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Schumann Resonance Observation in Polish Polar Station at Spitsbergen and Central Geophysical Observatory in Belsk

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Abstract

Two sets of Schumann resonance apparatus, each consisting of an electric ball antenna and two induction magnetometers, have been constructed in Belsk Observatory in 2003 and 2004. The apparatus have been installed in the Polish Polar Station in Hornsund at Spitsbergen as well as in Belsk Observatory. The vertical electric (Ez) and the horizontal magnetic (Bx, By) components have been measured in Hornsund and Belsk since September 2004 and February 2005, respectively. The sampling rate amounts to 100 Hz. The parameters of the magnetic and electric sensors make it possible to register four Schumann resonance modes (8, 14, 20 and 26 Hz). The observation results are presented.

Schumann resonances (SR) are the electromagnetic eigenfrequencies of the Earth-ionosphere cavity (Fig. 1). They were first predicted and discussed by W.O. Schumann (1952). The excitation source of Schumann resonances is the world thunderstorm activity. Resonances can be observed at around 8 Hz, 14 Hz, 20 Hz, etc. The first measurements and spectral analysis which confirmed the existence of such resonances were performed by Balser *et al*. (1960).

The observation of Schumann resonances can provide valuable information about the world thunderstorm activity, the properties of the upper dissipative boundary layer of the Earth-ionosphere cavity, and climatic changes. A large number of research projects shows influences of the SR signal on human health (blood pressure, melatonin level, cardiac and neurological disease).

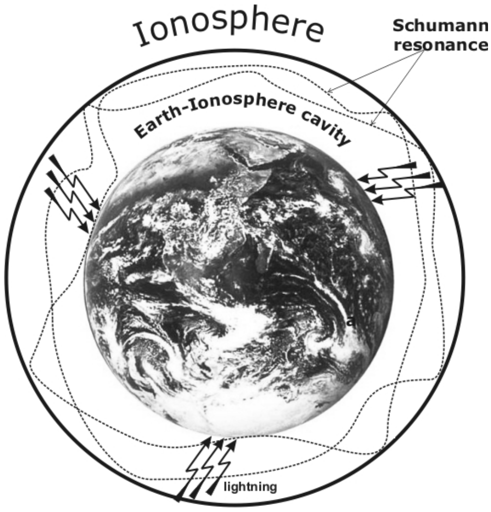

Fig. 1. Earth-ionosphere cavity.

In the Schumann resonance band we can find three major types of natural ELF radio noise (Ogawa *et al*. 1966): Extremely Low Frequencies (ELF) background, ELF flashes and ELF bursts. Figure 2 shows typical waveforms of these three Schumann resonance signals.

