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Statistical study of the East-West asymmetry of sunspots

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Abstract. The East-West asymmetry of sunspot areas has been analyzed on the basis of the Debrecen Photoheliographic Data (DPD). This material provides the opportunity to scrutinize the fine details in the distributions of the East-West differences depending on spot size and central meridional distance during the ascending and the descending phase of 22th cycle.

1. Introduction

Earlier studies of E-W asymmetry generally used the data of sunspot groups but the DPD (Győri & et al. (2004)) gives the possibility to investigate the E-W asymmetry on the basis of individual spot data. The printed version of the Greenwich Photo-Heliographic Results (GPR) also contains the area and the position of the induvidual spots in the years 1878-1915, but this detailed version of the GPR is not available electronically. We have studied 117268 sunspots in the years 1986-1989 and 1993-1997.

2. Distributions of the corrected sunspot areas

Functions of distribution of numbers of spots with given corrected (U+P) areas were determined against central meridian distance zones and the eastern and western halves displayed together to show the difference. The spots of corrected sunspot area being smaller than 6 millionths of the solar hemisphere ($A_c \leqslant 6$ MSH) were omitted to eliminate any visibility effect to the tiny spots. The $A_c \geqslant 20$ MSH spots do not show any differences between their distributions of the corrected sunspot areas in any zones. However, there are more sunspots of $A_c < 20$ MSH in the zone of $E75-85$ than in the zone of $W75-85$. This eastern excess is more accented in the case of the penumbral spots. The figures depict the data selected from the zones of E-W 75-85 where all the years of the DPD were considered. The eastern excess of small spots is similar in either ascending (1987-89) and descending phases (1993-95) of the solar cycle but in the latter case it is detectable only for spots of $A_c < 10$ MSH.

3. Conclusion

These results show that the E-W asymmetry can only be detected for the smallest spots. We think that this may be related to the fact (Ludmány & et al. (1998)) that the following parts of the sunspot groups are usually much more fragmented than the leading parts so the smaller spots are usually located in the following part. This fact and the geometry of the magnetic fields and the fine structure of the faculae may result in an asymmetry presented above because they affect the leading and following parts at the E-W limbs differently (Bartsch 1973; Sawyer 1973; Dezső, L. 1964). The details of this asymmetry and the mentioned interpretation will be presented elsewhere.

Figure 1. The 5-point moving average of the distribution of the corrected sunspots areas (corrected umbra + penumbra areas) in millionths of the solar hemisphere in the zone pairs of $EW75-85$ in the years 1986-89 and 1993-97.

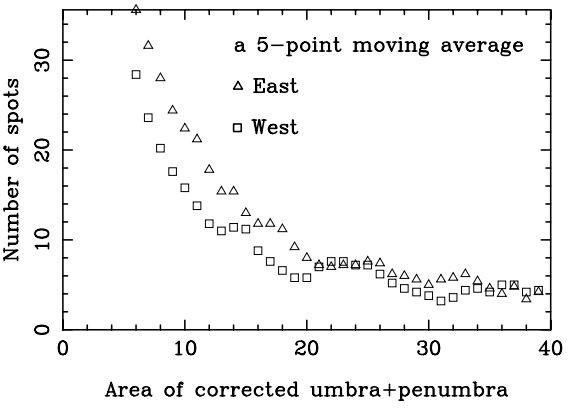
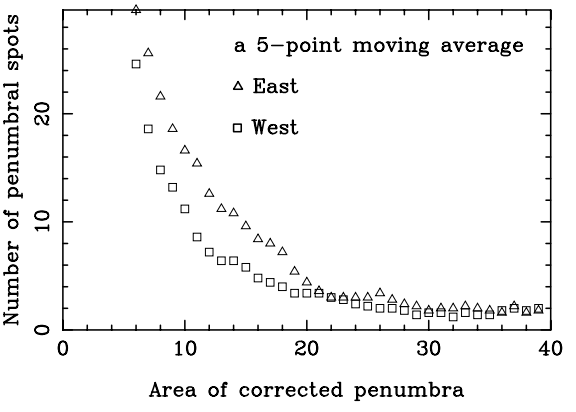


Figure 2. The 5-point moving average of the distribution of the corrected sunspots areas (penumbra areas of the spots without umbra) in millionths of the solar hemisphere in the zone pairs of $EW75-85$ in the years 1986-89 and 1993-97.



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