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Strong Electric Fields in the Middle Atmosphere: New Data from Ground-Based Measurements

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Background

Strong electric fields in the middle atmosphere could lead to considerable variations in the lower ionosphere parameters [1]. Therefore, these electric fields in the lower ionosphere should be taken into account while solving the problems encountered in ionospheric physics and radio-wave propagation. Thus, it will be of central importance to develop a reliable ground based monitoring method to measure the natural intense electric fields in the middle atmosphere.

Instrumentation

During 1978–1998 at Kharkiv State University, variations of the effective electron collision frequency in the ionospheric D region have been investigated under different solar and geophysical conditions by means of the partial reflection technique (operating frequency f=1.8–3.0 MHz, pulse length τ=25 μs, pulse repetition rate F=1 per second). The effective electron collision frequency values have been obtained in the altitude range of 60–66 km.

Data Reduction

A technique employing the experimental values of the effective electron collision frequency variations has been developed for estimating the variations in atmospheric electric fields at the lower boundary of the ionosphere. We have derived from these measurements that there are electric fields E>0.25 V/m in approximately 70% of the cases when partial reflection signals can be received from the altitudes mentioned above. The total number of measurement campaigns during which we have managed to obtain the data on strong electric fields at the lower edge of the ionosphere equals approximately to 200. The mean electric field magnitudes E as a function of altitude z are as follows: E(60 km) = 1.0±0.2 V/m, E(63 km)=0.5±0.1 V/m, E(66km)=0.3±0.1 V/m.

Discussion

The presence of significant electric fields at the lower edge of the ionosphere is an evidence that an additional source of electron heating should be taken into account while investigating a disturbed ionosphere and radio wave propagation in it. Besides, the results described above confirm the hypothesis that the anomalous changes in VLF signal phase observed on paths traversing regions of enhanced seismic activity a few days before earthquakes and in the vicinity of nuclear power stations during accidents with the escape of radioactive materials can be caused by changes of electric field in the earth-electrosphere capacitor [2, 3]. It should also be mentioned that the technique described permits a real-time derivation of changes in electric field intensities at the lower edge of the ionosphere from partial reflection measurements. Thus, strong electric fields in the middle atmosphere can be an essential component of the terrestrial electromagnetic environment.

References

[1] R. A. Goldberg, J. Atmos. Terr. Phys., vol. 46, no. 11, pp. 1083–1101, Nov. 1984.
[2] S. I. Martynenko *et al.*, J. Atmos. Electricity, vol. 16, no. 3, pp. 259-269, Oct. 1996.
[3] I. M. Fuks *et al.*, J. Atmos. Solar-Terr. Phys., vol. 59, no. 9, pp. 961–965, Sept. 1997.

Mid-Latitude Ionospheric Disturbances Induced by Modifications of High-Latitude Ionosphere by High-Power Radio Waves

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Background

The high power HF heater system stimulated ionospheric phenomena at Monchegorsk, Russia, at high latitudes from 22:00 UT to 02:00 UT each night during December 19, 1984, through December 22, 1984, interval. The Kharkiv State University partial reflection radar collected the data at middle latitudes during these modifications of the high-latitude ionosphere [1].

Instrumentation

The ionospheric heater operated at 3.3 MHz with the following parameters: maximum equivalent power 10 MW, vertically incident emissions, 3-min turn-on and 7-min turn-off intervals, 100% amplitude modulation depth, modulation period T=20 s. The diagnostics included the Kharkiv State University partial reflection radar operated at 2.0 MHz and emitted 25 μs pulses with a maximum equivalent power of ~10 MW at vertical incidence at repetition rate of 1 per second [1, 2].

Data Reduction

The mixture of noise and partially reflected signals recorded at 3 km intervals from z=45–84 km altitude at middle latitudes during the high-latitude heater turn-on and turn-off intervals at an ~3000 km distance was submitted to spectral analysis. The power spectra showed that there are spectral components with the periods T, 2T, 4T, and 8T at middle latitudes during the modifications with the period T at high latitudes.

Discussion

The analysis of temporal characteristics of the observed disturbances shows that the possible mechanism behind the rapidly evolving large-scale perturbation is probably the following: changes in mesospheric plasma conductivity due to high-power HF radio waves [1] → local changes in strong atmospheric electric fields [3, 4] → large-scale changes in the global electric circuit [5] → changes in the parameters of the middle latitude mesosphere [4] → large-scale changes in electromagnetic environment. The rapid changes in electron temperature and effective collision frequency apparently play the main role in this chain of cause and effect. The suggested mechanism of the physical processes associated with large-scale mesospheric electric field perturbations caused by local artificial high latitude ionosphere modifications can be used for the investigation of possible sources of interference in the terrestrial electromagnetic environment.

References

[1] A. I. Gritchin *et al.*, 5th International Suzdal URSI Symp. on the Modification of Ionosphere (ISSMI'98, Suzdal). Book of Abstracts, p. 40, Aug. 26–29, 1998.
[2] O. F. Tyrnov *et al.*, Turkish. J. Phys., vol. 18, no. 11, pp. 1260–1265, Nov. 1994.
[3] R. A. Goldberg, J. Atmos. Terr. Phys., vol. 46, no. 11, pp. 1083–1101, Nov. 1984.
[4] S. I. Martynenko *et al.*, J. Atmos. Electricity, vol. 16, no. 3, pp. 259-269, Oct. 1996.
[5] E. A. Bering *et al.*, Physics Today, pp. 24–30, Oct. 1998.