Supporting Information for

A 3D Full Stress Tensor Model for Oklahoma

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Additional Supporting Information (Files uploaded separately)

Introduction

The supplement includes formulas to convert P- and S-wave velocities, density to Young's modulus and Poisson's ratio; two screenshots of interactive tools and themselves used to choose inversion parameters (L-curve analysis); one screenshot of an interactive tool and itself used to view the material model at all depths and for depth profiles at any location; additional examples of observed and predicted dispersion curves; example depth slices of P-wave velocity and density models; the material model in a text file; and the stress field model in a text file.

Text S1

We use the following formulas (Shearer, 2009) to convert P- (V_p) and S-wave (V_s) velocities, density (ρ) to Young's modulus (E) and Poisson's ratio (σ).

$$E = \frac{(3V_p^2 - 4V_s^2)\rho V_s^2}{V_p^2 - V_s^2}$$

$$\sigma = \frac{V_p^2 - 2V_s^2}{2(V_p^2 - V_s^2)}$$

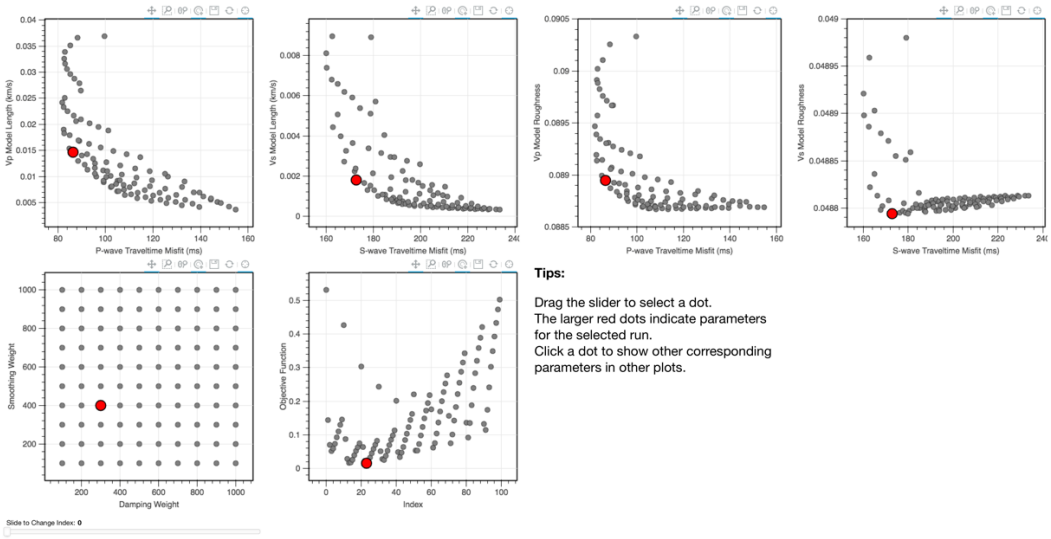

Figure S1. A screenshot of an interactive tool that we used to choose smoothing and damping weights. The red dot in the screenshot indicate the preferred weights and corresponding parameters. See Visualization S1 for details.

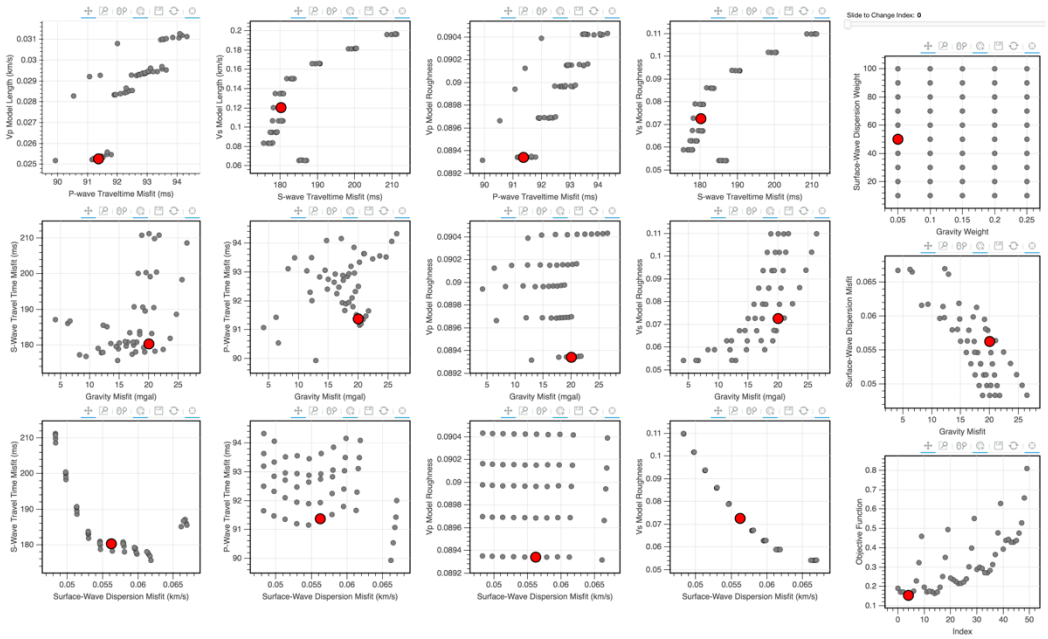

Figure S2. A screenshot of an interactive tool that we used to choose weights associated to surface-wave dispersion and gravity observations. The red dot in the screenshot shows the preferred weights and corresponding parameters. See Visualization S2 for details.

