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STATISTICAL CHARACTERISTICS OF THE SPECTRAL RESONANCE STRUCTURES OF ELECTROMAGNETIC BACKGROUND NOISE IN THE FREQUENCY RANGE 0-4 HZ INFERRED FROM THE AURORAL ZONE MEASUREMENTS

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Introduction

Polyakov [1976] suggested existence of a resonator for Alfven waves in the ionosphere. This suggestion came from the fact that refractive index for these waves has a minimum in the ionospheric F region. This idea has been proved both theoretically and experimentally by *Belyaev et al.* [1987, 1989]. In particular, they observed resonance structure in spectra of electromagnetic noise within the ULF frequency range. Since that time the idea on ionospheric Alfven Resonator (IAR) was intensively discussed in literature. Experimental study of spectral resonance structure (SRS), characteristics of which must (according to the IAR theory) strongly depend on ionospheric conditions, was also done, but all findings about peculiarities of SRS were obtained at middle latitudes. As to high latitudes, where ionosphere in some respects differs from mid-latitudinal one, the SRS characteristics were practically not studied. Only recently *Belyaev et al.* [1998] reported the results of observations of the SRS during several days in Kilpisjarvi (L=6). This is why it is interesting to investigate the morphological features of the SRS in the auroral zone.

In this paper the morphological characteristics of the SRS observed in the auroral zone will be examined statistically. The characteristics have been considered on the basis of large set of data obtained from Sodankyla Geophysical Observatory (SGO) in 1995-1996.

Data

Sensitive search coil magnetometer in SGO provides the continuous digital registration with sampling rate of 0.05 seconds since 1995. To visualize the observational results the daily spectrograms (dynamic spectra) of magnetic variations in the range 0-4 Hz are routinely calculated and plotted. Spectral Resonance Structure in the noise background intensity is often clearly seen in the spectrograms. An example of spectrogram containing the SRS is presented in Fig.1. The resonance structure is seen from 16 until 21 UT. Such spectrograms were used for creation of the SRS database, entries of which were the existence or absence of the SRS within 3-hour intervals of UT and, if the SRS existed, the frequency interval between resonance maximums. This database was used for statistical study.

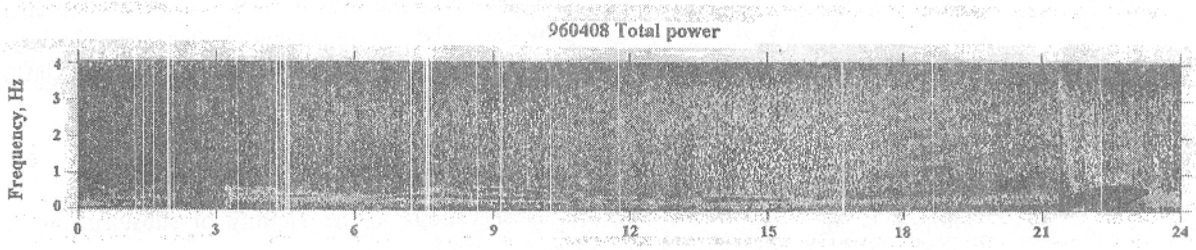

Fig. 1

Observational results

Fig. 2 shows the SRS occurrence probability as dependence on UT for different seasons. Local midnight in SGO marked on plots by arrow (~22 UT). It is clear seen that the occurrence is maximal in the wintertime and diminished in summer. Dependence of the probability of the SRS occurrence on MLT exhibits clear maximum at the evening hours and minimal in the morning. But there is also some dependence of the local time of the probability maximum and minimum on season.

Fig. 3 presents the frequency interval dependence on time and season. The frequency intervals are increased in winter and decreased in summer. For all seasons excluding winter the maximal frequency intervals are observed just at and after local midnight. In winter the maximal frequency interval is observed before midnight.

