Study on the occurrence rate of Ha solar flares in order to verify the existence of North-South and East-West asymmetries during the time interval 1994-2000.

Pothitakis G. [1], Preka-Papadema P. [1], Petropoulos B. [2], Pappas G. [1] and Polygiannakis J. [1].

[1] *Section of Astrophysics, Astronomy and Mechanics, Department of Physics, University of Athens, Panepistimiopolis Zografos, GR-15784, Athens, Greece*

[2] *Academy of Athens, Research Center for Astronomy and Applied Mathematics, 14 Anagnostopoulou str., Athens, GR-10673, Athens, Greece*

Abstract

We analyse the Ha solar flare occurrence rate on a daily basis during the period 1994-2000 and study the North-South and East-West asymmetries, introducing appropriate assymetry coefficients. Furthermore we examine the variation of these coefficients using various spectral methods (FFT, Successive Approximations, Wavelet). Our results confirm both the existence of significant NS and EW asymmetries and transient periodic components in the respective coefficients.

1 Introduction

The North-South (N-S) and East-West (E-W) distribution, including asymmetries, being some of the various manifestations of solar activity have been studied by various authors. The existence of N-S asymmetry is generally well established, but not so well understood. This asymmetry reverses its sign with the reversal of the Sun's magnetic dipole (Roy, 1977, Yadav et al, 1980, Verma, 1987, Verma et al, 1987, Vizosa and Ballester, 1987, Garcia, 1990, Atac and Ozguc, 1996). The existence of a systematic E-W asymmetry has been more controversial (Hewish and Bravo, 1987, Horas et al, 1990, Joshi, 1995, Li et al, 1998, Verma, 2000). One of the interpretations proposed, is the influence, over a few solar rotations, of the transit of active regions on the solar disk (Horas et al, 1990). In fact preferred heliographic longitudes for solar activity pointed out by Bai (1987,1988). Garcia (1990) indicate a relationship between the asymmetries and giant convective cells. All these works give a new aspect of the solar dynamo phenomenon and gain in importance with the recent development of seismic approaches with SOHO. Taking these into account, we perform a study of the N-S and E-W asymmetries of Ha flares occurrence rate during the ascending part of the cycle 23 in an attempt to corroborate or refute the NS, EW asymmetries and their possible periodic variation.

2 Analysis and Results

The Ha flares for the period 1994-2000 have been downloaded from NOAA, USA (*http : //ftp.ngdc.noaa.gov/STP/SOLAR_DATA/SOLAR_FLARES/*). Specific criteria were set in order to eliminate duplicate reports of the observed flares. From these data we have calculated N-S and E-W distributions. We introduced the Ha flare asymmetry coefficients:

$$A_{ns} = \frac{N_n - N_s}{N_n + N_s},\ A_{ew} = \frac{N_e - N_w}{N_e + N_w} \tag{1}$$

where N_n, N_s, N_e and N_w mean the number of Ha flares in each hemisphere. The variation of the coefficients A_{ns}, A_{ew} during 1994-2000 is shown in fig. 1, exhibiting probably periodic behaviour with significant fluctuations about zero. This

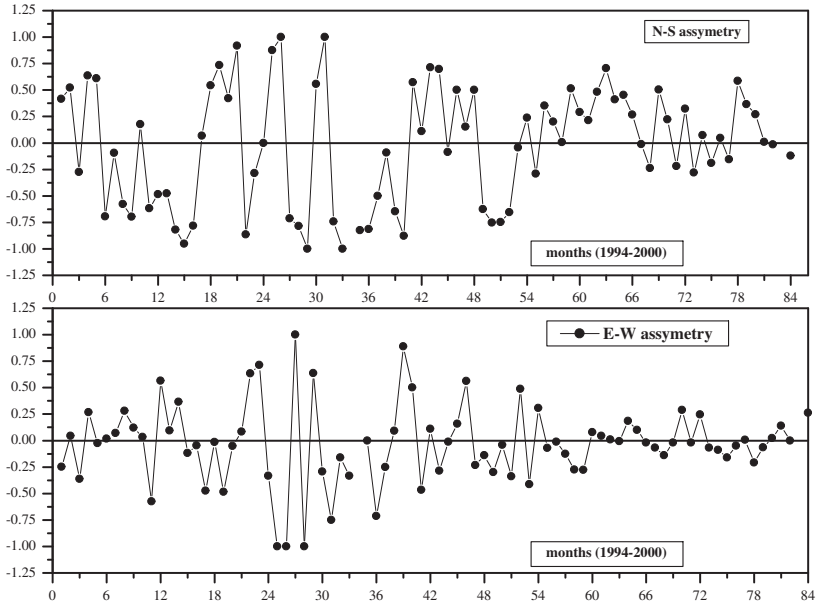

Figure 1: The coefficients of N-S and E-W asymmetries during the time interval 1994-2000.

