Progress in a direct numerical simulation of internal gravitational waves

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This wok shows progress in the development of a direct numerical simulation of internal gravitational waves that are generated when a cylindrical column of stratified salty water is set to vibrate vertically with enough amplitude. It is shown that, with the same procedure, Faraday gravitational waves can be studied if a stratification based on the hyperbolic tangent function is used. With this latter stratification we obtain essentially two fluids of constant density separated by a transition surface in which the gravitational waves are produced. A cylindrical geometry is used in the simulation, and the Navier-Stokes equations, the diffusion equation and the continuity equation are solved simultaneously. The Boussinesq approximation is used to solve this system of equations; that is, all density changes are neglected except in the buoyancy term. The frame of reference oscillates along with the stratified system so that an apparent gravity appears in the Navier-Stokes equations, in such a way that an oscillatory term is added to the usual gravity. This is a very usual characteristic of parametric instabilities. The Adams-Bashfort method is used in the numerical procedure in order to deal with the nonlinear terms, which are evaluated at previous times, while the problem at the present time is solved as a linear problem. The projection method is used to calculate the pressure by considering a fictitious velocity. Finite differences are used to deal with the vertical and radial coordinates, and a Fourier spectral method is used for the angular coordinate.