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A MULTIPLE DATA SET JOINT INVERSION GLOBAL 3D P-VELOCITY MODEL OF THE EARTH'S CRUST AND MANTLE FOR IMPROVED SEISMIC EVENT LOCATION

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Introduction

Goal: Improve our nation's ability to detect nuclear explosions around the world.

Approach: Using a 3D Earth model to locate seismic events will provide more accurate locations with smaller uncertainties as compared to 1D models.

History: SALSA3D is a global tomographic model of the compressional wavespeed in the mantle developed using body waves only. Results presented in poster S21B-2392.

Current Effort: Extend SALSA3D to include joint inversion of compressional body waves, surface waves and gravity.

Progress: We have accomplished joint inversion of body waves and surface waves in the western US. Infrastructure is in place to include gravity and to extend the model to global scale, but results are not available yet.

Tomography Equation solved with LSQR

$$\begin{array}{r} \text{Body Waves (P)} \\ \\ \text{Rayleigh Waves} \\ \\ \text{Constraints} \end{array} \begin{bmatrix} A_b \\ \\ A_{R_1} \\ A_{R_2} \\ \vdots \\ A_{R_N} \\ \\ C_{smooth} \\ C_{damp} \end{bmatrix} \left[\Delta s_P \right] = \begin{bmatrix} \varepsilon_b \\ \\ \varepsilon_{R_1} \\ \varepsilon_{R_2} \\ \vdots \\ \varepsilon_{R_N} \\ \\ 0 \\ 0 \end{bmatrix}$$

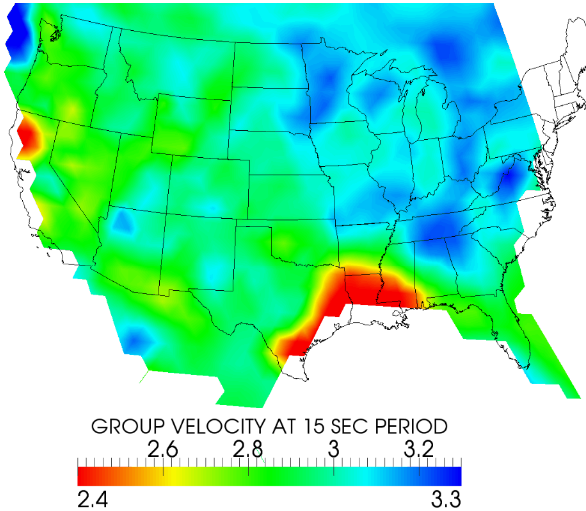
Model Covariance Matrix

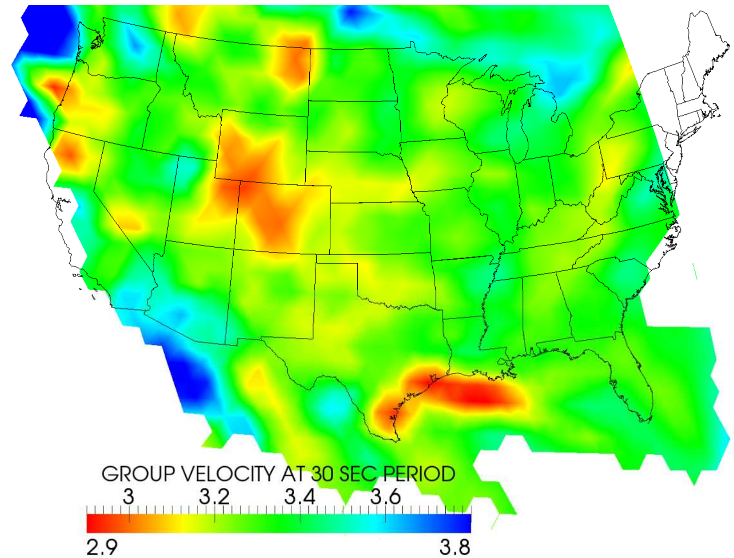
$$C_M = \left(A^T \Sigma_{d_0}^{-1} A + \Sigma_{s_0}^{-1} \right)^{-1}$$

