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Association of Short Term Asymmetric Cosmic Ray Intensity Decreases with Geomagnetic Storms and Solar Wind Plasma Parameters

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Abstract
We have observed 74 short term asymmetric cosmic ray intensity decreases for the period 1997-2013, which are associated with geomagnetic storms and solar wind plasma parameters (temperature, velocity). Out of 74, 62 events are found to be associated with geomagnetic storms. Further out of 74 events 71 events are associated with jump in solar wind plasma temperature (JSWT) and 67 events are associated with jump in solar wind plasma velocity (JSWV). From the analysis we observed the positive correlation between the magnitude of asymmetric cosmic ray decreases and magnitude of geomagnetic storms with correlation coefficient of 0.60. Further we find the positive correlation with correlation coefficients 0.42 and 0.33 between magnitude of asymmetric cosmic ray decreases with peak value of JSWT events and magnitude of JSWT events respectively. Again from the analysis positive correlation is found with correlation coefficients 0.38 and 0.23 between magnitude of asymmetric cosmic ray decreases with peak value of jump in solar wind plasma velocity (JSWV) events and magnitude of JSWV events respectively.
***Keywords:** - cosmic ray intensity decreases, solar wind plasma parameters, geomagnetic storms.*

1- INTRODUCTION

The galactic cosmic ray intensity remains constant in time and space outside the heliosphere, within the heliosphere, due to various dynamical processes occurring on the sun and extending into interplanetary space, the long term and short term variation in cosmic ray intensity takes place. There are mainly two specific types of cosmic ray intensity depressions, namely corotating and asymmetric short term decreases, characterized by a fast decrease within ~1 day followed by a more gradual nearly exponential recovery over a few days, have been observed continuously with neutron monitors since the 1950's. Recurrent modulations of galactic cosmic rays, characterized by a slow decrease and a gradual recovery within a period of ~27 days, comparatively, are less impressive changes in cosmic ray intensity.

The cosmic-ray intensity has its minimum at the maximum of the sunspot cycle. Generally, this variation is explained in terms of gradient and curvature particle drifts in the large-scale field of the heliosphere (Jokipii, Levy, and Hubbard1977) and diffusion/convection of cosmic rays (Morrison 1956;Burlaga et al 1984; Perko;& Burlaga 1992) in the solar wind (for recent reviews see McDonald 1998;Potgieter 1998Burger 2000) Coronal mass ejections (CMEs), large-scale eruptions of magnetized plasma from the Sun (Hundhausen 1993,199), are related to very strong, short-lived (Forbush) decreases of cosmic-ray intensity at Earth.

Disturbances in solar wind (SW) parameters such as proton speed, density and temperature, accompanied by highly fluctuating compressions of interplanetary magnetic field (IMF) cause short-term depressions in the galactic cosmic ray (CR) flux. Generally, these depressions are denoted as Forbush decreases (FDs), since they were first reported by Forbush (1937). Forbush decreases were related to solar activity by Simpson (1954).

2- DATA SOURCES

For this study we have taken asymmetric cosmic ray intensity decreases of magnitude ≥4%, from Oulu super neutron monitor. To determine disturbances in solar wind plasma parameters, hourly data of solar wind plasma temperature, velocity has been used and these data has been taken from omni web data.

3- DATA ANALYSIS AND RESULTS

From the data analysis of asymmetric cosmic ray intensity decreases and geomagnetic storms we have found that the most short term cosmic ray decreases associated with geomagnetic storms. We have 74 short term asymmetric cosmic ray intensity decreases out of these 83.87 % are associated with geomagnetic storms.

To sees how the magnitude of asymmetric cosmic ray intensity decreases is correlated with geomagnetic storms. We have plotted a scatter diagram between the magnitude of asymmetric cosmic ray intensity decreases and magnitude of geomagnetic storms (Fig.-1). We have found the Positive co-relation with co-relation coefficient 0.60 between the magnitude of asymmetric cosmic ray decreases and magnitude associated geomagnetic storms.

