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"HELIOSPHERIC CURRENT SHEET PASSAGES AT 1 AU DURING THE SOLAR MAXIMUM EPOCH 1979-80"

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ABSTRACT

Thirty eight cases of sector boundary passages of the heliospheric current sheet by the earth have been compiled on the basis of the interplanetary magnetic field data which have been collected by the magnetometer of ISEE-3 spacecraft. The analysis of these data has shown that sector boundaries in some cases occur preferentially in certain Bartels rotation days of the sun though their distribution within the solar rotation in the maximum of the solar cycle No. 21 is quite different than those in the maxima of the cycles No. 18,19,20.Moreover a gradual eastward shift of the heliosperic current sheet during the time span under consideration is evident. The particular behaviour of the sector boundaries in the last solar maximum epoch, in relation to the previous maxima, implies a logitudinal relocation of the heliospheric current sheet probably induced by the differential rotation of the solar surface as well as a reorganization of the solar activity. Such reorganizations have been determined to take place in successive 22-year solar cycles of various manifestations of the solar activity.

1.- INTRODUCTION

The sector structure of the interplanetary magnetic field (IMF) is probably one of the most impressive discoveries of the early satellite era. Nowadays it is widely admitted that the sector structure of the IMF is formed by a large-scale heliospheric current sheet (HCS),similar to a thick tangential discontinuity,whick stays quasi-sinusoidally on both sides of the solar equator and corotates with the sun separating in this way the interplanetary medium in 2-4 sectors.The IMF direction within each sector is uniquely or predominantly "away" from or "toward" to the sun while in the subsequent sector the field direction is opposite (Schultz, 1973; Wilcox et al. 1980). Intersections of the HCS with the earth's orbit on the ecliptic plane, which have been detected as abrupt changes of the IMF direction by 180 deg, have been referred to as sector boundaries. A detailed

analysis of observed and high-accuracy inferred IMF data covering the period 1957-1975 (cycles No. 19-20) have pointed out that a two-sector structure is prominent during the extremes of the solar cycles but a four-sector structure predominates during the intermediate years, especially in the descending branch of each 11-year cycle.In addition, sector boundaries seem to occur in selected days of the solar rotation. Actually, in the epoches of the extremes (+,-) boundaries, namely boundaries where the IMF direction is away from and toward to the sun, in front and behind of it respectively, occur mainly around the 11th day of the solar rotation while (-,+) boundaries prefer to concentrate in the two edges of the rotation. In contrast, sector boundary occurences during the descending branch of the solar cycle is a rather complicated case though an average four sector structure is finally formed (Tritakis,1979). Indications for sector boundary relations with atmospheric parameters have been mentioned by Shapiro (1976), Wilcox (1980) and Tritakis (1984) while Akasofu (1981) has described the coexistence of the HCS passage with major geomagnetic storms. Finally significant indications that the HCS affects seriously the low energy particles propagation in the interplanetary medium have been also reported (Tritakis,1984). It is evident that the various correlations between sector boundaries and a great number of solar, interplanetary and atmospheric parameters underline the great importance of the whole HCS pattern for the geosciences and the space physics. Therefore the main intention of this report is to elongate the sector boundary list with additional well defined cases as well as to emphasize that the heliospheric current sheet behaviour during the last solar maximum is compatible to that of previous solar maxima.

2.- DATA REDUCTION

Sector boundaries of the HCS have been detected by the data which have been collected by the ISEE-3 spacecraft from September 1978 to January 1980. This spacecraft was launched in August 1978 into a so far halo orbit around the so-called Langrange libration point (L1) between the sun and the earth where the heliocentric motion of the spacecraft remains in dynamic equilibrium by the gravitational forces of the sun and the earth. In any case, the spacecraft stays in front of the earth towards the sun which is an excellent position for observing travelling interplanetary phenomena. Sector boundary passages of the HCS by the earth are mainly manifested by abrupt or gradual changes,depending on the thickness of the boundary and the HCS inclination to the ecliptic, of the longitudinal angle of the magnetic field vector by 180 deg. All measurements are referred to the orthogonal earth-centerred GSE (Geocentric Solar Ecliptic)

coordinate system that has its x-axis towards the Sun, the Z-axis towards the North ecliptic pole and the y-axis completes a right-handed system. The predominant longitudinal angle of the magnetic field vector within " positive" or "away" and negative or "toward" magnetic sectors for the time under consideration was about 300 deg. and 120 deg. respectively. From detailed measurements of the IMF parameters, especially longitudinal and elevation angle values of the IMF, from September 1978 to the end of 1979, thirty eight cases of sector boundary occurences have been tabulated (Table I).

