STUDY OF DOMINATING PARAMETERS OF HIGH SPEED SOLAR PLASMA STREAMS IN RELATION TO COSMIC RAY AND GEOMAGNETIC STORMS

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ABSTRACT

The high speed solar wind streams observed near earth are generally associated with the solar features, such as solar flares and coronal holes. Past studies of these streams from the two sources have revealed distinctly different effects on cosmic ray intensity, whereas the effect is similar for geomagnetic disturbances. Moreover, the effect of the magnitude of the high speed streams (V) and its rate of increase (dv/dt) has also been a subject of investigation to understand their relative contribution in producing geomagnetic disturbances. From the analysis of some of the fast streams presented here, it is difficult to predict, which one of the two (V, dv/dt) is more effective in producing geo-magnetic disturbances. Further, in most of the cases, no substential decrease in cosmic ray intensity is observed.

1. Introduction. The high speed solar wind streams are now known to be associated with energetic solar flares during the period of high solar activity, and with large area solar coronal holes during the declining phase of solar activity. Their distinctly different effects on short-term cosmic ray intensity decreases has been recently pointed out (Venkatesan et.al. 1982). Lindblad and Lundstedt (1981, 1983) have compiled the list of high speed solar wind streams for the period 1964-78. Reference is also made in the same reports, that geo-magnetic activity is more closely associated with a large positive time derivative (dv/dt) than with large velocity. Moreover, it has been reported that geo-magnetic activity maximises earlier than solar wind velocity at the earth. (Ballif et.al. 1969; Sawyer and Haurwitz, 1976). However, from a critical review of literature, it is not possible to make a positive statement that dv/dt is better associated with geo-magnetic activity than with V. In this paper, we have considered some of those streams which show a very smooth and sharp rise in velocity, to find out the