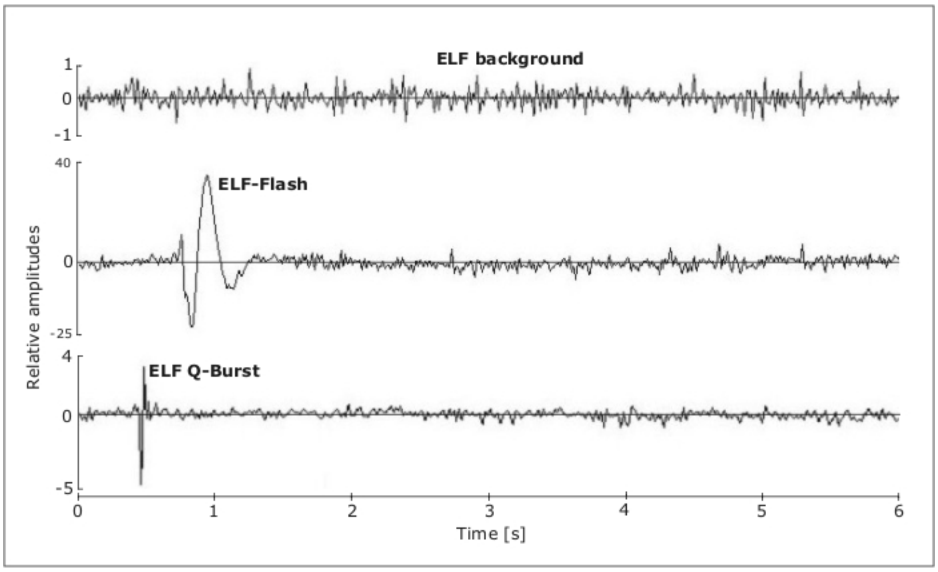

Fig. 2. Typical signal forms (Bx component measured in Belsk).

Two sets of Schumann resonance apparatus, with electric ball antennas (Fig. 3) and induction magnetometers (Fig. 4) were constructed in Belsk Observatory in 2003 and 2004. The SR apparatus were installed at the Polish Polar Station at Spitsbergen

(77.0°N, 15.5°E) and in Belsk Observatory (51.8°N, 20.8°E) in the frame of a Hungarian-Polish project. The project was supported by NATO Collaborative Linkage Grant (EST.CLG.980431). The locations of Polish Schumann resonance stations are shown in Fig. 5. The vertical electric (Ez) and the horizontal magnetic (Bx, By) components have been measured in Hornsund and Belsk since September 2004 and February 2005, respectively.

Fig. 3. Electric antenna.

Fig. 4. Induction coils.

A schematic diagram of the SR recording system is shown in Fig. 6. The magnetic sensors are buried half a meter deep in the subsurface. The electric ball antenna is put on a ceramics-made insulating pillar of two meter height. The preamplifiers are placed at the bottom of the electric antenna and inside of the induction coils. The preamplified SR signals are passed to the input of electronic console where they are filtered and afterwards amplified. The amplified signals are fed to the input of the 16-bit analogue-digital converter, then passed to the PC computer via parallel interface and saved on a hard drive.

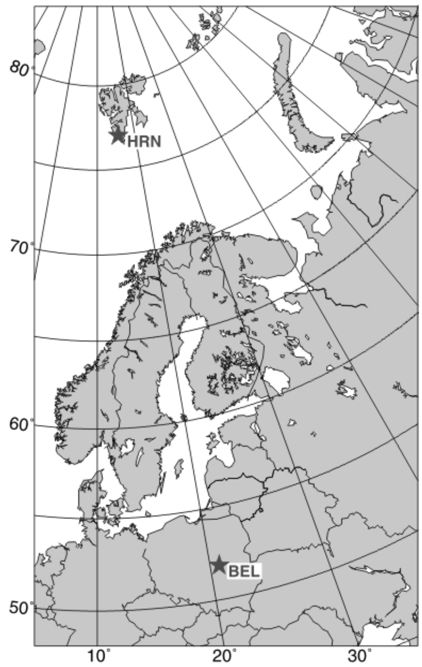

Fig. 5. Locations of Polish Schumann resonance stations: BEL – Belsk Observatory (Poland), HRN – Polish Polar Station in Hornsund (Spitsbergen, Norway).

