29th International Cosmic Ray Conference Pune (2005) **1**, 5–8

Statistical Analysis of Soft X-ray Flares during the 23rd Solar Cycle

Y.Q. Tang[a] and G.M. Le[a]
(a) National Center for Space Weather Monitor and Forecast,China Meteorological Administration,Beijing 100081,China
Presenter: Y.Q. Tang (tangyq@nsmc.cma.gov.cn), chn-tang-Y-abs1-sh11-poster

The data of the soft X-ray flares from Aug. 1996 to May 2005 corresponding to almost the current 23rd solar cycle have been investigated to study the North-South(N-S) and East-West(E-W) asymmetries with regard to the solar hemispheres. A slight southern predominance is found after analysis and a slight western excess is obtained for class $\geq$C1. But for the major flares(class X flares), a distinct northern predominance is found.

1. Introduction

It is well known that many solar activity phenomena exhibit some form of spatial asymmetry, especially North-South(N-S) asymmetry. And the spatial asymmetries of the soft X-ray flares were investigated by many papers. GOES satellites make the continuous observations of soft X-ray emission on the solar disk from 1975, the almost unbroken data makes the statistical analysis possible. Garcia[1] got the northern predominance in the 20th and 21st solar cycle for flares $\geq$M9. Li et al.[2] found an overall predominance of the southern hemisphere during the maximum phase of solar cycle 22 for flares $\geq$M1. Temmer[3] analyzed the period 1975-2000 for flares $\geq$C1, including two whole solar cycles, 21 and 22, and the rising phase of the 23rd solar cycle. He found that solar cycle 21 revealed a slight(51.0%) and solar cycle 22 a distinct(56.2%) excess of flare events in the southern hemisphere. Also he got the result that solar cycle 23 showed an obvious(54.2%) excess of the northern hemisphere for the rising phase.

The existence of East-West(E-W) asymmetry is not be well established and more controversial. Joshi[4] using Hα flares found no E-W asymmetry for solar cycle 21 and a small asymmetry for the solar cycle 22. Temmer[3] found slight eastern excess both for solar cycle 21(51.2%) and 22(50.8%).

We choose the data from Aug. 1996 to May 2005, which almost include the 23rd solar cycle, and collect the C, M, and X class flares. During the considered time span, 7987 flares for which the heliographic coordinates are given are accumulated. Then the statistical analysis is made to study the latitude and longitude asymmetries.

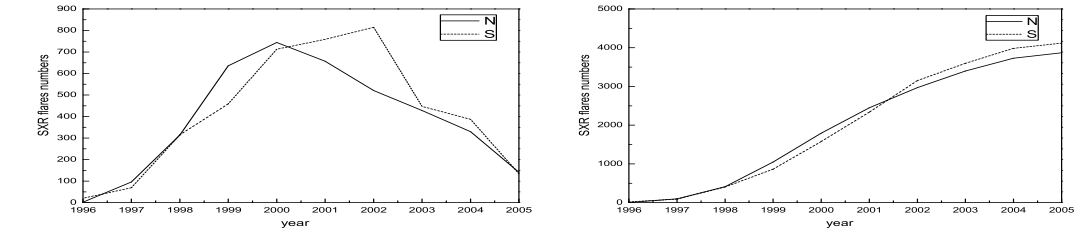
2. Analysis and Results

The data are collected in the Solar Geophysical Data(SGD).

2.1 N-S distribution

For the whole investigated time span of the distribution in heliographic latitude, we get 51.56% events for the southern and 48.44% events for the northern hemisphere. It shows a slight southern predominance, which continues the same N-S asymmetry with last two solar cycles. The result could be seen from Fig.1. The solid line indicates the northern flares, and the dashed line indicates the southern ones. The left one is the respective numbers of each year, while the right one is the cumulative numbers during the whole time span. We can see from Fig.1(b) that the flares shows northern predominance before 2001, which is same with Temmer[3]'s result, and then switch to southern predominance.

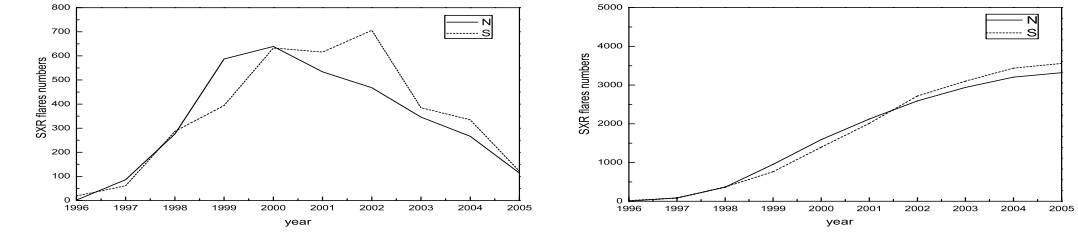
We divide the flares into two categories according to their intensity. Fig.2 shows the result for class C flares,



(a) respective flares number (b) cumulative flares number

Figure 1. N-S asymmetry of class C,M,X flares

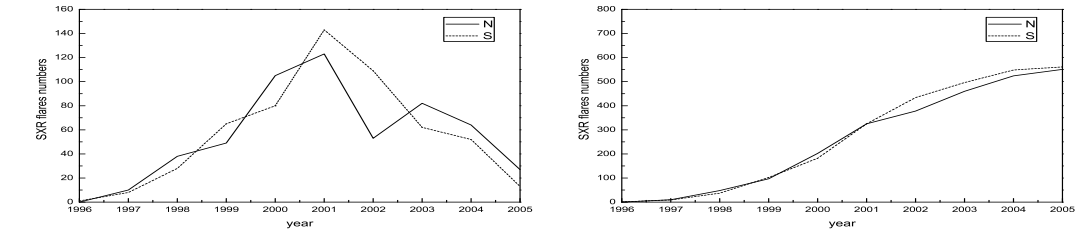
and Fig.3 shows the result for flares $\geq$M1. For class C flares, we get 51.74% events for the southern and 48.26% events for the northern hemisphere. For class M and X flares, we get 50.45% events for the southern and 49.55% events for the northern hemisphere. The result indicates that the low-intensity flares don't show smaller N-S asymmetry. Roy[5] reported that the latitude asymmetry of soft X-ray flares are dependent on the importance of the event, and Garcia[1] thought that the asymmetry is a function of flare intensities. But it doesn't seem to be supported by our statistics analysis of the 23rd solar cycle.