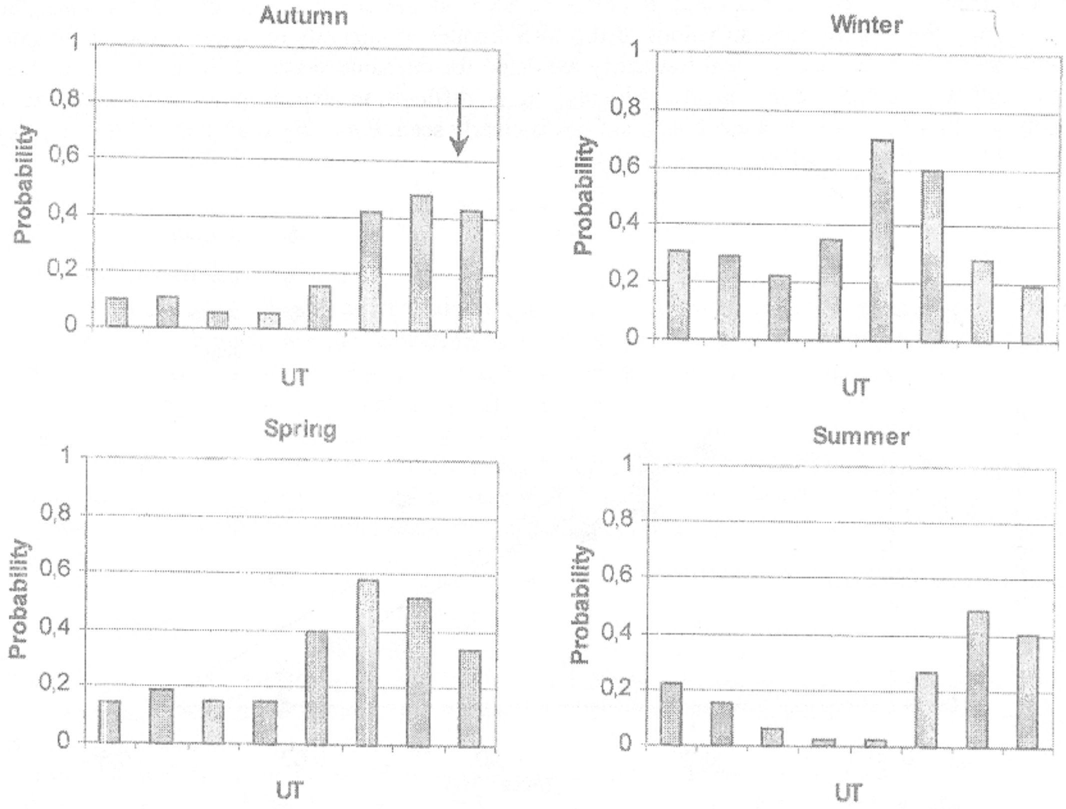

Fig.2 Dependence of probability of the SRS occurrence on UT for different seasons

