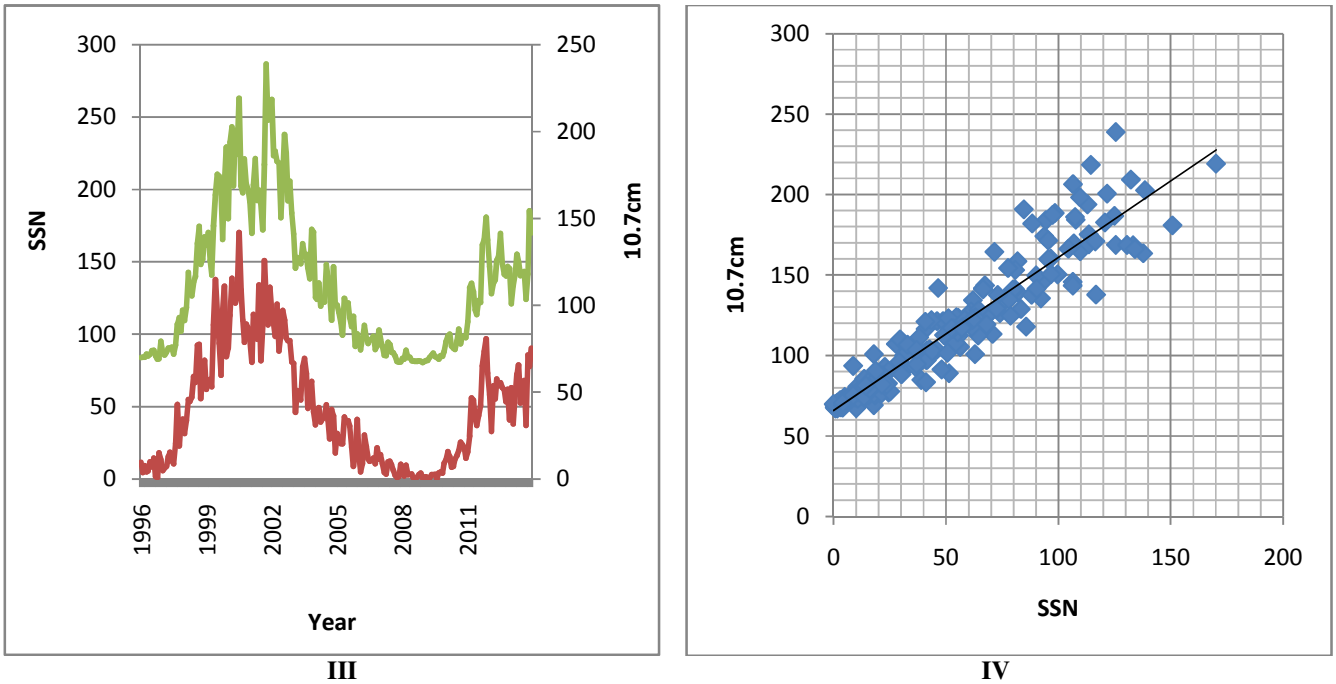
The changes in the solar winds magnetic field over the solar cycle, IMF strength reduces and the strength of IMF has been falling off to new low levels, which in turn reduces the GCRs entering the inner heliosphere, and a record high cosmic ray intensity observed during minimum period of solar cycle 23and24 and it is strength anti- correlation between sunspot number and GCR flux.. 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 heliosphereic current sheet. The sun is remarkably quiet, and 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.



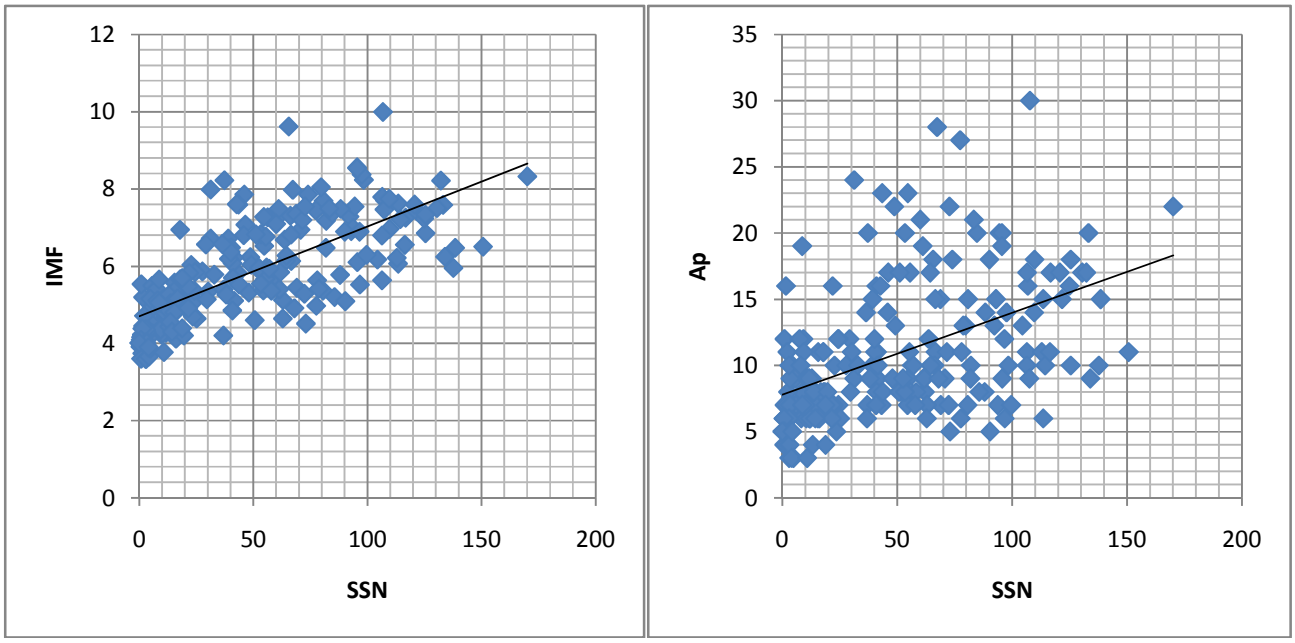
I II

Figure-1
Monthly mean Count rate of CRI (Oulu andMoscow) (i) with sunspot number(SSN) (ii) and Solar Wind velocity .



