POST-FLARE EFFECTS IN THE LOWER IONOSPHERE OF MIDDLE LATITUDES

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Beginning in the 1960s, we started to record cosmic radio noise from the region around the Polar Star on 29 MHz (KŘIVSKÝ and TLAMICHA, 1960) at the Ondřejov Observatory near Prague (49°54'N). Since the aerial characteristic was not too narrow, we received radio bursts of solar origin (of flares) at the noise level, SCNA effects (sudden cosmic noise absorption) at the time of intensive flare X-emission and in some rare cases, after large proton flares, small absorption effects of a few hours duration (KŘIVSKÝ, 1969). These post-flare absorption effects in cosmic noise are evidently analogous with PCA effects (polar cap absorption) and are connected with ionospheric absorption of radio cosmic noise, caused by fast particles of subcosmic radiation.

The recording of long-term absorption effects after large particle flares at European midlatitudes was reported in our astronomical papers already at the beginning of the 1960s. It was then usual to record radio cosmic noise with riometers at frequencies of about 18 MHz in the polar or subpolar regions in an effort to record PCA effects of subcosmic radiation (HAKURA, 1968). We attempted to record the complex of emissions mentioned as well as the effects in a new frequency range (30 MHz), which did not agree with the ideas of the contemporaneous representatives of the Ionospheric Department of the Geophysical Institute in Prague.

In recent years radio cosmic noise has been recorded at the Úpice Observatory in NE Bohemia (KLIMEŠ and KŘIVSKÝ, 1988).

We are presenting now a report on these long-term after flare effects of cosmic radio noise absorption (AF-CNA) at middle latitudes to the geophysical and ionospheric community for the first time.

The complex of the mentioned effects is demonstrated on the example of the observations and records of the proton flare of September 26, 1963. Figure 1 shows the development of the proton flare in Hα; the flare was of the usual flare-channel type, i.e. in the shape of two diverting ribbons connected with a rising flare-loop system at altitude. Figure 2a depicts the measurement of the width of the Hα line of this flare, and Figure 2b shows the record of atmospherics on 27 kHz with the X-emission effect which produced an anomalous ionospheric D-region (SEA - sudden enhancement of atmospherics); Figure 2c is a copy of the cosmic noise record on 29 MHz, and Figures 2d-f records of the radio flare bursts made with a radiometer on three individual frequencies; all the records are from the Ondřejov Observatory.

The flare started a few minutes after 07 00 UT and ended 09 10 UT. The CN records (c) clearly show that after the beginning of the flare, a fluctuating radio emission of the flare was recived, the decreasing values indicating a SCNA effect (7.2 dB). At about 09 10 UT the originaly undisturbed level was recovered and later, after 09 40 UT, a gradual long-term small absorption effect is

displayed. The duration of this after flare effect was a few hours.

The arrival of particles of sub-cosmic radiation was indicated by a PCA effect recorded by riometers (HAKURA, 1968), beginning at 11 15 UT on the same day. The commencement of the CNA after end of the flare, at about 09 40 UT (before the beginning of the PCA in the polar region), is probably connected with the arrival of faster particles in the ionosphere of middle latitudes. The geomagnetic storm with SSC began at 19 42 UT on September 27, 1963 (arrival of a particle cloud with a shock wave). The cosmic-ray Forbush decrease observed near the South Pole by Czechoslovak measurements began at 20 00 UT on September 27, 1963 (FISCHER and KŘIVSKÝ, 1965).

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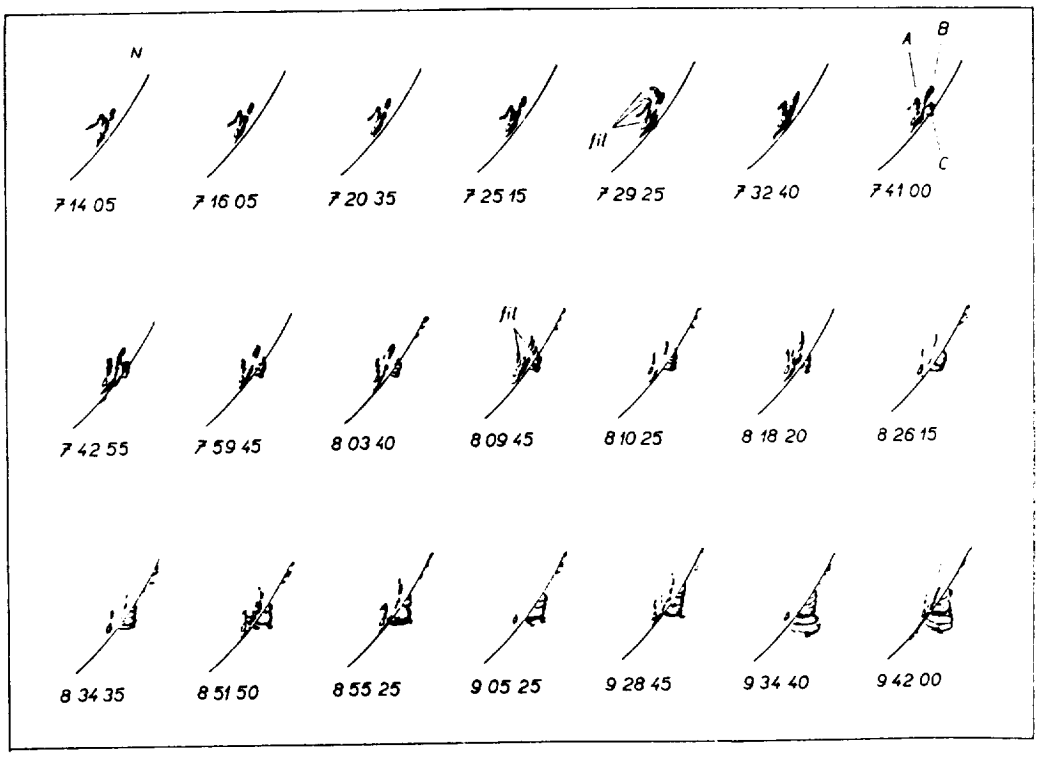