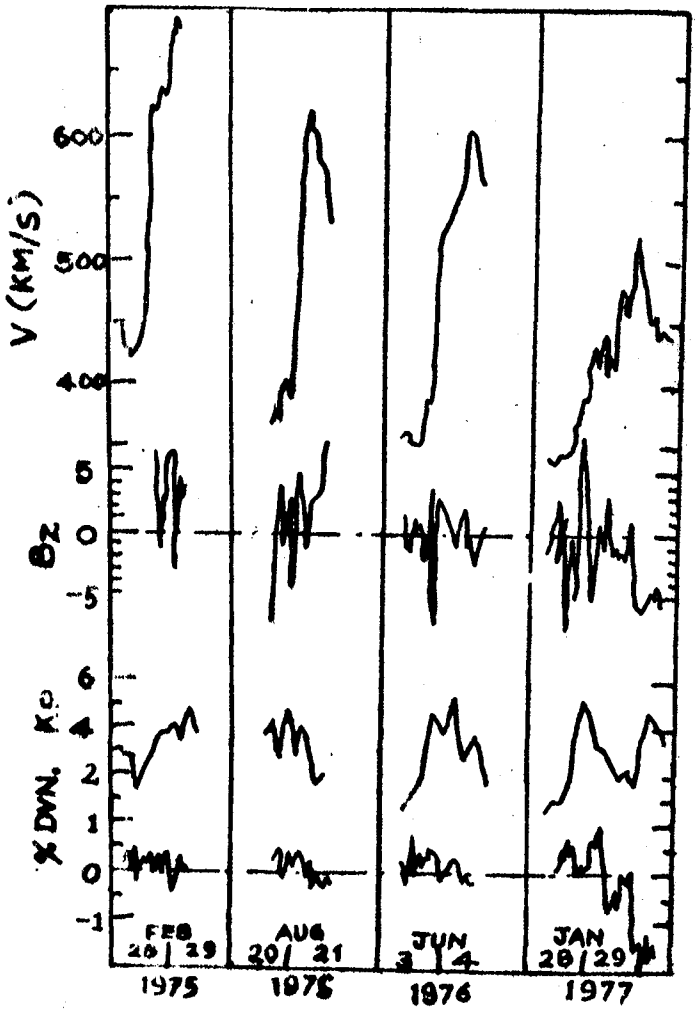

Fig.1 Shows the time intensity plot for three fast rise, high speed solar wind stream events selected from the catalogue published by Lindblad and Lundstedt (1983; see text for details) during the interval 1975-78; in all 25 events were selected. The fourth event (Jan. 28-30, 1977) represents a slow V but smooth rise in solar wind speed with relatively low value of maximum velocity. The Bz component of the interplanetary magnetic field as well as the Kp indices, and the percent deviation of cosmic ray intensity (Deep River neutron monitor) are also shown for each event.

effect of dv/dt and V on geo-magnetic disturbance index Kp, and cosmic ray intensity.

2. Selection of events. For the selection of events, we have made use of the catalogue published by Lindblad and Lundstedt (1983) andthe Interplanetary Medium Data Book, Supp. 1 (No.79-08; Dec. 1979). Moreover, the following conditions were imposed on the solar wind speed profile.

1. The initial velocity of the solar wind, before the start of the event, should be below or around 400 kms/sec.

2. Only that portion of the stream is considered for calculating dv/dt, during which the velocity monotonically increases.

3. The peak value of the solar wind stream is taken within 24-hours of the last hour of the dv/dt. For each event we have selected the maximum value of the 3-hourly Kp-indices for the duration of dv/dt, as well as the maximum value of 3-hourly Kp-indices during the 6-hours on either side of the hour of maximum V. Based on this selection criteria,