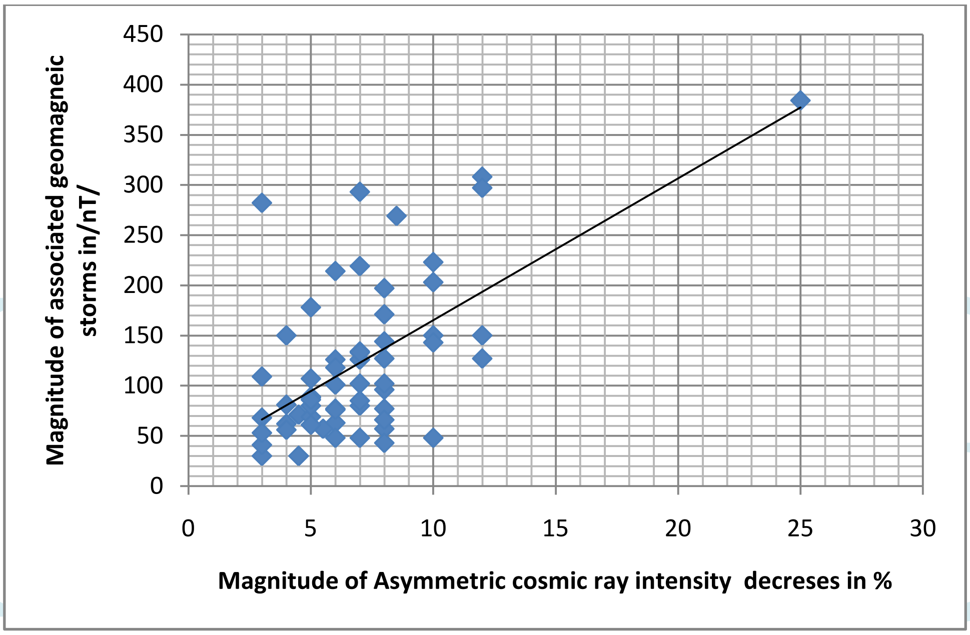

Figure1- Scatter plot between magnitude asymmetric cosmic ray intensity decreases and magnitude of associated geomagnetic storms showing positive correlation with correlation coefficient 0.60.

From the data analysis of asymmetric short term cosmic ray decreases and jump in solar wind plasma temperature we have found that the most of Asymmetric short term cosmic ray decreases are found to be associated with JSWT events. We have 74 Asymmetric short term cosmic ray decreases out of these, 71 (95.95%) asymmetric short term cosmic ray decreases are found to be associated with jump in solar wind plasma temperature.

To sees how the magnitude of asymmetric cosmic ray intensity decreases is correlated with peak value of JSWT events and magnitude of JSWT events. We have plotted a scatter diagram in Fig. 2 & 3. It is clear from the fig. that most of the asymmetric cosmic ray intensity decreases which have large magnitude are associated with such JSWT events having higher peak valve and higher magnitude, it is also inferred that some asymmetric cosmic ray intensity decreases which have large magnitude but they are associated with such JSWT events having lower peak value and magnitude. Positive co-relation has been found between magnitudes of asymmetric cosmic ray intensity decreases with peak value and magnitude of jump in temperature of associated JSWT events. Statistically calculated co-relation co-efficient is 0.42 and 0.33 respectively.

