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Galactic Cosmic Rays Modulation Due to Solar-Interplanetary Activity

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Abstract

The Sun displays a multiple magnetic activities collectivity referred as solar activity. Galactic cosmic rays are subjected to heliospheric modulation under the influence of solar outputs and their variability. We observed relation between selected solar activity parameters and GCR variation. The observation based on data of Omniweb data centre for solar- interplanetary activity and monthly mean count rate of cosmic ray intensity from neutron monitor Oulu (cutoff rigidity Rc=0.80 GV) during the period of 23/24 solar cycle .We observed a record high value of galactic cosmic ray intensity with low values of solar - interplanetary activity parameters during this minimum period of solar activity and also correlate count rate of cosmic ray intensity with solar activity parameters i.e. better anti-correlated.

Keywords: *Cosmic ray intensity (CRI), Magnetic clouds (MCs), Coronal mass ejections (CMEs), Heliospheric magnetic field (HMF)*

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INTRODUCTION

Galactic cosmic rays are charged particles, propagate through interstellar space that come from outside heliosphere [1] which energies ranging from ~ 10^3 ev to as high as 10^{20} ev [2]. Cosmic rays high energies >30 Gev transvers the helioshphere with small effect, whereas lower energy are modulated progressively with decreasing energy, get scattered (diffused) by fluctuations in structure and magnitude of interplanetary magnetic field. The heliospheric modulation of cosmic rays is a function of energy & position, increased with solar activity, with largest effects at low energy particles [3–5].

Solar activity varies from minimum to maximum energy ~11 years are reflected in cosmic ray observations near and at the earth. Cosmic rays are scattered by irregularities in the structure of heliospheric magnetic field and are usually caused by transient interplanetary events, which are related to coronal mass ejections (CMEs). Small decreases in galactic cosmic rays are associated with magnetic clouds (MCs) [6] are not preceded by shocks where as large decreases are associated with that MCs are preceding by shocks [7, 8].The interplanetary magnetic field (IMF) emanated from the Sun changes with the solar activity cycle, changing variations in speed of particle transport processes, such as diffusion, convection, particles drifts and adiabatic energy charges.

Modulation of CRs are depend on solar-interplanetary activity , where solar polar magnetic field is parallel to the galactic magnetic field, can easily connect with each other, so that GCRs can intrude more easily into the helio-magnetosphere along the magnetic lines of force, as compared with anti-parallel state of the magnetic field. The transition between two states has a time lag behavior of the polarity reversal, depending on the rigidity of the observed cosmic rays [9].

Solar and heliospheric conditions make this period interesting for the study of cosmic rays modulation with solar and heliospheric activity indices. The sun was much quieter, the heliospheric magnetic field was weaker and observed higher cosmic ray diffusion coefficient which allows an increase in cosmic ray intensity [10, 5]. Sunspots are low / absent strength of the HMF was exceptionally low and solar- interplanetary activity parameters where significant different from the previous

solar minimum [11, 12, 4]. The main unusual features in the GCR intensity in this anomalous period are excess of the maximum intensity during 2009-2010.

DATA ANALYSIS

Monthly mean count rate values of cosmic rays data were obtain from the website http://www.nmdb.in for individual CR neutron monitor at Oulu (Rc=0.81GV) Figure 1.

In this study data of monthly mean sunspot numbers (SSN), and solar flare index were taken from National Geographical Data Centre (NGDC) website *http://www.ngdc.noaa .gov/stp/solar/solar* data services.html have been used and Solar-interplanetary data were taken from Omniweb data base *http://www.omniweb.gsfc.nasa.gov.in* Figure 2.

