Geophysical Research Abstracts
Vol. 14, EGU2012-5475, 2012
EGU General Assembly 2012

Theoretical and numerical comparison of 3D numerical schemes for their accuracy with respect to P-wave to S-wave speed ratio

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Numerical modeling of earthquake ground motion in sedimentary basins and valleys often has to account for the P-wave to S-wave speed ratios (VP/VS) as large as five and even larger, mainly in sediments below groundwater level. The ratio can attain values larger than 10 – the unconsolidated lake sediments in Ciudad de México are a good example. At the same time, accuracy of the numerical schemes with respect to VP/VS has not been sufficiently analyzed. The numerical schemes are often applied without adequate check of the accuracy.

We present theoretical analysis and numerical comparison of 18 3D numerical time-domain explicit schemes for modeling seismic motion for their accuracy with the varying VP/VS. The schemes are based on the finite-difference, spectral-element, finite-element and discontinuous-Galerkin methods. All schemes are presented in a unified form. Theoretical analysis compares accuracy of the schemes in terms of local errors in amplitude and vector difference. In addition to the analysis we compare numerically simulated seismograms with exact solutions for canonical configurations.

We compare accuracy of the schemes in terms of the local errors, grid dispersion and full wavefield simulations with respect to the structure of the numerical schemes.