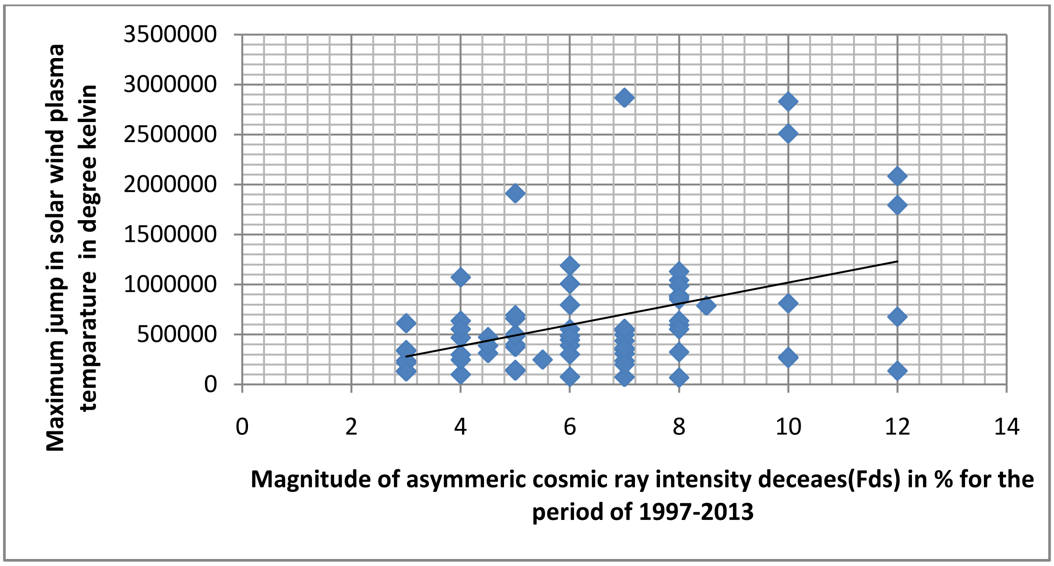

Figure2- Scatter plot between magnitude of asymmetric cosmic ray intensity decreases and maximum jump value of solar wind plasma temperature showing positive correlation with correlation coefficient 0.42.

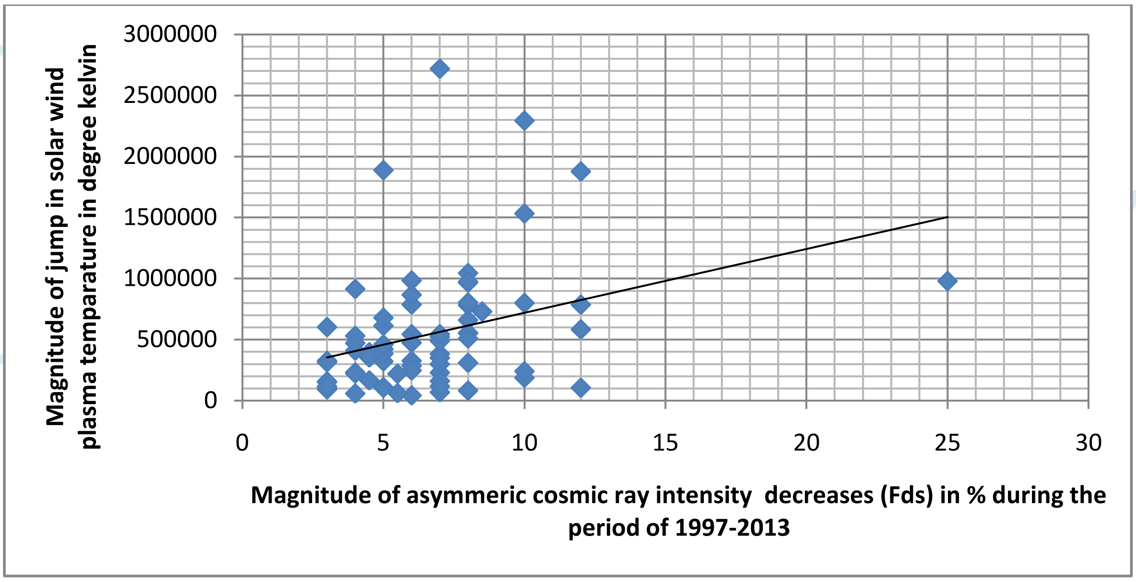

Figure3- Scatter plot between magnitude of asymmetric cosmic ray intensity decreases and magnitude of jump in solar wind plasma temperature showing positive correlation with correlation coefficient 0.33.

The asymmetric cosmic ray intensity decreases are also associated with jump in solar wind plasma velocity (JSWV). From the analysis we have 74 asymmetric cosmic ray intensity decreases. From the data analysis we have obtained that asymmetric cosmic ray intensity decreases are closely associated with JSWV events. Out of these, 67 (90.54%) asymmetric cosmic ray intensity decreases are associated with JSWV events.

To see how the magnitude of asymmetric cosmic ray intensity decreases is correlated with peak value of JSWV events and magnitude of JSWV events. We have plotted a scatter diagram in Fig. 4&5. It is clear from the fig. that most of the asymmetric cosmic ray intensity decreases which have large magnitude are associated with such JSWV events having higher peak value and higher magnitude, it is also inferred that some asymmetric cosmic ray intensity decreases which have large magnitude but they are associated with such JSWV events having lower peak value and magnitude. Positive co-relation has been found between magnitudes of asymmetric cosmic ray intensity decreases with peak value and magnitude of jump in velocity of associated JSWV events. Statistically calculated correlation coefficient is 0.38 and 0.23 respectively.

