A hybrid method to calculate teleseismic body waves in a regional 3D model using GEMINI and SPECFEM.

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Modeling waveforms of teleseismic body waves requires the solution of the seismic wave equation in the entire Earth. Since fully-numerical 3D simulations on a global scale with periods of a few seconds are far too computationally expensive, we resort to a hybrid approach in which fully-numerical 3D simulations are performed only within the target region and wave propagation through the rest of the Earth is modeled using methods that are much faster but apply only to spherically symmetric Earth models.

We present a hybrid method that uses GEMINI to compute wave fields for a spherically symmetric Earth model up to the boundaries of a regional box. The wavefield is injected at the boundaries, where wave propagation is continued using SPECFEM-Cartesian. Inside the box, local heterogeneities in the velocity distribution are allowed, which can cause scattered and reflected waves. To prevent these waves from reflecting off the edges of the box absorbing boundary conditions are specifically applied to these parts of the wavefields. They are identified as the difference between the wavefield calculated with SPECFEM at the edges and the incident wavefield.

The hybrid method is applied to a target region in and around the Alps as a test case. The region covers an area of 1800 by 1350 km centered at 46.2°N and 10.87°E and includes crust and mantle to a depth of 600 km. We compare seismograms with a period of up to ten seconds calculated with the hybrid method to those calculated using GEMINI only for identical 1D earth models. The comparison of the seismograms shows only very small differences and thus validates the hybrid method. In addition, we demonstrate the potential of the method by calculating seismograms where the 1D velocity model inside the box is replaced by a velocity model generated using P-wave traveltime tomography.