(a) respective flares number (b) cumulative flares number

Figure 2. N-S asymmetry of class C flares

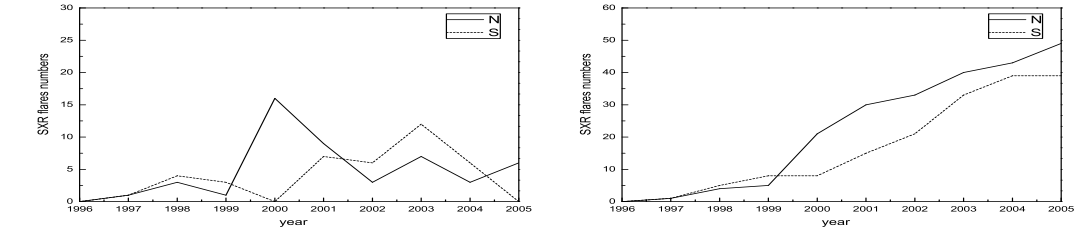
If we consider the class M and X flares respectively, we get 50.98% events for the southern and 49.02% events



(a) respective flares number (b) cumulative flares number

Figure 3. N-S asymmetry of class M,X flares

for the northern hemisphere for class M flares. But for class X flares, the result shows a distinct northern predominance. We get 44.32% events for the southern and 55.68% events for the northern hemisphere. See Fig.4.

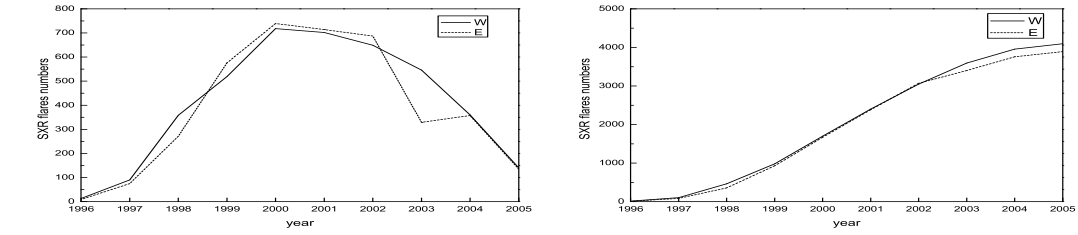


(a) respective flares number (b) cumulative flares number

Figure 4. N-S asymmetry of class X flares

2.2 E-W distribution

We also investigate the longitude asymmetry of the soft X-ray flares during the whole time span. It reveals a slight western excess after analysis. Fig.5 shows the respective flare numbers of each year and cumulative flare numbers for flares $\geq$C1. Solid line is western flares and dashed line is eastern flares. We get 51.27% events for the western and 48.73% events for the eastern hemisphere. From Fig.5(b), we can see that the western flares exceed distinctly in 2003. In the whole considered time span, excess of western and eastern changes alternately(Fig.5(a)). It shows a non uniform flare distribution in heliographic longitude.



(a) respective flares number (b) cumulative flares number

Figure 5. E-W asymmetry of class C,M,X flares

3. Conclusions

After analysis, the soft X-ray flares data from Aug. 1996 to May 2005 shows the N-S asymmetry. A slight southern excess(51.56%) is obtained for class C, M, X flares. Predominance begins in north and then shifts to south in 2001. From Fig.1(a) we can see that it should be correlative with the sunspot 11-year cycle. Our analysis indicates that solar cycle 23 shows the same N-S asymmetry with last two solar cycles(21 and 22)

compared with the obvious solar cycles(19 and 20). A long period cycle could be suspected. A long term study of N-S asymmetry should be made to prove the existence of a long period solar cycle which could correspond to the existence of a global magnetic field of long period variability([1]).

For major flares(class X flares), it shows a distinct northern predominance during the considered time span, especially in 2000 corresponding to the maximum of the 23rd solar cycle. We need to investigate further the incidence of flares with respect to large-scale magnetic structure and photospheric structure([6]).

Roy[5] reported that the latitude asymmetry of soft X-ray flares are dependent on the importance of the event, it means low-intensity flares show a smaller N-S asymmetry. But analysis result in this paper doesn't seem to support the opinion.

The distribution of the flares in heliographic longitude shows a non uniform distribution. But we get a slight western excess(51.27%) of the whole time span for the flares $\geq$C1. This is complementary to Temmer[3]'s work and is in agreement with his result of the rising phase of solar cycle 23.

References

[1] H.A. Garcia, Solar Phys. 127, 185 (1990).
[2] K.J. Li et al., Astron. Astrophys. Suppl. Ser. 131, 99-104 (1998).
[3] M. Temmer et al., ESA SP-477, 175 (2002).
[4] A. Joshi, Solar Phys. 157, 315 (1995).
[5] J.R. Roy, Solar Phys. 52, 53 (1977).
[6] T. Bai, Astrophys. J. 328, 860 (1988)