ON THE INCREASE OF SOLAR ACTIVITY IN THE SOUTHERN HEMISPHERE DURING SOLAR CYCLE 21

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ABSTRACT. The present paper investigates the north-south asymmetry for major flares (solar cycles 19 and 20), type II radio bursts (solar cycles 19,20 and 21), white light flares (solar cycle 19,20 and 21), and gamma ray bursts, hard X-ray bursts and coronal mass ejections (solar cycle 21). The results are compared with the found asymmetry in favour of the northern hemisphere during solar cycles 19 and 20 in favour of the southern hemisphere during solar cycle 21.

1. Introduction

The solar activity in the northern and southern hemisphere cannot be a priori assumed to be symmetric. In fact, there is evidence in the literature that the behaviour of solar activity is asymmetric. Earlier, many investigators studied various aspects of this peculiarity (Roy, 1977 and references therein). It is not clear whether the asymmetry obeys a definite cycle between the hemispheres or shows a random behaviour. Roy (1977) studied the north-south distribution for flares, sunspots and white light flares for a period of more than 2 solar cycles and found that the asymmetry in the northern hemisphere increases with the importance of events.

The present paper investigates the north-south asymmetry for major flares during the solar cycles 19 and 20, type II radio bursts for the solar cycles 19,20 and 21, white light flares for the solar cycles 19,20 and 21, and solar gamma ray bursts, hard X-ray (HXR) bursts and coronal mass ejections (CME's) for the maximum period of solar cycle 21.

2. Data and Analysis

The data for all major flares for the period of solar cycles 19 and 20 have been published by Dodson and Hedeman (1971, 75). The data of white light flares have been taken from a paper by Neidig and Cliver (1983). In the analysis white light flares given in the appendix of a paper by Neidig and Cliver (1983) have also been included. The white light flares discussed by Hiei et al.(1986) and Huang et al.(1986) are also included in the present study. The type II radio bursts observed during solar cycles 19,20 and 21 are included in the study. The gamma ray bursts observed during 1980-1981 by the SMM and Hinotori satellites are used for the study. The HXR data used in this study, for the period

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1981-1982 was recorded on the Hinotori satellite. During 1981-1982, the Hinotori satellite recorded 609 HXR bursts. Out of them, 284 profiles were excluded from our study (Verma and Pande, 1985), thus we have only 315 HXR bursts data for the study. The CME's data used in the present investigation are taken from a paper by Sheeley et al. (1984). In Table 1 we show major flares, white light flares, type II radio bursts, gamma ray bursts, HXR bursts and CME's events that occurred in the northern and southern hemispheres of the Sun during solar cycles 19,20 and 21 and sources of their data.

TABLE I : Number of various solar activity events recorded in solar cycles 19, 20 and 21.

Various solar activity events	Number of events in solar cycles 19		20		21		References/Source of data.
	N	S	N	S	N	S	
Major flares	407	195	589	330	-	-	Dodson and Hedeman (1971, 75)
Type II radio bursts	122	42	223	137	256	350	Dodson and Hedeman (1971, 75, 81) and Solar Geophysical Data (1980- 1987)
White light flares	18	8	22	17	8	17	Neidig and Cliver (1983), Hiei et al. (1986) and Huang et al. (1986)
Solar gamma ray bursts	-	-	-	-	40	51	Rieger et al. (1983) Yoshimori (1985)
HXR bursts	-	-	-	-	140	175	Hinotori satellite data
CME's events	-	-	-	-	16	21	Sheeley et al (1984)

N : Northern hemisphere, S : Southern hemisphere.

We have calculated the north-south asymmetry using the formula :

$$\text{Asymmetry} = \frac{2(A_n - A_s) \times 100\%}{(A_n + A_s)} \qquad \text{(Pathak, 1977)}$$

Here A_n and A_s are the number of events occurring in the northern and southern hemisphere respectively. In Figure 1 we have plotted N-S asymmetry indices versus solar cycles for various solar events.

