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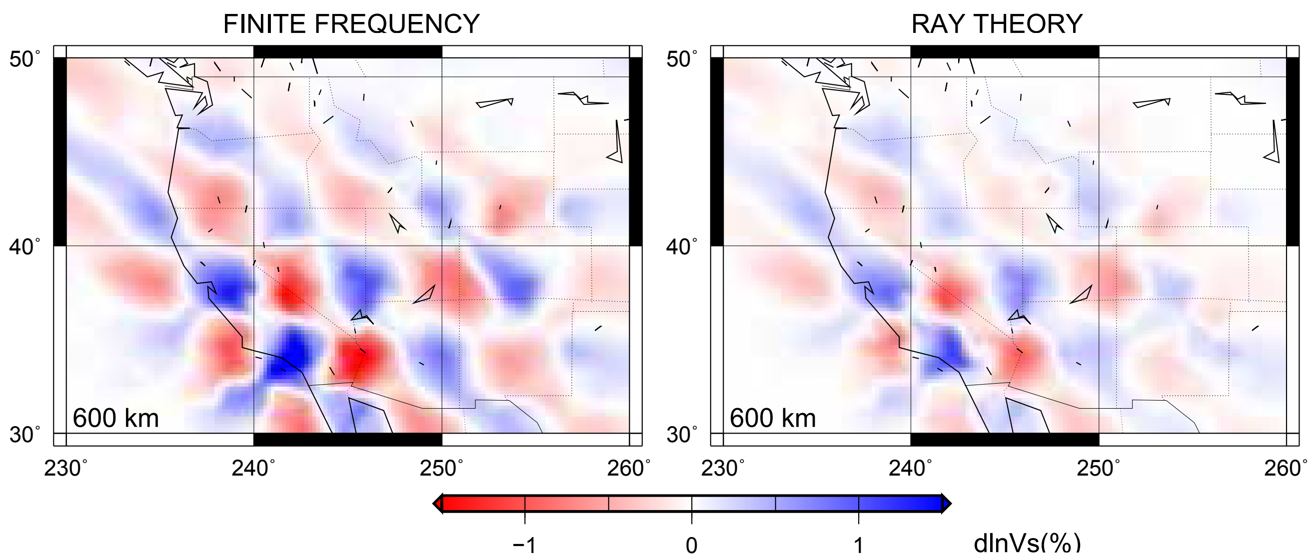
Significant progress in seismic tomography has recently come not only from the installation of densely spaced arrays, but also from the use of 'finite-frequency' interpretations of body waves in particular. The presence of dispersion in a delay time measured by cross-correlation indicates that the size of the anomalies that cause the delay is smaller than the Fresnel zone, whereas the magnitude of the dispersion contains information about the scale of the heterogeneity. In particular 'multiple-frequency' inversions, in which the cross-correlation time is determined for a series of bandpass filters, show a resolving power far superior to those using simple ray theory. Though waveform inversions quickly become nonlinear, the use of cross-correlation functionals helps to linearize the inversion even for large delays. Moreover, the use of volume Fréchet kernels that model the wavefront healing allows the linearization of body wave amplitude data, which are plagued by singularities when ray theory is used.

Two approaches to finite-frequency tomography have been pioneered recently: the `scattering integral approach' in which a large linear system of equations is solved, and the 'gradient' approach in which the solution is iteratively found along the gradients of the misfit function. Though the latter is often denoted as 'adjoint' method, both algorithms use the reciprocity principle and project back from the receivers to obtain computational efficiency.

The combination of dense arrays with finite-frequency theory brings us closer to the ideal of correctly estimating the amplitudes of seismic anomalies, which is of importance in mineral-physics interpretations.



This figure shows the result of a checkerboard resolution test with a small (1.5 x 10^4) number of S arrivals in US array. Left: multiple-frequency inversion of cross-correlation data in five frequency bands. Right: interpretation of the broadband delay times using ray theory. Figure courtesy Yue Tian.