Wave gradiometry is an array processing technique utilizing the shape of seismic wavefields captured by USArray TA stations to determine fundamental wave propagation characteristics. We first explore a compatibility relation that links spatial gradients of the wavefield with the displacements and the time derivatives of displacements through two unknown coefficients $\vec{A}$ and $\vec{B}$, which are solved through iterative, damped least-square inversion, to provide estimates of phase velocity, back-azimuth, radiation pattern and geometrical spreading. We show that the $\vec{A}$-coefficient corresponds to the gradient of logarithmic amplitude and the $\vec{B}$-coefficient corresponds approximately to the local dynamic phase velocity. These vector fields are interpolated to explore a second compatibility relation through solutions to the Helmholtz equation. For most wavefields passing through the eastern U.S., we show that the $\vec{A}$-coefficients are generally orthogonal to the $\vec{B}$-coefficients. Where they are not completely orthogonal, there is a strong positive correlation between the gradients of $\vec{B}$-coefficients and changes in geometrical spreading, which can be further linked with areas of strong energy focusing and defocusing. We then obtain isotropic phase velocity maps across the contiguous United States for 20 - 150 s Rayleigh wave by stacking results from 700 earthquakes. The strong velocity variations in the western U.S., correlate quite well with known geological features and the amplitude correction term generally improved the resolution of small-scale structures for all periods we analyzed. We also observe a velocity change along the approximate boundary of the early Paleozoic continental margin in the eastern U.S and two significant low velocity anomalies within the central Appalachians, one centered where Eocene basaltic volcanism has occurred, and the other within the northeastern U.S., possibly associated with the Great Meteor Hotspot track.

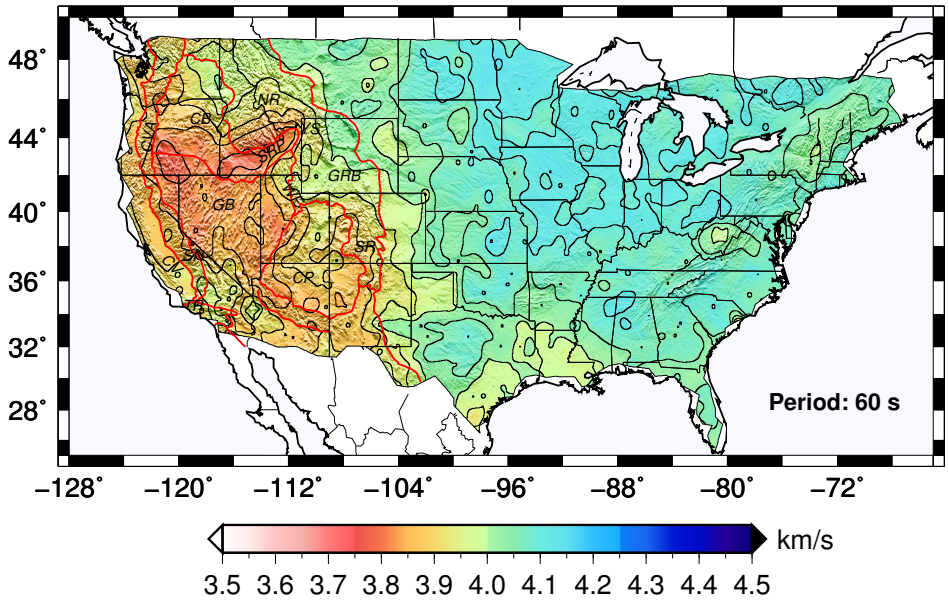

Figure 1: Isotropic phase velocity map for 60 s Rayleigh wave. Geographic features as indicated: CB, Columbia Basin; CP, Colorado Plateau; CVA, Cascade Volcanic Arc; CV, Central Valley; GB, Great Basin; GRB, Green River Basin; NR, North Rocky Mountain; SN, Sierra Nevada; SRP, Snake River Plain; SR, South Rocky Mountain; TR, Transverse Ranges; WF, Wasatch Front; YS, Yellowstone.