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Modeling seismic wave propagation through the Earth for imaging localized structures.

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Developing fast and accurate methods for modeling seismic wave propagation is important to image the Earth's interior and thus better understand its internal structure and its history. The most recent global tomographic models (e.g. French and Romanowicz, 2015, Bozdağ et al., 2016) have been obtained by modeling wave propagation using the spectral element method and exhibit key structures for our understanding of mantle dynamics, for example, vertically oriented broad low velocity plume conduits extend through-out the lower mantle beneath major hotspots. Improving the resolution of our global models, to further investigate key structures, is difficult because it is limited by the computational power currently available. To overcome this limitation, a novel imaging method called box-tomography have been introduced (Masson and Romanowicz, 2017), it allows to efficiently image localized structures of interest buried at arbitrary depth inside the Earth. In box-tomography wave propagation modeling, for the most part, is carried out in the vicinity of the structure of interest using a local solver. The wavefield recorded at the surface of the local modeling domain is then convolved with pre-computed Green's functions to obtain synthetic seismograms at arbitrary position at the surface of the Earth (Masson and Romanowicz, 2016). Clouzet et al. (2108) successfully implemented box-tomography using a regional spectral element solver (Cupillard et al., 2012) and obtained a tomographic model of North America. In this work, we investigate numerical schemes alternative to the spectral element method for modeling wave propagation locally in the box-tomography context. We aim at constructing a numerical scheme which combines the efficiency and the relative simplicity of the finite difference method together with an accuracy that compares to that of the finite/spectral element method when introducing sharp interfaces and complex geometries.