Results of magnetic measurements of ELF fields in Tomsk for the period 2013-2014

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ABSTRACT

The paper describes a method of magnetic measurements of natural electromagnetic fields ELF range. The results of the analysis of the frequency characteristics of fashion Schumann resonances in a suburban area in the seasonally-daily cycle of observations.

Keywords: Electromagnetic background, Schumann resonance, magnetic measurements, monitoring.

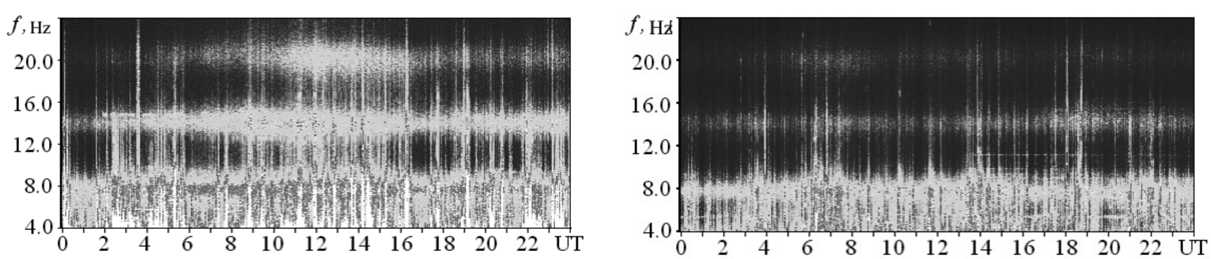
1. INTRODUCTION

Monitoring studies Schumann resonances (SR) [1-5] require a stable and regular registration of natural electromagnetic (EM) fields ELF range (frequency below 30 Hz). In 2013, in the suburban area was created measuring point at the site near the village Kolarovo (56.34 NL, 84.95 EL) at a distance of 17 km from the Tomsk. Measurements of the magnetic induction EM field tested using three-induction magnetometer LEMI-30 [6]. Data recorded in the world of UT through a global positioning system GPS (local time – LT = UT + 7 hours). Today the length of observations exceeding two years. The aim is to analyze the frequency characteristics of SR in seasonally-daily cycle of observations.

2. EXPERIMENTAL

During the measurements by LEMI-30 is registered temporary variation of the three orthogonal components of the magnetic induction EM field: B_x, B_y and B_z. Next, for each component of the field in the time window of 10 s (spectral resolution 0.1 Hz) by discrete Fourier transform amplitude spectra calculated $B_x(f)$, $B_y(f)$ and $B_z(f)$. It then computes the modulus of the horizontal component of the magnetic induction B_{xy}, which is used to calculate the resonant frequencies and amplitudes SR. Details spectral processing algorithm is presented in [5].

As an example, spectral processing algorithm in Figure 1 shows typical daily spectrogram EM fields in different seasons of the year. The spectrograms are changing in time-averaged spectra of ELF noise in the range of 4 to 24 Hz of the band spectrum for every 3 minutes (during the day - 480 spectra). Light color spectrogram corresponds to a high level signal, the dark - low. At present the first three spectrograms fashion Schumann resonances in a distinct bright horizontal bands (f_1, ~7.8 Hz; f_2, ~14,1 Hz; f_3 ~20,2 Hz). Levels mode SR average is different for different times of day and season of the year (fig. 1). Analysis of these laws in Tomsk for 2013 is presented in [5]. In the same study established regression relationship between the amplitudes of SR mode, which has a simple power law.



a) 05/15/2014

b) 12/31/2014

Figure 1 –Spectrograms modulus of the magnetic induction in the band from 4 to 24 Hz.

The resonant frequency is also not constant in time, but in contrast to amplitude variations in the nature of their more complicated [4].

