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Efficient spectral element surface wave propagation using anisotropic adaptive mesh refinement

Johannes Kemper, Federico Munch, and van Driel Martin
ETH Zürich, Institute of Geophysics, Earth Sciences, Switzerland (johannes.kemper@erdw.ethz.ch)

3D finite element simulations of seismic wave propagation can be accelerated substantially by adapting the discretization to the space dependent complexity of the wave field. This has been shown in the context of global seismology by Leng et al, 2016 and van Driel et al, 2018, where the wave field and especially the body waves remain much smoother in the azimuthal direction than in the source-receiver plane. In contrast, are most sensitive in the crust and hence obtain complicated patterns in the horizontal directions on Earth's surface. At the same time, the depth-dependence of the displacement is much simpler and therefore over-resolved by standard meshes used in global simulations.

Here, we propose two steps to take advantage of this: 1) Filter the source in the normal mode basis such that it only excites fundamental modes and 2) use radially elongated elements adapted to the complexity of the radial eigenfunctions to speed up the simulations. We show that our proposed method leads to a significant reduction of number of elements without decreasing the accuracy of the solution and show instructive examples.