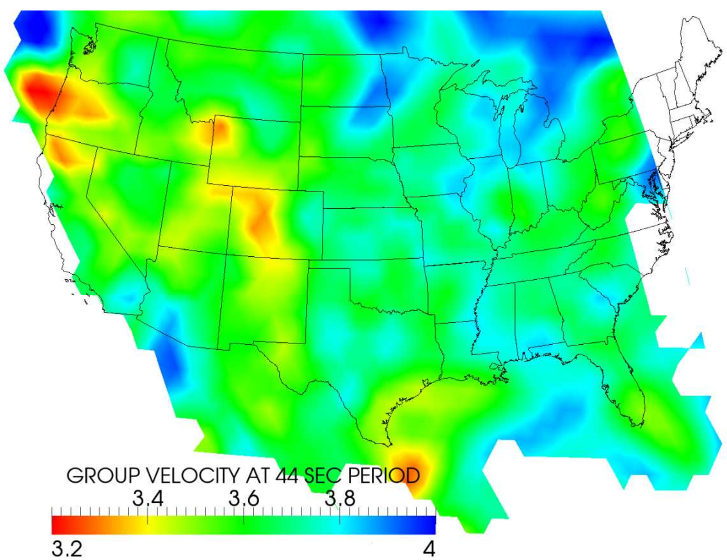
Model Resolution Matrix

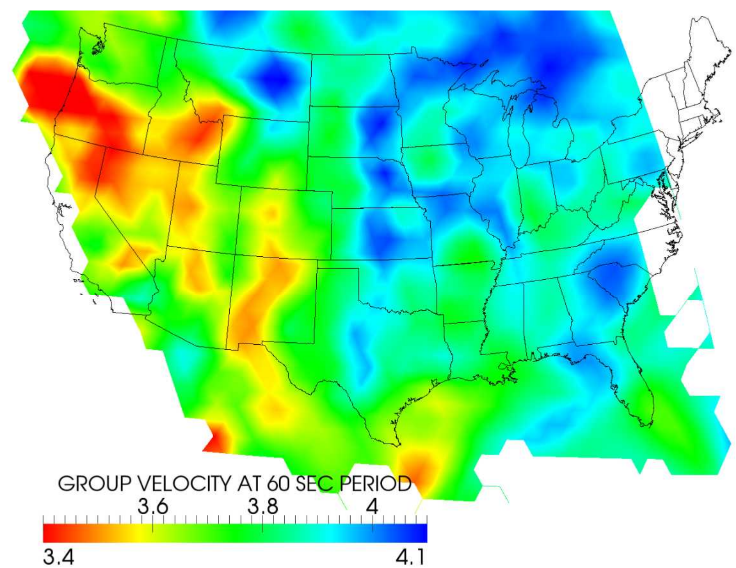
