

FLARE OCCURENCE IN THE COMPLEX OF ACTIVITY NOAA/USAF No. 4201, MAY 29 - JUNE 12, 1983

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ABSTRACT: The evolution of a large complex of activity NOAA/USAF No. 4201 in the period May 29 to June 12, 1983 was investigated. Almost 200 flares occurring in the complex were reported, most of which clustered at preferred sites where delta configurations with shear and strong gradients of the magnetic fields were present or new flux emerged.

ПОЯВЛЕНИЕ ВСПЫШЕК В КОМПЛЕКСЕ АКТИВНОСТИ NOAA/USAF №4201, МАЙ 29 - ИЮНЬ 12, 1983: Анализируется развитие большого комплекса активности NOAA/USAF № 4201 с 29-ого мая до 12 июня 1983. Почти 200 вспышек в этом комплексе было доложено, большинство из них накопилось около мест где находились дельта конфигурации со широким, большими градиентами магнитного поля и области нового магнитного поля.

VÝSKYT ERUPCIÍ V KOMPLEXE AKTIVITY NOAA/USAF No.4201, 29. máj - 12. jún 1983: Vývoj veľkého komplexu aktivity NOAA/USAF No.4201 bol analyzovaný v čase od 29. mája do 12. júna 1983. Zaznamenaných bolo približne 200 erupcií v tomto komplexe aktivity. Väčšina z erupcií preferovala tie lokality, ktoré sa vyznačovali delta konfiguráciami s veľkým shear-om, veľkými hodnotami gradientu magnetického poľa a novým magnetickým tokom.

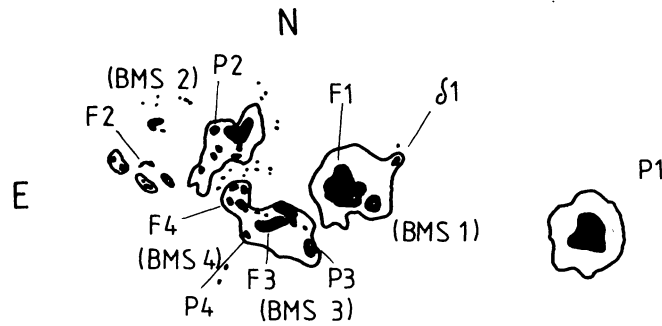
1. GENERAL MAGNETIC EVOLUTION OF THE COMPLEX

The AR-complex NOAA/USAF No. 4201 (SD No. 149-151/83, Mt. Wilson No. 23694) consisted of several bipolar magnetic systems (henceforth BMS). During the disc passage the inner structure of the AR-complex changed in dependence on the evolutionary state of each BMS at the given time. This was connected with the occurrence of almost 200 flares. Most of them were series of homologous flares clustered at the areas of strongest restructuring and interaction between the BMSs. From its transit over the eastern limb on May 29 to June 3 (see Figure 1 and Figure 2a, b) the BMS1 (SD No. 149) consisting of the spots P1 and F1 was the dominating group. It was a late phase (G-type) of the AR NOAA/USAF No. 4173 one rotation before. To the east of BMS1 was located the BMS2 (SD No. 150). This was a large scale emergent flux region which grew rapidly from June 3 and became the dominating system of the AR-complex on June 5. The spot P2 played the most important role. From June 5 it was by far the largest spot in the complex. Strong magnetic forces were interacting between this spot and the F-spots of the other BMSs. The forces were strong enough to break partly or completely the magnetic "neutrality" of these BMS's. On June 5 and 6 the last magnetic connections between the preceding (P1) and following (F1) polarity of the formerly dominating BMS1 were broken off. After that F1 was strongly connected to P2, whereas P1 continued to develop like a stable and relative unipolar spot. One rotation later it returned as a I-type spot to the west of the AR NOAA/USAF No. 4227.

