Teleseismic P wave Spectra from USArray and Implications for Scattering and Intrinsic Attenuation

Maps of relative variations in the upper mantle attenuation parameter t* are estimated by inversion of inter-station spectral ratios from teleseismic deep earthquakes recorded by USArray. High t* areas include much of the western Cordillera and eastern passive margin, and low t* dominates across the central U.S. Smoothed t* variations (Figure A) are moderately correlated with long-period surface wave attenuation tomography (0.6 Spearman rank) and anti-correlated with velocity tomography (-0.4). However, the two standard deviation magnitude of t* variations is a factor of ~3-10 greater than predicted by prior surface wave attenuation tomography or an anelastic olivine model. Similarly high t* in parts of the passive margin and western Cordillera suggest that the effect of thermally activated intrinsic attenuation can be overwhelmed by non-dissipative effects such as elastic scattering. Transverse component spectra are used to investigate the importance of scattering because they would receive negligible P wave energy in the absence of 3-D heterogeneity or anisotropy. Transverse-to-vertical spectral ratios (T/Z) show greater partitioning of P energy onto the transverse component and increasing T/Z with frequency for stations with high t* (Figure B). Our results indicate that scattering strongly influences spectral ratio t* estimates. Broadly similar geographic patterns of teleseismic t*, surface wave Q tomography, and velocity tomography may primarily reflect spatial covariance between intrinsic attenuation and scattering intensity.

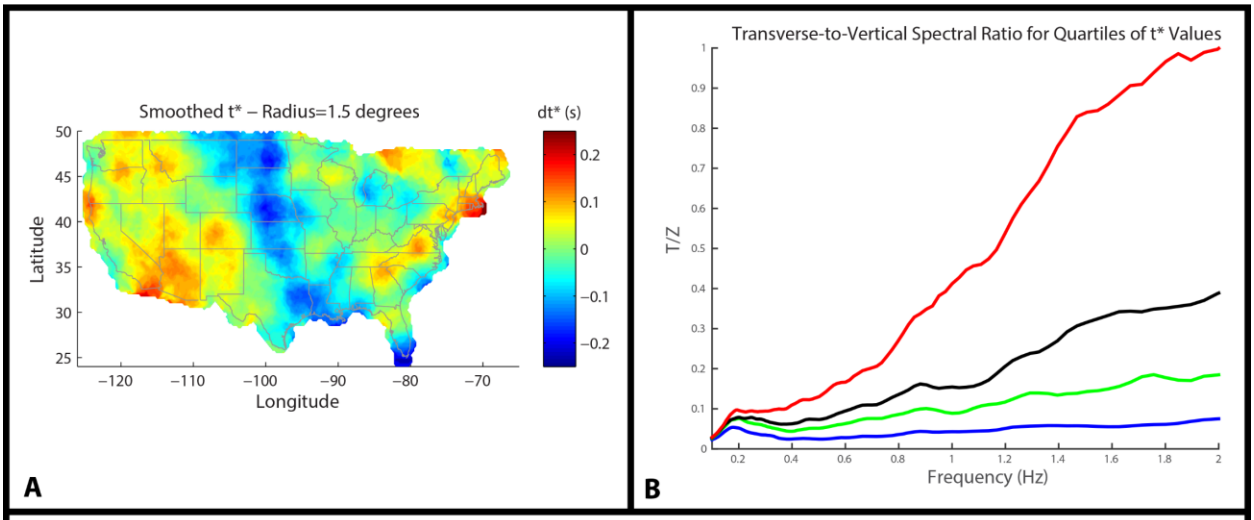

Figure A: Map of t* values across the United States with a smoothing radius of 1.5 degrees. High t* values can be seen in the western Cordillera and eastern passive margin. Low t* values are concentrated in the central United States.
Figure B: Transverse-to-vertical spectral ratios are plotted by quartiles of t* values. T/Z show an increase in t* with increasing frequency, particularly for the highest t* values.