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Low Frequency Noises (Emissions) are Reliable Means of Environmental Diagnostics

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Abstract

The natural, very low-frequency (VLF) noise emissions are generally looked upon as radio interference. In fact, these are an effective means for diagnostics and study of dynamic processes taking place in the Earth magnetosphere and ionosphere. They reflect the processes of magnetospheric and ionospheric plasma reconstruction and contain the information about the changes of environmental parameters.

The years-long, regular analyses of the results of satellite, low-frequency wave experiments have made it possible to obtain the time-and-space distribution of waves intensity and spectrum during magnetic-quiet time and geomagnetic perturbations as well. An integrated picture of development of a geomagnetic storm in low-frequency noise emissions and electron flows ($E_e \geq 40$ KeV) has been created.

A steep increase of the amplitude of low-frequency electromagnetic noise has been detected in the outer ionosphere over a strong earthquakes focus. A study has been made of the integrated picture of the changes of geophysical parameters over the areas of earthquakes anticipated. The response of ionospheric plasma has been registered over the earthquake epicenter area and in the magneto-conjugate hemisphere.

The results of integral analysis of the satellite-aided measurements of ionospheric plasma parameters have permitted detection of parameter changes, especially, those of low-frequency noise intensity over radioactive contamination areas. The evidence of this fact is the comparison of satellite-provided data on the changes of ionospheric plasma parameters with the ground data of registration of the content of cesium, technetium, iodine and other radio nuclides in the bottom sediments of the Barents and Kara Seas.

Key words: Low frequency noises; earthquakes; contamination

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1. Introduction

We have previously obtained the global space-temporary distribution of the natural low frequency intensity (daily allowances, latitudinal and altitude variations in absolute units) in different conditions of the geomagnetic disturbances. The response of plasmasphere ionosphere on processes of earthquakes preparation is shown by results of the complex analysis of satellite measurements of ionosphere plasma parameters. The response of ionospheric plasma has been registered over the earthquake epicenter area and in the magneto-conjugate hemisphere. The comparative analysis of the variations of the low frequency emission (0.1-20.0 kHz) intensity, low- and middle energy electron fluxes, plasma temperature and magnetic field power at satellite altitude by the Intercosmos satellite data above the different regions for example pollution zones has been carried out.

Considerable variations of parameters, especially, of low-frequency emission intensity over regions of radioactive pollution has been established. The scheme of global satellite monitoring for remote sounding of places of a burial place and utilization of a waste of nuclear fuel in a combination to possible land supervision is offered. It will allow organize high-informative monitoring of an environment space plasma state both over separate region, and in planetary scale.

Based on the results of complex analysis of satellite measurements of ionospheric plasma parameters, a variation of parameters is found, especially that of low-frequency emission intensity, above areas of radioactive contaminations. The evidence of it is provided by a comparison of satellite data on variations of ionospheric plasma parameters with data of recording cesium, technetium, iodine and other radio nuclides content in deep sea deposits of Kara and Barents seas.

Results of comprehensive study of radioactive contaminations by geophysical methods are presented in this paper. Application of satellite monitoring of low-frequency emissions for analyzing radioactive contaminants and solving environmental problems is shown.

2. Observation data

This paper is an analysis of satellite measurements of very low frequency (VLF) emissions in the range 100 Hz – 20 kHz, flows of mid- and low-energy electrons Ee≥40 keV, 50 and 120 eV)< density and temperature of ionospheric plasma. ”Intercosmos” satellite performed measurements of intensity of magnetic-field and electric-field components in VLF emissions at five frequencies 140, 450, 800, 4650 and 15000 Hz, flows of energy electrons and temperature of ionospheric plasma at the satellite altitudes (500 – 1000 km).

In all experiments the equipment of wave unit was of single-type and therefore its basic parameters were saved and accumulated: sensitivity, dynamic range, channels-tuning frequencies, relative passbands, electric charge and discharge time constants. A long-time existence of satellites life and a huge scope of data have made it possible to get an enormous amount of useful information for various geophysical conditions and for different time periods of day and night, etc. As a result, a uniform material has been accumulated that can be useful for statistic processing and correlation of variations in parameters of electromagnetic noise emissions. A usage was made of data on variations of other parameters of ionospheric plasma (energy electron flux density, for instance), which were simultaneously measured on board of the same satellite. All this allowed to obtain a comprehensive picture of phenomena occurred. In the process of our surveys we found out that electromagnetic processes recorded in the ionosphere can be related not only to phenomena of seismic activities, but to the current process in the lithosphere.

2.1 Low-frequency emission variations in the upper ionosphere over earthquake areas

Figure 1 shows the typical fragment of an analogous recording of magnetic component of low-frequency emission field onboard “Intercosmos 18” satellite two minutes before the strong earthquake, when satellite was flying near the future epicenter. Results are registered from an output of cannels of a spectrum analyzer in frequency band 0.1 – 20 kHz. As we can see, the emission is of impulse character and it is the most intensive at the frequency lower 1 kHz [Larkina et al., 1983].

