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Ionospheric manifestations of acoustic-gravity waves under quiet and disturbed conditions

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We present the observation results of wave disturbances in the ionosphere, which are known to be manifestations of atmospheric acoustic-gravity waves (AGWs). The observations have been conducted under quiet and naturally or artificially disturbed conditions by ionosonde and incoherent scatter radar located near Kharkiv, Ukraine.

Wave disturbance parameters under quiet conditions were obtained and analysed during geophysical periods including vernal and autumn equinoxes as well as summer and winter solstices. The prevailing oscillation in ionospheric F2- layer had the period of 140 – 200 min and relative amplitude of 0.1 – 0.2. The duration of this oscillation changed from 5 – 7 to 24 hours, depending on a season. The amplitude of fluctuations with other periods was noticeably smaller.

The time intervals at which the intensity of incoherent scatter signals varied quasi-periodically in the altitude range from 150 to 300 km were detected. The parameters of these variations were estimated using statistical analysis and bandpass filtering. The periods of wave processes were shown to be of 30 – 120 min, there durations did not exceed of 2 – 6 periods and relative amplitudes usually ranged from 0.03 to 0.15. The phase of oscillations was detected to propagate downwards. The vertical phase velocity of travelling ionospheric disturbances (TIDs) was estimated to be in the range from 50 to 200 m/s and increased with altitude.

The observations of the partial solar eclipse on January, 4, 2011 near Kharkiv were used to study the ionospheric parameters in naturally disturbed conditions. The F2-layer critical frequency dropped by a factor of 2.1. The time delay of these variations with respect to the main magnitude of the solar disk obscuration was equal to about 16 minutes. The virtual height of signal reflection near the maximum of the F2-layer ionization increased by 70 km, and the height of the model parabolic layer increased by 10 km. Some decrease in electron density and growth of quasi-periodic variations with periods of about 30 and 60 min were detected at all observable heights during this solar eclipse.

The diagnostics of wave processes has been performed during ionospheric modification experiments with EISCAT heater. This heater is at a distance of about 2400 km from Kharkiv incoherent scatter radar. We have detected the TIDs over Kharkiv with periods of 40 – 80 min. The duration of these disturbances has not exceeded 120 – 180 min. The relative amplitudes of the TIDs in electron density ranged from 0.05 to 0.15 and those in electron and ion temperatures were about 0.02 – 0.05. The possible mechanisms for the generation of AGWs and TIDs by high power HF radio waves are sharp thermal gradients at the edge of the heated region and modulation of the ionospheric current systems by periodic high power radio transmission.