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Triangular spectral element method for elastic wave simulation using iterative solvers based on Schwarz overlapping methods.

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The development of new seismic interpretation methods requires accurate numerical modeling tools for the simulation of the complete wave field in heterogeneous media with complex geometries. Geometrical flexibility is an important issue for computational seismology at both regional and local scales. Recent developments toward high-order numerical simulation of seismic wave propagation have been based on the Spectral Element Method (SEM). However classical SEM is restricted to unstructured quadrilateral mesh and today's geometrical flexibility is hardly achieved using it. Higher geometrical flexibility is therefore a strong motivation for exploring the use of triangular elements and unstructured meshes.

A Triangular Spectral Element Method (TSEM) is presented for elastic wave propagation using unstructured triangulation of the domain. TSEM makes use of a variational formulation of elastodynamics based on unstructured triangles that allows enhanced geometrical flexibility. Comparisons with classical SEM have shown similar accuracy and long term stability at the expense of an increased computational complexity.

We present here further developments of the TSEM making use of iterative solvers based on overlapping Schwarz and hybrid Schwarz-multigrid methods both in the time and frequency domains. In time domain, special attention is paid to high order implicit scheme. In spectral domain, special attention is paid to the conditioning of the TSEM Helmoltz operator. Accuracy and computational efficiency are assessed on canonical examples. Implications of these extensions for seismic inversion techniques will be discussed.