High speed solar wind streams and cosmic ray intensity variation

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Abstract

Two types of high speed solar wind streams namely flare generated streams (FGS) and corotating streams (CS) are taken to study the short-term changes in cosmic ray intensity. In this work we have selected in two types of streams for the period of 1991 to 1996. It is investigated that both of categories of these solar wind streams are found equally effective in producing cosmic ray intensity decreases. These streams are again grouped in to three classes (smaller, medium and longer) according to their duration of occurrence in days. Further, analysis of this study indicates that the medium solar wind streams are found more effective in producing transient decreases in cosmic ray intensity.

1. Introduction

Short-term changes in cosmic ray intensity variation are well known. A number of research works have been done since last four decades to understand the cause of cosmic ray modulation (Rao, U.R. 1971; Shrivastava, P.K. 1990). Solar wind plasma stream with high velocity were investigated as one of the important factor in cosmic ray modulation (Mishra *et al.* 1990; Shrivastava and Shukla, 1994).

In this work we have studied the effect of two types of solar wind streams on cosmic ray intensity for the period of 1989 to 1994.

2. Method

High speed plasma streams are shorted out from the plots and hourly values of interplanetary parameters. We have separated the two types of high speed solar wind streams into two categories. Flare Generated Streams (FGS) and Corotating Streams (CS) on the basis of various physical properties (Mavromichalki, 1988).

Following physical features are considered for the identification of corotating streams : (i) Proton density rises to unusually high values near the leading edges of the streams, (ii) The interplanetary magnetic field, (iii) Magnitude is

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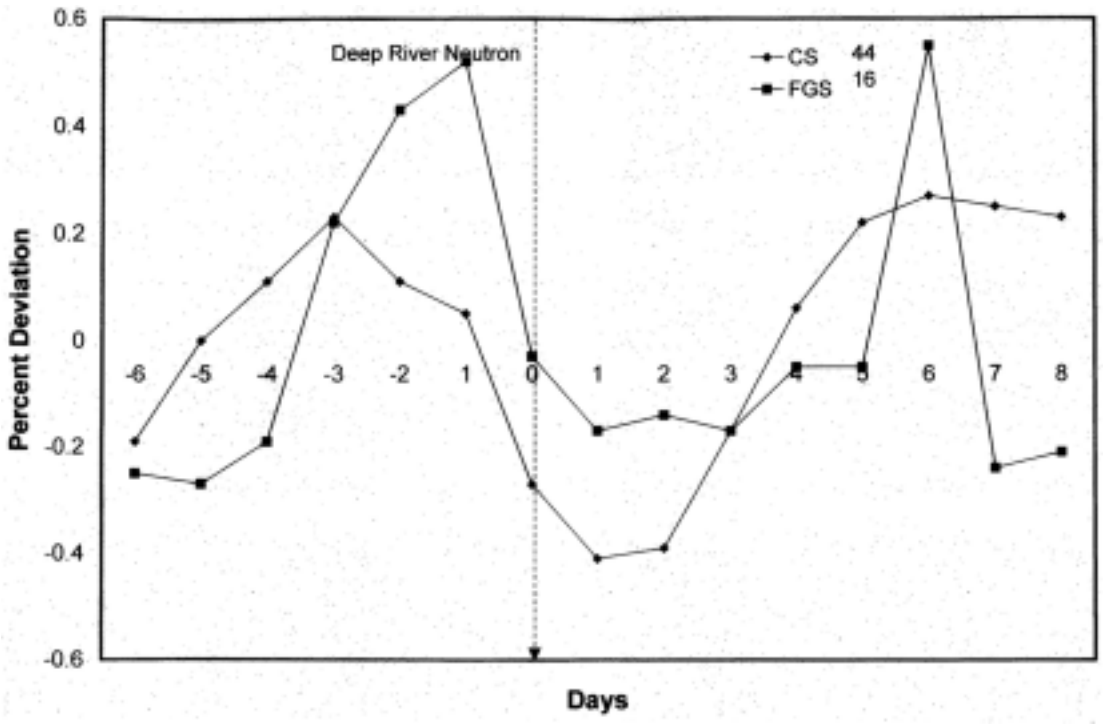

Fig. 1. Shows the average picture of cosmic ray intensity under the influence of medium range solar wind streams (5 to 6 days) for the period of 1989 to 1994.

proportional to bulk speed with constant polarity throughout the stream and (iv) The proton temperature varies in a pattern similar to that of flow speed. Flare generated streams are selected on the following criteria.

(a) All the interplanetary parameters show simultaneous increase.

(b) The bulk speed the proton density and magnetic field magnitude show large fluctuation in the maximum speed period.

