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Propagation of acoustic and gravity waves in the ocean: a new derivation for a general model

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Several authors ([3], [5]) have proposed to use the propagation of acoustic-gravity waves in the ocean to detect tsunamis, as the sound travels much more quickly in water than the tsunami itself. To model the acoustic-gravity waves, we consider the Navier-Stokes equations for an iviscid, weakly compressible and free-surface fluid and aim at a linear approximation of these nonlinear equations that retains the two types of waves.

We propose the following linearization method: the Navier-Stokes equations are written in Lagrangian coordinates, then linearized and a wave equation for the velocity is derived. In particular, the wave equation is written in a second order form with a symmetric operator which ensures the well-posedness of the obtained model.

Two aspects of this wave equation are then studied. First, an asymptotic limit for small Mach number is carried out and we show that our limit model is a generalization of known models for incompressible flow with varying density ([4]). Second, the system is put back to Eulerian coordinates and compared to other models in the literature. We show that the equations inside the domain and at the free surface are the same as in [1]. Our model retains also more complexity than the well-known wave equation for the fluid potential, which is obtained from more approximations and is widely used for practical applications ([4], [2]).

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