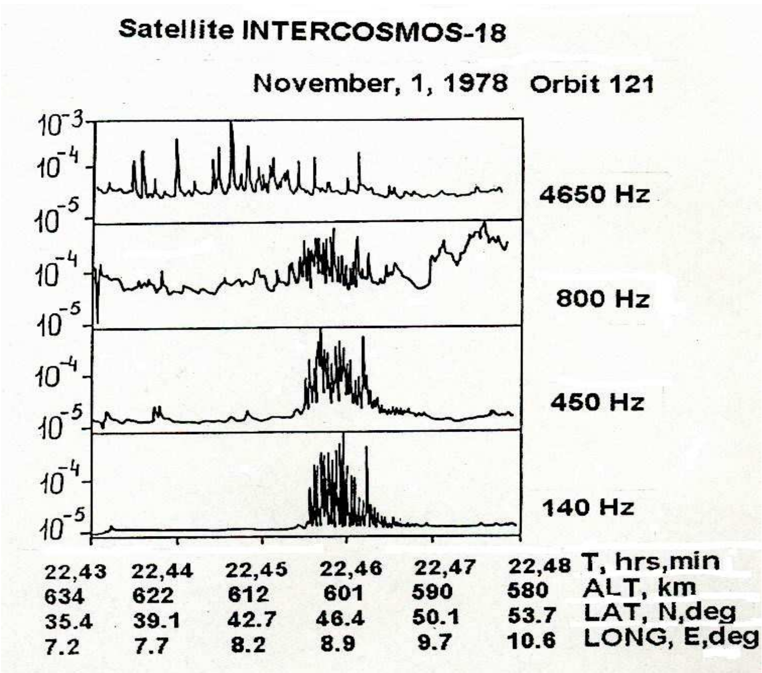

Figure1. The example of analogue record of a fragment of the magnetic component of low-frequency emission field onboard the “Intercosmos 18” satellite, made on November 1, 1978 two minutes before a strong earthquake, when the satellite was flying near the epicenter.

Next figure (see Figure 2) submitted middle latitudinal dependence of the low frequency noise intensity on frequency 4650 Hz for different geomagnetic activity conditions. These results have received for 4 months of “Intercosmos” satellite function and special (|) root-mean-square spread of data. The separate badges, as an example, show the noise intensity burst size, registered on channel output during earthquake preparation [Larkina et al., 1989]. From a drawing it is clearly visible that the emission intensity bursts, connected with development seismic activity, obviously exceeds emission level, usually observe in give space area.

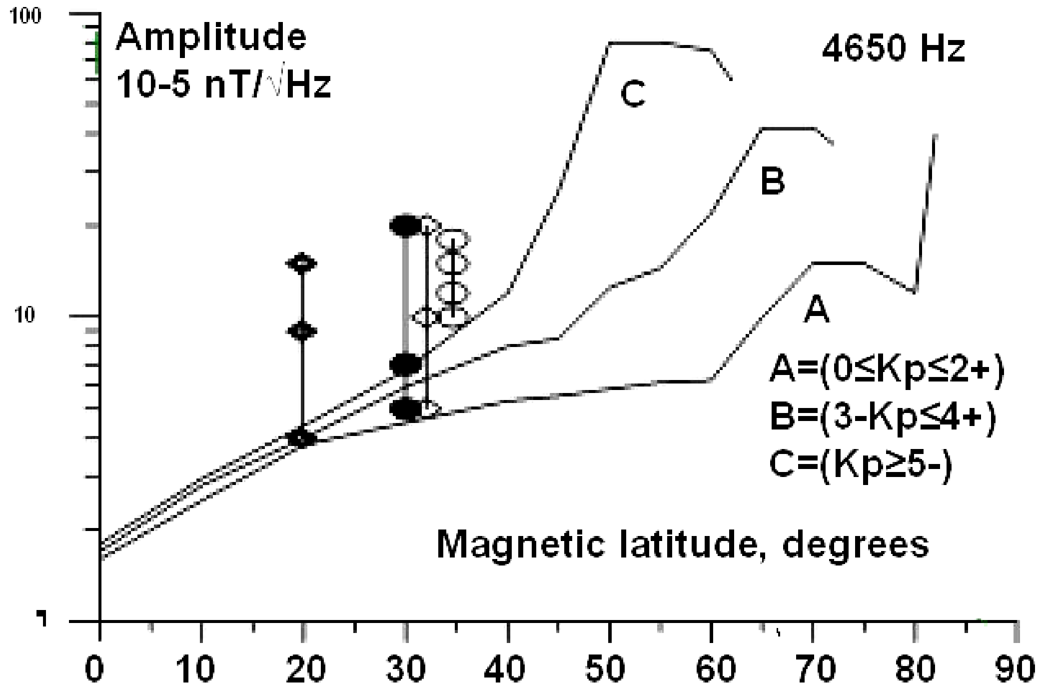

Figure 2. Middle latitudinal dependence of low-frequency noise intensity on frequency 4650 kHz for various geomagnetic activity conditions.

Outcomes of low-frequency noise observation above an epicenter of the same earthquake simultaneous on board two satellites is confirmed the earlier obtained information about plasmasphere response on processes of earthquake preparation. The satellite “Intercosmos-Bulgaria-1300” was flying at the altitude 800 km near an epicenter (January 21, 1982, 17.50.26,2 UT, φ=3,39°S, λ=177,4°E, depth 33 km, magnitude 4.6) 12 minutes before the main stroke. The bursts of wave intensity in range of 0.1-8 Hz were measured on its board. The “Aureol 3” satellite was flying near to this one at altitude 1970 km/s hours 48 minutes before main shock. The bursts of emission intensity in frequency band of 10 Hz-20 kHz, bound, according with processes of earthquake preparation, are marked. The figure 3 is plane of a magnetic meridian passing through an earthquake epicenter in coordinates: a geographic latitude (φ) and altitude (h), the parts of projection of orbits of these satellites and grid of lines L (h,φ)=const, where L is McIllwain parameter, are marked. The latitude of an earthquake epicenter is marked by cross (X). The satellite measurements were conducted in night time. In these conditions the natural low-frequency noise level at low and equatorial latitudes is usually small, so that the distinguish of noise bound with seismic activity is easied [Galperin et al., 1992].