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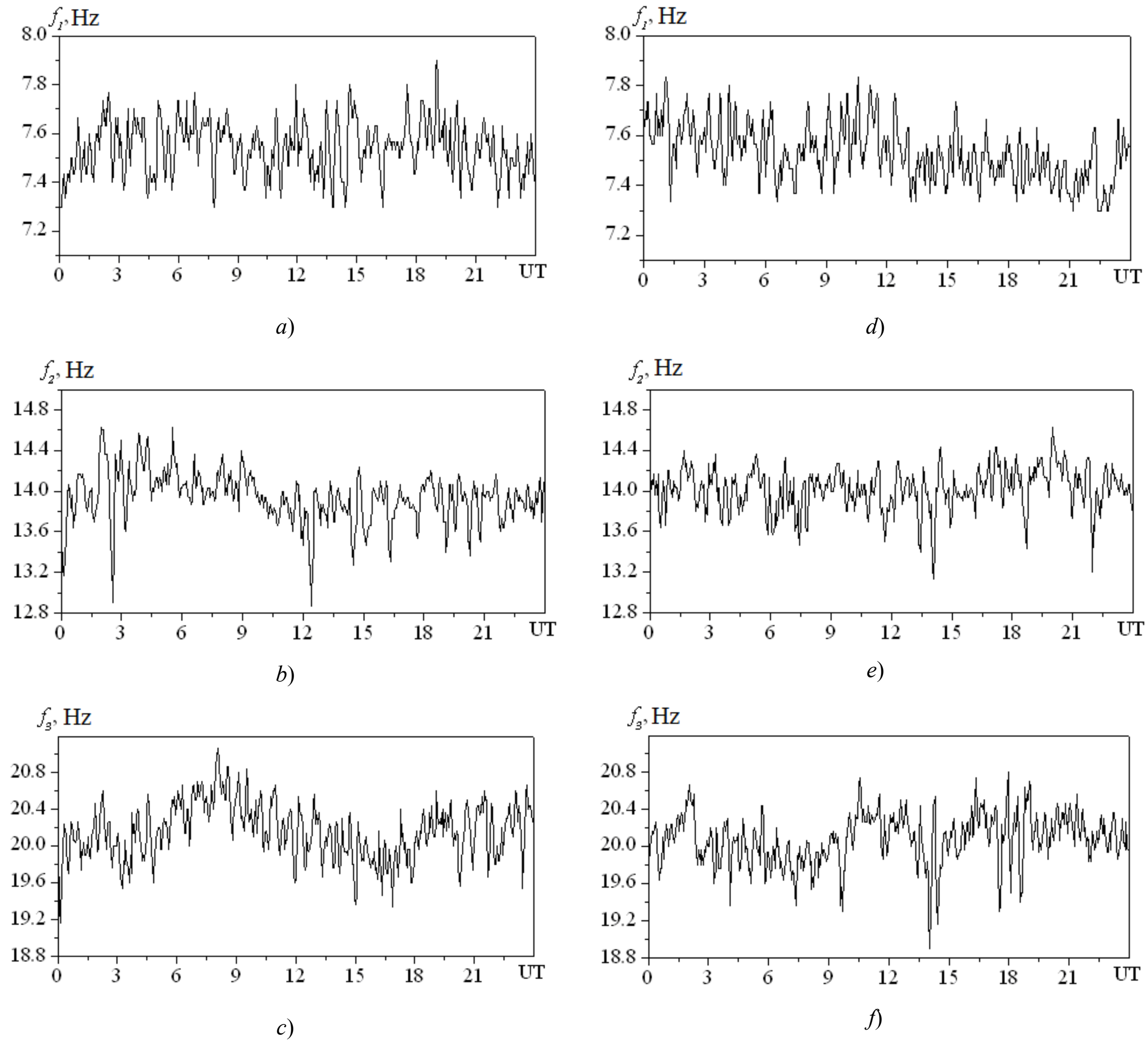
Figure 2 shows the results of the algorithm for the two experimental days (figure 1). For all three modes can be traced its own diurnal variation, typical for each season of the year.



05/15/2014 (*a - c*), 12/31/2014 (*d - f*)

Figure 2. Dependence of resonance frequencies (f_1, f_2, f_3) of the world time UT.

