An accurate and efficient finite-difference operator for the frequency-domain wave propagation

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We newly developed a finite-difference (FD) operator for the frequency-domain acoustic wave propagation. This operator uses a stretched stencil to avoid the numerical anisotropy. In general, direct solvers for sparse matrices are used in exploration geophysical community because they have some advantages over iterative ones , i.e. frequency dependent attenuation and multi-source configuration can be simply implemented. In the frequency-domain modeling, the computational costs (calculation time and computational memory) depend on not only the number of neighbors but also the bandwidth of the impedance matrix. So usage of higher-order schemes is not always conducive to the improvement of the computational costs.
In the present study, we use a stretched stencil of FD operator not to increase the bandwidth in the impedance matrix. Coefficients of the stencil are determined by a minimization process. We investigate the accuracy of our scheme using dispersion analysis and numerical experiment. They show that the proposed scheme can improve not only accuracy but also efficiency compared to the conventional 9-point scheme proposed by Jo et al. (1996).

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