It was revealed, that from 20 selected events of strengthening (amplification) particle precipitation accompany by low-frequency emissions intensity bursts, in 18 events the abnormal bursts have coincided with availability of earthquake [Galperin et al., 1992].

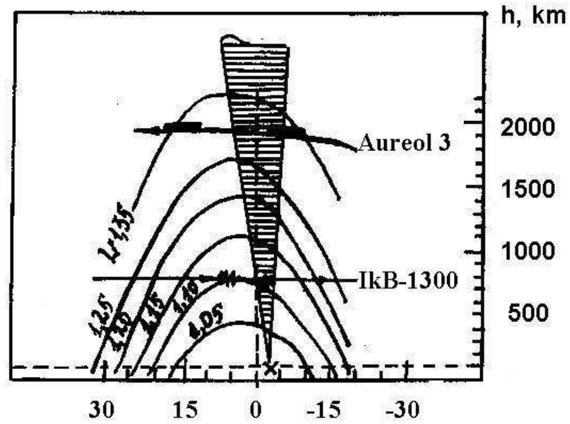

Figure 3. The plane of magnetic meridian passing through an earthquake epicenter in coordinates: geographic latitude (φ) and altitude (h) the parts of projections of orbits of these satellites and grid of lines L(h,φ)=const, where L is parameter McIllwain, are marked. The latitude of an earthquake is marked by cross (X).

The measurements series from two satellites above the same area of preparation earthquake, despite at difference in used instrumentation, has allowed to make the concluding, that seismoionospheric noise were presented above an future earthquake epicenter area a long time before main shock. Frequency band of registered noise is broad enough, from 0.1 Hz ("Intercosmos-Bulgaria-1300") up to 20 kHz (top range of instrumentation on board "Aureol 3".

We were analyzed not only individual events by satellite data, but we are received also statistical characteristics by formalism of data processing process help on modern computing means. We choose the few tens of earthquake taking into account the following. Sufficiently strong events with magnitude M>5.5 and depth <60 km were used. Only low latitude earthquakes with electromagnetic latitude of epicenter Φ>45° were considered. The ionosphere region with the low-frequency emissions observed by "Intercosmos 19" have been found to be formations ("noise belts") extended along ±60° of geographic longitude and ±3°of geographic latitude. Before the earthquake electric and magnetic components of emission field were observed, after earthquake there was observed only electric component. Frequency range, in which anomalous increase of noise bursts from a share Hertz to 20 kHz was noticed (20 kHz is top range of an equipment). The reliability of observed effect, calculated on the basis of experimental data processing made 85-90% [Larkina et al.,1983].

Thus, effect of electromagnetic emission excitation in the plasma-sphere above prepare earthquake zone is experimentally established. Appear theoretical work confirm a reality occurrence low-frequency electromagnetic emission in the upper ionosphere heights over the earthquake epicenters. These results are known and published. Here we shall give main attention to the complex analysis of plasma parameter data their start preceded on the earthquake main shock (forerunners).

2.2 Low-frequency emissions and energetic electron flows over future earthquake epicenters

Here we present the first direct comparison of electromagnetic VLF pulse with flow of the energetic particles over future and its magnetic conjugate region. Simultaneous data energetic electron (E=0.04-1.2 MeV) and magnetic and electric components of the VLF emissions (0.1-16 kHz) was measured onboard of “Intercosmos 19”. By complex analysis of that information we turned one’s attention to the coincidence of the bursts (emissions and flows) in the space and time over future earthquake epicentre.

The figure 4 shows the fragments of analogous data recording onboard the “Intercosmos 19” satellite which made on March, 29 1979, when the satellite was flying near the epicentre (Δt=-1.19h, $\Delta\lambda$=10°) of strong earthquake (M=5.8). The low frequency emission bursts (f=450 Hz and f=800 Hz) and behaviour of precipitation particle flow (E>40 keV) are presented.

It is obviously that the manifestation zone of anomaly VLF-ELF emissions (connected with earthquake) and registration zone of electron flux bursts coincide. At the figure4 we can see a strong short pulse periodicity of VLF signal. It is result of ionosound transmitter operation every 64 sec. But these pulses are not so strong disturbances to detect the effect of earthquake in the VLF-ELF emission or particles flux.

We have carry out the correlation analysis of the similarity forms of the emission pulse and flow density of energetic electrons spikes. The correlation coefficients for different realization lengths are presented in Table l. The realization length is formed by 70 points (00:50-00:53 UT). The length of the investigate part was 27 points (00:50:45-00:51:50 UT).

