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Cycle variation of Coronal Bright Points (CBPs) number from EIT/SOHO data

I. Sattarov[1], *N.V. Karachik*[2], *A.M. Tillaboev*[1], *Ch.T. Sherdanov*[2]

[1] Tashkent State Pedagogical University
[2] Astronomical institute AS of Uzbekistan

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Abstract. Temporal variations of coronal bright points number in EIT/SoHO data from 195 pass band for 1996−2008 are studied. For identification of CBPs the method developed by authors is used. It is found that: cycle variation of CBPs number is complete by July 2008; cycle variations of CBPs number are different at different latitudes.

Key words: Sun, corona, coronal bright points

1 Introduction

X-ray Bright Points (XBPs)-point-like features in solar corona were discovered in 1969 on first X-ray images of the Sun, obtained from sounding rocket (Vaiana, 1970). Later these features were extensively studied using observations from Skylab and recently Youhkoh (Sattarov et al., 2002; Hara, Nakakubo-Morimoto, 2003). Typically, XBPs appear as elongated brightenings which sizes vary between 4 and 50 Mm. Unlike some other solar features, XBPs are present at all latitudes on solar surface, both inside coronal holes and active region areas (Golub et al., 1974). Sattarov et al. (2002) has found that latitudinal distribution of XBP has two distinct maxima corresponding to active latitudes.

Golub et al. (1974) and Davis (1983) found that number of XBP anticorrelates with sunspot number and suggested that solar cycle may be characterized as an oscillator in the wavenumber space. This finding prompted Yoshmura in 1983 to suggest the existence of a secondary cycle of magnetic activity running in opposite phase to the sunspot cycle.

Similar point-like features were also identified on Extreme ultraviolet Imaging Telescope (EIT) images of the Sun in spectral lines of highly ionized iron, and were called EIT bright points. EIT is on board of Solar and Heliospheric Observatory (SoHO) launched at the end of 1995 and continues to operate up to the present time (Delaboudinnière et al., 1995). In the following discussion, we use more general name of these features – Coronal Bright Points (CBPs), as suggested, for example, by Sattarov et al. (2005a). McIntosh and Gurman (2005) have studied the cycle variation of CBPs from EIT/SoHO data for 1996−2006 and have found that CBPs number somewhat increases to solar maxima. They have used statistical method for photon count developed by Hara and Nakakubo (2003). Sattarov et al. (2007) have found that the CBPs cycle variations are different for different latitudinal belts and high latitudinal belts show anticorrelation with sunspot number.

In this report we will present results which show complete cycle variations of CBPs number and discuss latitudinal distribution of CBPs.

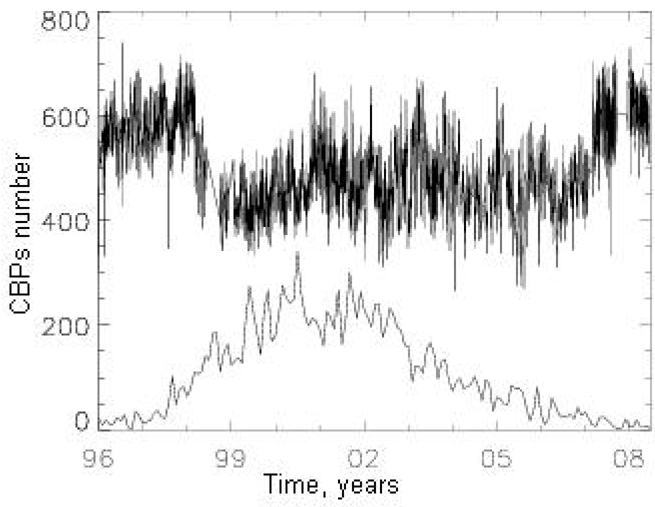

Fig. 1. Cycle variations of CBPs (top) and sunspots (bottom) number for 1996−2008. Scale of sunspots number is twice increased

2 Data set and coronal bright points identification procedure

We use calibrated full disk images from the Extreme-ultraviolet Imaging Telescope (Delaboudinnière et al., 1995) on board of the Solar and Heliospheric Observatory (SOHO) observed in 195 Å from 1996 to 2008. We employ EIT full disk synoptic data with spatial resolution of 2.64 arc. sec per pixel and six hours cadence. We identify CBPs using automatic procedure developed by us (Sattarov et al., 2005b; Karachik et al., 2006) and calculate various parameters including heliographic position, intensity, area, and background intensity around each CBP. In this report, we examine only number of CBPs, but not the other their properties.