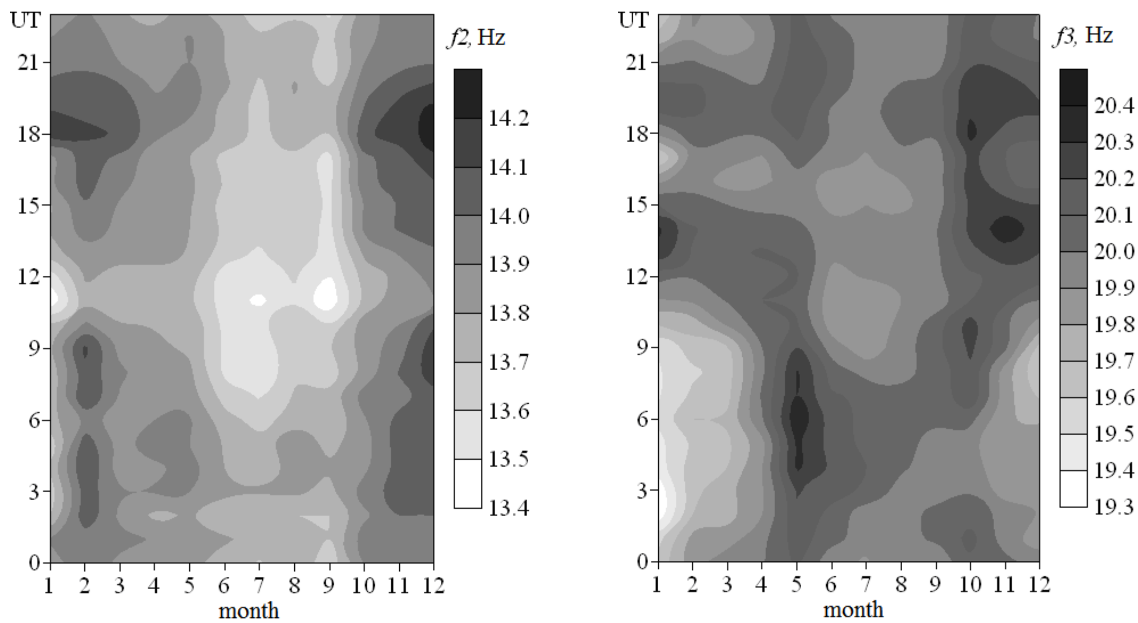
3. RESULTS

Data processing for the entire observation period (from 2013 to 2014) showed that the average of the first three events of the resonance frequencies close to those obtained by other authors [2-4].

By experimentally obtained data was further analyzed seasonally-daily variations of the resonance frequencies. They were built seasonally-daily distribution of average values of the three resonance frequencies SR. For example, the allocation for the second and third resonance frequencies, depending on the time of day and season of 2014 are shown in Figure 3 (*a, b*). Amplitudes over the same period are shown in Figure 4 (*a, b*).

Consider the basic laws. For the first resonance mode minimum values observed in ~6 UT in the winter months and ~7 UT in the summer months. Minimum falls on the spring equinox in ~20 UT.