$$R = C_M A^T A$$

Group Velocity

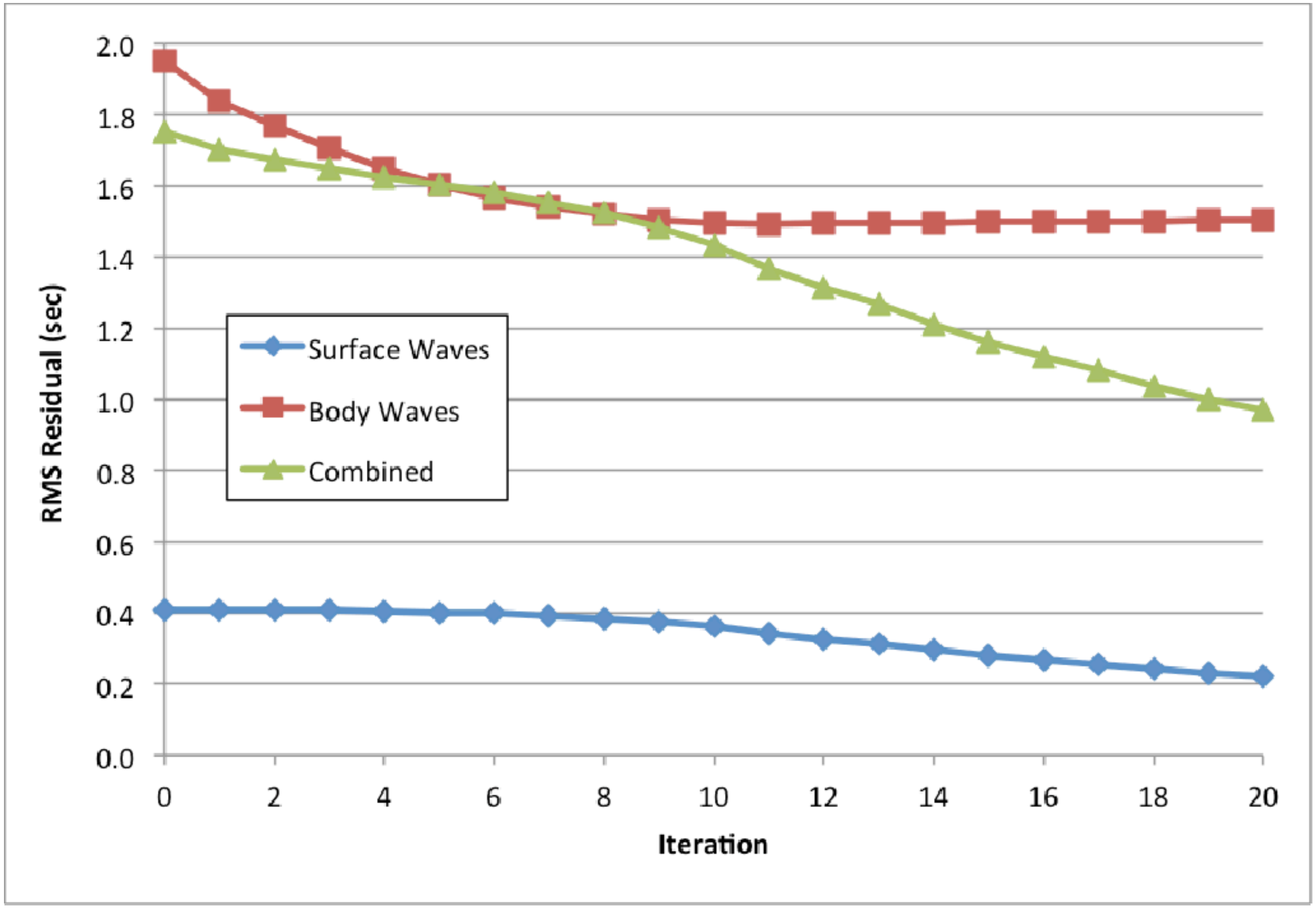


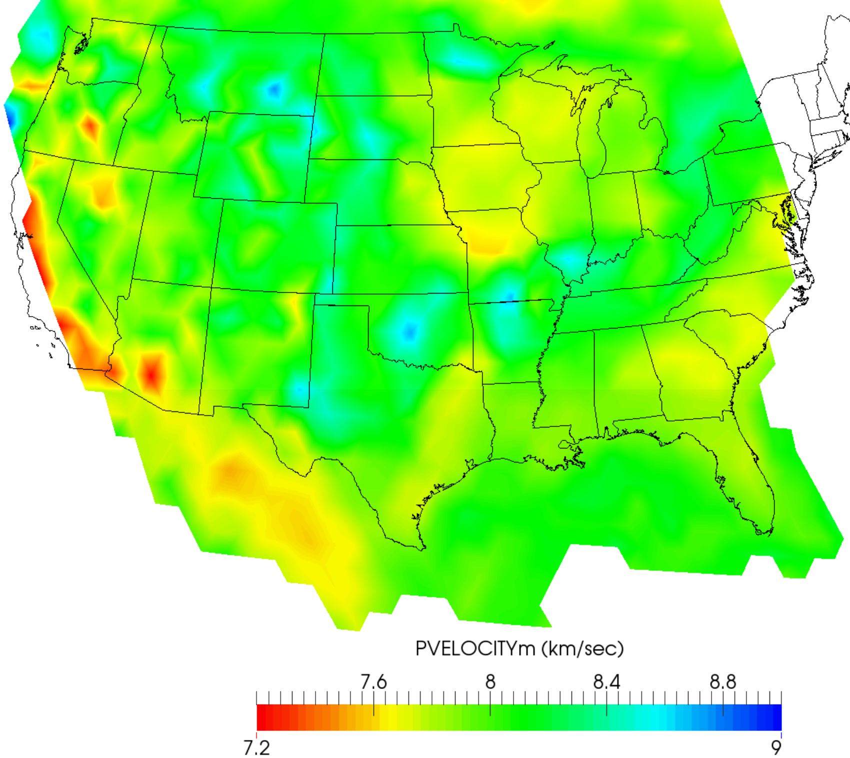


