GC2024-SG001

Ionospheric perturbations caused by a complex of atmospheric acoustic waves radiated during and after earthquakes

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The report examines several modern theoretical models of the acoustic coupling channel of the lithosphere-atmosphere-ionosphere, which can describe the effects of strong earthquakes and volcanic eruptions on the atmosphere and ionosphere. A key component of such a coupling channel is the effect acoustic-gravity waves (AGW) generated in the atmosphere due to earthquake-induced vibrations of the earth or ocean surface. The amplitude of the gas velocity in AGW increases with altitude due to an exponential decrease in atmospheric density. Ionospheric plasma is carried away by the wave movements of a neutral gas, which leads to the generation of electric currents in the ionosphere and geomagnetic perturbations.

We deal first with perturbations caused by both a direct acoustic wave radiated from the earthquake epicenter and AGW generated by seismic waves and tsunamis [1]. The phase velocities of ionospheric perturbations associated with these waves can be different, since the seismic waves excite the acoustic branch of the AGW in the atmosphere, whereas tsunamis generate mainly internal gravitational waves. Underwater earthquakes can also cause surface Lamb waves propagating along the boundary of the atmosphere with the ocean. The amplitude of the gas velocity in these waves decreases with altitude. Therefore, Lamb waves, as well as meteotsunamis generated by these waves, appear to have little effect on the ionosphere.

Recently, experimental data have been obtained on simultaneous oscillations of the geomagnetic field and atmospheric pressure with frequencies of 3.5-4 MHz occurring after a seismic event. These oscillations lasted about one hour and were localized in the vicinity of the earthquake epicenter. It is assumed that this effect is due to the propagation of vertical atmospheric waves generated by vibrations of the earth's surface. Under certain meteorological conditions, the acoustic wave may partially reflect from the lower boundary of the thermosphere, which leads to vertical acoustic resonance at millihertz frequencies. Theoretical analysis shows that this effect can explain the magnitude and spectrum of the observed GMPs not only in the vicinity of the earthquake epicenter, but also in the magnetically conjugate region [2].

The study was supported by the grant 22-17-00125 from the Russian Science Foundation.

References

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