Geophysical Research Abstracts
Vol. 13, EGU2011-2689, 2011
EGU General Assembly 2011

Full-wave ambient noise tomography at local and regional scales

Yang Shen and Wei Zhang
University of Rhode Island, Graduate School of Oceanograph, Narragansett, RI 02882-1197, United States
(yshen@gso.uri.edu, 001-401-87)

Compared to traditional methods that utilize surface waves from earthquakes, noise interferometry has several advantages, particularly in extending usable waves to short periods and providing constraints on shallow structure. For short-period waves, topography and strong heterogeneity near the surface may cause substantial wave scattering. The combination of strong near-surface heterogeneities and a large sensitivity of Rayleigh wave to velocity variations near the surface, for example, may have a significant effect on the phase and amplitude of seismic waves, particularly for short-period waves.

In this study, we adapt the full-wave finite-frequency method for ambient noise tomography. We use empirical Green's functions (EGFs) derived ambient noise to iteratively improve 3D velocity models at local and regional scales. To account for the near surface effect, we use a boundary-conforming grid in a non-staggered finite-difference method to simulate wave propagation at local scales. In a study of the crust and upper mantle beneath northern Cascadia, we use up to 5 years (2005-2009) continuous records from 69 broadband seismic stations. Travel time anomalies are measured by cross-correlating empirical and synthetic Green functions for a 3D reference model. Finite-frequency sensitivity kernels are computed using the scattering integral method. In the frequency and time window of interest, the empirical Green's function derived from cross-correlation of vertical-vertical components is dominated by Rayleigh waves, which are sensitive to not only shear but also compressional wave speeds. So the inverse problem is structured as a joint solution for Vp and Vs. The solution converges after 4 model iterations, with a total 96% variance reduction. Resolution tests show a Vp resolution in the shallow crust. The Vp structure is validated by a comparison with the results of an active-source experiment. A comparison of the observed and predicted earthquake waveforms shows a much-improved waveform fit, indicating that the new model could be used to refine seismic hazard assessment. The new model also reveals features related to other geological observations, such as the sediment basins and accretionary complex.

We will also report progress on full-wave ambient noise tomography of the eastern hemisphere, using long-period (50-400+ s) EGFs derived from up to 20 years of records from permanent seismic stations in Eurasia, Africa and Australia.