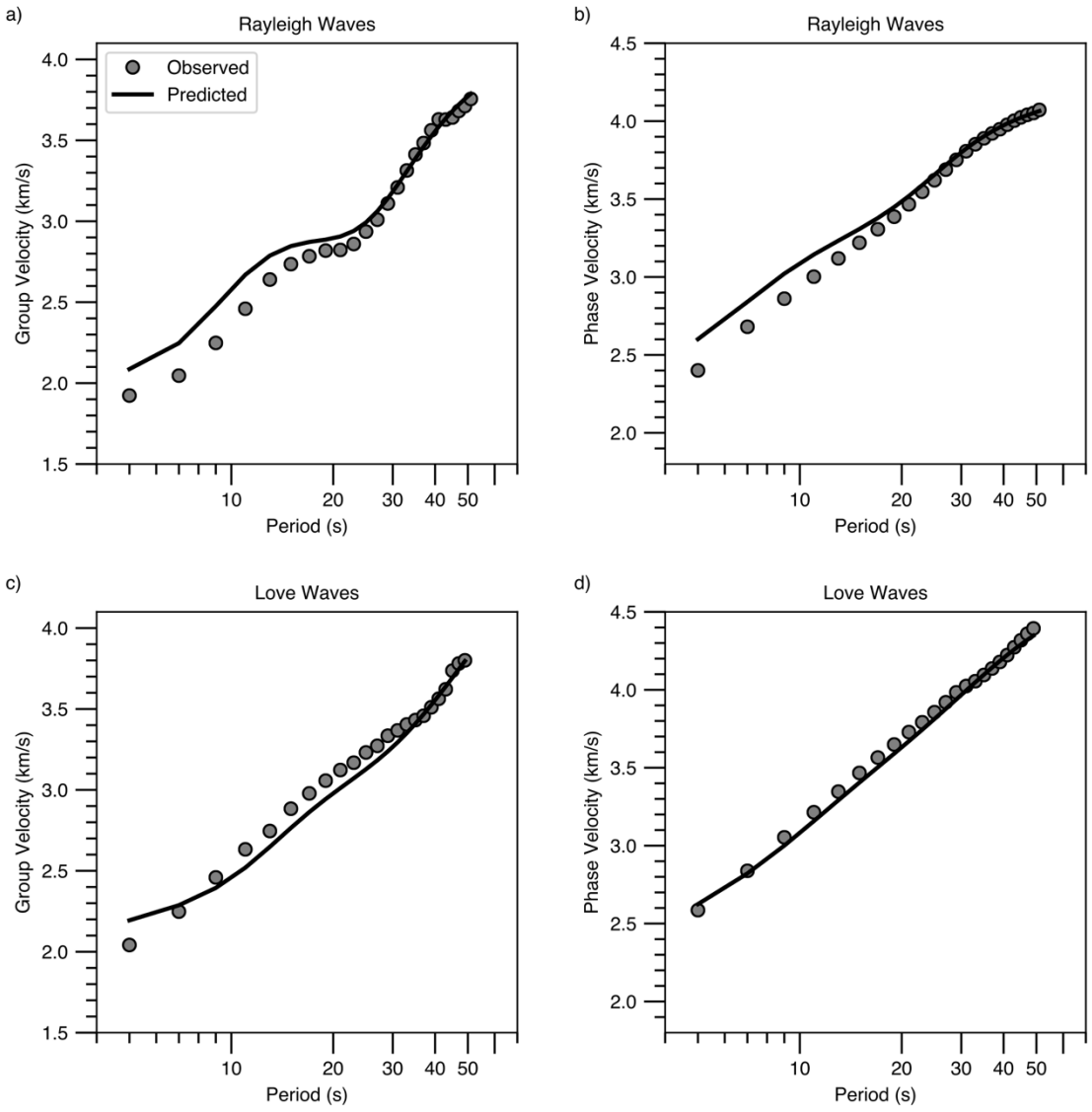

Figure S3. Additional examples of observed and predicted dispersion curves, a) Rayleigh wave group velocities, b) Rayleigh wave phase velocities, c) Love wave group velocities, d) Love wave phase velocities.

