Impact of High-Speed Solar Wind Streams on Cosmic Ray Intensity from 2009 to 2012

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ABSTRACT

High speed solar wind stream (HSSWS) events observed by space craft data near earth these streams for the period of 2009 to 2012, which correspond to ascending phase of recent solar cycle 24. In this work we have defined a HSSWS as a period as one having a rapidly rising increase in the solar wind speed (V) over a short period ($\Delta V \geq 350$ kms^{-1} in $\leq$ 24hrs) reaching a maximum value of $\geq$500 kms^{-1}. The duration of these HSSWS are taken from $\simeq$ 05 to 08 days. We have selected 51 HSSWS events satisfying the above condition. Daily values of comic ray from Oulu neutron monitor have been used in chree analysis of super epoch method. From the above analysis it is inferred that these long duration high speed solar wind streams produce transient decrease in cosmic ray intensity on short term basis.

Keywords: *High speed solar wind stream, Cosmic ray, Transient decrease*

I. INTRODUCTION

High speed solar wind stream (HSSWS) is important phenomena which produce Disturbances in interplanetary space. The short term intensity variations in cosmic rays are produced by solar outputs in the form of out flowing solar plasma. Changes in cosmic ray intensity generally associated with various interplanetary disturbances including high speed solar wind streams. Comic ray modulation due to solar wind are also well explained in terms of transpose theory of cosmic ray modulation processes (Parker, 1965)

HSSWS are identified as almost dynamical feature in interplanetary medium which affect both of cosmic rays and geomagnetic field of earth (Mavaronicholaki, 1988: Shrivastva and Shukla 1993) Mavaromichalaki et al 1988 have indentified two types of high speed solar wind streams (HSSWS), first Co-rotating streams (CS) and second solar flare generated streams (FGS). Both type of high speed solar wind streams are considered in the analysis.

Venkatesan et al 1982 and Mishra et. al. 1990 were first to identify distinctly different effects of high speed solar wind stream (HSSWS) on cosmic ray intensity. Later several researches have also reported the role of HSSWS in Cosmic ray Intensity variation time to time (Shrivastava and Shukla 1994: Shrivastava and Jaiswal 2003). Subha in 2000 also reported the role of V along with IMF B in Short term Change in cosmic ray intensity. Earlier, several investigators have also reported the decrease in cosmic ray intensity for solar cycle 23 (Shrivastava and Jaiswal 2003). Now we have extended our study for the period of 2009 to 2012 which correspond to ascending phase of recent solar cycle 24.

II. DATA ANALYSIS

The solar wind plasma speed data used in this analysis down loaded from NASA websites (http://onniwebgsfc.nasa.gov/cgi/nx.cgi). The pressure and temperature corrected daily values of cosmic ray from Oulu neutron monitor have been used. We have adopted the chree analysis of superposed epoch method to determine the average behavior of cosmic ray intensity.
In our work we have defined a HSSWS as a period as one having a rapidly rising increase in the solar wind speed (V) over a short period ($\Delta V \geq 350$ kms^{-1} in $\leq$ 24hrs) reaching a maximum value of $\geq$500 kms^{-1}. The duration of these HSSWS are considered $\simeq$ 05 to 08 days. We have selected 51 HSSWS events satisfying the above criteria.

III. RESULT AND DISCUSSION

To show the average behavior of cosmic ray intensity in influence of HSSWS, we have adopted the chree analysis of superposed epoch method in this analysis zero day is taken as the onset day of HSSWS (High speed solar wind stream)

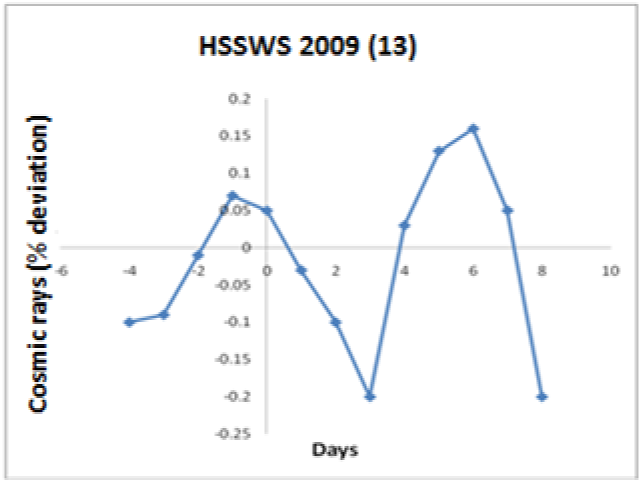

Figure 1.1: The result of chree analysis of superposed epoch method from -4 to 8 days with respect to zero epoch days for the year of 2009.the percent deviation of the daily mean cosmic ray intensity (Oulu neutrons) for a number