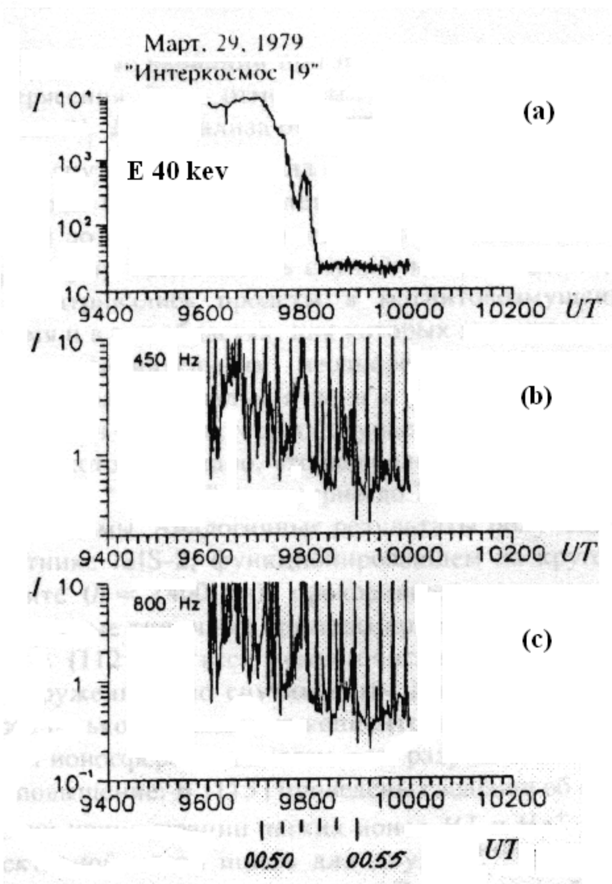

Figure 4 Particles and VLF emissions of "Inntercosmos-19" onboard registration is shown. The precursor pulse is marked by arrow. Pulse duration is about one minute.

It is seen, that the time correlation of the low frequency emission bursts and the pulse of precipitation particle flow is perfect (always R>0.5). It was turned out that a correlation coefficient for the lower energy electrons (E>40 keV) was higher and achieved 0.64÷0.72.

Table 1

Correlation coefficient of the VLF emission (f=400Hz and f=800Hz) and energetic particles (E>40 keV and E>100 keV) burst

Parameters	Correlation coefficient	
	27 points	70 points
40 keV/100 keV	0.9382	0.9367
450 Hz/800 Hz	0.9400	0.8860
40 keV/450 Hz	0.5630	0.6400
100 keV/450 Hz	0.5359	0.5925
40 keV/800 Hz	0.6190	0.7190
100 keV/800 Hz	0.5900	0.6461

It is necessary to note, that by investigation of magnetic conjugation of the low frequency noise anomaly pulses at the altitude of upper ionosphere we find the good conjugation between the bursts in the northern hemisphere (ionosphere above the future earthquake) and in the southern one. Shown in the Figure 5 in the geographic latitude-longitude coordinates are the “Intercosmos 19” satellite projection part of orbits 9189-9196 in the period before the earthquake of November 23,1980 (t=18:34 UT; φ=41,1°N; λ=15,34°E; M=6,7; H=33 km; LT=19,34) and after it when the emission burst was detected (the earthquake location is also shown). The L-shell and geomagnetic meridians have been mapped. Position of the earthquake epicentre is marked by a cross (x). The moment of the main shock is write bellow, near the sign (x).

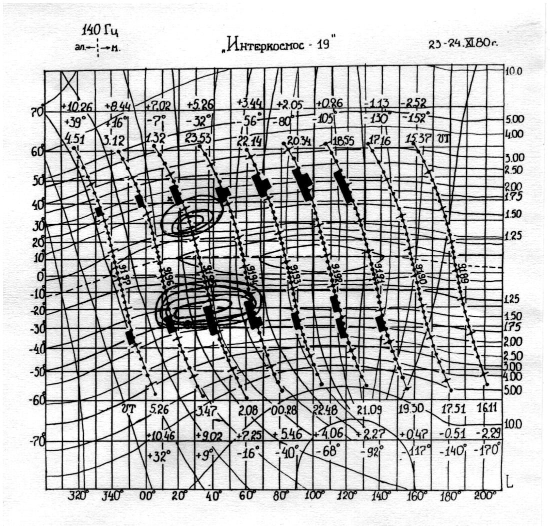

Figure 5 . The Intercosmos 19 satellite orbit projections.

The parts of orbit projections are blackened, where bursts of emission intensity are found. The emission levels of magnetic (to the right of the trajectory) and electrical field components on the frequency of 4650 Hz are denoted on the map by hatched bands. Each step corresponds to the increasing of the signal by 10 dB with respect to the background level. Near each histogram the absolute time values and time differences respect to the earthquake start time t (“+” after this moment and “-” before it) are indicated.

Process of earthquake preparation may be one of possible reason of the energetic particle precipitation or instability of inner radiation belt. It is can connected with the trapped particle anysotropy or the magnetic fields pulse disturbance and other local reasons. For examples, the operation of powerful ground VLF transmitter or lighting discharge are followed by the increasing of the particle precipitation from radiation belt. The seismomagnetospheric emissions may be exit due to the same reason. Here we presented the evidence of good correlation of local disturbances in the magnetosphere-ionosphere parameters connected with seismic activity.

It is found, that the observation zone of the very low frequency emission bursts can be connected with future earthquake and that the registration zones of the flux density are in good coincides. At conjugate hemispheres the observation zone of the bursts and their amplitude are coincided and very close. On base of such picture the model of precursor development in the plasmasphere over seismoactive region and conjugate area can be proposed [Ruzhin and Larkina, 1996].

2.3 Time sequence of seismic activity manifestations

This part shows the in-time development of electromagnetic and electric phenomena, accompanying the manifestations of seismic activity [Larkina, 2002].

Many days possibly months before an earthquake there come about perturbations of geoelectric field as events continue to develop, and the amplitude drows and oscillation characteristics changes in the seismic focus.

-Then the registration of geomagnetic field perturbations is started.

-After this there come about the perturbations of atmospheric electrical potential.

-Several days or hours before the earthquake there occur changes of ionosphere parameters, changes of critical frequencies and concentration change.

