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Periodic Variation of the North-South Asymmetry of Solar Activity Phenomena

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Abstract. We report here a study of various solar activity phenomena occurring in both north and south hemispheres of the Sun during solar cycles 8–23. In the study we have used sunspot data for the period 1832–1976, flare index data for the period 1936–1993, Hα flare data 1993–1998 and solar active prominences data for the period 1957–1998. Earlier Verma reported long-term cyclic period in N-S asymmetry and also that the N-S asymmetry of solar activity phenomena during solar cycles 21, 22, 23 and 24 will be south dominated and the N-S asymmetry will shift to north hemisphere in solar cycle 25. The present study shows that the N-S asymmetry during solar cycles 22 and 23 are southern dominated as suggested by Verma.

Key words. Sunspots—solar activity—solar cycles.

1. Introduction

The north-south (N-S) asymmetries of several manifestations of solar activity have been studied earlier by various authors. The literature also indicates that several solar activity phenomena show some form of the N-S asymmetry (Bell & Glazer 1959; Bell 1962; Roy 1977; Verma 1987). Bell (1962) finds long term N-S asymmetry in the sunspot area data. Roy (1977) studied the N-S distribution for flares, sunspots and white light (WL) flares for a period of more than two solar cycles and found that the asymmetry in the northern hemisphere increases with the importance of solar events. Hansen & Hansen (1975) are of the view that the overall filament configuration and their evolution with time compactly represent the general topology of the photospheric magnetic field and its evolution during the course of solar activity cycles. Reid (1968) reported N-S asymmetry in favour of northern hemisphere for the period 1958–1965. Howard(1974) studied solar magnetic flux data for 1967 to 1973 and found that the northern hemispheric flux exceeds by 7% over the southern hemispheric flux. White & Trotter (1977) investigated asymmetry of sunspot area and found that on an average the solar magnetic field cycle occurs uniformly in the northern and southern hemisphere. Swinson *et al.* (1986) also examined relative sunspot numbers and sunspot area. Their analysis shows that the N-S asymmetry of sunspot numbers favours northern hemisphere in the period 1947–1984 (Solar cycles 18–20). Verma (1987) studied six types of solar phenomena for solar cycles 19, 20 and 21. These include major flares, type II radio bursts, white light (WL) flares, Solar gamma-ray (SGR) bursts, hard X-ray (HXR) bursts and coronal mass ejection (CME) events. Verma (1987) found that the asymmetries in major flares, type II radio bursts and WL flares favour the northern hemisphere during solar cycles 19 and 20, asymmetries in type II radio bursts, WL bursts, SGR bursts, HXR bursts and CME events favour the southern hemisphere during solar cycle 21. Vizoso & Ballester (1987) studied the N-S asymmetry in sudden disappearances of solar prominences during solar cycles 18–21 and found that asymmetry curve can be fitted by a sinusoidal function with a period of 11 years. Verma (1992,1993) studied the N-S asymmetry of various solar activity phenomena and reported cyclic behaviour of N-S asymmetry. According to the study of Verma (1992, 1993) the N-S asymmetry has a trend of long term period of 12 solar cycles (110 years). Further, Verma (1992) predicted that the N-S asymmetry in solar cycles 22, 23 and 24 may be southern dominated and N-S asymmetry will shift to northern hemisphere in solar cycle 25. Recently Atac & Ozguc (1996) studied the N-S asymmetry in flare index and found a periodic behaviour.

The present study has been carried out to know the trend of N-S asymmetry in solar activity phenomena after the research works of Verma (1992, 1993). We also discuss the results obtained in the present study in the light of earlier works.

2. Observational data and analysis

In the present study the data for the solar activity phenomena includes sunspot area (SA), solar flares (SF), sudden disappearing filaments (SDF) and solar active prominences (SAP) are taken from various sources. The types of solar activity phenomena and sources of their references are given in Table 1.

The N-S asymmetry of solar activity phenomena during solar cycles 8–23 has been calculated using the following formula:

$$A_{ns} = \frac{N_n - N_s}{N_n + N_s}.$$

Here, A_{ns} is the N-S asymmetry index, N_n is the number of solar activity phenomena in northern hemisphere and N_s is the number of solar activity phenomena in southern hemisphere. Thus, if $A_{ns} > 0$, the activity in the northern hemisphere dominates, and if $A_{ns} < 0$, the reverse is true. To study the N-S asymmetry of solar activity events with long term period we have calculated the N-S asymmetry for solar cycles period

Table 1. Shows types of solar activity phenomena, period and their references.

