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3-D elastic wave propagation on regional to global scales using an ADER-DG method

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The complex 3-D material property distributions inside the Earth and detailed information on the physical dynamics of an earthquake require robust numerical methods to generate accurate results in form of seismograms. Furthermore, these simulations must be highly scalable on HPC infrastructures for realistic simulations. Possible applications are regional forward modeling studies for hazard assessment or seismic tomography on a global scale to illuminate the deep Earth's interior. The Arbitrary high-order DERivative Discontinuous Galerkin (ADER-DG) method is well suited to simulate 3-D elastic wave propagation to capture the high frequency content of the wavefield over long propagation distances. It is able to incorporate fine-scale Earth structures on a regional to global scale using flexible tetrahedral meshing and features like h-p adaptivity and local time stepping (Dumbser et al. 2007). We were able to successfully benchmark seismograms originating from simpler 1-D layered Earth models with synthetics of the well-tested spectral-element method. The verification towards 3-D models is carried out on a regional model of Europe taking the topography of the Earth's surface and Mohorovicic discontinuity into account using the EPcrust model of Molinari et al. (2011) on top of the AK135 model of Kennett et al. (1995). For the L'Aquila earthquake (Italy) in 2009 we compare synthetic seismograms of our ADER-DG solver with real data up to 20s period and can show a very good fit between the signals.

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