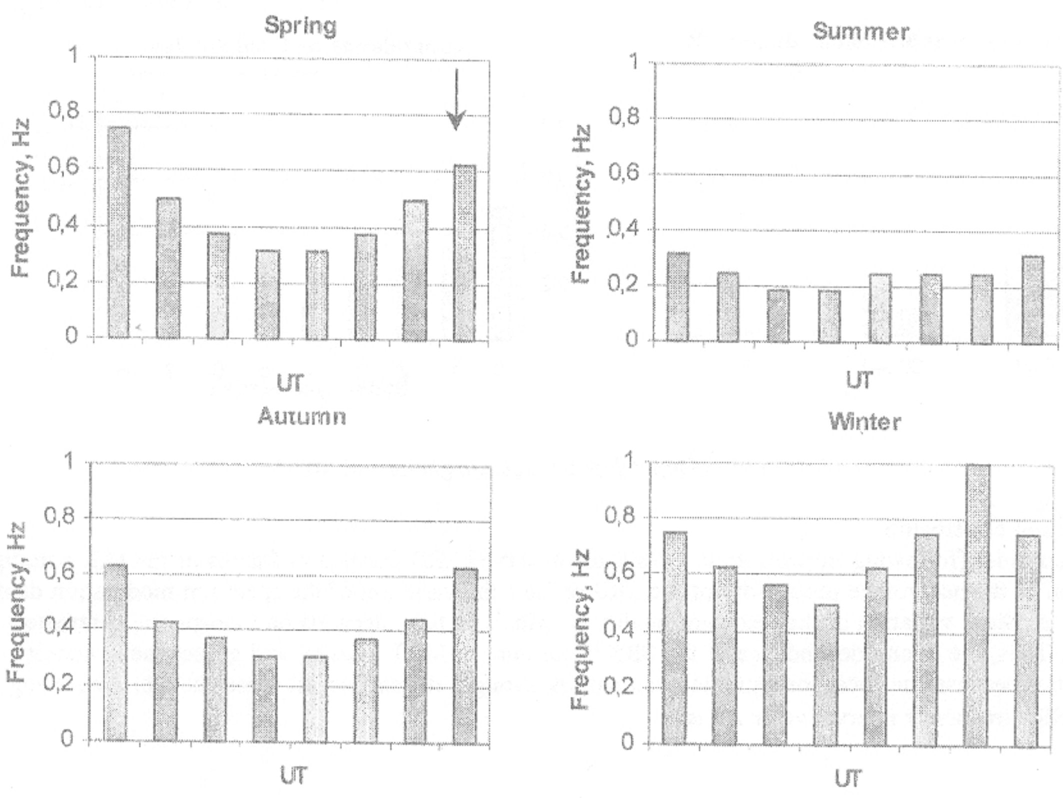

Fig. 3 Dependence of the SRS frequency interval (median values) on UT for different seasons

There is a dependence of the frequency intervals of SRS on the critical frequency of the ionospheric F-layer (Fig.4). To construct this Figure, median values of the SRS frequency intervals for a season were compared with the month median values of the F-layer critical frequency averaged for the same season. (The ionospheric data were taken from monthly bulletins published by SGO). Although it is difficult to expect good correlation from such raw comparison, the relationship between these two quantities is clearly seen. For every season the SRS frequency interval is larger the critical frequency is smaller.

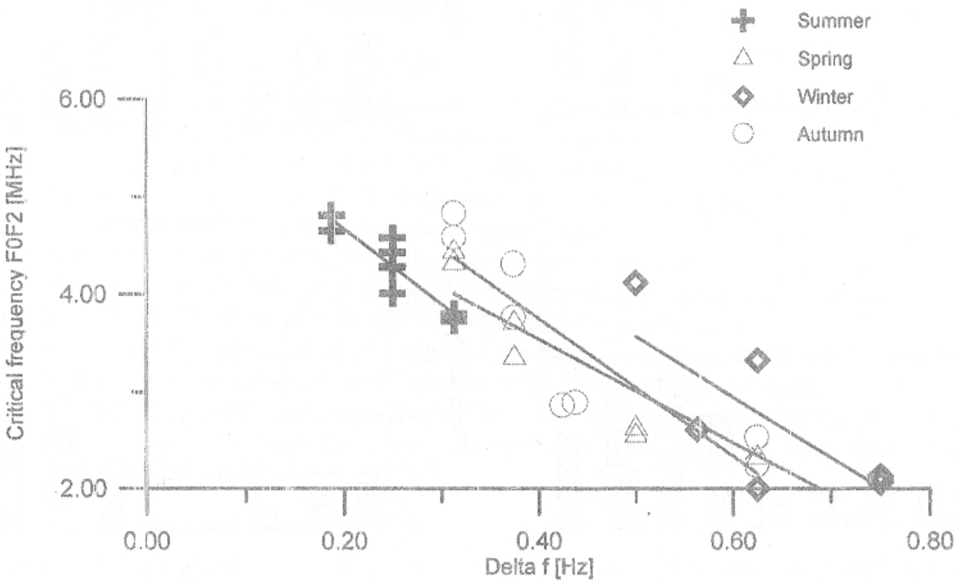

Fig. 4 Relationship between critical frequency of the ionospheric F - layer and the SRS frequency interval