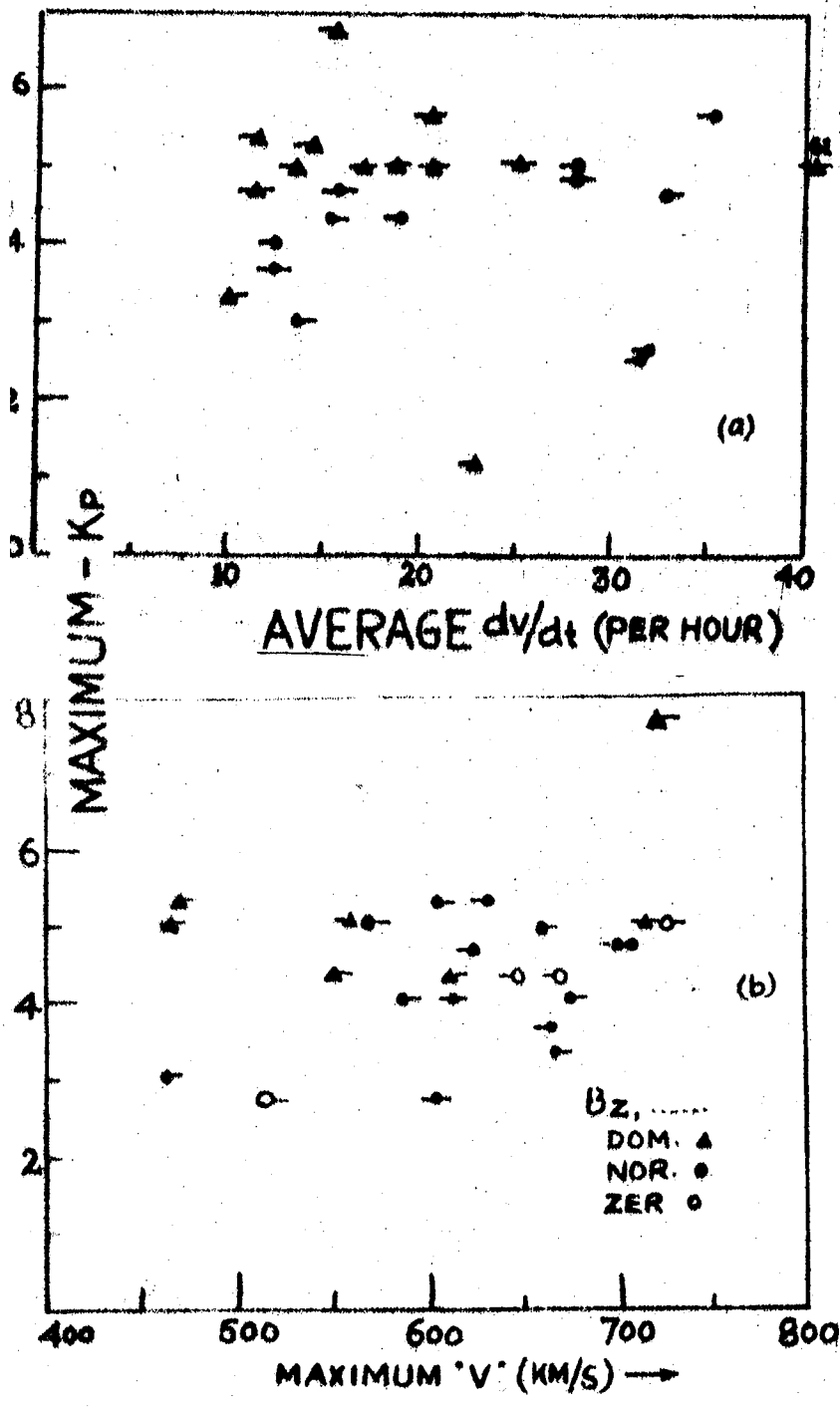

Fig. 2(a) Shows the crossplot between the average dv/dt & Kp-maximum for 25 high speed solar wind stream events. The magnitude of the negative excursion of Bz is represented by different symbols, and the length of the horizontal bars give the estimate of the duration of dv/dt. The position of the bar on right/left depicts the Kp max. being in the start/end of the dv/dt interval.

(b) Shows Kp max. plotted against the peak magnitude of solar wind speed(V) symbols have the same meaning as in fig 2(a). The position of the bar on right/left depicts the time of Kp max. being before/after within six-hours on either side of peak value of V.

we have identified 25 high speed stream events to investigate the effect of dv/dt and maximum-V, on Kp.

3. Analysis and results. Out of 25 high speed streams selected, three representative cases of high dv/dt and large V are depicted in figure 1. In the same figure we have also shown an event of low dv/dt and V, but associated

with highly negative values of Bz. It may be noted that all the three high dv/dt and "V" cases are associated with different conditions of other parameters (Bz, Kp and % deviation of cosmic ray intensity at Alert). From the first 3 cases depicted in figure 1, it can be inferred that Kp is high only when Bz is negative, and is affected equally both during dv/dt and V. This statement is further justified from the plot showing the case of low value of dv/dt and low V, where again for highly negative value of Bz, we find a moderate to high values of Kp. Any significant change in the cosmic ray intensity during the interval of high dv/dt and high V is not observed. On the contrary, a small decrease is associated with the last case of low V and dv/dt, which may be due to other causes.

In figure 2 and 3, we have shown all the 25 cases, correlating the observed maximum value of Kp with the value of dv/dt and V separately. The difference in the magnitude of Bz is also represented in the figure by plotting the value by different symbols. Moreover, the duration of dv/dt is represented by the length of the horizontal bars. The occurrence of maximum value of Kp at the start, middle or end of dv/dt is also represented. Similarly, in the case of V, the occurrence of maximum Kp, before or after the time of maximum V is also depicted.

From both the plots, it is clear that the maximum value of Kp is usually high for all the events (i.e. for maximum V and for average dv/dt), and does not show any significant relationship either with V or dv/dt. This is seen even when we divide the events for various categories of Bz. However, in most of the cases, Kp approaches maximum value either at the end of dv/dt interval, or just before V reaches to maximum values. We have also noticed that the maximum V and dv/dt are loosely correlated with each other, and that could be the reason why maximum Kp is seen in both the cases. Therefore, from the analysis presented here, we conclude that the value of Kp is generally high both during maximum V and high dv/dt and has no preferrence to occur during the interval of dv/dt.

4. References.

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