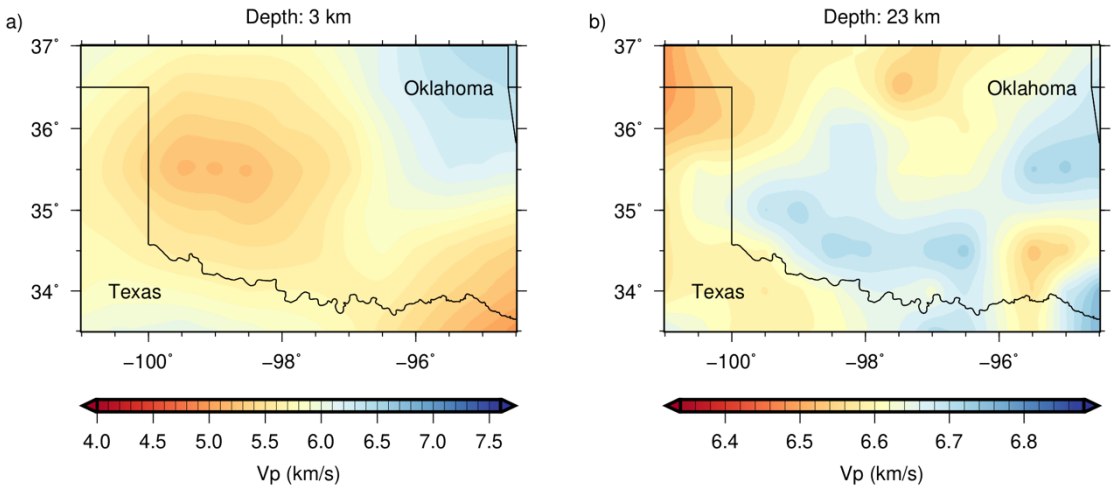

Figure S4. Depth slices of the P-wave velocity model at a depth of 3 (a) and 23 (b) km. The black line is the state boundary between Oklahoma and Texas.

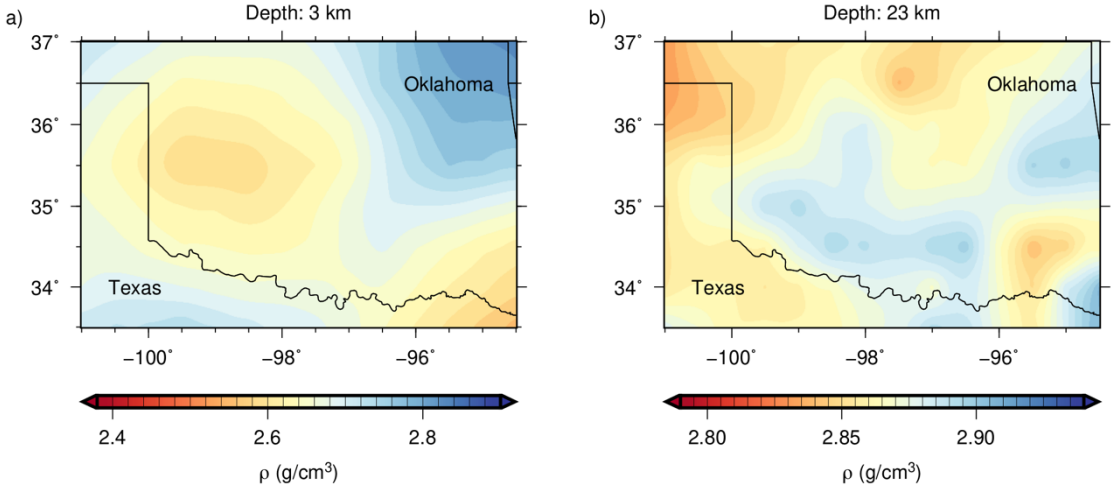

Figure S5. Depth slices of the density model at a depth of 3 (a) and 23 (b) km. The black line is the state boundary between Oklahoma and Texas.

