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# SOME FEATURES OF MERIDIONAL DEPENDENCE OF ELECTRON FLUX PARAMETERS INSIDE AURORAL ARCS

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**Abstract.** Using the database of a tomographic experiment, carried out on February 10-11, 1999 in the Kola peninsula, there were obtained and investigated some specific features of the meridional behavior of aurora luminosity and those of electron flux parameters (mean energy, energy flux and particle flux) inside auroral arcs. It is shown, that across the arc the variation of the volume emission rate maximum 427.8 nm has a 'bell' shape. The study of the electron flux parameters' meridional behavior showed, that when one arc appeared , the mean energy, energy flux and particle flux had the shape of an inverted «V» over the aurora arc. When several arcs appeared, the structure of an inverted «V» is only observed in the mean energy of electrons, while the energy flux and particle flux display a continuous decrease for the northward formation.

## Experiment

In February-March 1999, an experiment on optical tomography of ionosphere was carried out using three four-channel scanning photometers along the meridional chain at the three spaced receiving points: town of Apatity ($67^0$34', $33^0$24') – village of Verkhnetulomski ($68^0$35', $31^0$ 45') – village of Korzunovo ($69^0$24', $30^0$59'). The total length of the receiving chain was 226 km (see Fig. 1). The orientation of the chain was close to the direction of the geomagnetic meridian, which is shown in Fig. 1 by a continuous line. The photometers were adjusted to register the luminosity in the 320.0 nm, 427.8 nm, 557.7 nm and 630.0 nm emissions.

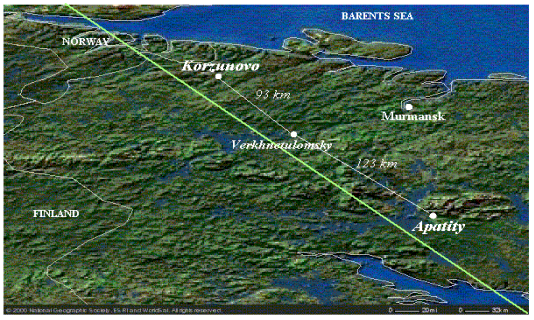


Fig. 1

## Meridional structure of luminosity and corresponding electron flux parameters

For research purposes we chose the period from 23:00 to 01:00 UT of February 10-11, 1999. During this time period, there was observed appearances of a relatively stable system of two arcs, positioned close to each other. Fig.2 provides examples of tomographic reconstructions of the volume emission rate of 427.8 nm for some time moments: 23:17, 23:19, 23:21, 00:01, 00:15. In the figure, the zero of horizontal distance corresponds to Apatity, 133 km to Verkhnetulomski, 226 km to Korzunovo. A distinction of the reconstructed luminosity distributions is the stretched nature of luminous formations along the geomagnetic field line (represented by continuous lines). However, the most prominent feature of the obtained two-dimensional distributions is the south to north directed tendency of the decrease of localization of both the lower border and the intensity maximum height inside auroral form (or forms). This fact is, first of all, an evidence of systematic increase of the hardness of the precipitated electron flux. A quantitative illustration of the given tendency is presented in Fig.3a, which shows the change of the 427.8 nm intensity maximum altitude ($H_{max}$) along the geomagnetic meridian in the direction from south to north. One can see from the figure, the altitude variation may reach the values of 4 to 8 km when the distance change was 140 km.

To estimate the parameters of energy spectrum of auroral electrons, which formed the obtained luminosity distribition, we are using the method, which was described in paper /1/. Fig. 3b shows the variation of the mean energy value of electron flux along the meridian, corresponding to time moments, performed in Fig. 3a. The events were grouped for the time intervals of 23.17-23.21 UT and 23.50-0015 UT. One can see from the figure the change of the mean energy value of precipitated electron flux lies within the range of 2.5-4.2 keV. We should note, that the energetic spectra were reduced taking into account the fact, that an electron beam was moving along magnetic field lines, rather than along the normal towards the Earth surface.

## Meridional dependencies of electron flux parameters inside auroral arcs

To investigate the small-scale structure of luminosity distribution in some types of auroras the profiles of volume emission rate were reduced from tomography reconstruction with the minimum possible distance step of 2,5 km. It corresponded to the size of grid tomography reconstructions. Fig. 4a (the top panel) presents the curves, which describe the behavior of 427.8 nm volume emission rate maximum ($I_{max}$) across the auroral arc at different moments

of auroral activity development. The same figure (the lower panel) presents the corresponding behavior of the luminosity maximum altitude (? ???). One can clearly see from the figure, the vatiation of the value of volume emission rate maximum demonstrates a good correlation with the luminosity maximum altitude change. The similar behavior of the given parameters across the arc is an evidence of the, first of all, corresponding nature of meridional distribution of the mean energy of an electron flux, which forms arcs (or bands), namely, inside the arc the electron beam hardness should be maximum near the center.

