LONGITUDINAL DISTRIBUTION OF THE COOL SOLAR SURGES

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Abstract. This investigation shows that solar surges are poorly associated with sudden ionospheric disturbances (X-ray) implying that solar surge material is cool and does not heat the corona. The investigation also shows that solar surges are most prolific at longitudes 80°, 110°, 260°, and 290°.

1. Introduction

The solar surge is a fast phenomenon in the solar chromosphere and corona and extends into the corona much higher than the top of the chromosphere (Macris, 1971). The surge is possibly a consequence of an ejection of plasmoid inside strong magnetic field zone in a solar active region (Cao *et al.*, 1978). Nearly all the observations point to the fact that a surge is situated within the umbra and penumbra of a sunspot (Gopasyuk and Ogir, 1963). According to Pettit (1943) surges are frequently ejected from the edges of the caps (prominences).

Recent observations (Roy, 1973) have shown that surges are composed of bundles of fibres ($< 1''$) separated from one another by some arc sec and each fibre is connected with an Ellerman bomb. The majority of the observations also show that surges are often born together with flares (Kiepenheuer, 1968; Rust, 1968). Surges, typically last 10–20 min and show a strong tendency to recur, at a rate of nearly 1 per hour for small surges (Tandberg-Hanssen, 1977). The velocity of the ejected material is 100–200 km s^{-1} and reaches a maximum height of 2×10^5 km (Tandberg-Hannsen, 1977).

In this paper we present a study of solar surges and their relation with sudden ionospheric disturbances (SIDs). We present also the longitudinal distribution of solar surges on the Sun.

TABLE I

Number of SIDs recorded in a year due to solar surges and total number of surges in years

Year	Total number of solar surges	SIDs due to solar surges
1980	74	9
1981	357	20
1982	266	20

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2. Observational Data

For our analysis the main source of data is the *Solar Geophysical Data* (SGD). Daily recorded solar surges along with their locations and times are given in SGD, published in the chapter concerning 'mass ejection from the Sun'. Also for studying the relationship of SIDs with solar surges we have used SGD.

3. Relation of Surges with SIDs

To date the nature of the association of surges with SIDs has not been studied well. Very few surges show association with SIDs. Rust *et al.* (1977) using Skylab observations for 54 surges concluded that the surges do not heat corona and hence confirm the customary view that the surges are cool mass ejections.

To find the association of solar surges with SIDs, we noted the number of surges and the times of their occurrence. We checked these noted surge times with recorded SID times from the list in SGD for 1980, 1981, 1982, and 1983. Since the correlation of SIDs with flares is well known (100%), we reckoned those SIDs as SIDs due to surges for which there is no known flare on the solar surface and for which no large prominence eruptions had occurred simultaneously. In Table I, the number of surges observed in the period 1980–82 and their association with SIDs is given. In 1980 a total of only 74 surges were recorded, out of these 9 are found to be associated with SIDs. Similarly, in 1981 against 357 recorded surges only 20 surges were found to be associated with SIDs. Again in 1982, out of 266 recorded surges only 20 were found to be associated with SIDs. In all, during 1980, 1981, and 1982 out of 697 surges recorded only 49 (7%) were found to be associated with SIDs.

Most SIDs are caused by an increase in ionization in the ionospheric D-layer and this layer is mainly affected by X-rays between 1–10 Å (Švestka, 1976). The 7% association of surges with SIDs found in the present analysis, indicates that most of the surges do not produce X-rays during their ejection from the Sun. Energetic soft X-ray (1–10 Å) emission requires temperature $> 10^7$ K and it originates in such a hot plasma through bremsstrahlung continuum and lines of heavily stripped ions (Švestka, 1981). Since surges normally do not seem to produce SIDs, therefore we infer that the ejected surge material is relatively cool material and hence will not heat the corona, which also agrees with the customary view regarding ejected surge material (Rust *et al.*, 1977).

4. Longitudinal Distribution of the Solar Surges

To study the longitudinal distribution of the solar surges we used 'mass ejection from the Sun' data, published in SGD. SGD started publishing these data from January 1980. From SGD (1980, 1981, 1982, and 1983) we have noted down the longitude (RA) of each surge, irrespective of the duration. We have counted all the small and large duration surges. We have plotted a histogram as shown in Figure 1a, makes it clear that there are two peaks in 1980, first at 110° and second at 290° longitudes. The separation

