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Surface-wave phase velocity maps of North America with inter-station waveform analysis

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The western United States encompasses a variety of tectonic features, including regions with east-west extension, volcanic areas and relatively stable cratonic regions.

In the last decade, the Transportable Array (USArray) has been installed throughout the U.S, and these waveform data have facilitated a variety of tomographic studies in this region using body and surface waves, and ambient noise analysis making the most of the high-density seismic network.

In this study, we have developed a new method of fully non-linear waveform fitting to measure inter-station phase velocities, using the Neighborhood Algorithm (NA) as a global optimizer. This algorithm searches for model parameters to fit two observed waveforms on a common great-circle path by perturbing the phase term of the fundamental-mode Love and Rayleigh waves. We have employed the reliability parameter, which represents how well the waveforms at two stations can be fitted in a time-frequency domain. This parameter is used as a data selection criterion for the subsequent step of phase velocity mapping.

The method has been applied to observed waveform data of the USArray from 2007 to 2010, and we could collect a large-number of phase speed data (over 45000 for Rayleigh and 15000 for Love) in a period range from 30 and 200 seconds, at short distances less than 1000 km. The phase velocity models for Rayleigh and Love waves indicate good correlation on large scales with the recent tomographic maps derived from different approaches for inter-station phase velocity measurements (Foster et al., 2013); e.g., significant slow velocity anomaly in volcanic regions in western Unites States and extremely fast anomaly in the cratonic region in the longer period range, which implies the robustness of such tectonic features as well as the validity of our new measurement technique. The current method can be expanded for the measurements of inter-station higher-mode phase velocities, which will be of great help in enhancing the vertical resolution of the 3-D shear wave models.

Keywords: surface wave, phase velocity, tomography, North America