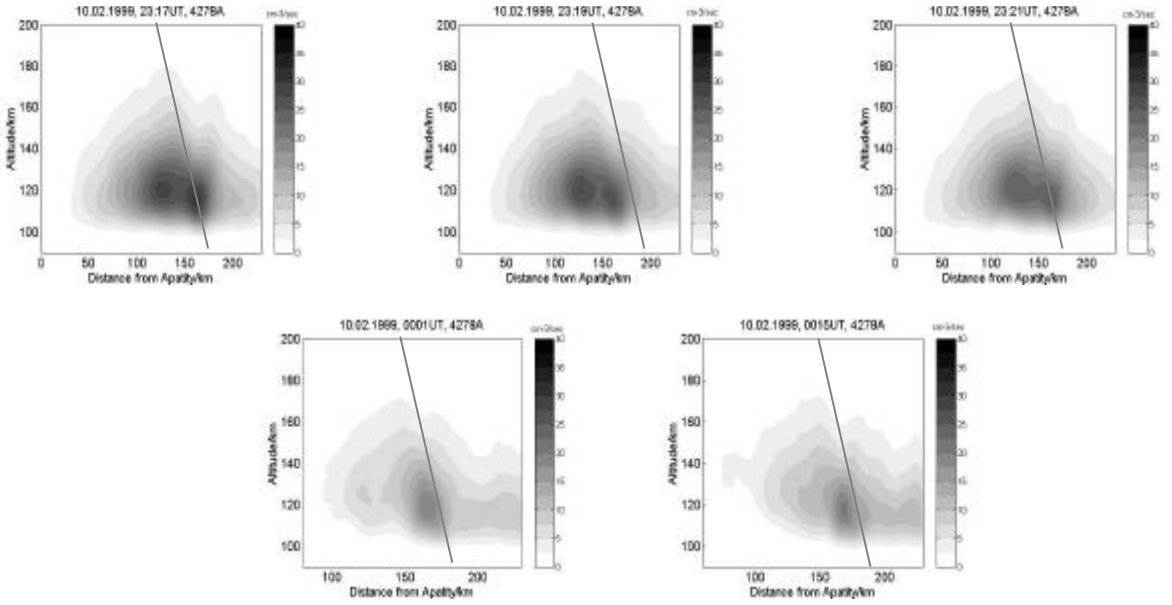


Fig 2. Tomographic reconstructions of the volume emission rate of 427.8 nm

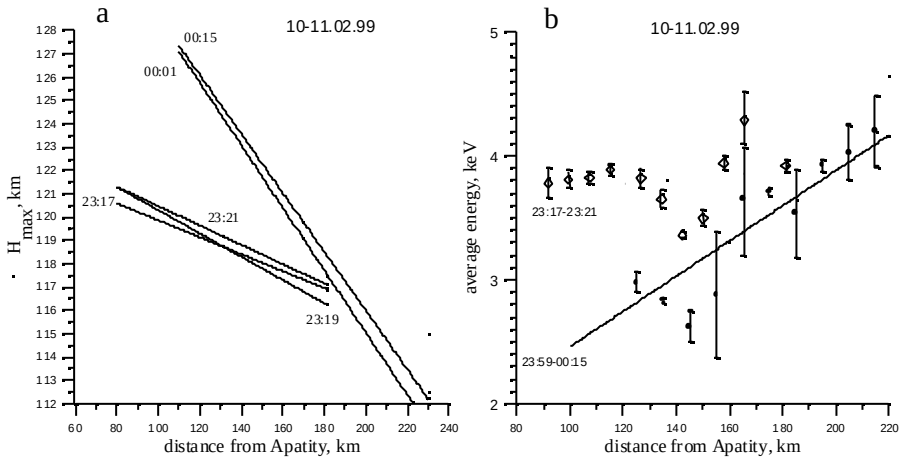


Fig 3 Distribution of intensity maximum altitude and average electron energy along meridian.

Fig. 4b shows the variations of electron flux parameters across the arcs (the value of electron mean energy, that of the energy flux and that of particle flux). Taking into consideration the fact, that electron beams move along the magnetic field lines, coordinate axes in fig. 3b were chosen as follows: axe X is directed perpendicular to the

magnetic field line, whereas axe Y is directed along the magnetic field line. One can see from the figure for all considered cases the structure of an inverted «V» can be taken in the changes of the mean energy value across the arc. However, the changes across the arc of the energy flux and particle flux at various time moments demonstrates a different nature. For the moments of 00:01 UT and 00:15 UT when there can be observed one arc, the variation