Solar Activity Phenomena	Period	References
Sunspot area	1832–1871	Wolbach (1962)
	1874–1954	Janes (1955)
	1955–1976	Annals Royal Greenwich Observatory, England
Solar flares	1936–1993	Atac & Ozguc (1996)
	1994–1998	Solar Geophysical Data (1995–1999)
Solar prominences	1957–1998	Verma (2000)
Sudden disappearing filaments	1945–1985	Vizoso & Ballester (1987)

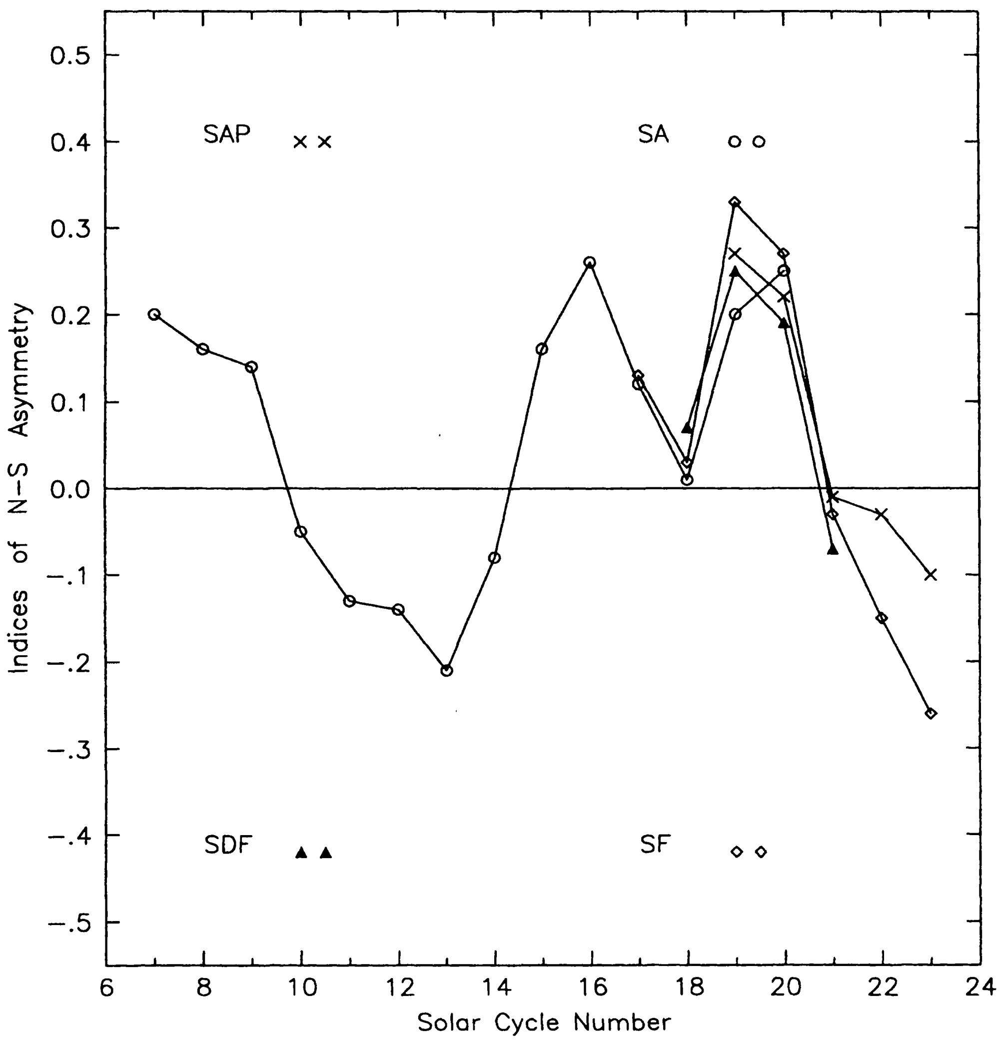

Figure 1. Plot of N-S asymmetry of Various Solar Active Phenomena versus Solar Cycle Number.

between 8–23. The plot of the N-S asymmetry indices versus solar cycle number is shown in Fig. 1.

3. Results and discussions

The present study examines the N-S asymmetry for solar active phenomena which includes sunspot area, solar flares, solar active prominences etc. between solar cycles 8–23. According to the earlier works of Verma (1992, 1993) the N-S asymmetry of solar active phenomena has a periodicity about 12 solar cycles (110 years) and Verma (1992) had also predicted that the solar cycles 22, 23 & 24 may be southern dominated and N-S asymmetry will shift to the northern hemisphere in the solar cycle 25. From Fig. 1 it is clear that the N-S asymmetry of solar active phenomena during solar cycles 22 & 23 favours southern hemisphere as predicted by Verma (1992). Thus the present investigations support and confirm the results of Verma (1992).

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