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Title: Tomography of Southern California via Bayesian Joint Inversion of Rayleigh Wave Ellipticity and Phase Velocity from Ambient Noise Cross-Correlations

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Abstract:
We present a regional-scale shear velocity model for Southern California with enhanced shallow resolution through Bayesian joint inversion of short-period Rayleigh-wave phase velocity and ellipticity measurements. Phase velocity and ellipticity, or horizontal-to-vertical (H/V) ratio, measurements by cross-correlating daily continuous time-series from 2015 across 315 stations and retaining relative amplitude information among each station's vertical and horizontal components. We analyze H/V ratios for each station from every cross-correlation pair in period ranges 6 to 18 seconds, obtaining over 1 million total measurements for an average of about 4,000 measurements at each station, to which we apply strict quality criteria to retain robust isotropic H/V ratios. Because H/V ratios of Rayleigh waves have shallow and localized sensitivity, they provide strong constraints of the near-surface while phase velocities provide sensitivity to the middle and lower crust. We combine H/V and phase velocity measurements in a Bayesian joint inversion, with the SCEC Community Velocity Model CVMS4.26 as a starting model, to determine a new shear velocity model. As seen in Figure 1, the updated model features strong gradients in the upper few kilometers while improving fit to H/V and phase velocity data at all examined frequency ranges. The new shallow structure will greatly impact simulation-based studies of seismic hazard, especially in the near-surface low-velocity zones beneath densely-populated areas like the LA, San Bernardino, and Ventura Basins. Other areas of the model contain features that have previously only been imaged in focused local studies, including the correct depth of the southern Central Valley, fold structure of the Ventura and Oak Ridge Anticlines, velocity contrast across the Newport-Inglewood fault, and strong Precambrian igneous rocks in the eastern Transverse Ranges. Well-known large-scale features common to previous studies are also resolved, including velocity contrasts across the San Andreas, San Jacinto, Garlock, and Elsinore faults, mid-crustal high-velocity structure beneath the Mojave Desert, and shallow Moho beneath the Salton Trough. Our results demonstrate the considerable improvement to ambient noise imaging that can be gained from the incorporation of spatially dense Rayleigh wave H/V measurements.

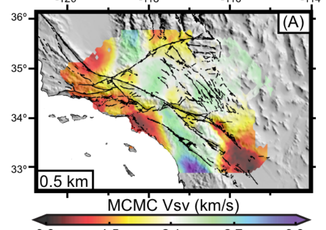

Figure 1. New shear velocity model (here, 0.5 km depth presented) of regional Southern California from Bayesian joint inversion of H/V and phase velocity measurements obtained via ambient noise cross-correlation.