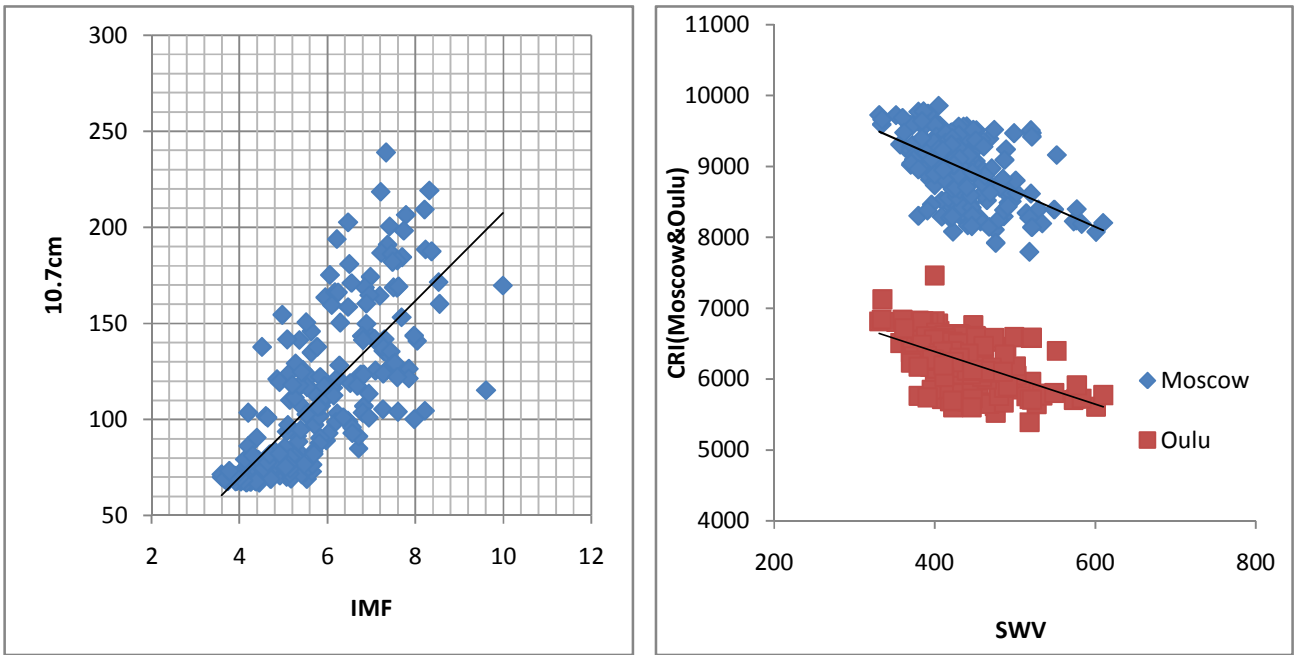
III IV

Figure-2
(iii)Monthly mean sunspot number with 10.7cm solar radio flux and (iv) their correlation



V VI

Figure-3
Correlation between monthly mean sunspot number (v) with IMF and (vi) with Ap



VII VIII

Figure-4
Correlation between (v) monthly mean 10.7 cm solar radio flux with IMF and (vi) monthly mean count rate of CRI (Moscow –blue and Oulu -red) with solar wind velocity

Conclusion

Solar- interplanetary indices, tilt of the heliosphereic current sheet, 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, and a small time-lag between CRI and solar activity, of about two months with very high correlation during period of minimum of 23 and ascending phase of solar cycle 24.

Reference

1. The 27-Days Cosmic Ray Intensity Variation during Solar Minimum 23 and 24. R. Modzelewska., M.V. Alania, *Solar Phys,* **286,** 593-607, **(2013)**

2. Modulation in Cosmic ray During the Declining and Minimum Solar Activity Period of Solar Cycle 23. B.K. Tiwari., B.R. Ghormare., P.K. Shrivastava., D.P. Tiwari, *Res. J. Physical Sci.,* **2(2),** 9-12, **(2014)**

3. Long term modulation of cosmic rays and inferable electromagnetic state in solar modulating regions K. Nagashima and I. Morishitha, *Planetary and space Sciences,* **28(2),** 117 **(1980)**

4. Galactic cosmic ray radiation hazard in the unusual extended solar between solar 23 and 24. N.A. Schwadron., A.J. Body., K. Kozarev., M. Golightly., H. Spence., L.W. Townsend., and M. Owens, Space Weather, **8,** S00E04,doi:10.1029,2010SW000567, **(2010)**

5. Understant the behavior of the heliospheric magnetic field and the solar wind during the unusual solar minimum between cycle 23 and 24. Zhao L., Fisk L., *Solar Phys.,* **274,** 379 **(2011)**

6. Study of variation in Cosmic ray Intensity due to Solar-Interplanetary activity between 1996-2013, B.K. Tiwari., B.R. Ghormare., P.K. Shrivastava., D.P. Tiwari, *Res. J. Physical Sci.,* **2(3),** 4-8, **(2014)**