

High-Order Schemes for Acoustic Waveform Simulation

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This article introduces a new fourth-order implicit time-stepping scheme for the numerical solution of the acoustic wave equation, as a variant of the conventional modified equation method. For an efficient simulation, the scheme incorporates a locally one-dimensional (LOD) procedure having the splitting error of $\mathcal{O}(\Delta t^4)$. Its stability and accuracy are compared with those of the standard explicit fourth-order scheme. It has been observed from various experiments for 2D problems that (a) the computational cost of the implicit LOD algorithm is only about 40% higher than that of the explicit method, for the problems of the same size, (b) the implicit LOD method produces slightly less dispersive solutions in heterogeneous media, and (c) its numerical stability and accuracy match well with those of the explicit method.