Seismic wave propagation in oceanic crustal structure using staggered-grid finite differences

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We simulate seismic wave propagation in large scale 3D structure using staggered-grid finite differences. We use viscoelastic media taking into account the effect of attenuation on the seismic wave and include memory variables in the velocity-stress formulation via generalized Zener body rheological model. The structure model is horizontally (x and y directions) and vertically (z direction) divided into subregions, which allows us to perform an efficient parallel computation for a large number of grids using MPI libraries. The computation time is 2.3 hour in the case of 600x600x300 grids in space and 3000 grids in time for 10 Zener bodies at each space grid using Altix 4700 (Itanium 2 1.6 GHz). In order to precise and stable computations in fluid media, we arrange solid-fluid interfaces on the grid of shear stress components so that the discretized formulation satisfy the boundary condition in which their components discontinue at the interfaces. We also use a variable approximation for spatial derivatives, a fourth-order accuracy in fluid and solid media and second-order accuracy around the fluid-solid interfaces. We apply the structure model of the Nankai Trough to our constructed codes and present seismic wave propagation there focusing on the effects of attenuation and fluid media.