A Comparative Study of Different Time Integration Schemes Applied to Finite Difference Elastic Wave Simulations

Otilio Rojas[1], Josep De La Puente[2], Jose Cela[2], and Santiago Fernández[3]

[1]Universidad Central de Venezuela
[2]Barcelona Supercomputing Center
[3]Repsol

Abstract

Seismic modelling algorithms, with few exceptions, discretize space and time independently. While spatial discretization is frequently achieved with high-order accuracy to allow for coarser grids, the temporal integration is regarded as less important and hence dealt with using low accuracy operators. We will compare different time integration techniques for elastic wave modelling and evaluate their cost and benefit in terms of the accuracy they can achieve, additional memory required and overall compute cost. Our implementations include a standard two-step Leap-frog scheme, a less popular Leap-frog method of three levels, Runge Kutta of three and four stages and other multistep methods.

We will focus on staggered-grid explicit time-domain finite-difference algorithms for the elastic wave equation. Our tests involve both different propagation distances and Courant numbers. We will end up with a recommendation of spatial and temporal orders and integration techniques depending on the modelling problem setup and the available computing platform. This comparative study presents preliminary analysis of the stability, convergence, and dispersion properties of this suite of time-space solvers for elastic wave propagation problems.