The large Forbush decrease of Magnitude $\geq 3\%$ in cosmic ray intensity have been excluded from the study to avoid their influence. We have adopted the chree analysis of superposed epoch to determine the average behaviour of cosmic ray intensity. Daily mean cosmic ray intensity of Deep River have been used for the period 1989 to 1994.

3. Results

Earlier it has been reported that solar flare generated high speed solar wind streams are dominated during high solar activity period and produce large

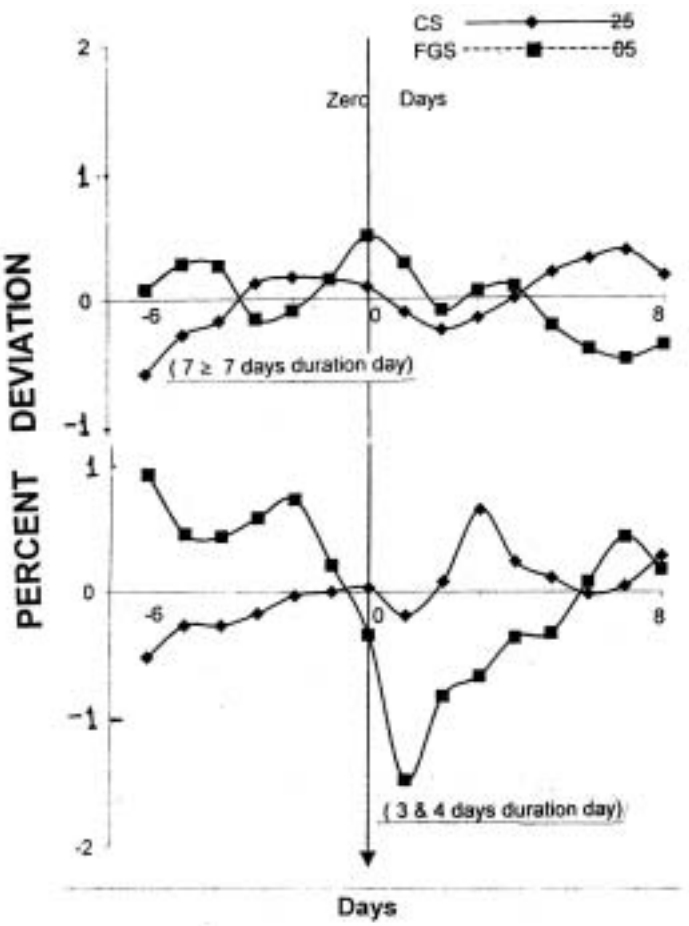

Fig. 2. Shows the average picture of cosmic ray intensity under the influence of longer streams (upper panel) and smaller streams (lower panel) for the period of 1989 to 1994.

transient decrease in cosmic ray intensity (Mishra *et al.* 1990). After the identification of two types of solar wind plasma streams in 1988, several attempts have been made to show their influence on cosmic ray intensity on short-term basis (Shrivastava and Shukla, 1994). More recently Shrivastava and Jaiswal, 2003 reported almost equal influence of FGS and CS solar wind streams on cosmic ray transient decreases for the period of 1991 to 1996, using the oulu neutron monitors data. For further analysis, we have again separated these events (FGS and CS) into three categories according to their duration. These categories of durations are (i) 3 to 4 days (ii) 5 to 6 days and $\geq$ 7 days.

To determine the average behaviour, we have adopted the chree method of superpoch epoch and on carried out the analysis for selected events. The results of chree analysis for medium range solar wind streams (5 to 6 days) are plotted

in Fig. 1. It is seen from the figure that the medium range streams produce significant decrease in cosmic ray intensity. However, magnitude of decrease is found larger ($\geq 4\%$) in case of CS stream. Similar type of analysis has been done for smaller and longer duration solar wind streams as shown in Fig. 2. Result of chree analysis for same period does not show any meaningful result for smaller and longer duration streams. It is expected that smaller duration streams produce effect on cosmic ray intensity due to influence of intense solar flares. On the other side longer duration streams show little impact on cosmic ray intensity.

4. Discussion

The anti correlation between particle density and solar wind speed within high speed plasma streams suggest that the enhance conversion of cosmic rays from the inner heliosphere may be a major process producing corotating particle depressions in high speed streams.

5. Conclusions

(i) It is concluded that both the FGS and CS streams produce short-term transient decreases in cosmic ray intensity for the period of 1991 to 1996.

(ii) Medium range (5 to 6 days duration) solar wind streams are found to be more effective in producing cosmic ray transient decreases.

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