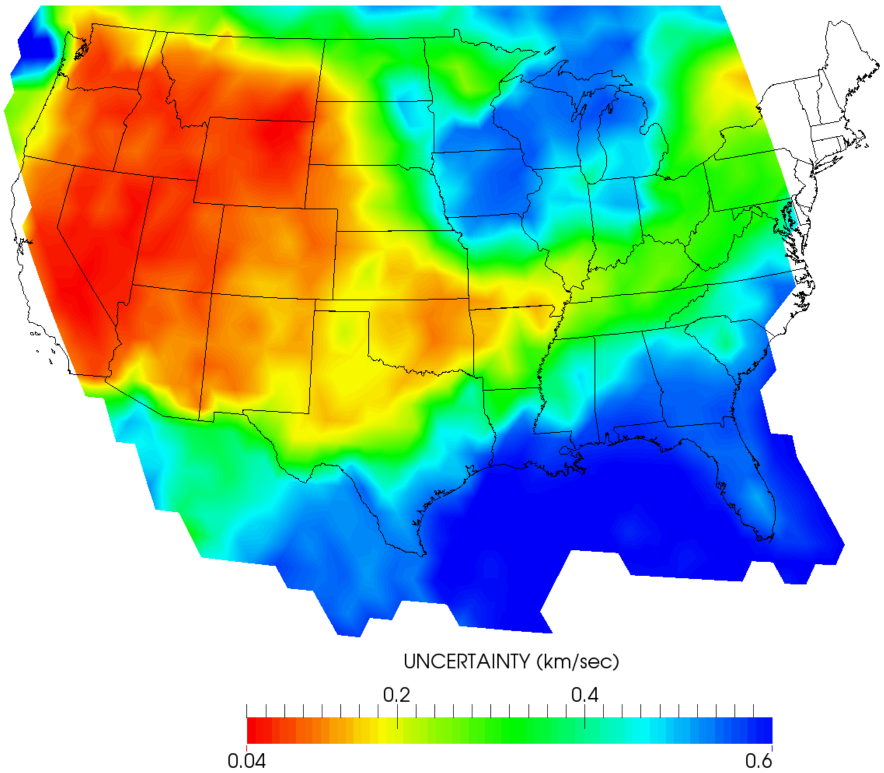




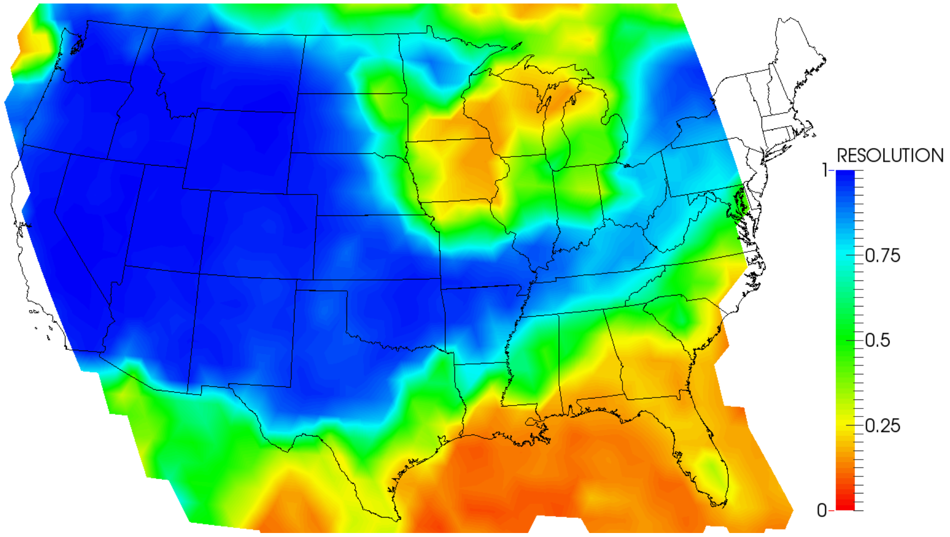
Residual Reduction