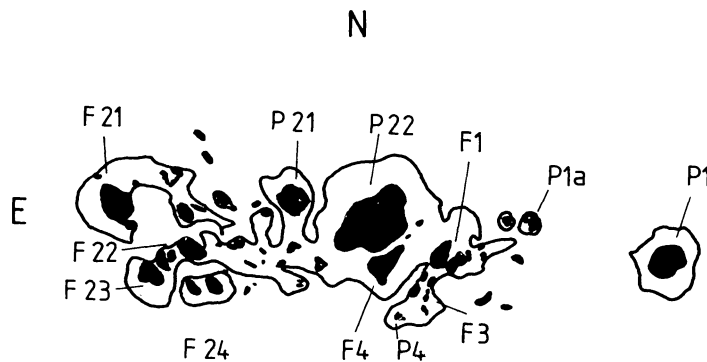
After June 3 the F-parts of the BMS's 3 and 4 (located to the south of BMS1 and BMS2) began more and more to interact with P2 too. We observed a strong sheared field between P2 and the other F-parts (F1, F3 and F4) colliding with it. It seems that the collision between F4 and P22 showed a certain degree of "elasticity". This and the structure of the magnetic vector on June 7 (Figure 3a, b) indicate that no direct magnetic connections existed between F4 and P22, but a neutral sheet was located between them. The vector magnetogram of June 7 further indicates that strong currents flowed on the leading edge of BMS2. These currents and the neutral sheet are able to drive fast reconnection and very effectively accelerate particles to high energies. (Ding et al., 1985).

2. TRENDS OF THE CUMMULATIVE SUMMATION CURVE OF THE F-INDEX

In Figure 4 the cumulative summation curve of the F-index for the studied AR-complex is presented. For all the flares, observed by the stations of the world-wide network and published in Solar Geophysical Data, the product $I \times D$ was computed for the individual flares where I is the flare importance according to the old classification scale (Křivský, 1969, 1975) and D is the duration of the flare in minutes. The values of the product are plotted according to the time of occurrence of the flare along the F-axis to coordinate with the value obtained before. It is clear that the summation curve for this



June 03, 1983



June 07, 1983

Fig. 1: Sketch of the active region on June 3 and 7.

AR-complex could be characterized by one trend from the time of the first flare observed (May 29 at 09:20 UT) till the end of the last observed flare (June 10 at 15:15 UT). This average trend would amount to a F-number of 382 per day. Such trends are typical for very active regions producing flares with magnetoplasmic clouds and particles (Křivský, 1975). And indeed protons registered at GOES on June 15 at 04:35 UT were attributed to a flare occurring in this AR-complex which at that time was 30° behind the W-limb (SGD 476-II, 1984, 118).

If we want to separate periods of partially different trends we can distinguish four trends during the passage of the AR-complex over the solar disc,

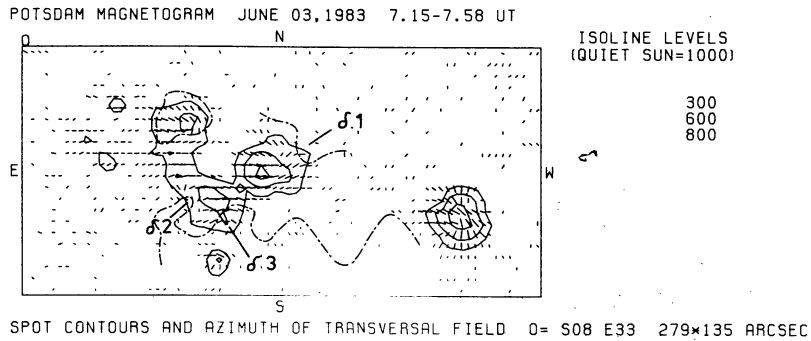


Fig. 2a: Transverse field and contour map of sunspots, length of line segments corresponds to the strength of the transverse magnetic field in logarithmic scale
 - · - neutral line, - - - - zero line of the line of sight component

