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THE NATURAL VLF EMISSION AS DIAGNOSTICS AND ESTIMATION MEANS OF THE FLUXES OF SOLAR X-RAY BURSTS

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Abstract. The possibility to detect the chromospheric flares based on the natural VLF emission intensity data on the Earth's surface is considered. Diagnostics of the change of solar X-ray burst flux at 0.5-4 Å and its estimation are discussed as possible.

The effect of solar flare short-wave emission on the Earth's ionosphere was considered by A.Mitra (1977) where the determination of solar X-ray fluxes by indirect methods is described. In low-frequency range for this aim are used the signals of transmitters operating at tens-hundreds kilohertz frequencies. The records of the natural emission (atmospherics) are considered to be suitable for the detection of flares but to be hardly used for the investigation of ionosphere physics as the detected noise represents the integral effect of many sources and the sources are of a random character.

Here the possibility is studied of the detection of solar chromospheric flares and the estimation of X-ray flux accompanied by powerful bursts in the range 0.5-4, 1-8 Å based on the change of the regular noise background intensity of the natural low-frequency emission detected on the Earth.

For many years in Yakutsk (φ = 62°N; λ = 129,7°E) the natural ELF-VLF emission at 0.5-10 kHz is being detected continiously. One of the types of continious low-frequency emission is a regular noise background (RNB) determined as a separate class (Vershinin, Ponomarev, 1966). RNB is is available constantly on the records and is characterized by a smooth temporal rounding. A spectral distribution of RNB intensity is two emission bands in ELF-VLF ranges divided by a deep minimum at 2-4 kHz (Murzaeva, 1974).

For the analysis were used the records of ELF-VLF emissions obtained in Yakutsk in 1973-1974 by 8-channel registrator (Druzhin et al., 1976) and from 1978 to now by 13-channel registrator in 0.5-10 kHz range. Besides, satellite data of solar X-ray fluxes were used (SGD, 1973-1985).

A comparison of RNB records with solar X-ray fluxes showed that the change of ELF-VLF emission intensity and its value depend on a value of X-ray burst flux. Almost simultaneously with solar X-ray burst the RNB intensity increases at 0.5-3 kHz and decreases at ~3-10 kHz. The enhancement maximum is at 0.5-0.8 kHz, the highest weakening - at 4-6 kHz (Murzaeva, 1977; 1981). The increase of X-ray flux by an order of 2-4 causes both weakening and an enhancement of ELF-VLF emission RNB intensity from ~2-3 to ~15-20 dB.

A change of RNB intensity spectral distribution during solar flares was considered by Murzaeva, Fligel (1980; 1984).

In Fig.1 is shown RNB intensity averaged on 5 flares in 1973-1974 and in 1981 versus a frequency. On Y-axis is put a ratio of RNB intensity measured at a flare maximum (I_b) to a pre-flare RNB level (I_o) calculated as 10 lg I_b/I_o (Murzaeva, 1977).

In Fig.2 is presented an example of RNB intensity change during a flare at various concrete frequencies of the range under investigation and solar X-ray flux record obtained by the satellite (SGD, 1973). A dynamics of VLF emission intensity at 5.6 kHz and of X-ray flux repeat each other (in counterphase). However, ELF emission intensity increase during a flare is not always observed and a frequency at which occurs a transfer from RNB intensity increase to its decrease is rather variable. Besides, ELF emission intensity enhancement caused by the influence of enhanced solar X-ray flux on the ionosphere is hardly different from ELF emission flare caused by other types of ionospheric and magnetospheric disturbances. At the same time a sharp weakening of RNB intensity at VLF frequencies observed during chromospheric flares is opposite to VLF emission bursts and is of a characteristic for chromospheric flares form. Therefore to study the variations of solar X-ray fluxes were used the experimental data at 5.6 kHz which, besides, appears to be at frequency range where RNB intensity weakening is maximum during a flare and RNB record level is high enough as compared with the instrument noise.