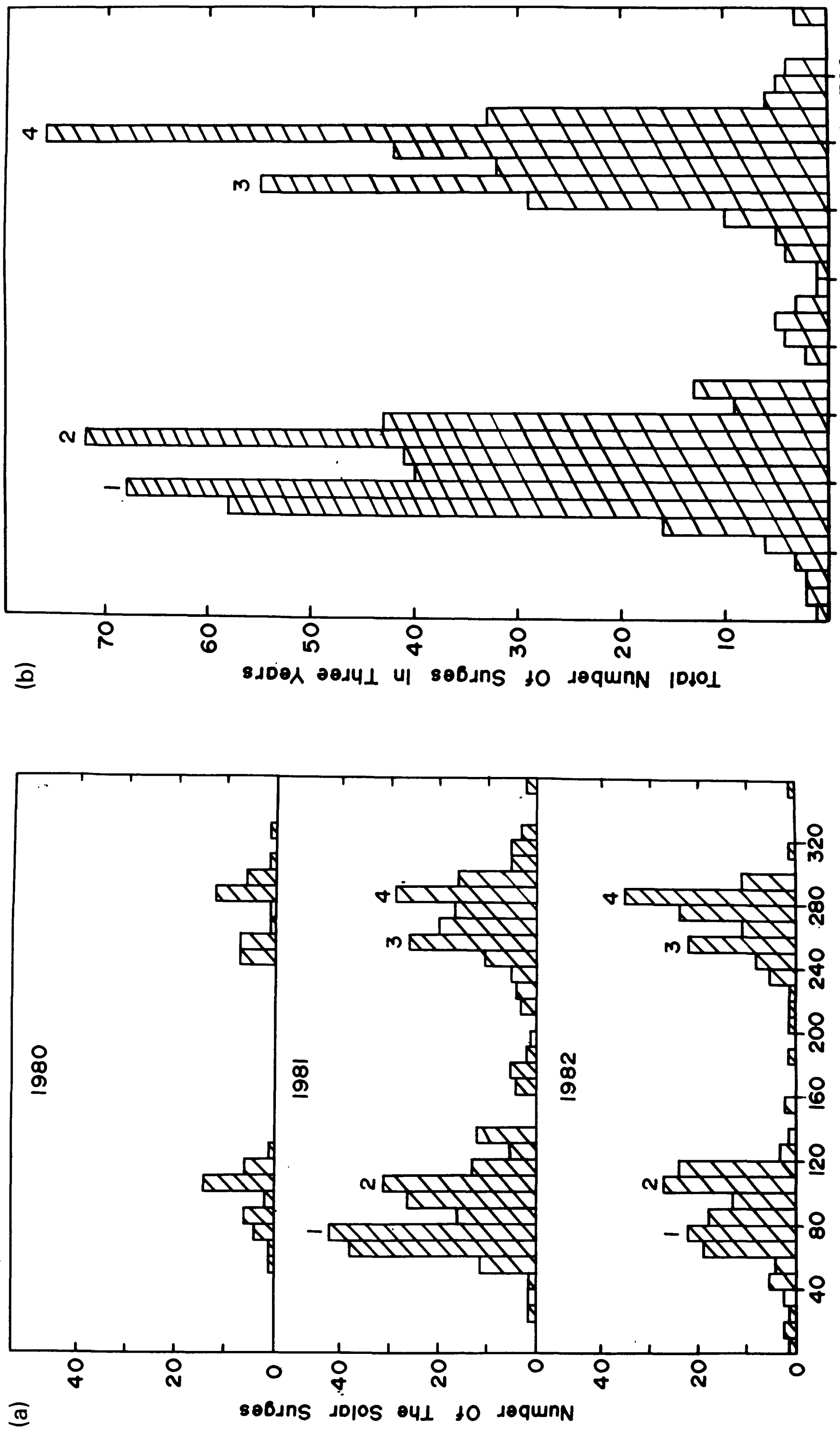

Fig. 1a–b. Plot of number of surges versus heliographic longitudes.

between the two peaks is 180°. In 1981, we find four peaks at 80°, 110°, 260°, and 290°, respectively, and similarly in 1982, we again find four peaks at 80°, 110°, 260°, and 290°, respectively. The separation between 80° and 260° is 180° and 110° and 290° is 180°. Again if we add up the numbers of surges of 1980, 1981, 1982 and plot them versus longitude, the distribution is as shown in Figure 1(b). Therefore, we infer that the surges are most prolific at 80°, 110°, 260°, and 290° longitudes. Since surges occur only in active regions, one may infer that there are four active longitudes on the Sun.

The separation between the peaks 1, 3 and 2, 4 is 180° and the separation between the peaks 1, 2 and 3, 4 is 30 only. It is also clear that active longitudes exist in two groups in the peaks 1, 2 called as *A* group and the peaks 3, 4 called as *B* and the centroids of the groups are separated by 180° in longitude.

Earlier Warwick (1965) and Švestka (1968) pointed out the existence of two active Carrington longitudes on the Sun. Recently Bogart (1982) interpreted the 13.5 day peak as pointing to the existence of active longitudes on the Sun separated by 180° in longitude on the basis of power spectrum analysis of Sunspot data for a period of 128 years. Our analysis of longitudinal distribution of the solar surges shows that alongwith these two active longitudes, two more active longitudes exist on the Sun. This is clear from Figure 1.

Thus, though our study covers a period of only three years for surge data there is a clear indication that four active longitudes exist on the Sun.

5. Conclusion

In this paper we have studied relation between solar surges and SIDs and longitudinal distribution of the solar surges on the Sun. From the above study we infer that:

(1) Solar surges show very poor association with SIDs and they do not seem to produce enhanced flux of soft X-rays and thus surge material does not seem to heat the corona.

(2) The solar surges are found to be most prolific at 80°, 110°, 260°, and 290° longitudes, respectively, and that four active longitudes exist on the Sun.

(3) The four active longitudes are concentrated in two zones and the zone separation is 150° in longitude.

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