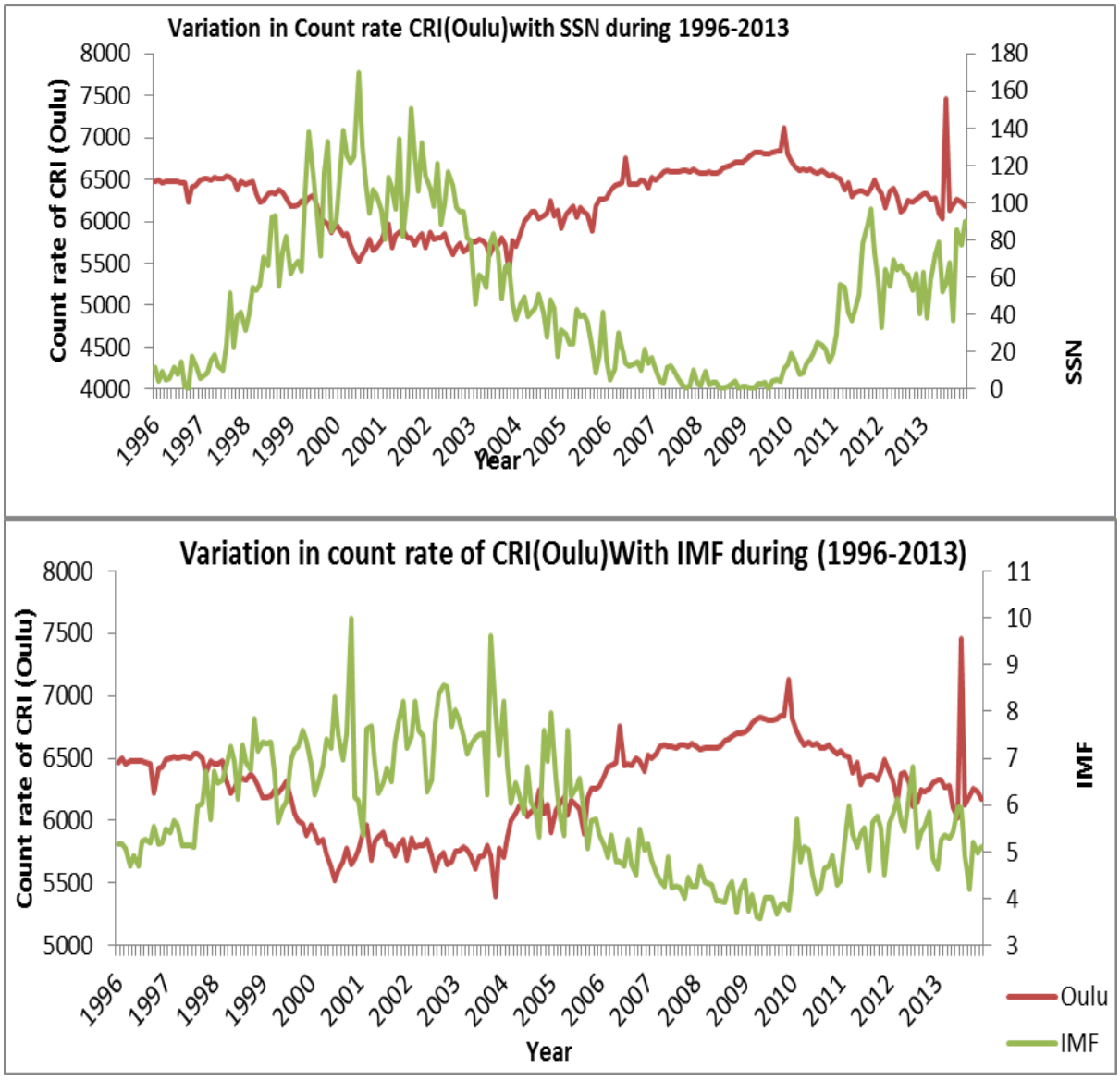

***Fig .1*:** *Shows Variation in (left) Counts Rate of CRI with Sunspot Number and (right) Count Rate of CRI with Interplanetary Magnetic Field.*

