PREFERRED BARTELS DAYS OF HIGH SPEED SOLAR WIND STREAMS : AN UPDATE

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ABSTRACT. Comparison of distribution of solar wind streams as a function of Bartels rotation days for two successive epochs indicates several significant differences. These are likely to be due to the differing nature of IMF and solar wind in the two solar cycles 20 and 21.

Lindblad (1981) carried out an analysis of 346 high speed solar wind streams observed at 1 Au during 1964-75 to show that the corotating streams, in particular, occurred most frequently near Bartels day 17 for negative polarity of IMF and near day 4 for positive polarity. For the non-recurrent flare-associated streams, the occurrence distribution did not show any well defined peak. He provided a schematic model with fast wind flow from tilted polar caps, the tilt being different for the two epochs 1964-70 and 1971-75. Mavromichalaki et al (1988) have just recently published a reference catalogue of well-defined high speed plasma streams for the period 1972-1984. This is basically an update of the earlier list of Lindblad (1981) with an overlap of 3 years. Lindblad's table contained only dominant polarity of the IMF (either away or toward the sun) for the duration of the stream whereas the new table provides cases where a sector boundary crossing (+/- or -/+) was embedded in the solar wind streams.

In this note we study the distribution of the solar wind streams as a function of Bartels rotation days for the different categories to provide a comparison with the earlier epoch. Fig. 1 shows the occurrence of high speed solar wind streams (computed in an identical fashion as was done by Lindblad (1981)) for corotating and flare-generated plasma. For each type, the distribution is further subdivided into two categories depending upon the polarity of IMF. The period of analysis is restricted from 1976 to 1984, leaving out the common period 1972-75, covering almost the entire solar cycle 21. As the number of cases of fast streams associated with sector boundary crossings were far less, we combined both the corotating and flare-generated streams. The distributions for the two types of boundaries

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are also shown in Fig. 1.

The striking features of the figure are summarised below:

(i) In contrast to the strong peak-to-valley modulation of the occurrence by a factor of 7 for the corotating streams during the earlier solar cycle, the present list exhibits only a factor of 3 to 4 with higher modulation in association with positive polarity.

(ii) The clear phase-shift of one half solar rotation observed earlier is absent for the corotating streams with opposite polarities.

(iii) Though the number of flare-generated streams are small, their occurrence pattern reveals a clear phase-opposition for the two polarities. This is again, in contrast to the earlier result of Lindblad (1981) for the 1964-75 data set.

(iv) Well defined preferred days near 10 for positive polarity and near day no. 3 and 23 for negative polarity are observable for streams associated with flares.

(v) For the combined list of streams linked with sector boundary passage, a phase-opposition in occurrence pattern between -/+ and +/- boundaries is discernible. As the earlier list did not have this category, it is not possible to decide whether this has been a persistent feature over the last two solar cycles at least.

The observed differences in the distribution patterns between solar cycles 20 and 21 may be attributed to the intrinsic differences in the solar activity and IMF between the two cycles. For example 1964-65 was a period of marked four sector pattern of IMF while 1974-75 was dominated by two sector solar wind streams. Also for corotating streams, the peak in occurrence will be well-marked only when the auto correlation function exhibits a 27-day periodicity. If the recurrent intervals have 28-day periodicity a broadening of the occurrence peak will be observed when data is arranged over a 27-day interval. This is found to be so when the polarity of mean solar magnetic field is examined for some of the years like 1977 etc. (Solar Geophysical data, Prompt Reports).

The most conspicuous difference between the two epochs is the occurrence pattern for flare-generated streams particularly in association with negative polarity. Is it a mere coincedence that solar flares responsible for these streams occurred on a preferred Bartels' day or the associated sunspots were so long-lived and active that the high speed streams could be repeatedly observed?

The phase opposition, noticed for the two types of sector boundaries in Fig. 1 will have to await confirmation mainly because the total numbers for the two cases are so different (almost double for the +/- type of boundary) and the individual occurrence numbers for -/+ consequently turn out to be too small. Nonetheless, if polarity change during high speed streams exhibit such features, it may be possible to infer the nature of the warp in heliospheric current sheet and suggest suitable schematic models to account for the observed features during the solar cycle 21.

REFERENCES

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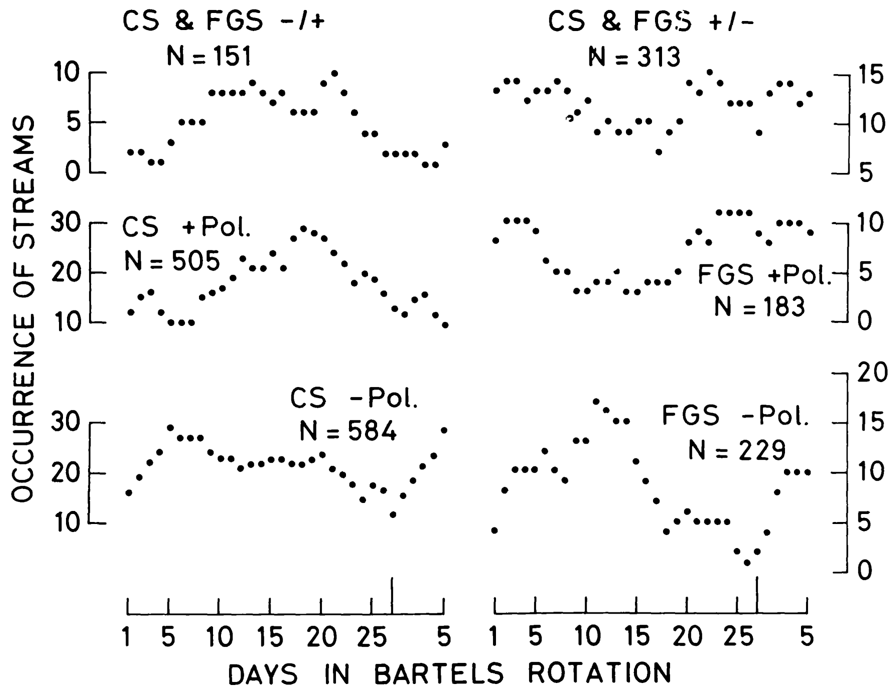

Fig. 1 Occurrence number of high speed solar wind streams during the years 1976-1984 as a function of days in Bartels rotation. CS indicates corotating streams and FGS indicates flare-generated streams. + Pol. and - Pol. indicate IMF directed away and toward the sun respectively.