- Several hours or days before the earthquake there come about the variations – amplitude increase of natural pulse electromagnetic Earth’s field according to the ground data.

-Ten of minutes-hour before the earthquake geomagnetic pulsations Ps (0.02-1 Hz) take place.

- Ten of minutes-hour before the earthquake the intensity of electromagnetic emissions increases at satellite-flight altitudes.

-Luminous effects take place.

2.3 Statistical characteristics of the size of ionosphere zones of responses to earthquake preparation process

Determined are the space- and – time values of the zone of abrupt changes of ionspheric plasma parameters over the regions of main seismic shock preparations (earthquake moment). The statistical results are listed in table 2

Thus, the effect of noise growth over the impendent earthquake epicenter in the range 0.120 kHz, detected for the first time according to “Intercosmos 19” satellite data was confirmed by the results of signal analysis on “Intercosmos 18”, “OGO 6”, and later on “Aureol 3” satellites

Table 2
Space- and – time values of the zones of seismo-ionospheric anomalies observed at upper ionosphere altitudes

Parameter	Range	Zones size	Time (up to)
Wave	ELF/VLF	Δλφ±°Δλ±°	Several hours
Electrons	Ee≥40 ke	0.1 L	2.5-3 hours
Plasma density		±°	Days

It was found that earthquake preparation processes were accompanied by the changes of ionospheric plasma parameters [Larkina and Ruzhin, 1998]

- an increase of low frequency emissions (magnetic and electric components) intensity from a few fractions of Hz to a few kHz,

- a flux of quasi-trapped and precipitation energetic particles (with an energy of 40 – 250 keV), which appears a few hours before the main stroke of earthquake,

-changes of ionospheric plasma density and temperature.

The local perturbations of ionospheric plasma parameters by seismic activity effects bay be taken advantage for the short-term earthquake prediction in combination with a set of parameters registered on the Earth's surface.

The combination of results mentioned above has made it clear that the ionosphere, as a whole, and the phenomena occurring therein are indicative of the processes taking place in the lithosphere. It is clear from the information given here that it is advisable to create a special service, incorporating in it the ground-based measurement facilities and satellite-based complex of one or more satellites with the respective equipment installed therein. This means that the prediction of heavy earthquakes will be possible in the near future.

Combined with ground-based measurements the satellite measurements make it possible to considerably expand the geography of monitored regions and to realize the earthquake prediction also in the areas traditionally regarded as seismically stable.

Thus, there was detected for the first time and confirmed by large amounts of experimental data the phenomenon of emergence of low-frequency noise emissions at upper ionosphere altitudes and over seismic focuses of heavy earthquakes. The space- and –time values of the zone of plasma parameters change at upper ionosphere altitudes were determined. A method was proposed and introduced to select, receive and make use of satellite experiments data for earthquakes prediction. Low-frequency noise emissions (100 Hz – 20 kHz) are traditionally considered to be radio interference, and as a matter of fact (in reality) these are World perception devices that carry information about the parameters of the environment, wherein these emissions are excited and propagated. Besides, low-frequency emissions are indicative of the processes taking place in the Earth lithosphere.

3. Results of ground-based of the environment pollution measurements

When studying the works of expeditions to the North, we found data on distribution of (^{137}Cs) cesium concentration in the waters of Barents and Kara Seas [Matishov et al., 1994]. The content of radio nuclides in various masses of Barents and Kara Seas was studied in details for the first time in August-October 1982 during the 12th run of research ice-breaker ship “Otto Schmidt”. Explored and examined were offshore waters of Barents, Kara and Greenland Seas. Radioactive contamination was determined according to analysis results of samples taken from sea water and deep sea deposits. Anomalously high concentrations of ^{137}Cs were registered in southern part of Barents, Kara Seas and in the eastern part of Greenland Sea. Almost all higher levels of radio cesium were observed in the offshore waters to the west and east of Novaya Zemlya, as well as to the north of Kola and Motovsky Bays. Contaminated water bodies penetrated through southern Novaya Zemlya’s straits to the Kara Sea. One can observe practically the same concentrations of ^{137}Cs in the waters of south-western part of this sea as in the southern part of Barents Sea.

The Figure 6 illustrates the ^{137}Cs radionuclide grid map of bottom and surface waters in Barents and Kara Seas on the basis of analysis of samples taken from the sea water and deep sea deposits. Yuzhno-Barents cavity is characterized by an elevated content of ^{137}Cs cesium in deep sea deposits.

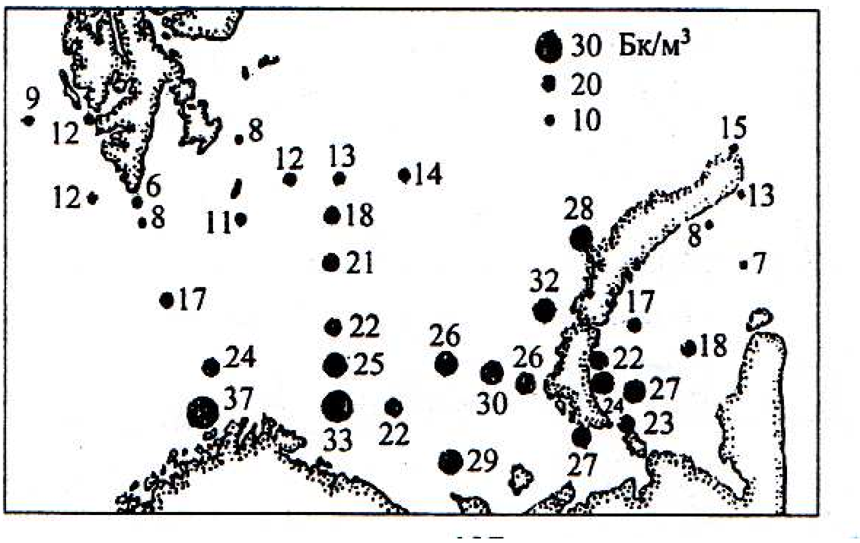

Figure .6. Distribution of cesium concentration in bottom and surface waters of Barents and Kara Seas.

