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HAZARDOUS ULF ELECTROMAGNETIC ENVIRONMENT OF MOSCOW CITY

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Abstract

For the first time magnetic measurements of the industrial noises in the ultra low frequency (ULF) range (0.1-10 Hz) have been conducted at several locations in the center of Moscow, its suburbs and near countryside. The natural electromagnetic background at these frequencies includes geomagnetic oscillations of Pc1 type (f~0.5-2 Hz) and the first mode (~8 Hz) of Schuman resonance of the Earth-ionosphere cavity. The ULF range is the most important from biological point of view because its lower part coincides with the principal frequency of human heartthrob (f~0.5-1.0 Hz), and its higher part corresponds to the brain α-rhythm. There are many papers which report on significant effects of strong (H>1.5 nT) magnetic field oscillations at these frequencies in peculiar reactions of living organisms and the man. It is found that in the center of Moscow the level of technological magnetic fields at frequencies ~0.5 Hz reaches 250-300 nT. That is three orders of magnitude higher than Pc1 geomagnetic pulsation maximum amplitude. The magnetic noise at 8 Hz in the center of Moscow is about 1 nT, which exceeds the natural oscillations at this frequency by ~ two orders of magnitude. The magnetic noises in Moscow suburbs as well as in the industrial parts of Podolsk town are 10 to 15 times weaker. A very high intensity of technogenic ULF magnetic fields in the megalopolis arouses concern about their possible hazardous effects on health of inhabitants and stimulates deployment of extensive research programs in this area.

Introduction

An important role of the natural and man-made electromagnetic field variations in biological life of our planet is well established [e.g. Presman, 1968; Sidyakin et al., 1980; Plekhanov, 1990; Temuryanz et al., 1992, and many others]. Since 1960s the flow of information on the influence of natural magnetic fields on biological objects has been continuously expanding. It seems not occasionally that the frequencies of most vitally important rhythms of cardiac and nervous systems of the man are coincident with certain discrete frequencies in the geomagnetic field fluctuations. For instance, the natural electromagnetic field background includes geomagnetic pulsation of Pc1 type (f~0.5-2 Hz) and the first mode (~8 Hz) of Schuman resonance of the Earth-ionosphere cavity. The lower part of this frequency range coincides with the principal frequency of the human heartthrob (f~0.5-1.0 Hz) and its higher part corresponds to the brain α-rhythm. Among numerous types of oscillatory regimes observed in the geomagnetic field, the waves in these frequency ranges are of primary importance as permanent synchronizers of biological processes. Living organisms are known to be adapted to the "ordinary" level of these waves intensity, while its strengthening can affect the stress-reaction.

The industrial and technological activity of the modern society is so intense, and influence of its results on the environment is so strong that examination of solar and geomagnetic activity impact as compared to the background factors related to the industrial activity is a serious problem [e.g., Shapiro, 1988]. The aim of this paper is to study the technological ultra low frequency (ULF, 0.1-10 Hz) magnetic fields in different regions of Moscow, its suburbs and nearby country. The frequency range of interest includes natural geomagnetic oscillations of Pc1 type (f~0.5-2 Hz) and the first mode (~8 Hz) of Schuman resonance.

Observations

Complex instrumentation including a highly sensible ULF receiver of inductive type, amplifier, digital converter and personal computer has been used for the measurements. The observations were being performed in the daytime. Since only one instrumentation set was available, we were able to measure only one component of the magnetic field, which was typically either the North-South (X) or East-West (Y) one.

In this paper we present the first observations conducted in two central sites of Moscow (near Theatralnaya square and the Park Kultury metro station) as well as in the southern-western Moscow suburbs (near the Kaluzhskaya metro station). The control measurements were performed in a small village of Podolsk region, about 70 km south of the Moscow center.