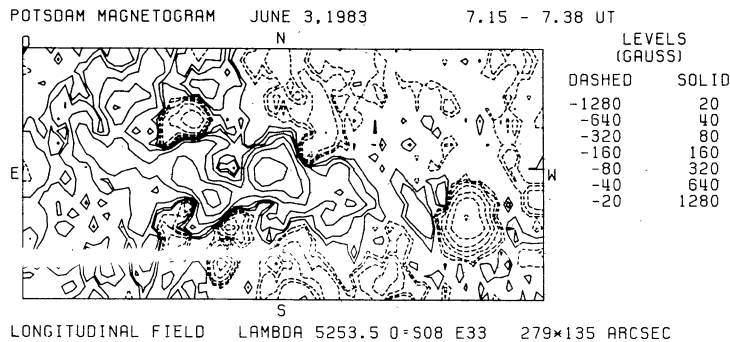


Fig. 2b: Longitudinal magnetic field.

which are denoted by roman numbers in Figure I. Trend I (beginning May 29 at 09:20 UT, end on June 2 at 14:53 UT) with an average of the F-number of 207 per day. Trend II (beginning on June 2 at 14:53 UT, end on June 6 at 15:39 UT) with the average F-number of 694 per day. Trend III (beginning on June 6 at 15:39 UT, end on June 8 at 13:53 UT) with the average F-number of 438 per day. Trend IV (beginning on June 8 at 13:53 UT, end on June 10 at 15:05 UT) with the average F-number 105. The steepest trends are trends II and III where the energy release in form of flares was largest.

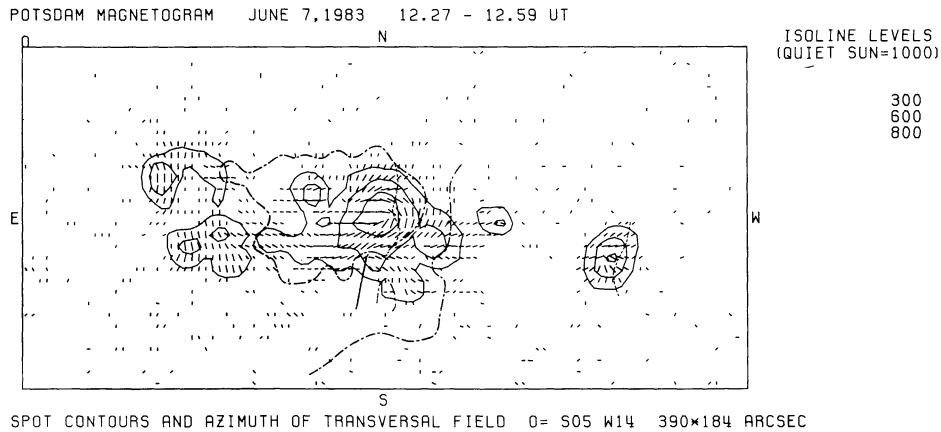


Fig. 3a: Transverse field and contour map of sunspots.

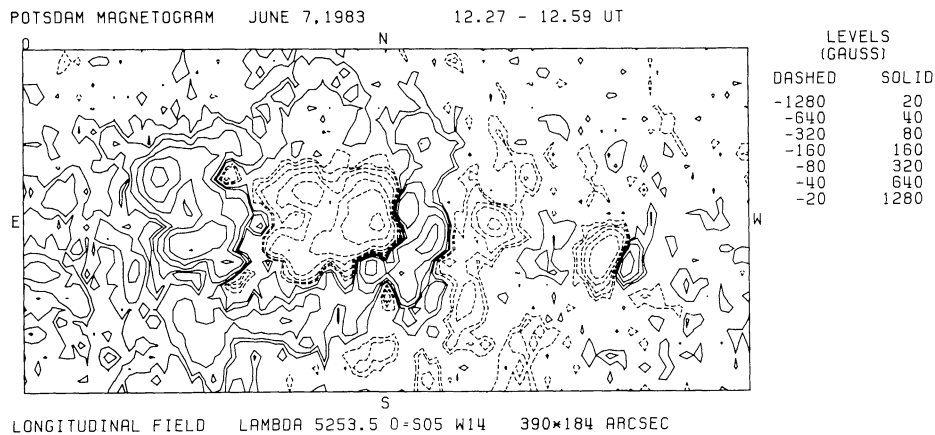


Fig. 3b: Longitudinal magnetic field.