3 Complete cycle variation of CBPs number

Figure 1 presents cycle variation of CBPs number in 195 Å pass band of EIT (top curve) and solar activity (bottom curve) for the period from January 1996 up to July 2008, which includes previous solar activity minimum (Apr 1996). Cycle variation of CBPs number differs from solar activity cycle for sunspots. Solar activity minimum coincides with CBPs number maximum. At previous solar activity minimum we have found about 570 CBPs, such number of CBPs were found also at the end of 2007 and first half of 2008. From the other one, at August and September of 2008 sunspots were not observed. It seems at August 2008 solar activity reaches its deep minimum.

CBPs number behavior between two minimum is very complicated: at the ascending phase of solar activity cycle sharp decrease and before the end of the cycle rapid growth are observed; at solar maximum the number varies in a complicated manner. So we have studied cycle variations of CBPs number for different latitudinal belts of solar surface.

Figure 2 presents cycle variations of CBPs number for 1996-2008 at different latitudinal belts. At ascending phase of solar activity the sharp decrease is observed in all latitudinal belts. After the sharp decrease at different belts the number of CBPs behaves differently: at solar equator its fluctuation grows up to 2004 (end of descending phase) after that it slowly decreases up to the end of solar activity. As it can be seen at equator belt in Figure 1 the number of CBPs anticorrelates with sunspot number: for example in 2001 the rise of CBPs number corresponds to the drop of sunspots number; at active region belt, at first, it slightly increases and after that it slowly decreases up to 2005, and later it increases up to deep minimum of solar activity; at high latitudinal belt at the solar activity maximum CBPs number reaches its minimal value; after the maximum (2003, year of reverse polarity of polar magnetic fields) the number is increasing up to solar activity minimum. In 2008 at all latitudinal belts number of CBPs reaches maximal value that is about observed in 1996.

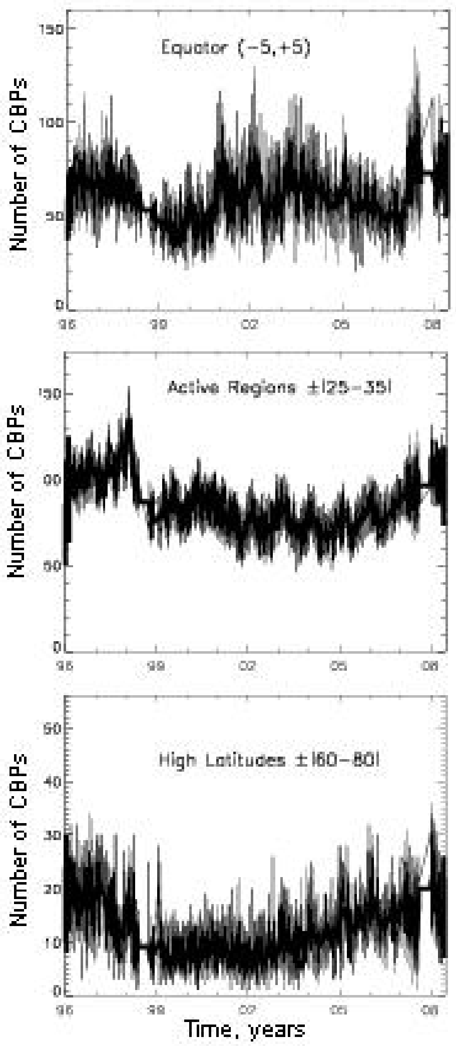

Fig. 2. Cycle variations of CBPs number in different latitudinal belts

4 Conclusions and discussions

From above presented results we could conclude that the last years EIT/SoHO data are suitable for study cycle variation of CBPs number. In the middle of 2008 CBPs and sunspots (23) cycles are completely finished. The cycle variations of CBPs for different latitudinal belts are complete by 2008 also. Cycles of CBPs and sunspots anticorrelates in general as it was found by Golub et al. (1974) and Davis (1983) earlier.

Cycle variations of CBPs number differ at different latitudinal belts: at ascending phase of solar activity (after a small rise in active region belt) the number sharply decreases up to minimum value in all latitudinal belts; at high (more than 60º) latitudes CBPs number increases after the polarity reverse of polar magnetic fields; in active region belt the number decreases up to 2005 after that it slowly increases to maximum at solar activity minimum; nearly the solar equator after the sharp decrease the number changes as solar activity with maximum at 2003 (after sunspot maxima).

As it was found earlier (Sattarov et al., 2002; McIntosh & Gurman, 2005) there are two types of CBPs: quiet and active regions coronal bright points. It seems the cycle of quiet region CBPs begins at solar polar regions and expands toward solar equator. Maxima of quiet region CBPs number takes place at solar activity minima. Number of quiet and active region CBPs anticorrelates with sunspots number. Active region CBPs are small (5−10 Mm), in general, and part of them may be as foot points of coronal loops.

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