Fig.1 demonstrates average amplitude spectra of technogenic ULF magnetic noise at the above locations. These spectra display very high signal intensity in the lower part of the frequency range and its decrease with the frequency growth. There were no distinguished frequencies in the observed ULF noise. At the center of the capital

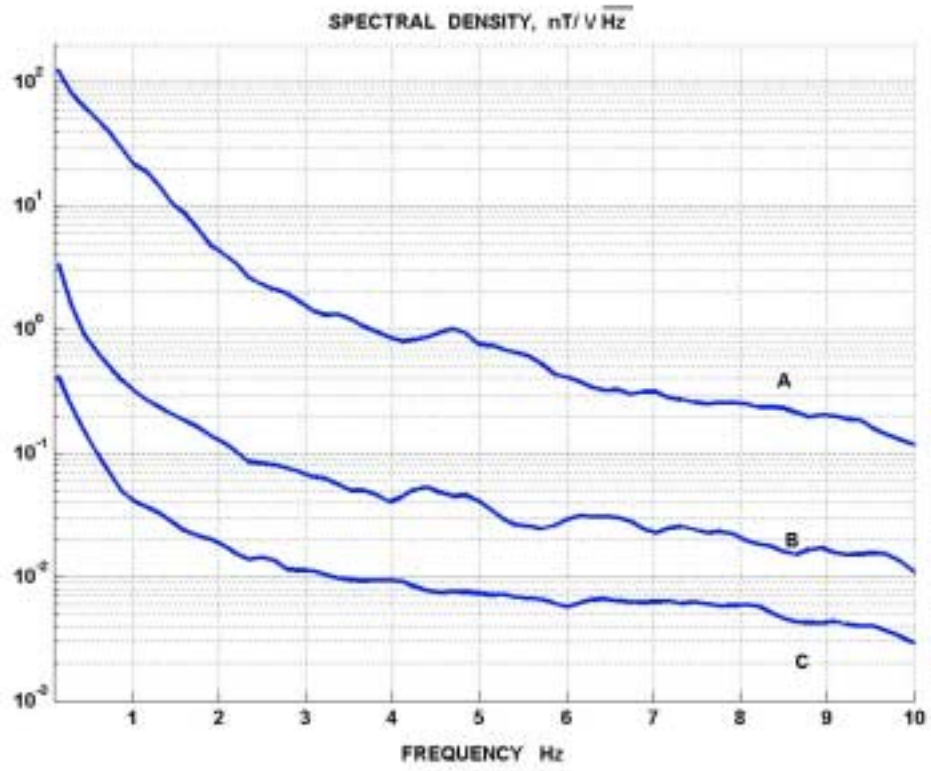

Fig.1 Averaged amplitude spectra of technogenic ULF magnetic noise in the Moscow center (A), Moscow suburbs (b) and in the country (c).

the spectral density at 0.5-1.0 Hz was about two orders of magnitude larger than in the suburbs and about three orders as high as that measured in the country.

Fig.2 shows examples of the magnetic measurements in two frequency bands of 1 Hz width around the central frequencies of 1 and 8 Hz corresponding to the center of Moscow (a), Moscow suburbs (b) and countryside (c). A typical feature of the amplitude-time ULF variations is an irregular sequence of group and separate pulses with the amplitudes in excess of 100 nT, the magnitude of the separate pulse reaching 200 nT.

Fig.2a shows strong ULF oscillations observed near the Park Kultury metro station. The ULF wave intensity in the east-west direction appeared to be stronger than that in the north-south direction. Such an anisotropy was observed rather frequently, which might be connected with the electric power line distribution in the region of observations.

In the suburbs (Fig.2b), and especially in the countryside (Fig.2c), the number and amplitude of the pulses are significantly lower.

Discussion

Due to the absence of strong sources of technogenic ULF magnetic fields far from industrial centers, the ULF spectra observed in the country site are supposed to represent the level of natural electromagnetic variations at the middle geomagnetic latitudes. According to [Troitskaya, 1964; Jacobs, 1970], the maximum amplitudes of Pc1 geomagnetic pulsation commonly observed in the daytime is about few tenths of nT. The maximum intensity of natural emissions at 7-9 Hz (first Schuman resonance mode) is also observed in the daytime and is equal to several hundredths of nT [e.g., Vladimirov and Kleimenova, 1962; Bliokh et al., 1977]. This means that the level of ULF fields at the frequencies of 0.5-1.0 Hz in the center of Moscow is nearly 1000 times as large as the natural electromagnetic ULF waves amplitudes. Many authors [e.g. Kholodov, 1975; Sidyakin et al., 1980; Halberg 1989; Plekhanov, 1990; Temuryanz et al., 1992; Vladimirsky et al., 1995; Breus et al., 2002] argue that the high level of the man-made ULF radiation may affect living organisms and cause specific reactions. The magnetic field oscillations at 0.5-10 Hz become biologically important if their magnitude exceeds 1.5 nT [Sidyakin et al., 1980; Plekhanov, 1990; Vladimirsky et al., 1995].