3. CHARACTERISTICS AND LOCALIZATION OF FLARES

A general characteristics of the flares occurring in the studied AR-complex was their small H-alpha importance. Almost exclusively subflares occurred, less than 5% of the flares had an H-alpha importance 1. No flare with importance 2 or larger was observed. According to the X-ray classification (Solar Geophysical Data) the AR-complex produced 58 C-class flares, 11 M-class flares and 1 X-class flare which occurred on June 6 at 13 31 UT and was accompanied

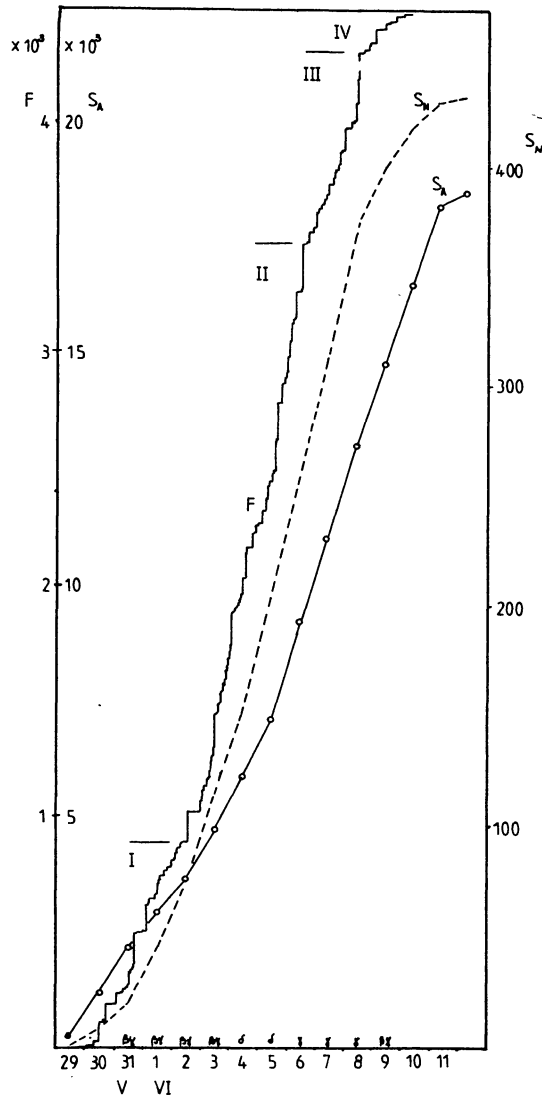


Fig. 4: Cumulative summation curve of the F-index of the AR-complex NOAA/USAF No. 4201. S_A shows the daily area covered by spots and S_N their number.

by a magnetic Type IV event.

The main flare localizations changed with the evolution of the AR-complex. From May 29 to June 2 most of the flares occurred in the vicinity of the two active filaments between P1 and F2, indicated by the positions of the neutral lines in Figure 2a.

From June 3 to June 6 the main localizations were:

- area of interaction between BMS1 and BMS3, active delta configuration, (Figure 2a, b).
- BMS2/ large scale emerging flux
- area of interaction between BMS1 and BMS 2
- area of interaction between BMS2 and BMS3 and 4

From June 6 on

- south of P22 and following parts of BMS's 1, 2 and 3 (Figure 1) where a strongly sheared field and a neutral sheet formed (Figure 3a, b). The X-class flare on June 6 occurred at this location, as well as, the last observed M-class flare on June 8 which also was accompanied by a type IV event.

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