Geophysical Research Abstracts, Vol. 5, 06199, 2003

3D STAGGERED-GRID FD MODELING OF SEISMIC MOTION IN VISCOELASTIC MEDIA

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We present a synthesis of our recent advances in the numerical modeling of seismic motion, demonstrate the necessity to account for the position of the material discontinuity within a finite-difference (FD) grid cell, and show a possible future improvement in accounting for medium heterogeneity.

Moczo et al. (2002) addressed a problem of justification and construction of heterogeneous elastic FD schemes. They found that in the case of a planar material discontinuity in general position in the Cartesian coordinate system, 21 generally nonzero elastic coefficients are necessary to describe the averaged medium representing the discontinuity. Assuming local interpolation of a general non-planar discontinuity by a planar interface, the corresponding heterogeneous FD scheme would require tremendous memory or computing time. Assumption of simplified boundary conditions led to a robust FD scheme with volume harmonic averaging of torsion and bulk moduli. Numerical tests show that the scheme is more accurate than standard staggered-grid schemes. Nevertheless, we present an alternative numerical approach which does not require simplified boundary conditions, is computationally efficient, and may be more accurate in certain situations.

Kristek et al. (2002) developed a technique to simulate planar free surface in the 4th-order FD schemes based on adjusted FD approximations at grid points at and near free surface. The technique is considerably more accurate/efficient than the standard stress-imaging. On the other hand, the above mentioned numerical approach in combination with a vacuum formalism can be a robust solution for the free-surface topography.

In order to incorporate a realistic attenuation allowing both arbitrary Q(f)-law and

its spatial variability we use a rheology of the generalized Maxwell body. We show how to determine anelastic functions of the averaged medium representing a material discontinuity. We define (1) the anelastic functions in a new way and (2) a new coarse spatial distribution of the anelastic functions in order to properly account for material discontinuities and, at the same time, to have it memory-efficient. Numerical tests demonstrate that our approach enables more accurate viscoelastic modeling than other approaches.