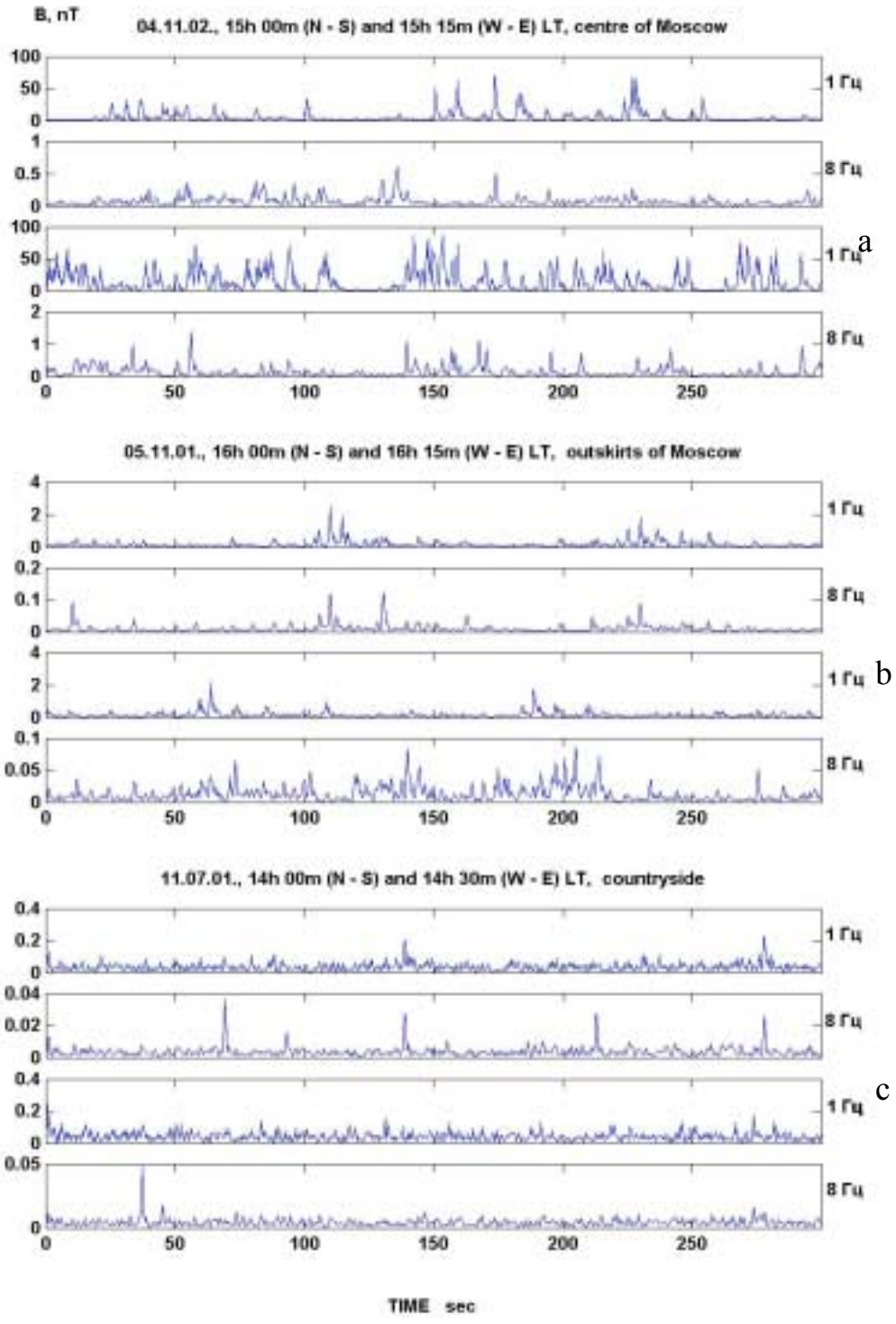

Fig. 2 Magnetic measurements in the frequency bands of 1 Hz width around the central frequencies of 1 and 8 Hz related to the center of Moscow (a), Moscow suburbs (b) and nearby countryside (c).

Conclusion

The performed measurements have demonstrated an extremely high level of the man-made electromagnetic ULF noises in Moscow. The magnitudes of these noises are 2 to 3 orders as large as the values of natural geomagnetic signals. Such a high level of industrial ULF magnetic fields could be hazardous for the health of inhabitants.

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