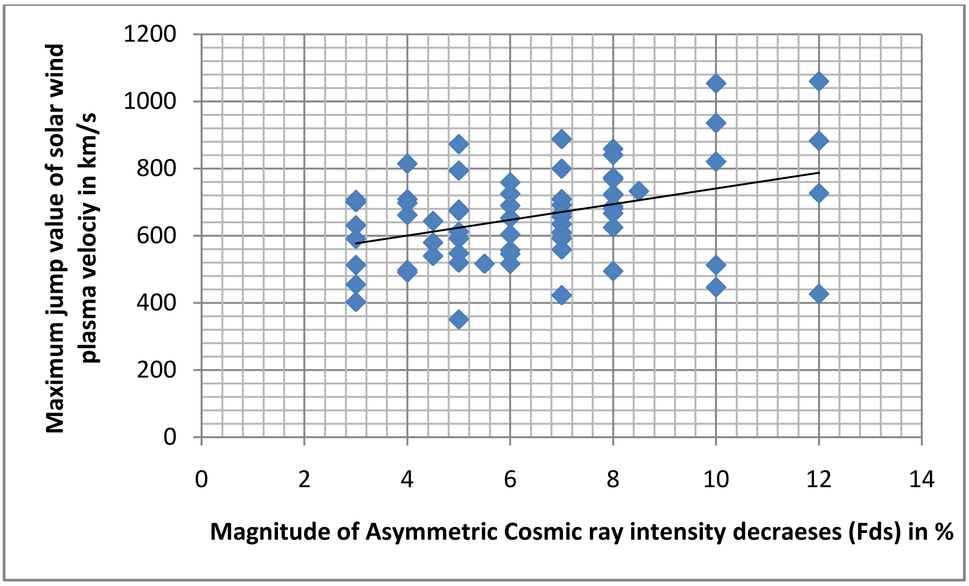

Figure4- Scatter plot between magnitude of asymmetric cosmic ray intensity decreases and peak value of associated JSWV events showing positive correlation with correlation coefficient 0.38.

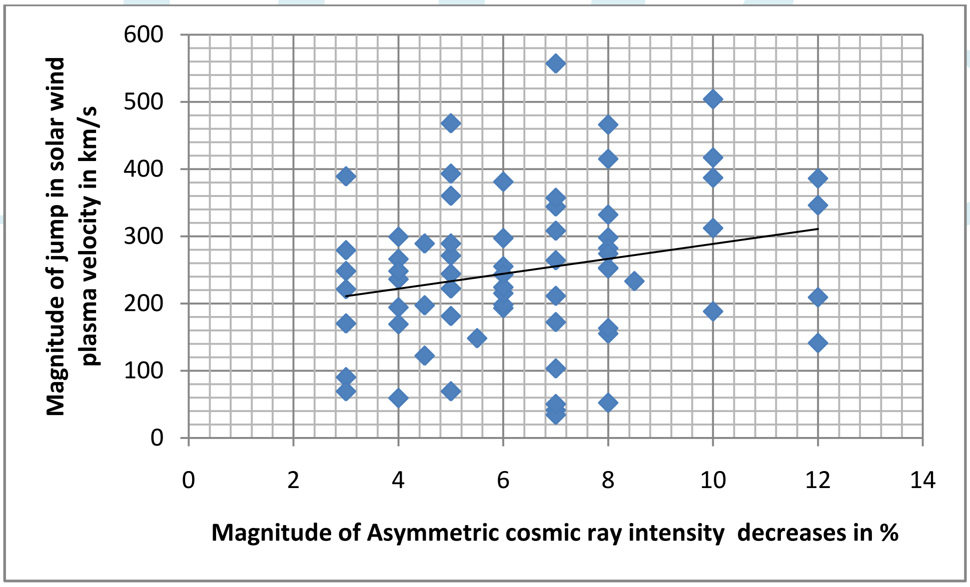

Figure5- Scatter plot between magnitude of asymmetric cosmic ray intensity decreases and magnitude of associated JSWV events showing positive correlation with correlation coefficient 0.23.

4- CONCLUSION

From our study 62, out of 74 asymmetric cosmic ray intensity decreases (83.78%) are found to be associated with geomagnetic storms. Positive correlation with correlation coefficient 0.60 has been found between magnitude of asymmetric cosmic ray intensity decreases and geomagnetic storms. Positive correlation have also been found between magnitude of asymmetric cosmic ray intensity decreases and associated jump in solar wind plasma temperature and solar wind plasma velocity. From these results it is concluded that majority of the asymmetric cosmic ray intensity produce disturbances in solar wind plasma parameters.

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