Fig. 1 Drawings of selected stages of evolution of the proton flare of Sep 26, 1963. The drawings were derived from the Hα photographs of various exposures. The empty field is a spot, the flare field is represented by a black surface. Some of the pictures showed flare absorption filaments; these are marked by arrows and shadowing. The lower flare ribbons in the chromosphere are marked A, B, the ascending tops of loops with C.

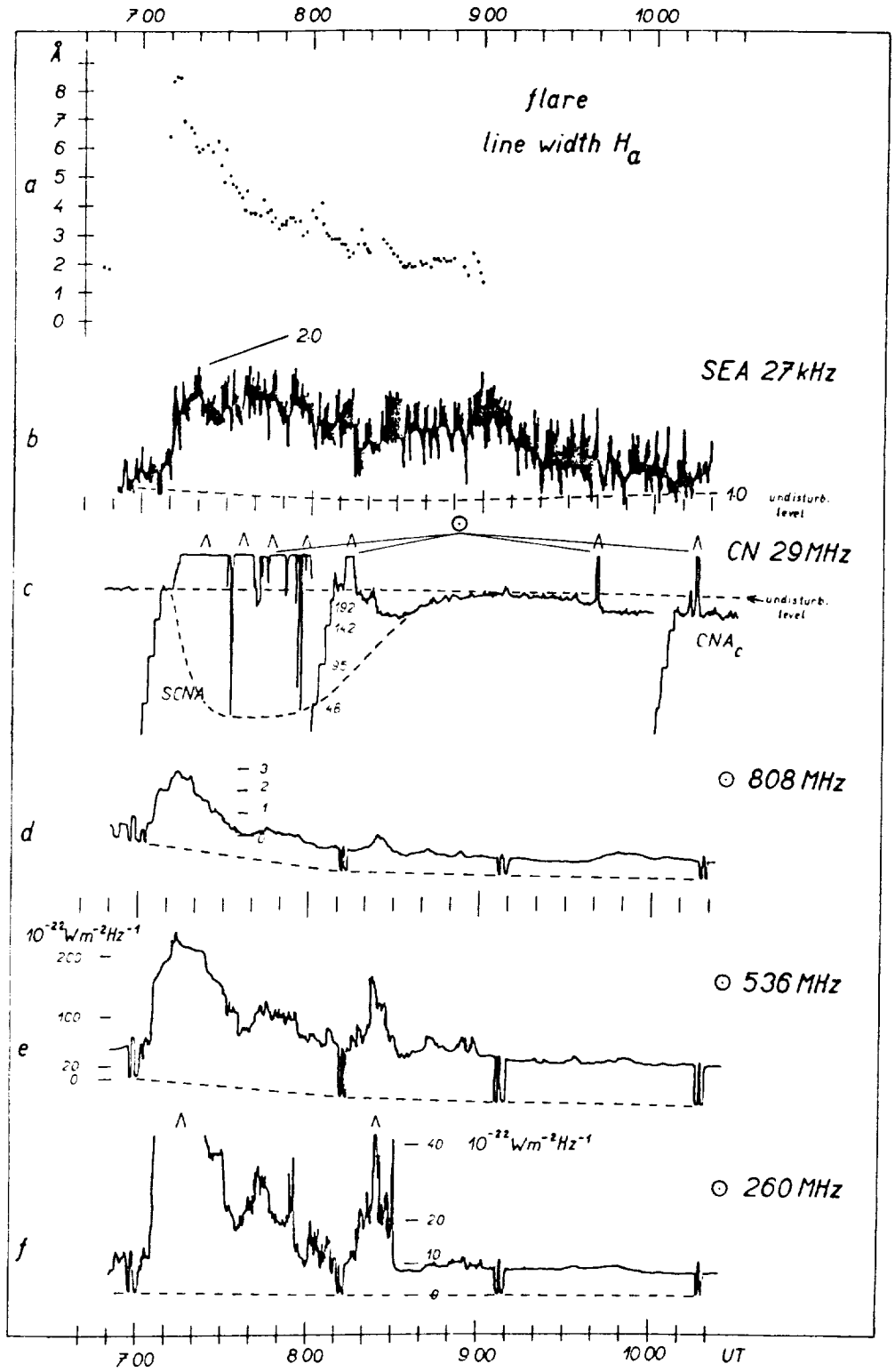
7 00
8 00
9 00
10 00
flare
line width H_α
a
Å
8
7
6
5
4
3
2
1
0
2.0
SEA 27 kHz
b
1.0
undisturb. level
CN 29 MHz
c
192
142
95
46
SCNA
CNA$_c$
undisturb. level
⊙ 808 MHz
d
3
2
1
0
10^{-22} Wm^{-2}Hz^{-1}
200
100
20
0
⊙ 536 MHz
e
40
10^{-22} Wm^{-2}Hz^{-1}
⊙ 260 MHz
20
10
0
f
7 00
8 00
9 00
10 00
UT

Fig.2