LOW FREQUENCY EMISSION RADIO HINDRANCE, as a MEANS of DIAGNOSTIC of PROCESSES in NEAR-EARTH SPACE

V.I. Larkina

IZMIRAN, Troitsk town, Moscow Region, 142190, Russia, E-mail: larkina@izmiran.rssi.ru

ABSTRACT

All of us have got used to consider, that radio noises in low frequency band (0.1 – 20 kHz) is a radio interference. Actually, these low frequency emission can be very useful and beneficial. They can be very reliable means, the instrument for study of a world ambient us. The low frequency emissions bear the information on environment plasma parameters, plasma, in which they are excited and propagated.

ITRODUCTION

Magnetosphere is gigantic natural laboratory, in which diverse geophysical processes occur. In a magnetospheric plasma are present electrical and electromagnetic fields. Magnetosphere plasma presents a mix of various energy particles from thermal up to highly and super highly energy particles. Besides in a plasma, by certain (determined) conditions, are excited electromagnetic and electrostatic waves and they interact with plasma particles, resulting to evolution of the variety geophysical phenomena on an earthly surface and in magnetosphere of the Earth. Thanking into account all this, the magnetospheric plasma differs from a laboratory plasma, where it is possible serially to enter particles, to change fields, "warm up" of a plasma and etc..
In the last years interest to quantitative and qualitative researches of radio noises as natural, so and artificial origin in the near-Earth space in an extensive range of frequencies (especially in 0.1 - 20 кГц) has considerably increased.
Detailed investigations of the space-temporary and spectral characteristics of low-frequency emissions and their connection with different geophysical phenomena permits to use their property for means of diagnostics and study of dynamic processes in magnetosphere. By results of the analysis of the information obtained by the "Intercosmos" satellites, the low-frequency emissions bear the information on environment parameters, in which they are excited and propagated, about flows of energy particles, penetrating in various areas of spaces and causing to excitation of these emissions. The mutual variations of low frequency noises and vigorous electrons in different geomagnetic activity conditions, during geomagnetic storms, in both in main and in recovery phases, are showed.

EXPERIMENTAL DATA

As a quality of a parameter of a level disturbances of a magnetic field in average latitudes (in the region of closed lines of magnetic field) was used Dst-variations. The amplitude of noise increases linearly proportionally with increasing Dst-variations and the maximum of emission intensity during magnetic diturbances is moved on more low a L-shell [1].
During disturbances and storms, in a main phase of the storm a maximum of intensity of low frequency emissions and of the particle flows, responsible for excitation of noise are moved toward the Earth to more lower L-shells. In the recovery phase there is a backward motion. The emission energy propagates preferentially along the lines of force of the Earth's magnetic field (gyromagnetic guiding, plasmapause effect or ducts). Thus, the emission in the vicinity of L_{max} may be considered as plasmaspheric hiss generated in the near-equatorial region of the plasmasphere just inside the plasmapause.

Table 1 shows the value of speed of moving (movement) of a maximum of $\Delta L_{max}/\Delta Dst$ for low frequency emissions and $\Delta L'_{max}/\Delta Dst$ - for particles during the main and recovery phases of the storms. The value $\Delta L_{max}/\Delta Dst$ is somewhat than that of $\Delta L'_{max}/\Delta Dst$ greater in the main phase, but these values are equal in the recovery phase. Hence, as the storm develops, the maximum of the electron flux density moves at a slower rate than the maximum of the noise amplitude.

Table 1. Variations of (in) $\Delta L_{max}/\Delta Dst$ and $\Delta L'_{max}/\Delta Dst$ for different phases of the storm

Parameter	Phase of Storm	
	Main, γ^{-1}	Recovery, γ^{-1}
$\Delta L_{max}/\Delta Dst$	$-4\cdot10^{-2}$	$3\cdot10^{-3}$
$\Delta L'_{max}/\Delta Dst$	$-3\cdot10^{-2}$	$3\cdot10^{-3}$

A similar cosideration of the variation with other indices of geomagnentic activity such as Kp and AE does not give such consistent results, as those obtained with Dst. The reason for this is probably that Dst is the best measure of geomagnetic disturbance in the region of the magnetosphere, where plasmaspheric noise are generated.

Knowing the relation between the amplitudes of the magnetic and electric noise field components and having the information about variations of the magnetic and electrical component values of low frequency emission fields we can calculate the density of an ambient satellite plasma for the case of a quasilongitudinal radio wave propagation.

We have worked out a technique and algorithm of such calculations. We have established, that it is possible to use the results of measurement of magnetic and electrical components of low-frequency emission field in quiet conditions for definition plasma density of the average latitudes at absence of measurements. The valuation of concentration mistake did not exceed 10-15%.