3.1 *Results of satellite observations of ionosphere parameters above contaminated zones*

Let us consider some examples of radioactive contamination zone observations made on the basis of the satellite data and compare them with contamination zones identified earlier.
We plotted the "Intercosmos-19" satellite's path in March (a) and in June (b) 1979 on the grid map showing ^{137}Cs content in deep sea deposits (see figure 7). The satellite travel paths were observed above one and the same region and exactly at one and the same local time.

Above contamination zones in the region of Yuzhno-Barents cavity one could observe a considerable and simultaneous increase of VLF emission intensity (by ~20dB) and flux density of low-energy precipitating electrons (Ee~50 eV and Ee~120 eV) and ionospheric plasma temperature (by 20-25%). In this very region intensive fluctuations of parameters were recorded. A non-dimensional value, known as a correlation coefficient R, is used in practical work for characteristics of relationship between two random variables. Having done a correlation analysis of simultaneous bursts of magnetic-field and electric-field components in VLF emission, we were able to get information on similarity (proximity) of burst shape of noise field components. A correlation analysis showed that observable bursts are of electromagnetic nature and the correlation coefficient of burst envelope of magnetic-field and electric-field components in the region under study amounted to 0.81-0.98.

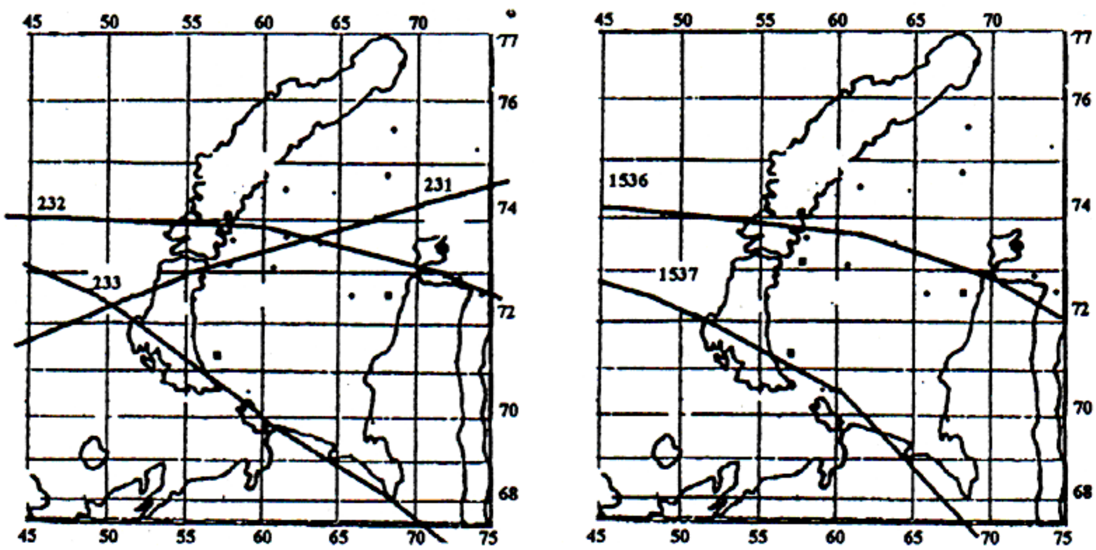

Figure 7. Paths of "Intercosmos-19" satellite projections in the regions of Barents and Kara Seas.

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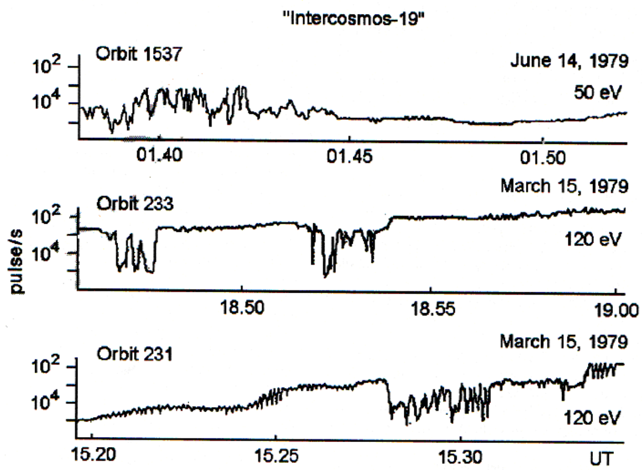

Fig. 8 Fragments of recordings showing the electron flux density above the contamination zones.