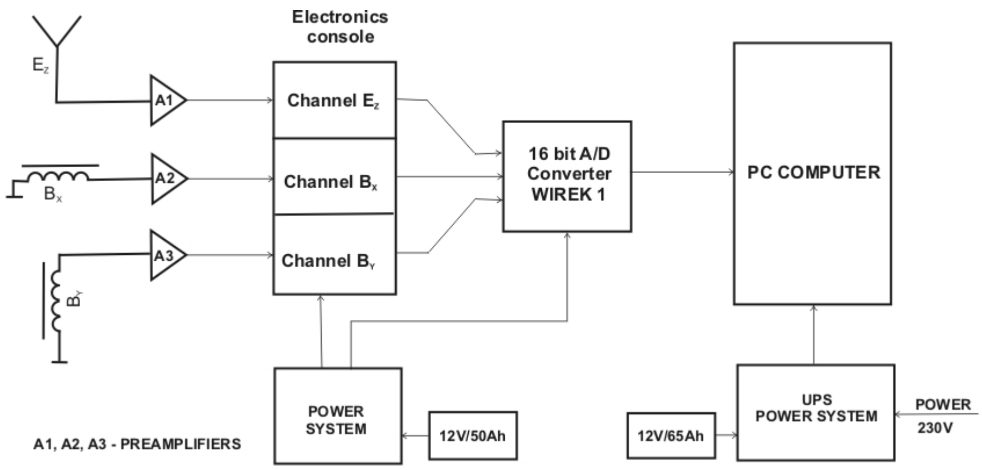

Fig. 6. Schematic diagram of the SR recording system at Spitsbergen and Belsk.

The sampling rate amounts to 100 Hz. The parameters of the magnetic and electric sensors make it possible to register four Schumann resonance modes (8, 14, 20 and 26 Hz). Examples of time series and power spectrum density (Bx, By and Ez components) recorded in the Schumann resonance frequency range in Belsk Observatory are shown in Figs. 7 and 8.

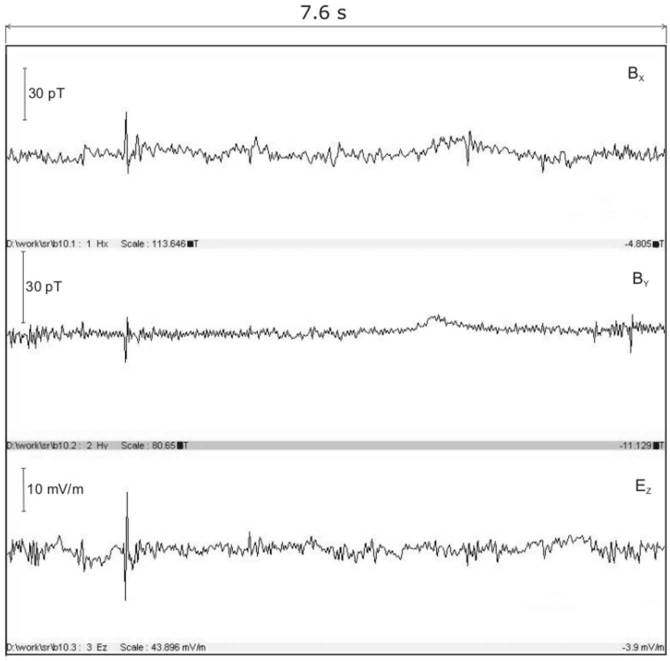

Fig. 7. Time series recorded in the Schumann resonance frequency range in Belsk Observatory (September 18, 2005).

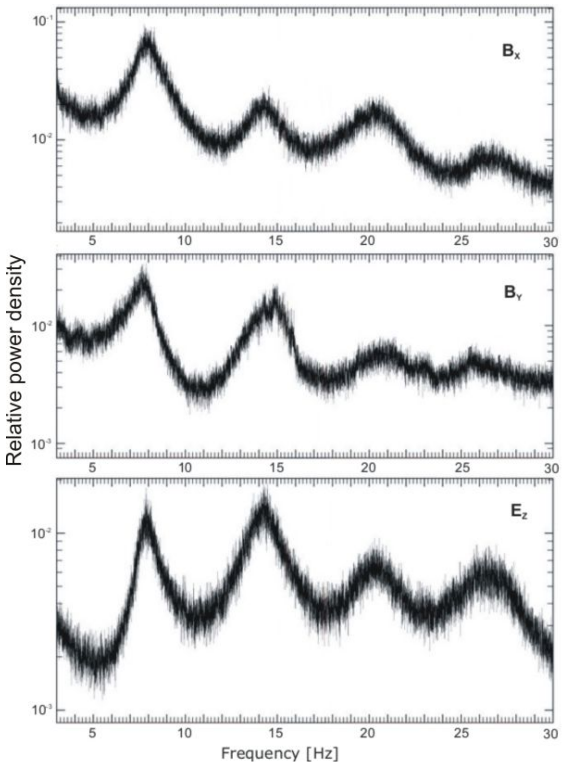

Fig. 8. Spectrum of Bx, By, and Ez components (Belsk, September 18, 2005) with four Schumann resonance modes.

