Long-Term Datasets for the Understanding of Solar and Stellar Magnetic Cycles
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Study of Long-Term Variations in Hemispheric Asymmetry of Solar Activity

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Abstract. Sunspot activity exhibits hemispheric asymmetry. We study the long-term variations in the hemispheric sunspot area from Kodaikanal white-light data during 1921 – 2011. The results on the presence or absence of double peak in an individual solar cycle, dominant hemispheric activity, and phase lag between the activities of northern and southern hemispheres, etc., are presented.

1. Introduction

The north-south hemispheric asymmetry in solar activity indices is well known. In the photosphere and chromosphere, it is sunspot area and number (Li *et al.* 2009), differential rotation (Javaraiah & Gokhale 1997), magnetic flux (Song *et al.* 2005), plage index (Dorotovic *et al.* 2007), filaments number (Li *et al.* 2010). Recently, we (Ravindra & Javaraiah 2015), studied the hemispheric asymmetry in sunspot area obtained from Kodaikanal Observatory (KO) white-light data during the whole solar cycles 23 and the rising phase of current cycle 24. In this paper, we have analyzed the extended KO data during the period 1921 – 2011 and studied the hemispheric asymmetry in sunspot area during each of the cycles 16 – 23.

2. Data, Results, and Discussions

The data used here are obtained from the Kodaikanal 6″ equatorial mount telescope. The white-light images are taken with this telescope since 1904 till today, with the same optical set-up and photographic films. The sunspots on the disk are detected using the semi-automated STARA code (Watson *et al.* 2009). The area occupied by the sunspots was measured and corrected for the projection effect. The sunspot area is averaged over a month and obtained the time series of the monthly averaged sunspot area in each hemisphere.

Figure 1(left) shows the monthly averaged sunspot area plot against time. The monthly averaged area shows not only the regular pattern of 11-year cycle, it also shows each cycle is different from other. The thirteen-month smoothed sunspot area plot (Figure 1(right)) also shows the same results but in addition to that it also shows the activity dominant hemisphere. The peak in activity does not occur in each hemisphere at the same time. This may lead to the appearance of double peak in the sunspot cycles (Ravindra & Javaraiah 2015). The time of occurrence of the peak in each hemisphere during each cycle can be seen in the same plot. In cycles 18 and 19 the southern hemisphere activity started earlier than the northern hemisphere by about 5-months. But, in cycles 22 and 23 the northern hemisphere activity started 5 months before the southern hemisphere

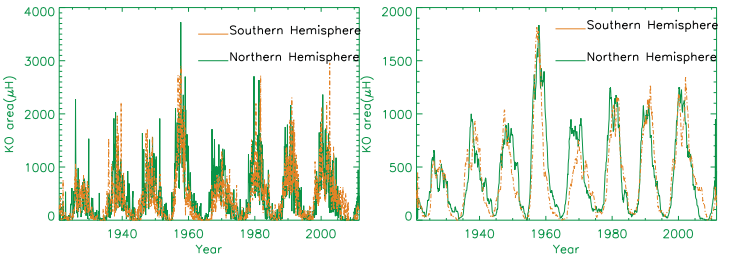

Figure 1. The monthly averaged sunspot area shown separately for the northern and southern hemispheres (left). The data starts from 1920 and ends at 2011. Thirteen-month smoothed sunspot area in the northern and southern hemispheres is also shown (right).

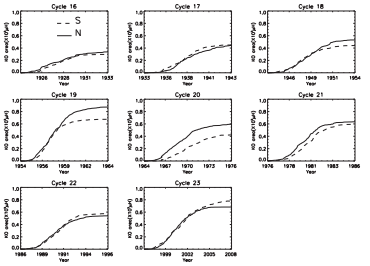

Figure 2. Cumulative monthly sum of sunspot areas in the northern and southern hemispheres obtained from Kodaikanal Observatory white-light images for cycles 16 – 23.

activity. In cycles 20 and 21 the northern hemisphere activity starts 12 and 10 months, respectively, before the southern hemisphere. On the other hand, in cycles 16 and 17 the activity levels in both the hemispheres started near simultaneously.

In order to see the activity in which hemisphere is dominant in a cycle, in Figure 2 we have plotted the cumulative sum of monthly averaged sunspot area against time. This plot shows that in cycles 18, 19, 20, and 21 the northern hemisphere is dominated in activity over the southern hemisphere. On the other hand in cycles 17, 22, and 23 the southern hemisphere activity dominated over the northern hemisphere. The cycle 16 shows the equal activity level in both the hemispheres. The same plot also shows when the dominance of activity occur during the progress of cycle.

Here we have analyzed the Kodaikanal Observatory uniformly measured white-light data of about 100 years and found that there exist some noticeable differences in the temporal behaviors of the monthly mean sunspot area in the northern and southern hemispheres during different solar cycles. In future, we would like to compare the results obtained from the Kodaikanal data with those of the Greenwich and other data sets.

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