In the eighties the investigations of electromagnetic effects related to earthquakes at ionosphere altitudes with the use of satellite measurements were initiated.

It was established by the Intercosmos satellites [2], for the first time, and by the data of satellites OGO 6 [3] and Aureol 3 [4] was confirmed, that on board satellite above zones of preparation of earthquakes the abnormal bursts of low-frequency emission intensity are registered.

It was discovered:

-increase of intensity of low-frequency emissions 3-6 hours before and 3-6 hours after strong earthquakes (M>5,5), when the satellite was flying, near the epicentre;

-dimension of burst observation zones ±3° along latitude and ±60° along longitude. These are the so-called “noise belts”;

-amplitude of noise bursts increase when satellite is moving to the epicentre along longitude, to the moment of the main shock - along time;

-before the earthquake electric and magnetic components of emission field were observed, after the earthquake there was observed only electric component;

-reliability of the observed effect, calculated on the basis of experimental data processing made up 85-90% [5].

Further we investigated variations of the other plasma parameters above epicentres of the future earthquakes and have established, that the processes of earthquake preparation are accompanied by simultaneous changes: of low frequency emissions intensity (magnetic and electric componements), of concentration and temperature of a plasma environmental by Earth and vigorous electron precipitation [6].

It was definited space-temporal zones of changes of the plasma parameters: of fields of low-frequency noise intensity, flows of vigorous particles and density of a plasma by “Intercosmos 19” satellite data (see table 2).

Table 2. The sizes of a zone of supervision seismoionospheric anomalous on the upper ionospher heights.

Parameter	Range	Size of zone	Time(before)
Waves	ELF/VLF	$\Delta\varphi\pm3°$ $\Delta\lambda\pm60°$	Some Hours
Electrons	≥ 40 keV	0,1 L	2,5-3 hours
Plasma Density		±3°	Day

Thus, we can see variety of change of near-Earth space plasma parameters over the earthquake epicentres. Everything are additional attributes, indicative local disturbances of the magnetosphere parameters by effects of seismic activity and can be used as short-term earthquake prediction together with whole complex other satellite and, certainly, ground result of supervision (observations).

We suggested a method of selecting, obtaining and using of data for Earthquake prediction. Earthquake prediction program according to the given above methodics was elaborated and adopted in IZMIRAN [7].

CONCLUSION

Thus, is visually showed, that the radio interference in sound frequency band can be very useful. They can be utilised for diagnostic of a condition of near-Earth space, ambient ground, and for the forecast of earthquakes.

References:

[1].Larkina V.I., Likhter Ja.I. Storm-time Variations of Plasmaspheric ELF Hiss //J. Atm. Terr. Phys. 1982. Vol.44, N 5. P. 415-423

[2]. Larkina V.I., Nalivaiko A.V., et al.. Observation nboard the "Intercosmos 19" VLF emissions associated with seismic activity //Geomagn. I Aeronom. 1983. Vol. 23, № 6. P. 842-846

[3]. Gokhberg M.B., Pilipenko V.A., Pohotelov O.A. Satellite observations of electromagnetic emission over the epicentral region in the pre-earthquake stage //Doklady Academii Nauk (DAN). 1983. Vol. 268, № 1. P. 56-58

[4]. Larkina V.I., Migulin V.V., Molchanov O.A. et al. Earthquake Effects in the Ionosphere according to the Intercosmos 19 and Aureol 3 Satellite Data //Results of the ARCAD-3 Project and of the recent programmes in magnetospheric and Ionospheric Physics. Toulouse. 1985. P. 685-699.

[5]. Larkina V.I., Migulin V.V., Molchanov O.A. et al. Some statistic results on very low frequency radiowave emissions in the upper ionosphere over earthquake zones //Physics of the Earth and Planetary Interiors. 1989. Vol. 57. P. 100-109

[6]. Larkina V.I., Ruzhin Yu.Ya., Mineev Yu.V., Afonin V.V. Investigations of the Local Plasma Disturbancws at the Satellite Orbit over Earthquake Epicentre //Geomagnetic Field and Ionosphere Variations /Proceeding of the Second INDO-RUSSIAN Symposium on Nature and Variatins of the Geomagnetic Field M.: Trovant 1998. P.260-269

[7]. Larkina V.I. About possibility of the prognosis of katastrophic earthquakes by satellite monitoring of plasma parameters //Storm-term prognosis of disastrous earthquakes using radiophysical ground-based and space methods /Editors: V.N. Strakhov, V.A. Liperovsky / RAN, United Institute of Physics of the Earth. M. 1998. P. 51-63