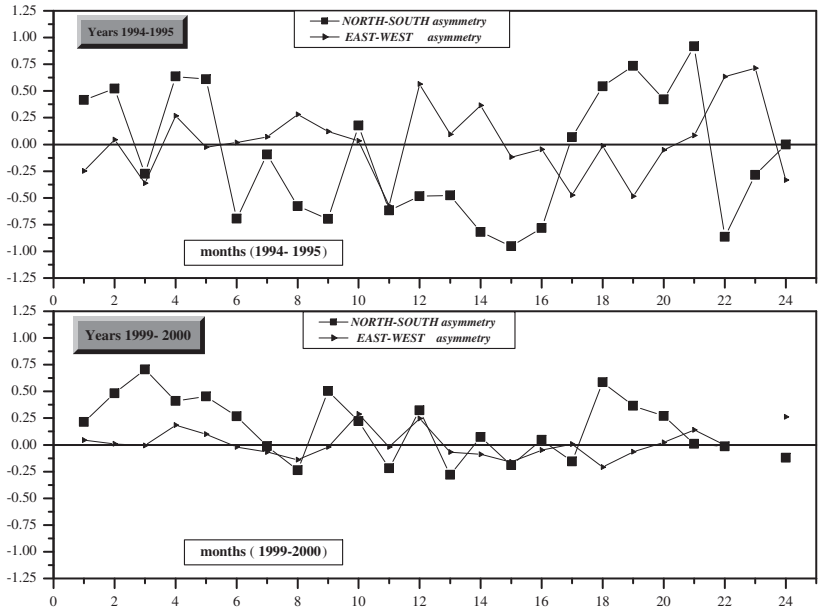

Figure 2: The coefficients of N-S and E-W asymmetries during the time interval 1994-1995 (solar min) and 1999-2000(solar max).

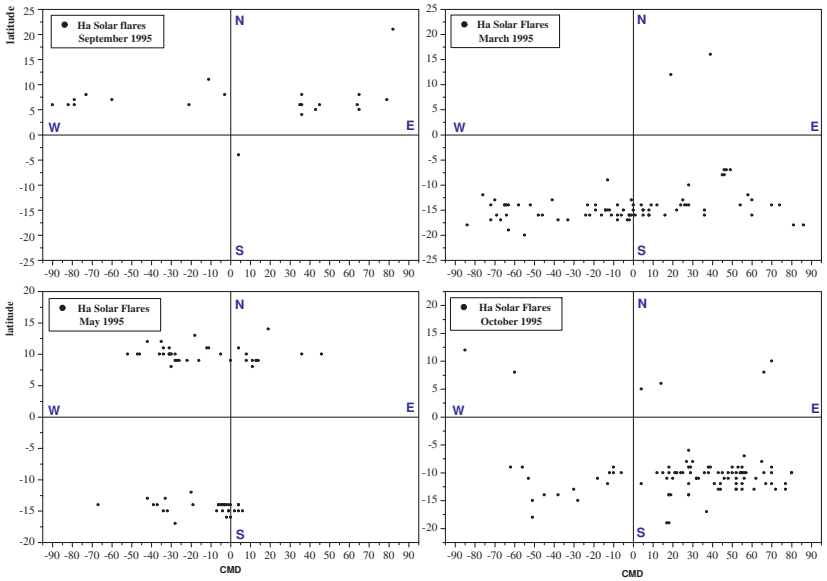

Figure 3: Heliographic distribution of Ha flares during solar minimum (1995). N-S and E-W asymmetries are shown.