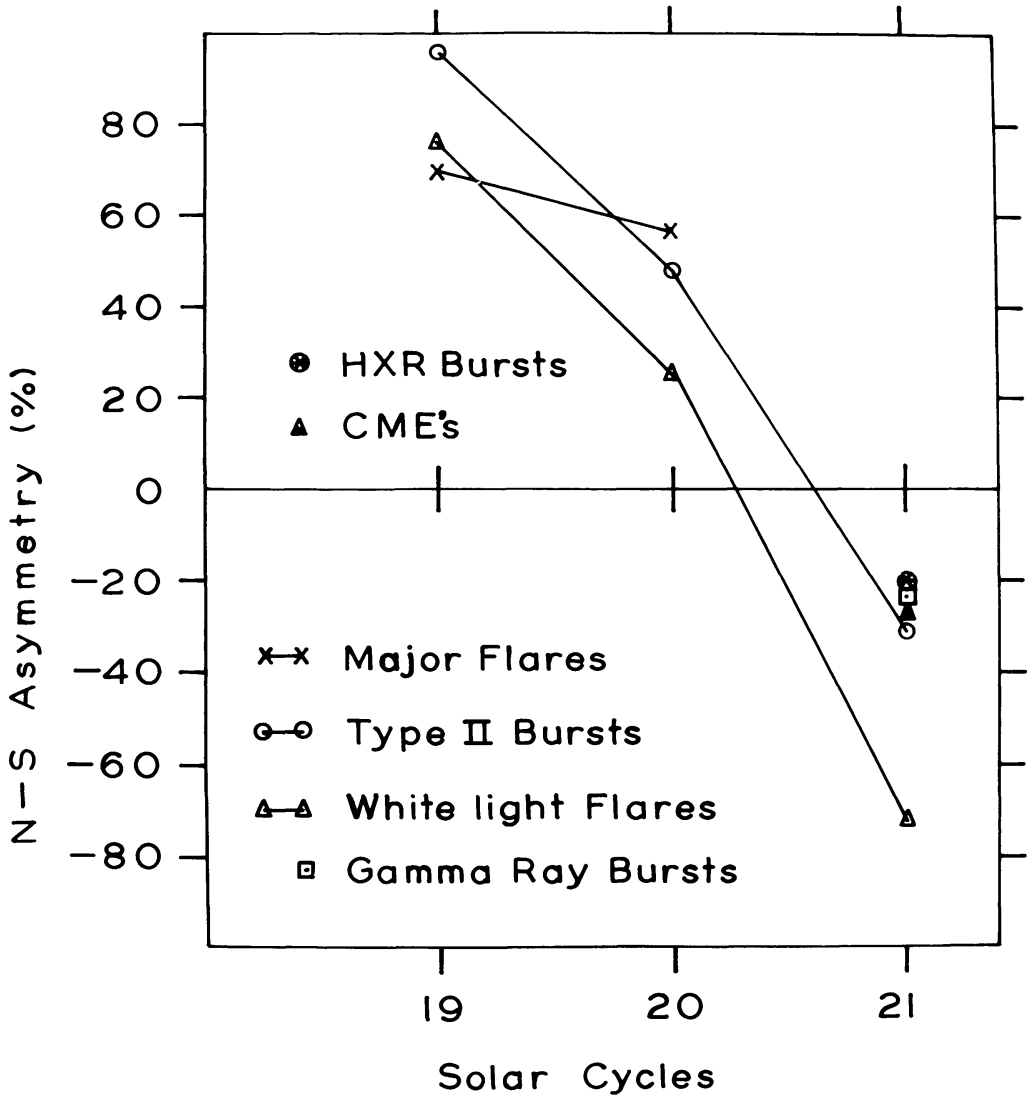

Fig. 1 A plot of various types of solar activity events in solar cycles 19,20 and 21 versus N-S asymmetry index.

3. Results and Conclusions

From Table 1 and Figure 1 it is clear that the asymmetry occurs in the northern hemisphere during the cycles 19 and 20 while during cycle 21 the asymmetry favours the southern hemisphere. This is true because during cycle 19 and 20 major flares, type II radio bursts, white light flares all favour northern hemisphere while during cycle 21, type II radio bursts, white light falres, gamma ray bursts, HXR bursts and CME's events favour

southern hemisphere. After solar cycles 19 and 20 the asymmetry shifted from the northern to southern hemisphere (in cycle 21). It is of course too early to state that asymmetry may be a regular feature on the Sun with some definite periodicity. The change in asymmetry from the northern to the southern hemisphere may be related with Sun's interior as indicated by Eddy (1976).

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