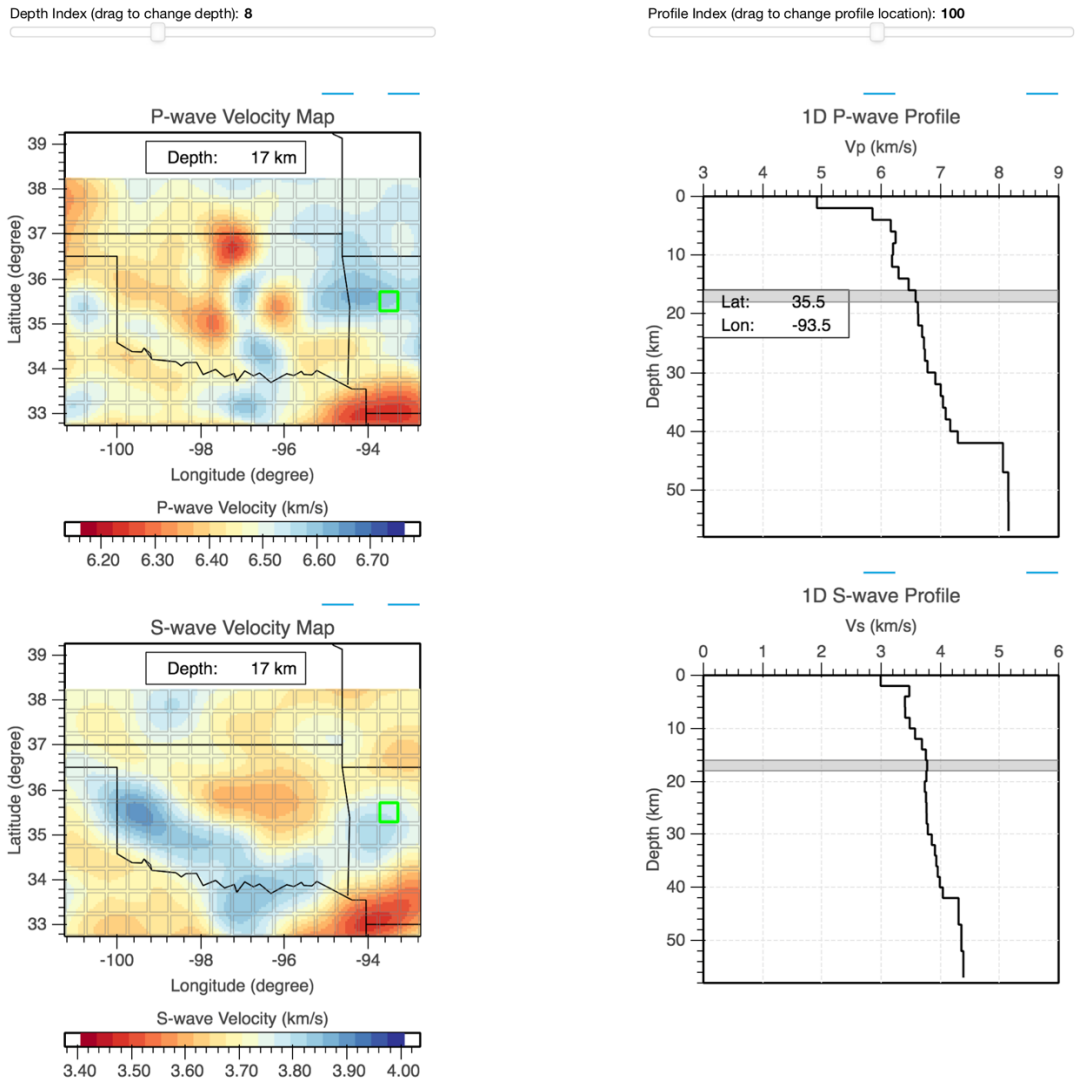

Figure S6. A screenshot of an interactive tool (Visualization S3) that can be used to view the material model (P- and S-wave velocities) at all depths and for depth profiles at any location.

Data Set S1. The material model we inverted using multiple geophysical observations. The data set contains six columns. From left to right, the columns represent latitude, longitude, depth in kilometers, P-wave velocity in kilometer per second, S-wave velocity in kilometer per second, and density in gram per cubic centimeter, respectively.

Data Set S2. The stress field model computed with a tectonic force of N74˚E and a stress increment of 55. The data set contains nine columns. From left to right, the columns represent latitude, longitude, depth in kilometers, S11 in pascal, S22 in pascal, S33 in pascal, S12 in pascal,

S13 in pascal, and S23 in pascal. S is the stress tensor at a location. The subscript 1 represents north, 2 for east, and 3 for down.

Visualization S1. An interactive tool to select optimal smoothing and damping weights for the material model inversion using the L-curve analysis.

Visualization S2. An interactive tool to selected optimal weights for gravity and surface-wave observations for the material model inversion using the L-curve analysis. Each dot in the plot represents an inversion. The first four columns use scatter plots to show the relationship among P-wave traveltime misfit, S-wave traveltime mist, gravity misfit, surface-wave dispersion misfit, P-wave velocity model length (difference from the starting model), S-wave velocity model length, P-wave velocity model roughness, and S-wave velocity model roughness. In the last column, the top panel shows the gravity weight and surface-wave dispersion weight for the inversions. The middle panel presents the gravity misfit and surface-wave dispersion misfit for all the inversions. The bottom panel shows the objective function (see Syracuse et al., 2015) we used to select the optimal weights. A slider at the very top can be used to highlight all the values associated to one inversion.

Visualization S3. An interactive tool to view the P- and S-wave velocities as depth slices and depth profiles side by side.