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Radially anisotropic shear wave model of North America from multi-mode surface tomography using USArray

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A three-dimensional radially anisotropic shear wave speed model beneath North America is constructed from multi-mode surface wave dispersion, using the high-density broadband seismic array (USArray) in the United States. We developed a fully automated technique for multi-mode dispersion measurements based on a nonlinear waveform fitting, and analyzed over 60,000 long-period three-component records of seismic stations in North America from 2000 to 2008. Seismic stations from the IRIS and USGS networks and transportable USArray stations are used in this study. We have collected about 23,000 paths for the fundamental-mode Rayleigh waves, and 11,000 for the higher-mode Rayleigh and fundamental-mode Love waves, and about 4,000 for the higher-mode Love waves. These path-specific phase speeds are then inverted for multi-mode phase speed maps incorporating finite-frequency effects via the surface-wave influence zone, within which surface waves are coherent in phase. A high-resolution 3-D anisotropic shear wave speed model is derived from simultaneous inversions of local dispersion curves of Love and Rayleigh waves. The obtained 3-D model indicates a large-scale strong velocity contrast between the western and central United States with slow anomalies beneath the Rocky Mountain Range down to 150 km depth and fast anomalies beneath the cratonic areas. The radial anisotropy of the current 3-D model reveals detailed tectonic features in the western United States; e.g., slow shear wave speed anomalies and radial anisotropy (SH>SV) beneath the regions with on-going horizontal extension; i.e., the Rio Grande Rift, and the Basin and Range. Vertical resolution of the model is enhanced by the use of the higher modes, which enables us to resolve down to the mantle transition zone and the uppermost lower mantle, despite vertical smearing effects; e.g., subducted Juan de Fuca plate beneath the western US, and a possible fragment of the Farallon plate in the uppermost lower mantle beneath the eastern US.

Keywords: surface waves, tomography, anisotropy, North America