Exploiting a Priori Model Reduction Methods to Accelerate Seismic Simulations

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Abstract

Seismic modeling and applications (imaging, migration and inversion techniques, e.g., Baysal et al., 1983; Pratt, 1999; Virieux and Operto, 2009) usually require a huge number of very expensive simulations to provide accurate results. Solutions are obtained from different values of some design parameters, such that frequency and position of source/receivers, while both geometry and boundary conditions remain fixed between simulations. Actual practice adopts an expensive and time-consuming brute force approach that generates a direct solution for each required set of parameter values. This im- poses workable limits to the number of simulations that are feasible to compute in practice. In this work, an a priori reduced order method based on proper generalized decompositions (PGD) is exploited as an attractive alternative strategy to the usual practice. More precisely, the wave field is generalized to provide any particular solution of the seismic problem at negligible computational cost. The PGD technique is then applied to obtain an approximation of this generalized wave field, using it as a database for providing any required particular solution in a real-time framework. A simple 2D problem in frequency domain is used to exemplify the potential of this methodology. The strategy will be particularly useful when- ever many realizations of modeling are required (i.e. many shots and frequencies are involved) such as in RTM and FWI applications.