Toward a multiscale seismic velocity model for Alaska

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Seismic velocity structure is a fundamental characteristic of any given region. Seismic velocity models provide a starting point for iterative seismic tomographic inversions, whereby the velocity models are improved while minimizing differences between observed and synthetic seismograms. The success of the tomographic inversion is driven by three features: (1) the availability and quality of observed data; (2) the accuracy of the forward model to compute synthetic seismograms; (3) the accuracy of the inverse model. The availability and quality of data in Alaska motivates the underlying multiscale nature of the seismic velocity model. Target structures at scales of 1 km include onshore and offshore seismic reflection and refraction surveys, as well as tidewater glacier settings (e.g., Yahtse glacier), where water, ice, sediments, and rock must be taken into account. Target structures at scales of 10 km include large sedimentary basins (e.g., Cook Inlet basin, Nenana basin) and active volcanoes (e.g., Mount Spurr, Augustine Volcano). Target structures at scales of 50 km include the continental crust, and at 100 km include the subduction system comprising slabs, crust, and upper mantle. After generating unstructured hexahedral meshes for several of these models, I perform 2D and 3D seismic wavefield simulations using the spectral-element method (SEM). The SEM simulations may be used within an adjoint-based inverse problem, as demonstrated extensively for the southern California crust. Future efforts will involve assembling all different structural and seismic data into constructing initial 3D seismic velocity models in Alaska. These 3D models will serve as a basis for iterative seismic inversion using spectral element and adjoint methods.

Snapshot from a wavefield simulation of a $M_w 9.2$ scenario earthquake on the Aleutian megathrust. Accurate structural models are needed to improve the predicted ground displacements for such earthquakes.