Figure are examples of recording of electron flow with energy 120 and 50 eV in the regions of Barents and Kara Seas. It is clear from it that burst were accompanied with fluctuations. Results were recorded by a satellite during its complete orbits 231 and 233 (March 15, 1979) and 1537 (June 14, 1979). The most intensive bursts with fluctuations were observed in the region of Yuzhno-Barents cavity

We observed similar simultaneous bursts with fluctuations when satellites travel above zones of deep faults. Very much so that these bursts might be related with radon gas radiation, as it was assumed in the paper [Pulinets et al., 1999]. It is necessary to note that direct measurements of radon gas content in the Yuzhno-Barents cavity were not carried out, as far as I know. At the same time, concentrations of radioactive elements, which to some extent can be the source of radon, were studied on the basis of comparatively small amount of samples. Obtained results show a tendency to increasing of this parameter in the water layer along the western periphery of archipelagos Novaya

Zemlya, as well as in the layer of deep sea deposits along the same periphery. The authors of the given surveys associate an elevated content of radioactive element concentration with technogenic pollution of this region as a result of aftereffect of nuclear weapons tests and radioactivity carryover from Europe and North America by Atlantic streams.

3.3 Comparison of satellite-based and ground-based measurement results

Let us consider a reliability of the last thesis on the basis of a specific example. There are several radioactive contamination zones in northern latitudes of our hemisphere. One of the zone detected – a zone in close vicinity to Scandinavia's western coast line. The authors [Matishov 1994 and Matishov, 1998] explained this contamination zone by a release of poor-quality radioactive wastes from the Sellafield-based nuclear fuel reprocessing works to the Irish Sea and La-Hague in the English Channel. In the mid-70's waste disposal from these facilities were extremely high. The impact of relatively soluble radionuclides (Cesium-137, Technetium-99 and Stibium-55 (Sb) produced in Sellafield is traced at long distances in the inshore waters of Norway and southern part of Barents Sea. Almost entire cesium discharged with other wastes from Sellafield works is dumped to the sea, then it migrates from the Irish Sea to the North Atlantic (Pond) and then turns out to be in the North Sea. Radionuclides of English and French origins are carried by Norwegian coastal currents and in a limited volume are drifted to the south-western basin of Barents Sea. The paper [Matishov et al., 1998] provides maps containing information about ^{137}Cs content in surface waters of the north-western Europe on a year-to-year basis. We have taken a good advantage of using their maps, which offered data for those years during which our satellites were actively used.

"Intercosmos-19" satellite passed above the region of elevated content of radio nuclides near the coastline of Scandinavian peninsular. We observed very intensive bursts of emissions and low-energy electrons with fluctuations above the region of Scandinavia's western cost that is in other words above the contamination zone one can observe turbulent regions that was evidenced by acquisition of small-scale variations (fluctuations) of plasma parameter intensity. The figure 9 illustrates a grid map with information on radionuclide content near western coastline of Scandinavia. On the map of ^{137}Cs distribution in the Scandinavian peninsular region for 1979, we plotted the paths of "Intercosmos-19" Satellite's orbits 236 and 1540, which passed near western coastline of Scandinavian peninsular in March and June of 1979. In this figure certain parts of satellite projection paths, where simultaneous bursts of wave intensity and electron flux density accompanied by intensive fluctuations were observed, are shaded (hatched).

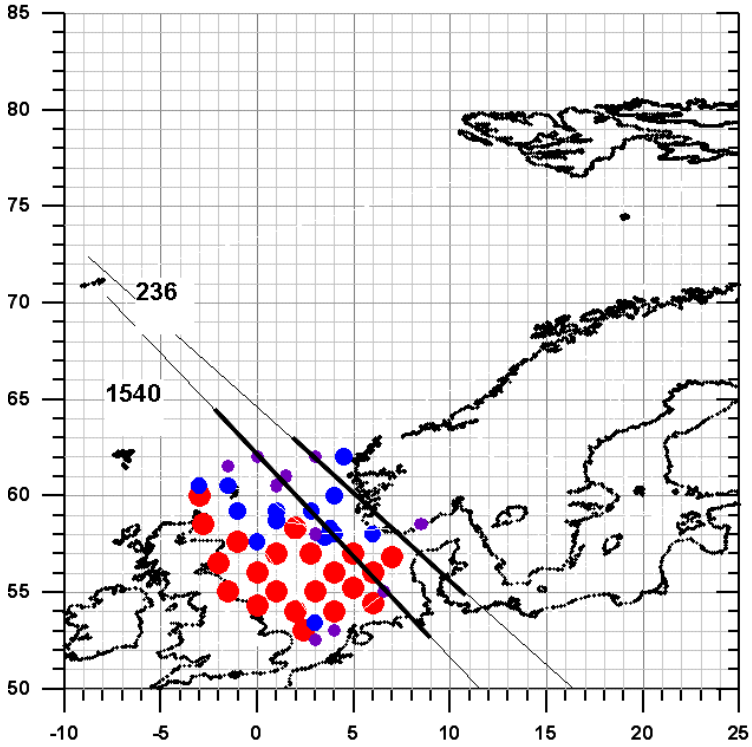

Figure 9. A map showing the distribution of radio nuclides to the west of Scandinavia and "Intercosmos-19" satellite's projection paths.

It is clear from this figure that shaded (hatched) parts of satellite projection paths coincide with contamination zones, or in other words, simultaneous bursts of wave intensity and electron flux density, accompanied by intensive fluctuations, were observed above the zones, where radio nuclides were monitored.

The regions, where simultaneous fluctuations of ionosperic plasma parameters were recorded, and regions characterized by elevated concentration of radioactive elements, coincided [Larkina V.I., Ruzhin Yu.Ya. et al., 2004]. This work was carried out for a series of satellite travels in March and June 1979. The results achieved were the same. It confirms the conclusion that radioactive contaminations can really be detected (found) on the basis of expert assessment of satellite measurements of VLF noises and other parameters of ionospheric plasma, which are in its turn are indicative of the Earth's crust structure.

