SH 5.1-15

ANOMALOUS LOW LEVEL OF COSMIC RAY INTENSITY DECREASES OBSERVED DURING 1980

A.K.Jain, P.K.Pandey and S.P.Agrawal
Physics Department(Vikram Space Physics Centre)
A.P.S.University,Rewa (M.P.) 486003, India

ABSTRACT

Past studies have revealed solar cycle changes in the sunspot activity, as well as in many other solar parameters, such as, solar flares and solar coronal holes. These solar features in turn produce the observed cyclic variations in the interplanetary plasma and fields. Both the cosmic ray intensity as well as the intensity of geomagnetic disturbances are affected by the interplanetary changes and produce 11/22 years periodicity. During the period of high solar activity, solar flares are more abundent, and are expected to produce large Forbush type cosmic ray decreases as well as intense geomagnetic disturbances. An anomalous situation has been noticed during the year 1980 (period of high sunspot activity), when both the geomagnetic disturbance index Ap, as well as the magnitude and number of Forbush decreases are small. Such an anomaly occurs, inspite of the fact that both the sunspot numbers and the energetic solar flares are almost maximum during the present solar cycle. Further investigations reveal that the observed solar flares in 1980 are also situated in favourable longitudes, and hence the cause for such an observed anomalous low values of Ap and the cosmic ray decreases, is presently not understood.

1. Introduction.

The long term variation in the solar activity is generally represented by sunspot numbers, which shows a recurrent tendency with a period of eleven years. Many other associated solar parameters, such as solar flares, coronal holes, also show 11/22 year cyclic variations (see e.g. review, Rao, 1972). Intense solar flares generally produce high speed solar wind streams, which in turn produce geomagnetic disturbances as well as significant decreases in cosmic ray intensity (see, e.g. review, Lockwood, 1971; Agrawal and Singh, 1976). It is therefore, expected that more number of Forbush decreases with larger magnitudes should be observed during the period of high solar