In addition we have considered the dependence of the SRS occurrence on geomagnetic activity (Fig. 5). The occurrence dramatically decreases when activity (characterized by local K or global Kp indeces) grows.

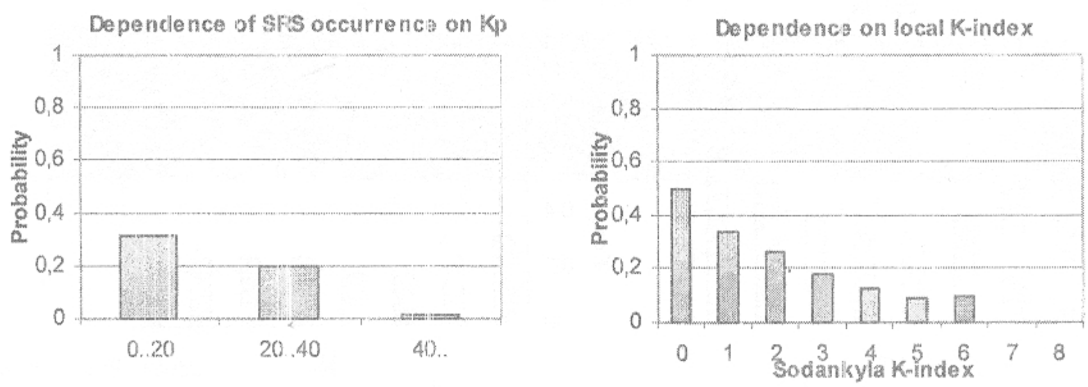

Fig. 5 Dependence on geomagnetic activity

Discussion and conclusions

Let's consider (following *Belyaev et al.* [1989] the observed SRS features in frames of the IAR paradigm. In fact, the variation of the occurrence probability of the SRS reflects the variation of the spectrum modulation depth. In terms of the IAR, it means variation of the resonator quality Q, which, in turn, depends on ionospheric parameters (*Belyaev et al.* [1990]). Thus, the strong dependence of the SRS occurrence at MLT, season, and geomagnetic activity (Fig.2, 5) is not surprising because the local ionospheric peculiarities strongly depend on all these factors. According to the IAR theory the SRS frequency interval value ΔF is:

$$\Delta F = \frac{c}{2 \cdot L \cdot n_a} \propto N_e^{-1/2},$$

where L –hight scale of the n_a decrease above the F-layer maximum; n_a – Alfven refractive index in the region of the F-layer maximum.

$$n_a = \frac{c\sqrt{4\pi\rho}}{H_0} \propto N_e^{1/2},$$

where H_0 - magnetic field, ρ - plasma density.

Thus, ΔF variations (Fig.3) also mean diurnal and seasonal variations of the ionospheric parameters. Dependence of ΔF on critical frequency agrees with the prediction of the theory of the Ionospheric Alfven Resonator. But, as it seen from Fig.4, for different seasons the same value of F0 corresponds to different ΔF. This means that there is the influence of other parameters. The main factor is, probably, the electron density scale height of the topside ionosphere.

If the SRS/IAR relationship is established, the SRS observations may be used for ground-based diagnostics of the upper ionosphere parameters. The result presented in Fig.4 confirms the SRS/IAR relationship. But this relationship needs more confirmation. The next step to prove the responsibility of IAR for the observed SRS will be investigation of relationship between above-described statistical SRS characteristics and statistical peculiarities of the auroral ionosphere.

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