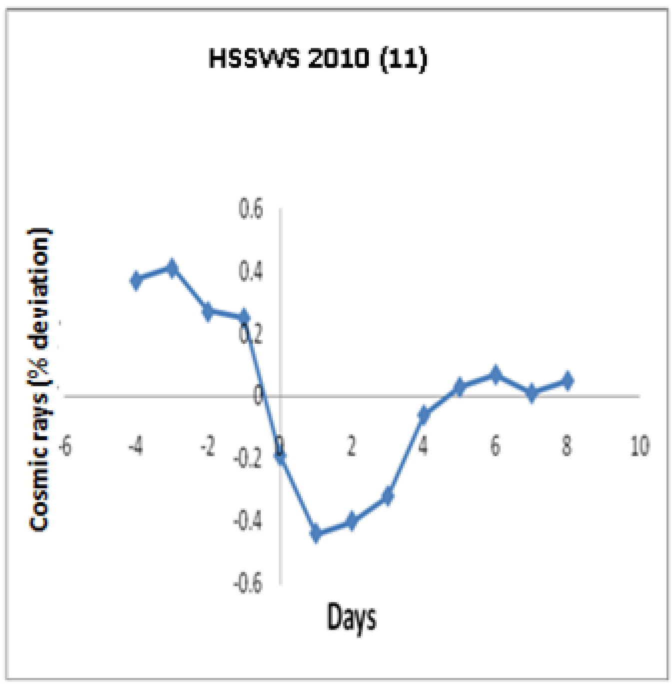

Figure 1.2: Same as figure 1.1 but for the year 2010

We have done the analysis for the period of 2009 to 2012. The result of chree analysis for - 4 to 8 days have been plotted in figure 1 as a percent deviation of the data from the Oulu neutron monitor station. Deviations for each year are obtained from the overall average of the 13 days number of events is given in brackets beside the year in figure. Figure 1.1 shows the result of chree analysis for the year 2009 it is clearly shows the transient decrease in cosmic ray ntensity. Decrease starts -1 day and reaches maximum on +3 days from the zero day, maximum decrease Amplitude is observed 0.2, and similar analyses have been done for the years of 2010, 2011 and 2012. Figures 1.2 show the results of chree analysis for the year of 2010 respectively, it is clearly show the transient decrease in cosmic ray intensity, decrease start -1 day and reaches maximum on +1 day from the zero day, maximum decrease amplitude is observed 0.44.

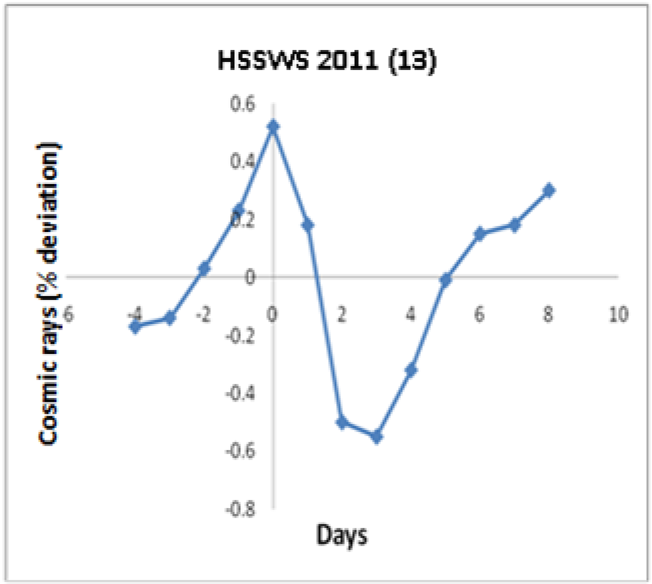

Figure 1.3: Same as figure 1.1 but for the year 2011

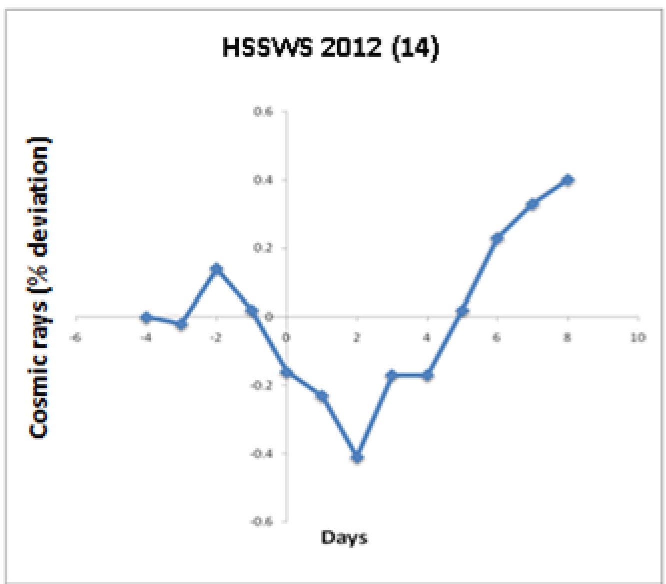

Figure 1.4: Same as figure 1.1 but for the year 2012

Figure 1.3 and 1.4 shows the result of chree analysis for the years of 2011 & 2012. In year 2011 decrease start 0 day and reaches maximum +3 day from the onset day, maximum decrease amplitude observed 0.55. In Year 2012 decrease start -2 day and reaches maximum +2 day form the onset day, maximum decrease amplitude is observed 0.41.

All these four years which cover the ascending phases of recent solar cycle 24 reveal significant transient decreases in cosmic ray intensity. However magnitude to decrease is found to be larger in the year of 2010, 2011 and 2012.

Result of our analysis can be explained mathematically that the enhancements of solar wind plasma speed produce perturbations in interplanetary magnetic field which produce barriers in the path of charged cosmic ray particles.

IV. CONCLUSION

High speed solar wind streams (HSSWS) produce transient decreases in cosmic ray intensity for the period of 2009 to 2012, which correspond to ascending phase of recent solar cycle 24.In most of the years decrease start -1 days and reaches maximum on ≃ +2 day from the onset day of HSSWS.

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