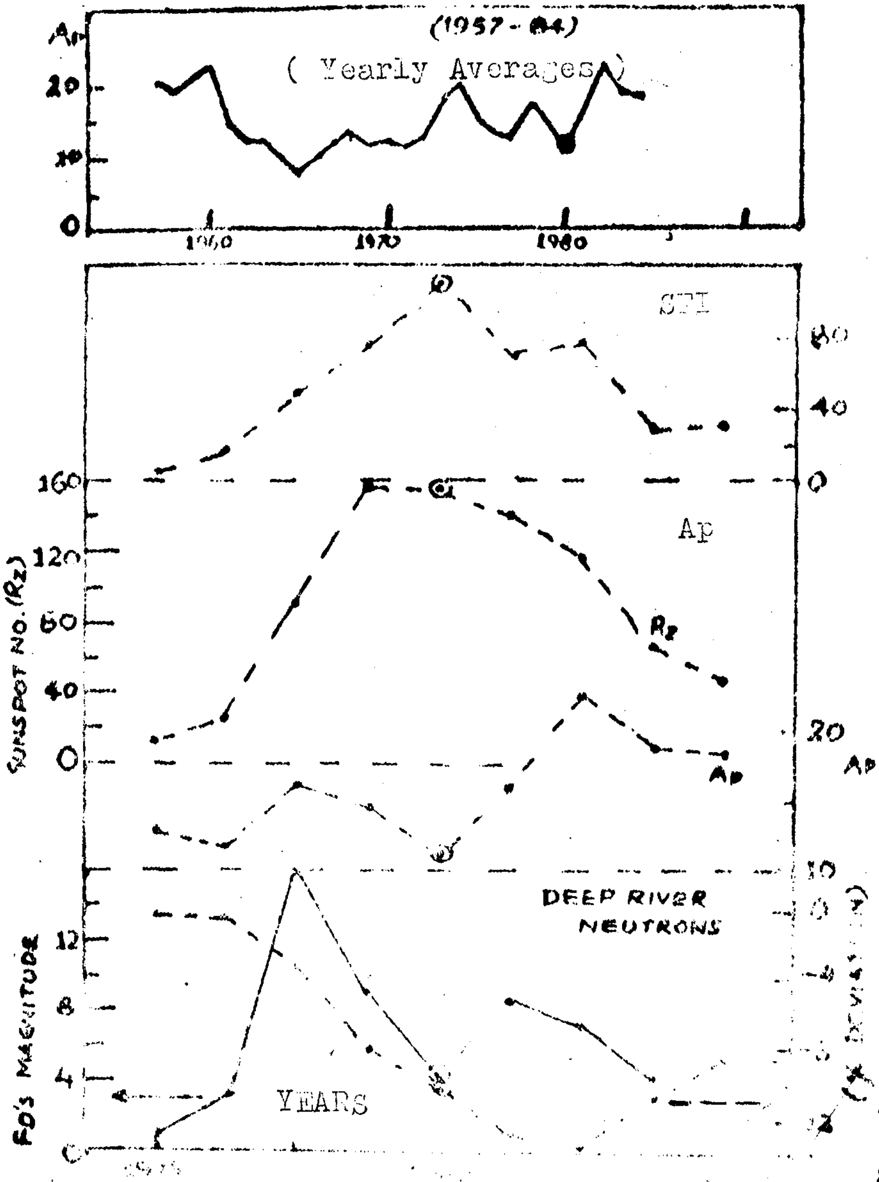

Fig. 1 (top) shows the yearly average variation of the geomagnetic disturbance index Ap, for the years 1957-84. The values for the year 1980 is encircled in this plot as well as in other plots of this figure to clearly identify the anomaly. (bottom) The yearly average values of the solar flare index (see text for details for the computation of SFI), The sunspot number, the Ap index, the Forbush decrease index (see text for details), and the cosmic ray intensity deviation from its max. value observed during Sept.-Nov. 1976, are also shown in the fig. for the years 1976-84. In some cases, the average values for 1984 are derived from 8-10 months data.

activity (e.g. 1979-81). Moreover, the geomagnetic disturbance index Ap should also be high during such periods. In this context, an anomalous situation is observed during the year 1980, when both the Ap index, as well as the number and magnitude of Forbush decreases are quite low. In this paper, we investigate this anomaly to understand, why larger number of energetic solar flares observed in the year 1980 are in-effective in producing geomagnetic disturbances as well as Forbush decreases.

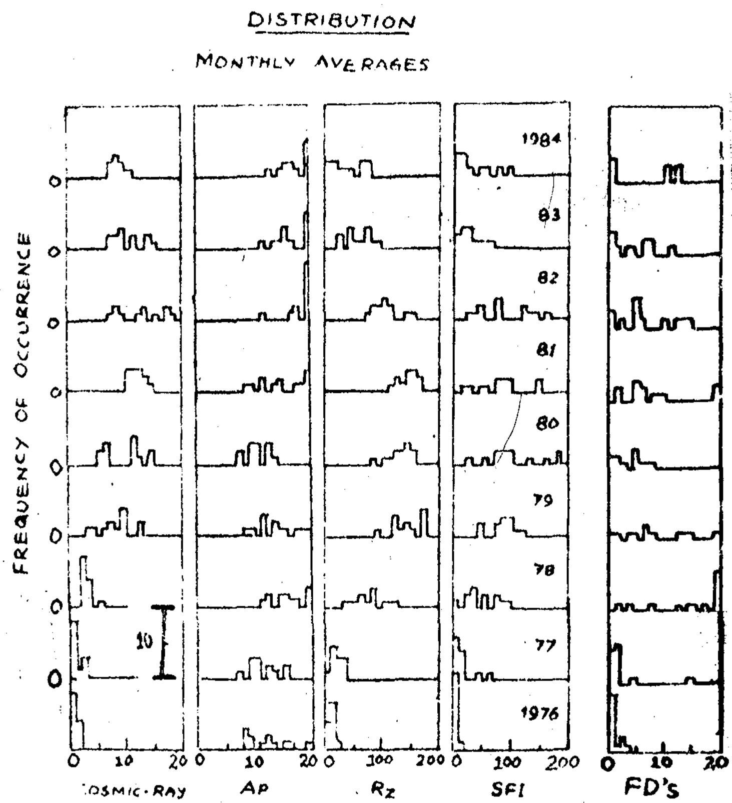

Fig.2 Shows the distribution of monthly averages for all the five parameters for which the yearly averages are shown in figure I. The anomalous low value of Fd's and of Ap index, for the year 1980, is clearly evident.