Figure 9 presents the mean daily relative amplitude variations in October 2005. The amplitude maxima clearly show the activity of the large thunderstorm regions during the day. The complex demodulation by (Sátori *et al.* 1996) as a spectral technique has been used for determination of peak-frequencies and the corresponding amplitudes of the first three Schumann resonance modes.

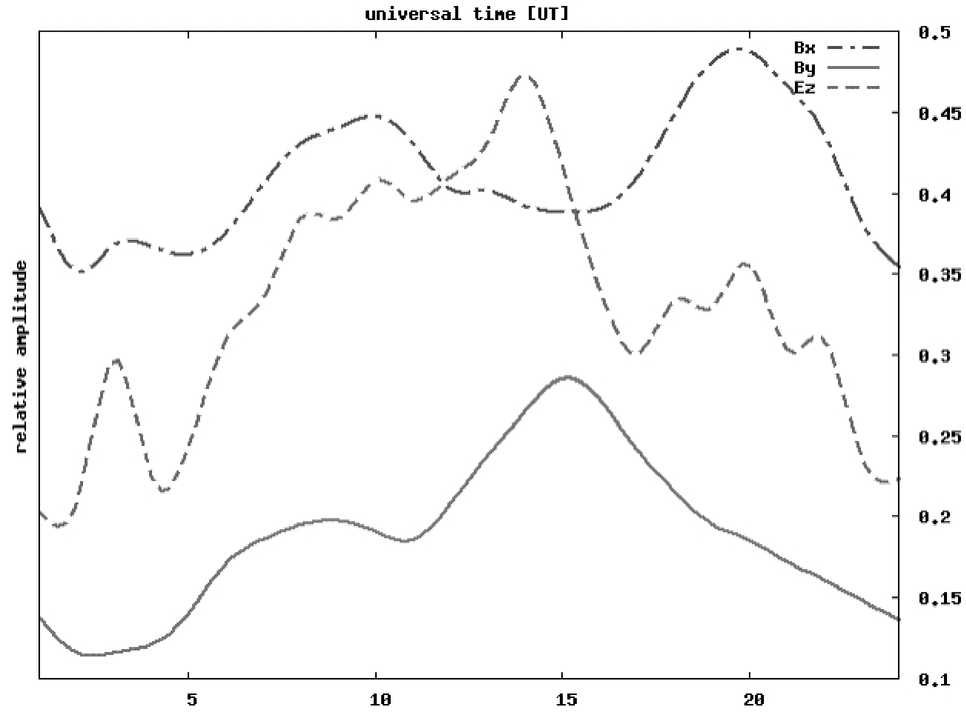

Fig. 9. Mean daily variations of relative amplitudes for the first Schumann resonance mode - Bx, By, and Ez components (Belsk, October 2005).

References

Balser, M., and C.A. Wagner, 1960, *Observation of Earth-ionosphere cavity resonances*, Nature **188**, 638-641.

Ogawa, T., Y. Tanaka, T. Miura and M. Yasuhara, 1966, *Observation of natural ELF electromagnetic noises by using the ball antennas*, J. Geomagn. Geoelectr. **18**, 443-454.

Sátori, G., J. Szendroi and J. Vero, 1996, *Monitoring Schumann resonances – I. Methodology*, J. Atmos. Terr. Phys. **58**, 1475-1482.

Schumann, W.O., 1952, *Über die strahlungslosen Eigenschwingungen einer leitenden Kugel, die von einer Luftschicht und einer Ionosphärenhülle umgeben ist*, Zeitschrift für Naturforschung **7a,** 149-154.

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