

Title: Fully Scalable Solver for Frequency-Domain Visco-Elastic Wave Equations in 3D Heterogeneous Media

Abstract: We develop a controllability strategy for the computation of frequency-domain solutions of the 3D visco-elastic wave equation, in the perspective of seismic imaging applications. We generalize the controllability results for such equations beyond the sound-soft scattering (obstacle) problem. We detail the conjugate gradient implementation and show how an inner elliptic problem needs to be solved to compute the Riesz representative of the gradient at each iteration. We select a spectral-element spatial discretization and a fourth-order Runge-Kutta time discretization. We implement the controllability method in the framework of the SEM46 full waveform modeling and inversion software, to inherit for its excellent scalability which relies on an efficient domain decomposition algorithm. We perform a series of numerical experiments to validate the approach and illustrate its scalability up to more than fifteen hundred cores. In this case, with an elapsed time of less than 50 minutes, we solve a problem on a cubic domain containing up to 160 wavelengths in each direction, involving more than 1.7 billion unknowns.