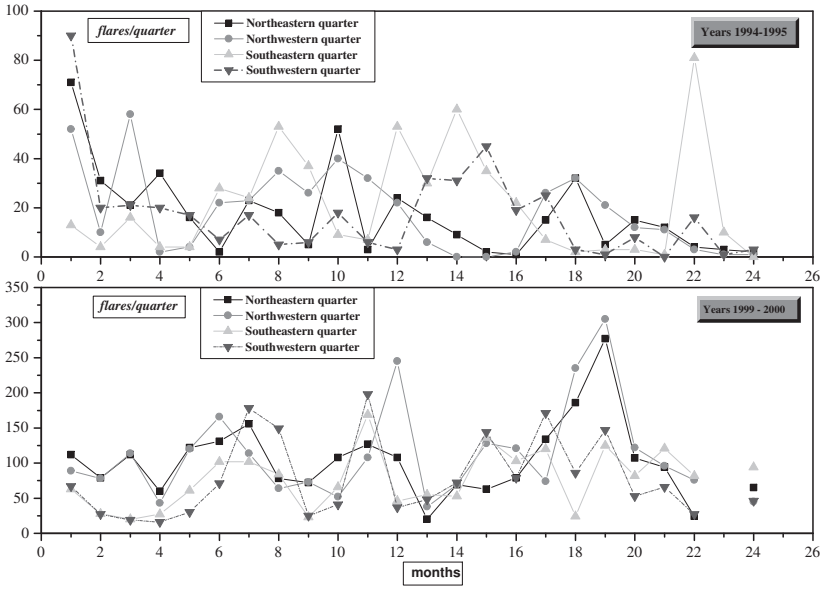

Figure 4: The Ha flare occurrence rate during the solar minimum (1994-95) and solar maximum (1999-2000) separately for each of the solar disk quarters.

variability is different between periods of solar minimum (1994-95) and maximum (1999-2000) (see fig. 2). The fluctuations are more pronounced during the solar minimum. Especially A_{ew} does not show any significant fluctuation during the solar maximum. Samples of the heliographic distribution of the Ha flares are presented in fig. 3. It is clear that the N-S and E-W asymmetries are more pronounced during the solar minimum while during the maximum only N-S asymmetry is slightly discernible in agreement with Roy (1977) and Horas et al (1990). Furthermore the northern hemisphere seems to be more active during the ascending part of the cycle 23. Similar results have been obtained by other authors for different time intervals. We also examine distributions of the Ha flares with respect to the NW, NE, SW and SE quarter of the Solar disk. Our results for the solar minimum and maximum are presented in fig. 4. The SE quarter appears the most active during the minimum, on the contrary the NE and NW quarters were the most active during the solar maximum. The periodic behaviour of the Ha flaring rate and of the coefficients A_{ns}, A_{ew} during the ascending part of cycle 23 has been examined and periodicities of 27, 59, 137 and 330 days were obtained in the occurrence rate of flares using the wavelet analysis. Similar results were obtained in the time interval 1966-1988 by Xanthakis et al (1992).

3 Conclusions

The analysis of the N-S and E-W distributions of Ha flares from 1994 to 2000 points toward the following:

1. There is a N-S asymmetry with flares in the North hemisphere more abundant than in the South hemisphere.

2. Flares are not uniformly distributed in heliographic longitude. There is an E-W asymmetry which is not as pronounced as the N-S asymmetry.

3. The asymmetry distribution is most evident during solar minimum.

Further investigation of the relationship between asymmetry coefficients and intensity of the events is planned for future. Furthermore we believe that the variability of the asymmetry coefficients should be studied for a longer period.

References

Atac T., Ozguc A., 1996, Sol. Phys., 166, 201
Bai T.,1987, ApJ, 314, 795
Bai T.,1978, ApJ, 328, 860
Garcia H. A., 1990, Sol. Phys., 127, 185
Heras A. M., Sanahuja B., Shea M. A., Smart D. F., 1990, Sol. Phys., 126,371
Hewish A., Bravo S., 1986, Nat, 324, 601 Joshi A., 1995, Sol. Phys., 157,315
Li K. J., Schmieder B., Li Q. Sh., 1998, A&A Sup. S., 131,99
Roy J.R., 1977, Sol. Phys., 52, 53
Verma V. K., 1987, Sol. Phys., 114, 185
Verma V. K., Pande M. C., Uddin W., 1987, Sol. Phys., 112, 341
Verma V. K., 2000, Sol. Phys., 194, 87
Vizoso G., Ballester J. K., 1987, Sol. Phys., 317, 323
Xanthakis J., Poulakos C., Petropoulos B., 1992, A&S.Sci., 188, 321