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Spectral-Element and Adjoint 3D Tomography for the Lithosphere of Central Italy

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Our aim is to iteratively improve an initial 3D tomographic model of the lithosphere in central Italy. The spectral-element method (SEM) is adopted to perform accurate numerical simulations of the wavefield generated by foreshocks and aftershocks of the 2009 L'Aquila (Italy) earthquake, and by some additional events. The inversion is performed using SEM in combination with the adjoint method and a gradient-based minimization algorithm. The region is characterized by a highly complex geological setting, that features strong topographic and alluvial basin effects. All these 3D heterogeneities are implemented for the simulations, also accounting for wave attenuation and Moho discontinuity. We consider a total of 63 events and 52 stations in central Italy. Three-component synthetic waveforms are compared to the corresponding recorded data within the period ranges 2-20 s and 6-20 s. We estimate multitaper traveltime misfit functions based upon frequency-dependent multitaper traveltime differences. The misfit function gradients, required for the model update, are calculated from adjoint sensitivity kernels. Successive iterations feature reduced traveltime misfit functions and improved agreement between observed and synthetic waveforms, leading to an updated 3D tomography for the central Italy region.