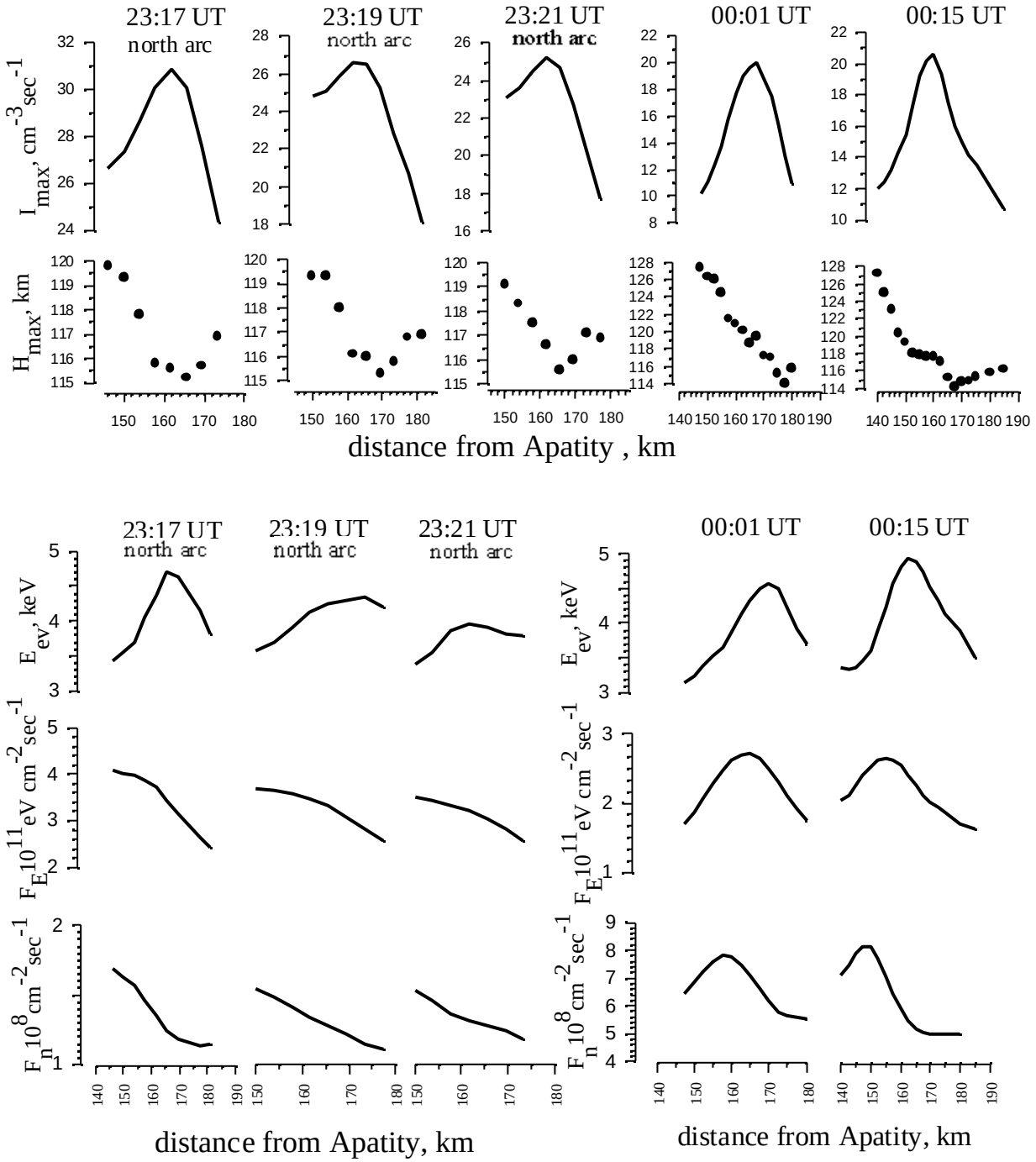


Fig 4. Distribution of intensity characteristics and electron flux characteristics inside auroral arcs

line of both energy flux and particle flux across the arc has a form, simulating an inverted «V». In 23:17, 23:19 and 23:21 UT during two arcs appearance, the structure of inverted «V» is only observed in variation of the mean energy of electrons, whereas the energy flux and particle flux decrease towards the north.

## Conclusions

It is shown, that using the method of optical tomography it is possible to investigate from the earth's surface the

dimensional structure of auroral luminosity and to reduce the precipitated electron flux parameters. The most prominent feature of the obtained two-dimensional luminosity distributions is the tendency to decrease both the luminosity maximum height inside the auroral form and the lower border of luminosity from south to north. For all observation moments of the steady stage of aurora the tendency to the increase of the electron mean energy can be traced from south to north along the meridian for the whole auroral form.

The results of the study of the meridional behavior of precipitated particle flux parameters show, that, when one arc appears, all parameters of precipitated electrons (the mean energy, the energy flux and particle flux) look like an inverted «V» inside the luminosity arc. If several arcs appear, the structure of an inverted «V» is only observed in the electron mean energy, whereas the energy flux and particle flux gradually decreases towards the north.

## References

1. Sergienko T.I., Ivanov V.E. Deducing the auroral electron spectra from EISCAT electron density measurements. // Proc. of the planning meeting for joint studies with ORSTED, the EISCAT incoherent scatter radars and other ground based instruments. -1996. – Report No 54. - P.145-148.