2. Computation of solar flare and Forbush decrease index.

In another paper (SH 4.4-12) we have described the computation of the solar flare index (S.F.I.) from the list of observed energetic solar flares of importance ≥ 1, published in prompt reports of solar Geophysical Data. Briefly, SFI has been computed by giving weight to the importance of the solar flare by its numerical value, and also by considering weights for the brightness of the flare. Similarly, the Forbush decrease index has been computed for each month, by numerically adding the magnitude of all the Forbush decreases observed in that month. A decrease in cosmic ray intensity is considered only when its magnitude is $\gtrsim 1.5\%$, and the decrease is clearly seen in at-least two high latitude neutron monitor stations. The derived Fd's index has been denoted as Fd's Σmagnitude, and has been used in the diagrams presented later in this paper.

3. Results and Discussion.

The long-term variation of the geomagnetic disturbance index Ap for the years 1957-84 is plotted in figure 1 (top portion of the figure). We note that the yearly average value of Ap index is quite low during the year 1980. The plot also shows the minimum value of Ap observed during 1965, the year of minimum solar activity. Other solar and geophysical parameters are plotted in the bottom part of figure 1. Both, the sunspot numbers, as well as the solar flare indices are at their peak value during the year 1980, whereas the Ap index is at its minimum value. We also note that the long term cosmic ray intensity decrease shows a smooth decline starting in 1977 with a minimum in 1982. However, the Forbush decrease index shows a very low value in 1980 as compared to the adjacent values. Thus the low values of Ap and Fd's are quiet anomalous, particularly when one observes the large excess of energetic solar flares represented by SFI. To further analyse the distribution of the five parameters represented in figure 1 on yearly basis, we have generated a frequency histogram for each year, and for each parameter, using their monthly values. Such a distribution is plotted in figure 2, for the years 1976-84. Thus, even on a monthly average basis the anomaly of the low values of Ap index, as well as of the Fd's is apparent. To ascertain that the low values of Ap index and of Fd's during 1980, is not due to any large asymmetry in the longitudnal distribution of the solar flares, we have plotted in figure 3, the frequency histrogram for all the solar flares of importance ≥ 1. From the figure, it is seen that there is no deficiency in the number of solar flares in the longitude region 60° East to 30° West for the year 1980, as compared to the years 1979 and 1981. Such an observation, therefore, rules out the possibility, that the solar flares during 1980 are unfavourably placed to be geo-effective. From the results presented here, we therefore note that even-though we have demonstrated the anomaly in terms of low geo-effectiveness of the energetic solar flares during 1980, however, we have not been able to identify the cause for such an anomaly. It is expected that other characteristics of the cosmic ray time variation might be able to provide some clue to understand the reported anomaly.

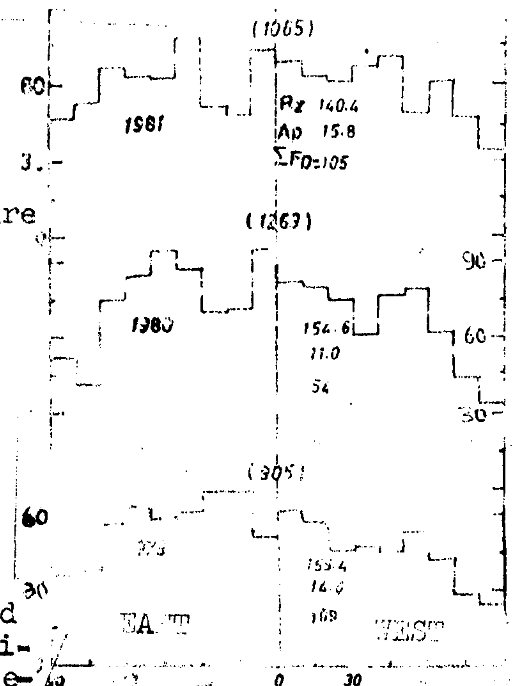

Fig.3 Shows the frequency distribution with heliolongitude of the individual solar flares of importance ≥ 1, for the years 1979, 80 & 81. The yearly average values of Rz, Ap and Fd index (Σ Fd) are also mentioned in the fig. alongwith the total number of solar flares for each year.

4. References.

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