

Automatic detection method, forecast and alert of solar proton events

Ganghua Lin

Key Laboratory of Solar Activity, National Astronomical Observatories,
Chinese Academy of Sciences,
Datun Rd. 20A, Chaoyang District, Beijing, 100012, China
email: lgh@bao.ac.cn

Abstract. The methods of automatic solar active phenomenon or event detection have been researched and explored by people for many years, which have gone into actual services. The paper analyzes the relationship between these methods of automatic detection and the forecast or alert, using the solar short-term proton events predictions as an example. Using automatic method to conduct forecast or alert is under thinking.

Keywords. Sun: activity, particle emission, magnetic fields, solar-terrestrial relations; methods: data analysis, statistical

1. Introduction

The forecasts and alerts of space environment for live of human being, development of society and aerospace profession are vital and necessary. At the same time, the automatic detection methods have characteristics of reliability and rapidity. With the growing demand for forecasts of solar activity, there is great need for these methods. In the past many years, methods of automatic solar active phenomenon or event detection have been researched and explored by people, and gone into actual service. That whether these methods can be used systematically in the forecasts and alerts of space environment or not has a preliminary analysis in the paper.

2. Forecast or alert factors

The forecast is to predict solar event or phenomenon that is going to occur several days later. The alert is to warn an event that is going to occur in dozens of minutes or dozens of hours. They have both similarities and differences. To facilitate the further analysis, table 1 presents the forecast or alert factors of proton event that are frequently used, the obtained method and the automatic detection method. In Table 1, the forecast factors are main clues of propagation process of proton and potential factors of occurrence of the proton event; the obtained method refers to the observing equipments by which the factors can be obtained; the automatic detection method refers to the explored method that is used for detecting the corresponding phenomenon or event.

In the proton event forecast system, the main factors can be roughly separated into four category wang 1999.

Among them, sunspots related factors are : Zürich classification and area of sunspot groups, magnetic classification and magnetic density of sunspot groups, McIntosh classification, special sunspot groups and transverse field structure, sunspot volution structure and movement, alternation of the area of sunspot groups 3 days before the explosion of flare event.

Table 1. Forecast or alert factors of solar proton event.

Forecast or alert factors	Obtained method	Automatic detection method
Soft x-ray flare or <i>Halp</i> flare	X-ray or full disk Ha telescope	explored. Ming <i>et al.</i> (2003)
sunspot:		explored. Curto <i>et al.</i> (2008), Benkhalil <i>et al.</i> (2006), Ming <i>et al.</i> (2003)
1 The McIntosh classification	1 The first McIntosh parameter z, the second McIntosh parameter p, the third McIntosh parameter c.	
2 The magnetic classification	2 SOHO MDI 6767Å magnetograms, CaII 8542 Å magnetogram (Kitt Peak), the FeI line magnetogram (Mt Wilson).	
3 The recent flaring activity	3 The recent X-ray flares observed on GOES, event lists and the current movies of SOHO EIT FeXII 195Å	
4 The level of flaring activity	4 The X-ray background level on GOES.	
5 Special magnetic classification of sunspot group		
10.7 cm radio flux	10.7 cm radio flux at frequency 2800MHz 2695MHz is an alternative. The latest SOHO MDI continuum or Catania observation	downloading
Proton event of impulse type	It is corresponding to type III and V of radio eruption. STEREO	
Proton event of progression type (be rich in proton)	It is corresponding to type II and IV of radio eruption. STEREO	
Frequency of flare activity		explored. Ming <i>et al.</i> (2003), improvable output
CME-driven interplanetary shock waves	LASCO, STEREO, EIT FeXII 195Å, the list of radio bursts prepared by SEC or/and the latest Culgoora PRESTO message.	
Coronal magnetic field	LASCO, EIT 284Å, TRACE 195Å full-disk GOES/SXI, SOHO/MDI(NSO/KPVT), STEREO	
Interplanetary magnetic field	ACE, the CELIAS/MTOF/PM sensor on the SOHO spacecraft	
Flux density of proton. The distance between the flaring region and root segment region of open magnetic field line in the interplanetary.	GOES 11 STEREO	downloading
Solar disk location of flare eruption		Explored. Ming Qu, <i>et al.</i> (2003)
Proton peak flux levels	GOES11	downloading

Active area related factors are: the shape of magnetic neutral line, magnetic flux emerge and longitudinal field gradient, flare activities frequency, similarity between current active area and old proton active area.

The location related factors are: the location of flaring on the solar disk, reproducibility between active region longitude and proton flare, the active area and the foot points of line of magnetic connection of solar-terrestrial are at the same magnetic polarity area, the active area and disk center locate at the same magnetic polarity area, active area and foot points on disk of line of magnetic connection of solar-terrestrial are in the same sector area of interplanetary magnetic field.

