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Finite-difference modeling of tsunami as a seismic wave based on the Cowling approximation of self-gravitation effect

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Since Ward(1980,JPE), farfield tsunami simulations have been done based on the normal mode theory for a self-gravitating global earth model with sea layer. Recently, this method was extended to the modeling of atmospheric gravity wave (infrasound) as well as long-period seismic waves (solid-earth oscillation) and/or tsunami (e.g. Kobayashi, 2007, GJI; Watada, 2009, JFM). In this study, we focus on the shallow part of the earth including sea and use a local version of elastodynamic equation for self-gravitating flat earth model to simulate nearfield tsunami. We simplify the equation by ignoring the perturbation of the gravitation potential (i.e. retaining the initial acceleration of gravity; called the Cowling approximation) and assuming the acceleration of gravity to be constant over the computational domain. We reformulate the equation into a velocity-stress form which is a set of the first-order equations and does not include the displacement but the particle velocity, and discretize it with a staggered-grid finite-difference time-domain method which is often employed for strong-motion simulation. This scheme can model both of seismic waves and tsunami due to nearfield oceanic earthquakes at the same time. In the presentation we will show some computational examples.

Keywords: Tsunami, numerical simulation, Cowling approximation, self-gravitating effect, seismic wave