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Elastic waves in ice-covered ocean

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The problem of propagation of acoustic waves in a shallow ice-covered sea is considered in frames of the mathematical model of the layered medium: ice sheet over a liquid layer (shallow sea) positioned on an elastic half-space (seabed). As the result of analytical solution the simplified dispersion equation has been derived and used for further analytical and numerical analysis. It has been shown that there are five types of waves subject to propagate in the layered model medium: flexural waves of ice-cover, Rayleigh-type wave on the boundary between elastic half-space and the liquid layer, normal modes in ice (as in waveguide), hydro-acoustic normal modes and quasi-longitudinal wave in ice plate. Variations initial conditions as well as source parameters allow obtaining solution for acoustical pressure.

Field experiments with geophones, hydrophones and microphones were carried out on the Ladoga Lake (Leningrad Oblast in northwestern Russia) using small controllable explosions as source signals. The experiment has shown satisfactory agreement with theoretical results.

Analysis of the dispersion equation for various parameters of the model provides an opportunity to estimate geophysical characteristics of the geophysical medium, based on the experimentally registered wave's velocities. It has been shown, that it is possible to extract valuable information from flexural and Rayleigh-type waves in the low-frequency domain of the recorded data via spatial-temporal analysis. Separate study of those waves allows measuring ice thickness (which is important because of ice melting and ecological situation in Arctic) and velocity of transverse waves in seabed (that can help to determine type of material and can be useful in mineral deposit prospecting).