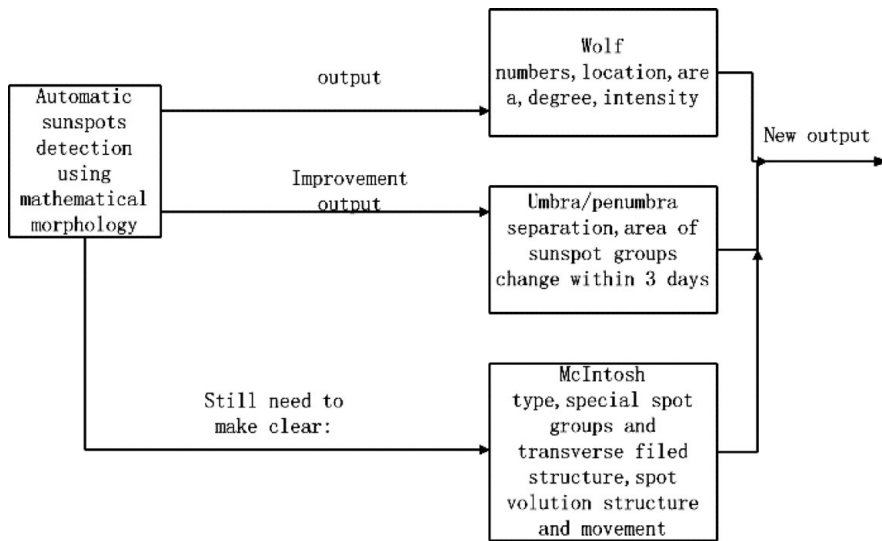


Figure 1. Sunspots automatic detecting and related forecast factors.

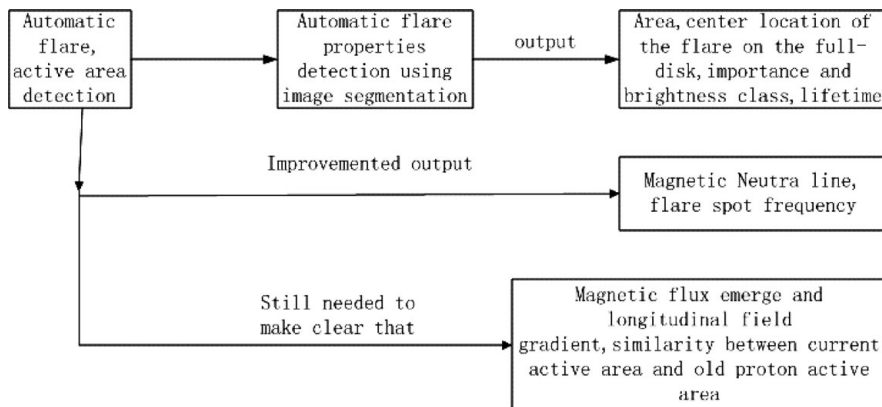


Figure 2. Active area automatic detecting and related forecast factors.

The soft X-ray related factors are: soft x-ray flux, integral peak flux of 1-8Å, flare duration time of x-ray.

3. Method of automatic detecting and forecasts or alerts of flare proton event

The flare proton event has been introduced. We build relationship between the methods of automatic detecting on solar events or phenomena and their forecasts or alerts. Figure 1 presents possible output and possible output after improvement by means of automatic detection. Some factors may need to be made clear by further human interference. Figures 2 and 3 have similar structures and meanings.

4. Discussion

From Figures 1-4 we can see that half of all the factors can be automatically detected. Sixty percents of them can be automatically gained after the improvement. One third of

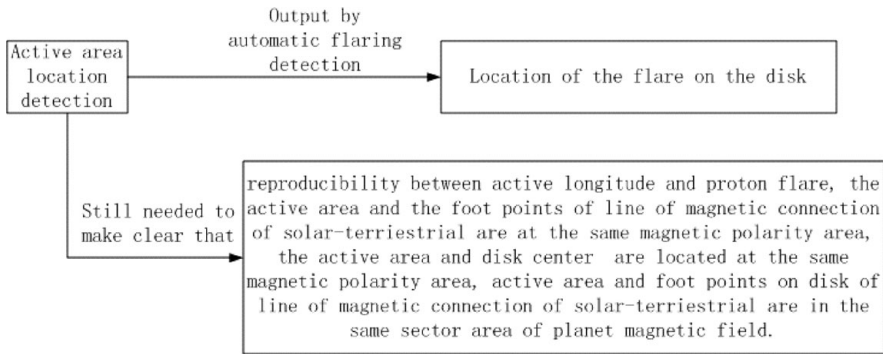


Figure 3. Active area location detecting and related forecast factors.

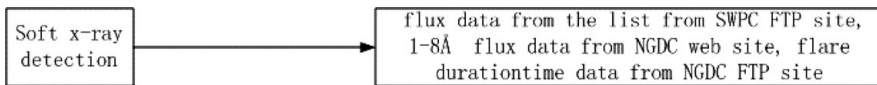


Figure 4. X-ray detecting and related forecast factors.

the remains still need to be make clearer. We can find that some factors of the one third can be automatically obtained by downloading data, computed, others still need to be further analyzed by human.

I thank the editor for his careful and earnest. The work is supported by National Natural Science Foundation of China under grants 60673158.

References

- Benkhalil, A., Zharkova, V. V., Zharkov, S., & Ipson, S. 2006, *Solar Phys.*, 235:87-106
- Curto, J. J., Blanca, M., & Martinez, E. 2008, *Solar Phys.*, 250:411-429
- Ming Qu, Frank Y. Shih, Ju Jing, & Haimin Wang 2003, *Solar Phys*, 217:157-172
- Wang Jialong 1999, *Chinese Journal of Astronomy and Astrophysics*, 19, 4, 412:418