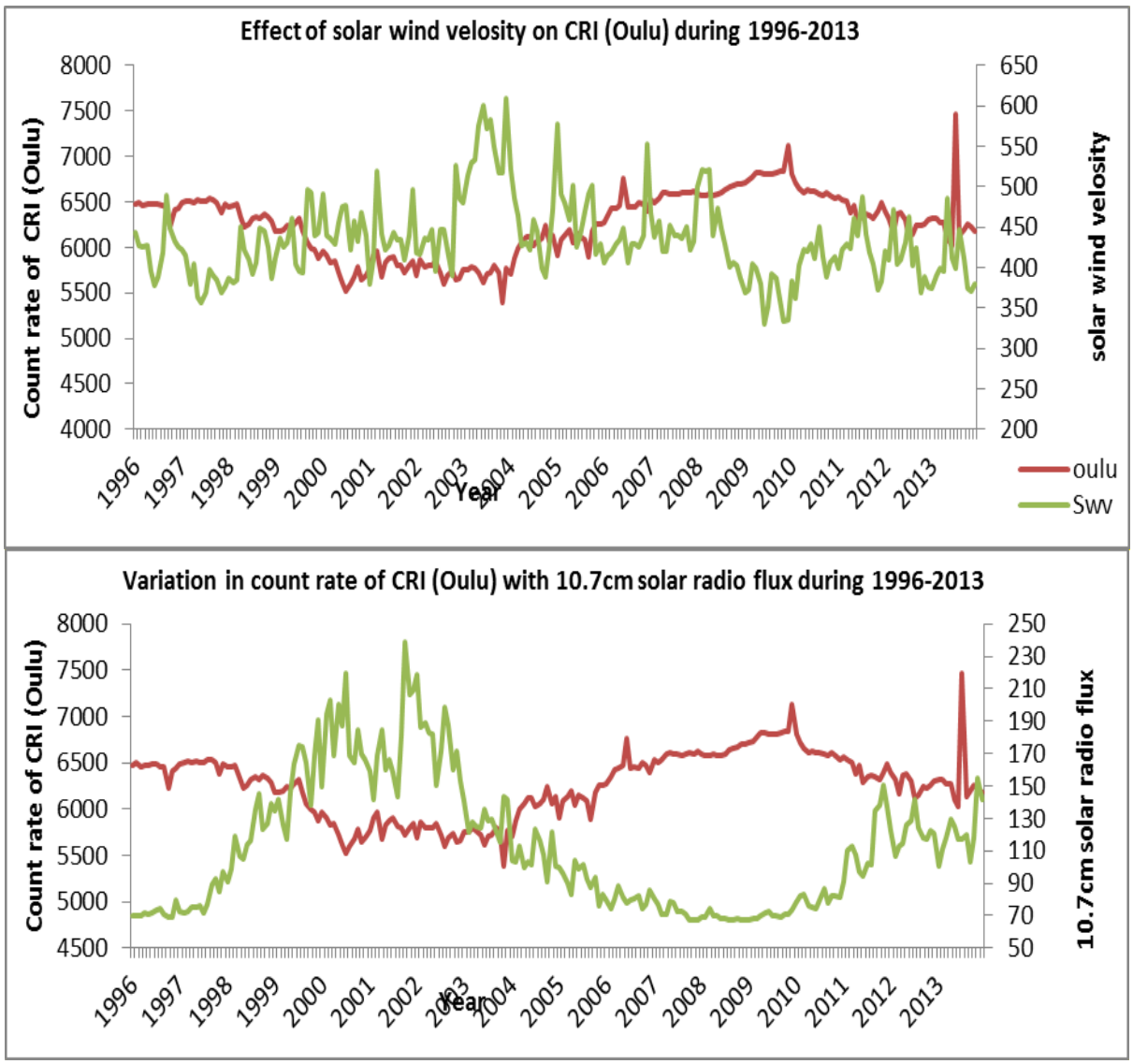

Fig. 2*: *Shows Variation in (Left) Counts Rate of CRI with Solar Wind Velocity and (right) Count Rate of CRI with 10.7 cm Solar Radio Flux.

DISCUSSION AND CONCLUSIONS

Cosmic ray intensity is closely related with halo CMEs associated with X-ray solar flares of different categories and interplanetary shocks. Cosmic ray intensity variation are produced by the transient disturbance such as traveling interplanetary shocks, are produced by coronal mass ejection. The large decreases in CRI are associated with MCs preceded by shocks, whereas, small decreases are associated magnetic clouds are not preceded by shocks. The variation cosmic ray intensity are inversely correlated with solar activity indices and these variations are produced by solar wind velocity is related to convection and diffusion, depends on the interplanetary field strength and its fluctuations, and the tilt of the heliosphereic current sheet (HCS). The rate of decrease in cosmic ray intensity is faster with respect to increase in interplanetary magnetic field and solar wind velocity, although the correlations are poor.

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