3.- DISCUSSION

The entries of the table I concern to thirty eight sector boundary cases detected during 505 days of observations near the last solar maximum, namely from the day No. 226 of 1978 to the day No. 365 0f 1979. Since the time of observation consists of 505:27=18.7 Bartels rotations, there is an average of 38 sector boundaries : 18.7 Bart. rot.=2 sec.bound/rot. which confirms previous conclusions that during the solar maxima a two-sector pattern predominates (Tritakis, 1979). In figure 1, the frequency distribution of the (+,-) and the (-,+) sector boundaries within a typical solar Bartels rotation is depicted. From this histogram it is evident some preference of the sector boundaries to occur in certain days of the Bartels rotation.Actually the highest peaks of the (-,+) boundary cases occur during the 11th and the 25th Bartels days (figure 1.low panel) whereas most of the (+,-) boundaries are concentrated between the 1st and the 8th Bartels days (figure 1,upper panel). In figure 2, we have presented the frequency distribution of sector boundaries which occurred during the maxima of cycles No. 18,19,20. High and statistically significant peaks of (+,-) and (-,+) boundary cases are obvious in the 11th and 27th Bartels days of the low panel and around the 20th day of the upper panel,respectively. From figures 1 and 2, it is clear that the sector boundary distribution in the maximum of the solar cycle No. 21 is different from the relevant distribution in the cycles No.18,19,20. Sector boundary cases which have been compiled by the ISEE-3 data and tabulated in table I have been depicted in a Bartels type format in the figure 3. From this figure a continuous shift of the sector boundaries during successive Bartels rotations is evident. In the meantime, a significant tendency of the sector boundaries to occur in certain days is also evident. For instance, (-,+) sector boundary cases between the Bartels rotation No. 25-27 Bartels days while the (+,-) cases between rotation No. 1993-1996 prefer to occur on the 7-8 Bartels days. The disagreement of the sector boundary cases distribution in the maximum of the solar cycle No.21 and the maxima of the cycles No. 18,19,20 probably implies

TABLE 1.-
Sector boundary passages of the IMF from September 1978 to the end of 1979.-

	DAY No.	BARTELS DAY No.	APPROX. TIME U.T.	SIGN.
1978	226	27	20	+/-
	237	11	12	-/+
	255	2	20	+/-
	264	11	12	-/+
	267	14	16	+/-
	270	17	16	-/+
	282	2	21	+/-
	292	12	02	-/+
	311	4	20	+/-
	318	11	12	-/+
	328	21	20	+/-
	337	3	02	-/+
	349	15	02	-/+
	362	1	02	+/-
1979	12	16	22	-/+
	24	1	23	+/-
	42	19	04	-/+
	54	4	14.30	+/-
	69	19	23	-/+
	82	5	08	+/-
	99	22	12	-/+
	111	7	20	+/-
	125	21	16	-/+
	138	7	09	+/-
	157	26	10	-/+
	166	8	07	+/-
	184	26	04	-/+
	193	8	02	+/-
	210	25	08	-/+
	222	10	19	+/-
	237	25	21	-/+
	251	12	20	+/-
	264	25	03	-/+
	277	11	10	+/-
	280	14	20	-/+
	286	20	03	+/-
	293	27	05	-/+
	336	16	16	+/-

Data gaps exist between the days No.305-330 and 337-365 of 1979.-

some kind of longitudinal relocation of the HCS induced by the differential rotation of the solar surface and the reorganization of the solar activity which has been determined to take place at the end of each 22-year solar cycle. The effect of the HCS passages by the earth in certain days of the solar rotation deserves a much further and detailed study because it can lead to significant conclusions about the HCS configuration as well as to relations between the IMF and several phenomena of the upper geosphere.

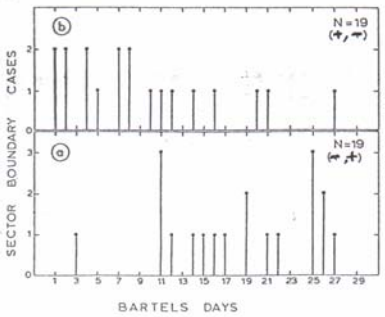

Figure 1: Frequency distribution within Bartels rotation of the (+/-) (upper panel) and the (-/+) (low panel) sector boundary passages detected by the ISEE-3 spacecraft.

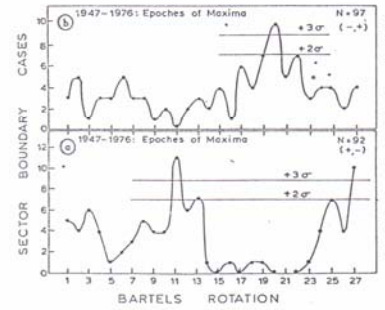

Figure 2: Frequency distribution within Bartels rotation of the (+/-) (low panel) and the (-/+) (upper panel) sector boundary passages detected in the epoches of maxima of the solar cycles No. 18-20 (1944-1976). The statistical confidence levels 0.05 and 0.01 have been defined in both panels of this figure.