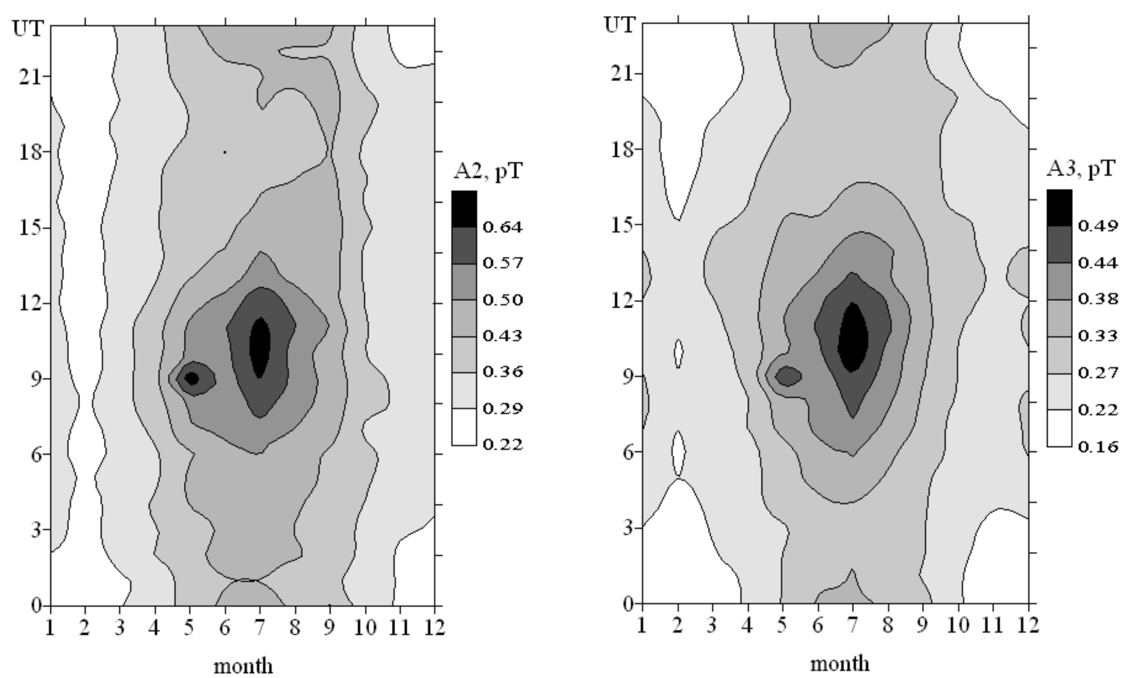
The seasonal cycle of observations of deviation from the average value does not exceed ~±0.4 Hz.



a) *b*)

Figure 3. The distribution of the resonance frequencies f_2 (*a*) and f_3 (*b*), depending on the season and the world time UT.

Especially the second resonant mode is a relative increase in the number of minima and maxima in comparison with the first mode. The minimum values are observed in the summer months in ~12 UT. The maximum values are observed in winter ~9 UT and 18 UT. The seasonal cycle of observations of deviation from the average value does not exceed ~0.6 Hz. For the third resonance mode the maximum deviation from the average value does not exceed ~1.0 Hz. Thus, the range of variation of the resonance frequency increases with the number of the mode of the Schumann resonances.



a) *b*)

Figure 4. The distribution of the amplitudes SR A_2 (*a*) and A_3 (*b*), depending on the season and the world time UT.

The amplitudes of the three modes SR changed almost simultaneously, with the amplitudes decrease with increasing numbers of mode. On average, each month has a maximum value of the amplitude of the first mode, the minimum - the third. The amplitude of each mode is maximum in the summer months, the lows seen in February (Figure 4).

The highest values were observed in ~ 09 UT 13 May 2014 during a severe thunderstorm near the observation point.

With the growth of the average values of the amplitudes of the increased spread of values. The standard deviation of the amplitudes for the entire period for the first mode does not exceed ~ 0.45 pT ~ 0.31 pT for the second and third mode - ~ 0.22 pT.

Regular background noise, comprising modes of Schumann resonances is thunderstorm nature - SR excitation sources are World centers of thunderstorm activity, located in the equatorial regions of the Earth (Africa, South and Central America, Asia, and Indonesia) [3-5].

Based on the data, the greatest influence on the amplitude of the first three modes of SR in the Siberian region of the World has a storm center in Southeast Asia (~ 11 UT). At ~ 00 UT noted the influence of the American thunderstorm center. Influence of the African Centre of thunderstorm activity was relatively low.

4. CONCLUSION

The analysis of the data for 2013 and the newly obtained experimental data studied quasi-periodic variations in resonance frequencies and mode amplitudes SR depending on the time of day and season of the year.

It is shown that the variation of the resonance frequencies SR is not synchronous. For each of the resonance frequency observed your own seasonal daily variation. And with the increase in the number of rooms fashion extremes (highs and lows) in seasonally- daily distributions of resonance frequency increases.

In contrast, the amplitudes of all three modes SR average change almost simultaneously (maximum and minimum values in the diurnal amplitudes coincide in time). Elevated values of the amplitudes correspond to a season-high storm activity (May-September) at middle latitudes.

In conclusion we note that for each type of resonant frequency distributions constructed has a very similar view for two consecutive years (2013 and 2014). The extent of variations of resonant frequencies in the seasonally-day cycle increases with the number of the mode of the Schumann resonances.

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