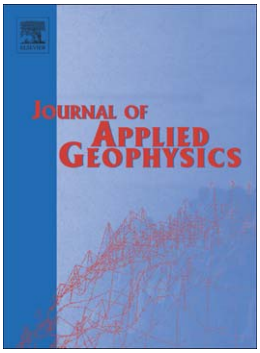

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Modeling of frequency-domain scalar wave equation with the average-derivative optimal scheme based on a multigrid-preconditioned iterative solver

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ABSTRACT

An efficient finite-difference frequency-domain modeling of seismic wave propagation relies on the discrete schemes and appropriate solving methods. The average-derivative optimal scheme for the scalar wave modeling is advantageous in terms of the storage saving for the system of linear equations and the flexibility for arbitrary directional sampling intervals. However, using a LU-decomposition-based direct solver to solve its resulting system of linear equations is very costly for both memory and computational requirements. To address this issue, we consider establishing a multigrid-preconditioned BI-CGSTAB iterative solver fit for the average-derivative optimal scheme. The choice of preconditioning matrix and its corresponding multigrid components is made with the help of Fourier spectral analysis and local mode analysis, respectively, which is important for the convergence. Furthermore, we find that for the computation with unequal directional sampling interval, the anisotropic smoothing in the multigrid precondition may affect the convergence rate of this iterative solver. Successful numerical applications of this iterative solver for the homogenous and heterogeneous models in 2D and 3D are presented where the significant reduction of computer memory and the improvement of computational efficiency are demonstrated by comparison with the direct solver.

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