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Nonlinear propagation of the acoustic perturbations in the viscous thermosphere and ionosphere above earthquakes

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The nonlinear behavior of acoustic waves and their dissipation in the upper atmosphere and ionosphere is explained on the basis of experimental data and numerical simulations. Two events are presented: a) Infrasound waves generated by vertical motion of the ground surface during the Mw 8.3 earthquake that occurred near Chilean coast on 16 September, 2015, are studied. It is shown that the infrasound waves changed their waveform in the upper atmosphere owing to nonlinear effects (large amplitudes). This change resulted in the formation of the "N-shaped" pulse that resembled a shock wave. At the same time the spectral content of the wave packet shifted toward the lower frequencies. The observation of co-seismic disturbance in the ionosphere at the altitude of about 200 km by continuous Doppler sounding at approximately 800 km horizontal distance from the epicenter is in good agreement with numerical solution of compressible fluid equations for the viscous atmosphere. b) Observation and numerical simulation of the co-seismic disturbance in the ionosphere over Taiwan, triggered by seismic waves generated by the Mw 7.8 earthquake in Nepal on 25 April 2015, reveal that even at the horizontal distance of about 3700 km from the epicenter, the nonlinear phenomena partly contribute to the change of the spectral content of the acoustic wave packet in the upper atmosphere. However, the N-shaped pulse was not observed at this distance.