Sometimes during several hours one can observe a number of flares, for instance, on July 21, 1981. The variations of RNB level caused by them are superposed on its regular daily changes. Nevertheless, (see Fig.3) in the behaviour of RNB curve is reflected the dynamics of flare X-ray flux. A picture is being clarified if to subtrack the daily variations of RNB intensity from the total curve course.

We carried out a statistical treatment of the experimental data on a number of chromospheric flares and estimated solar X-ray flux during flares. In the case when X-ray fluxes (F) increase during a flare by an order of ~ 2 or more they are as $F = c(I_b/I_0)^{\kappa}$ where c and κ are determined based on the experimental data. The estimated X-ray flux (in the first approximation) is shown in Fig.3. A comparison with the satellite data (SGD, 1982) evidences its agreement.

Thus, using data of continious ground-based registration of the natural VLF emission one can:

- on characteristic for the period of chromospheric flares form of RNB intensity decrease of VLF emission to detect solar flares accompanied by powerful solar X-rays bursts;
- on the change of VLF emission RNB intensity to carry out a continious diagnostics of changes of solar X-ray burst flux and to estimate its value.

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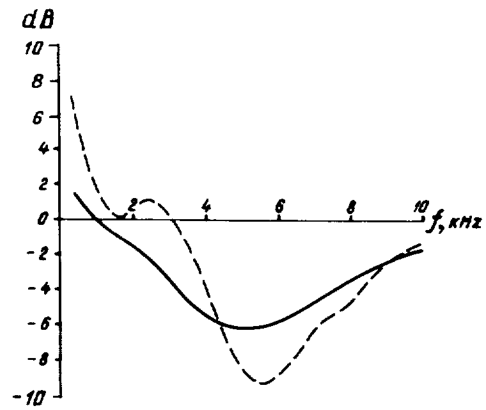

Fig.1. A change of RNB intensity averaged on 5 flares in 1973-1974 (———), in 1981 (– – –)

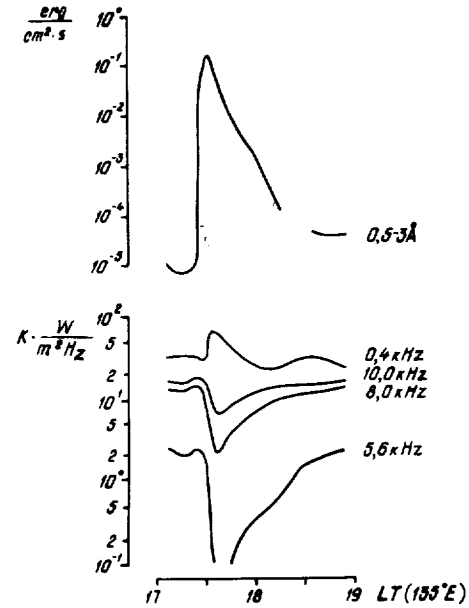

Fig.2. A change of RNB intensity during the May 3, 1973 flare at various frequencies and solar X-ray flux on satellite data (SGD, 1973)

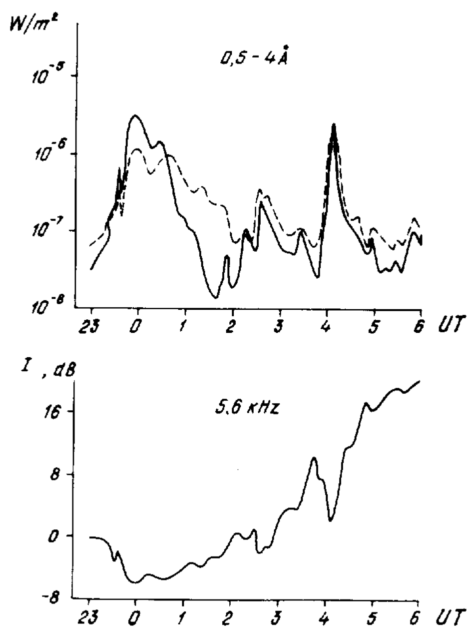

Fig.3. The record of RNB intensity of the natural VLF emission and solar X-ray flux (satellite data - SGD, 1982) during a number of flares on 21.07.81 (——), X-ray flux obtained on VLF emission data (– – –).