3.4 Comparison of measurement results obtained at two simultaneously travelled satellites

Simultaneously with "Intercosmos-19" satellite there was a Japanese satellite ISS-b [Summary Plot… 1983], which recorded flows of hydrogen, helium an oxygen ions. Based on published data, we plotted the grid maps showing the distribution of light ions above the region of our interest.

On the grid map of hydrogen ion distribution, we plotted the "Intercosmos-19 satellite paths (circuits 234 and 1537). Thickening of satellite path lines indicates the region of simultaneous variations of ionospheric plasma parameters with small-scale changes. Having analyzed simultaneous fluctuations of parameters on the basis of satellite data received from simultaneously travelled satellites, we have found out that the highest intensity of light ions, particularly of hydrogen and helium (data provided by ISS-b satellite), coincided with the region, where intensive fluctuations were recorded (data provided by "Intercosmos-19 satellite). These effects were observed above zones of elevated radionuclide content in Barents and Kara Seas [Larkina V.I., Ruzhin Yu.Ya., et al.]. The same thing was observed above western coastline of Scandinavia too.

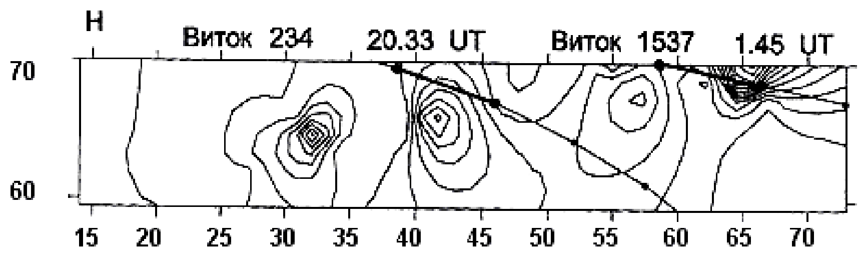

Figure 10 . Distribution of hydrogen ion intensity according to ISS-b data and "Intercosmos-19" satellite (circuits 234 and 1537).

The given example is evidence confirming that radioactive contaminations can be detected by satellite surveys of the Earth's crust structure, whereas light ions can be an indicator of radioactive contamination. Based on discovered observational relationships of ionosheric plasma parameters measured by satellites, we have elaborated a method for detecting radioactive contamination zones [Patent №22907597, 2003].

4. Discussion

As you know, atomic oxygen, hydrogen, helium, etc. among others are the components of ionosheric plasma. Surveys by means of Satellites S 3-3 and DE-1 showed that flows of energy ions O^+ with non-Maxwellian distribution by velocities ("conici" type) are observed at high latitudes along line of force (altitude 400 km and higher). The paper [Sharp et al.,1973] made a presumption saying that such a mechanism accelerates ionospheric ions perpendicular to the magnetic field. A similar crosswise heating of ions (particularly 0^+) can provide for a new mechanism suggested in [Winglee et al., 1987]. Ion heating produces current-induced Shear Alfven Waves (SAW). Existence of electromagnetic component (probably, SAW) in the region of ion conic source was proved in [Gurnett et al., 1984]. The authors demonstrated that a significant part of energy is transferred by electromagnetic waves SAW. SAW waves can provide a crosswise heating of ions at the current lower than electrostatic waves – cyclotron waves. As a result, it gives rise to sufficiently intensive oscillations, the frequency of which is close to cyclotron frequencies of hydrogen and oxygen ions (ω_{BH+} and ω_{BO+}). In our case (satellite orbit 234, please refer to Fig.8) the value of measured geomagnetic field amounted to B_0=0.486 γ. Then

$\omega_{BO+}=eB_0/m_{0+}c$; $f_{BO+}=\omega_{BO+}/2\pi$; f_{BO+}=~60 Hz

If presumed that such waves can be excited and propagated of higher harmonics as well (3 ω_{BH+} and $3\omega_{BO+}$). Then emission intensity growth at the frequencies 140 and 800 Hz can give evidence of excitation of electromagnetic waves at satellite altitudes [Larkina and Strunnikova, 1988].

5. Conclusion

Thus, it is established that stability simultaneously occurred variations of low-frequency emissions, flows of low-energy electrons with energy Ee=50 eV and Ee=150 eV and temperature of ionospheric plasma are observed above radioactive contaminated zones detected (recorded) in Kola Bay, Barents, Kara, North and Greenland Seas.

Zones, where simultaneous fluctuations of ionospheric plasma parameters are recorded at the satellite altitudes, coincide with well-known regions, where higher concentrations of radio nuclides are registered. Thus, one can consider it proved that any elevation of radioactive element concentration is prognostic of technological environmental impact of radioactive elements. We have proposed a method of detecting radioactive pollutions in the atmospheric boundary layer, water surface layer and seabed layers of hydrosphere according to data of satellite monitoring of ionosphere plasma parameters.

We are also familiar with data confirming the increase of concentration of heavy elements along some active long-living deep-seated faults. In addition to that, deep heat and deep gases, such as helium, hydrogen, radon and methane, can enter the atmosphere through these zones of faults. And thereby, if recorded, they can be a sign of radioactive contamination.

Based on all above-mentioned, we are suggesting a method of diagnostics of radioactive contaminations in the atmospheric boundary layer, water surface layer and seabed layers of hydrosphere using the results of satellite monitoring of ionosphere plasma parameters: intensity of low-frequency noise radiations, low-energy electron flux density and ionospheric plasma temperature [Patent №229075972, 2003].

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