1. Introduction

Ice-shelf flexure modeling was performed using a full 3D finite-difference elastic model, which takes into account sub-ice-shelf surface flow. The sub-ice shear stress was described by the wave equation (Childress and Wykoff, 1967), in which the ice-shelf flexure results from the hydraulic pressure perturbations in sub-ice water. The modeling of the ice-shelf vibrations was performed in the full model, which includes known boundary equations with the water equation for non-ice flows (i.e. for ice-shelf stresses). Nevertheless, the numerical simulation reveals that the numerical solution stability requires the application of an additional method in the numerical approximation. The aim of this work is to use an attempt to apply an additional approximation in the boundary conditions to improve the numerical stability of the model.

2. Field equations

Basic equation

Boundary conditions

where $P_{xx}$ is the horizontal displacements and vertical displacement, respectively.

3. Numerical experiments

The numerical simulation shows that the modeling of the ice-shelf vibrations can be performed in the full model, which links well known momentum equations with the wave equation for non-ice flows, i.e. for sub-ice water flow. Nevertheless, the numerical simulation reveals that the numerical solution stability requires the application of an additional method in the numerical approximation. The aim of this work is to use an attempt to apply an additional approximation in the boundary conditions to improve the numerical stability of the model.

4. Summary

The numerical simulation shows that the modeling of the ice-shelf vibrations can be performed in the full model, which links well known momentum equations with the wave equation for non-ice flows, i.e. for sub-ice water flow. Nevertheless, the numerical simulation reveals that the numerical solution stability requires the application of an additional method in the numerical approximation. On the other hand, in contrast to the Holdsworth & Glyn-Jones model (dipole model), ice-shelf vibrations are not always feasible for the incident waves in the full model. "Not always feasible" means that incident ocean waves induce cyclical ice-shelf deflection with the same frequency, but the deflection amplitude is (in non-stationary case) not equal to the one in the incident wave. Indeed, the explanation can be given from the point of view of the elastic medium deflection theory. Exactly, the full model contains two nonlinear elastic medium deformations, which implies that there is a distinction in the deformations of different horizontal layers in the ice shelf. Thus, the three stress components $N_{xx}, N_{yy}, N_{xy}$ are nonzero. The forcing complementary happens the deflections of the plate. In other words, the plate described by the full model is anticipated to be more rigid in comparison with the thin plate, which is described by the thin plate model.

References


Fig. 1. Ice-shelf center-line profile, which has a hyperbolic shape and which was applied in the numerical experiments.

Fig. 2. The histories of ice-shelf terminus deflection obtained for the incident ocean waves in the "integrality" part of the spectrum (Barnes et al., 2010). The amplitude of the incident wave is equal to 1 m.

Fig. 3. Successive ice-shelf deflection profiles, $L_{x}=300m$. The period of the forcing is equal to 100s, the amplitude of the incident wave is equal to 1 m.

Fig. 4. Ice-shelf maximal and minimal deflections, respectively, $L_{x}$=300m. The period of the forcing is equal to 100s, the amplitude of the forcing is equal to 1 m.

Fig. 5. The histories of ice-shelf terminus deflection obtained for the incident ocean waves in the "integrality" part of the spectrum (Barnes et al., 2010). The amplitude of the incident wave is equal to 1 m.

Fig. 6. Successive profiles of the pressure perturbations along the center-line, $L_{y}$=30m. The period of the forcing is equal to 100s, the amplitude of the incident wave is equal to 1 m.

Fig. 7. The histories of ice-shelf terminus deflection obtained for the incident ocean waves in the "integrality" part of the spectrum (Barnes et al., 2010). The amplitude of the incident wave is equal to 1 m.