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Improving full-waveform inversions using spectral-element seismic wave propagation on emerging HPC architectures

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A major challenge in seismic tomography is to increase the resolution and reliability of Earth subsurface models. Full-waveform inversions have become the most promising approach to connect high-resolution body wave tomography and lower-resolution surface wave tomography from local, regional to global scales. The main advantage of using as much seismic information as possible to infer physical properties of Earth's internal structures further highlights the need of investigating the resolution, robustness and uncertainty of resulting seismic models. Furthermore, full-waveform inversions require increasingly accurate simulations of seismic wave propagation in complex 3D media to further improve our current knowledge of subsurface structures. However, such numerical simulations are computationally expensive and need high-performance computing (HPC) facilities for further improving the current state of knowledge. We demonstrate current challenges in full-waveform inversions and highlight advances on improved misfit criteria for gradient-based optimization schemes as well as uncertainty quantification for seismic models on current HPC systems.