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SIMULATION OF THE PLANAR FREE SURFACE IN MEDIA WITH NEAR-SURFEC LATERAL DISCONTINUITIES IN THE 3D 4TH ORDER STAGGERED-GRID FINITE-DIFFERENCE MODELING OF SEISMIC MOTION

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Recently, Kristek et al. (2002) have developed a new technique to simulate planar free surface in the 3D 4th-order staggered-grid finite-difference (FD) modeling of seismic motion. The technique directly prescribes zero values of the stress-tensor components Tzx and Tzy at the free surface (in one formulation or zero value of Tzz at the free surface in the alternative formulation), applies adjusted 4th-order FD approximations to the z-derivatives at the grid points at and below the free surface, and uses neither virtual values above the free surface nor stress imaging. Numerical tests for a homogeneous halfspace and 1D layered models against the DWN (discrete wavenumber) method proved very good accuracy (also for Rayleigh waves) and efficiency of the technique which requires not more than 6 grid spacings per wavelength in the range of epicentral distances up to 22 times the wavelength. Because in the modeling of the earthquake ground motion material discontinuities reaching the free surface have to be included, we performed numerical tests of our technique for models with vertical and oblique material discontinuities reaching the planar free surface. We compared the synthetics with those calculated by the standard finite-element (FE) method. We used the FE method because, unlike the FD method, satisfying boundary conditions at the free surface and at internal material discontinuities poses no problem for the FE method. The numerical comparisons demonstrate level of accuracy of our technique for simulating the planar free surface in media with lateral discontinuities. We also compare synthetics obtained using our technique with those calculated using the standard stress-imaging technique of Levander (1988).