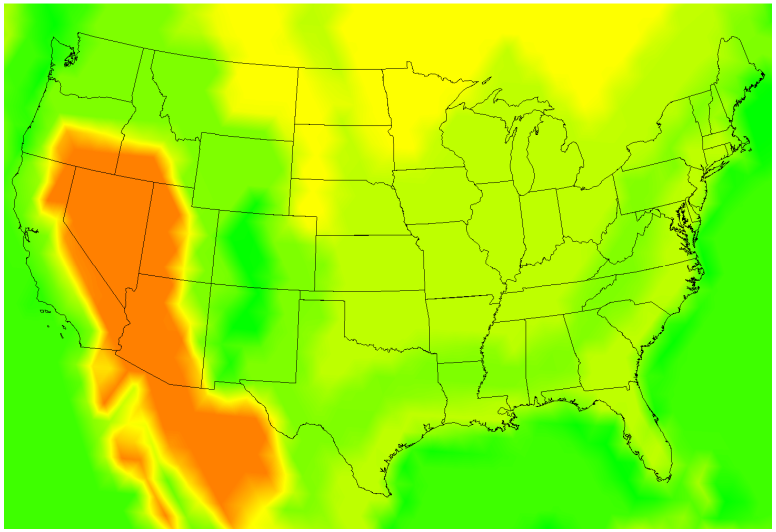


UPPER MANTLE

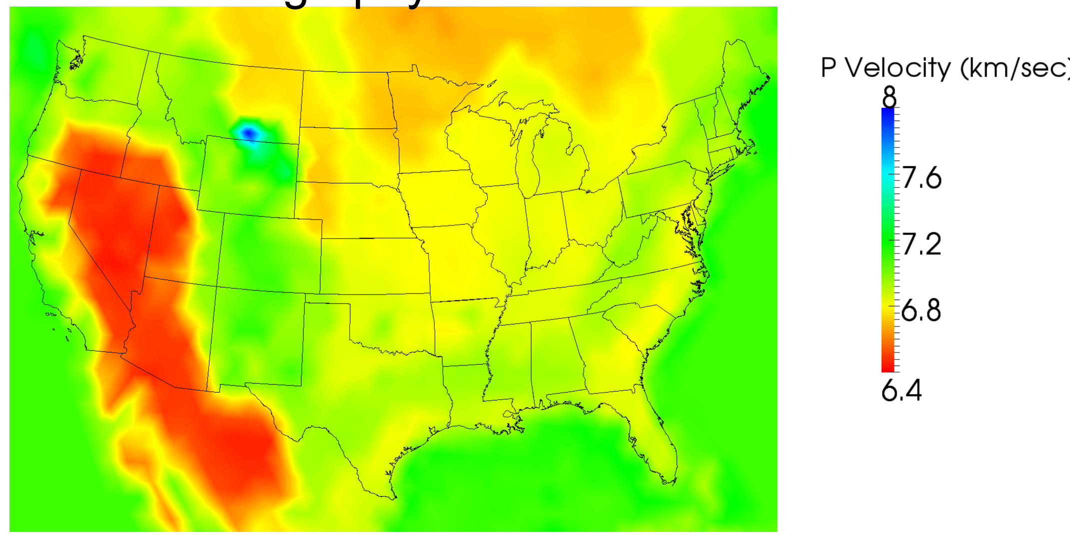


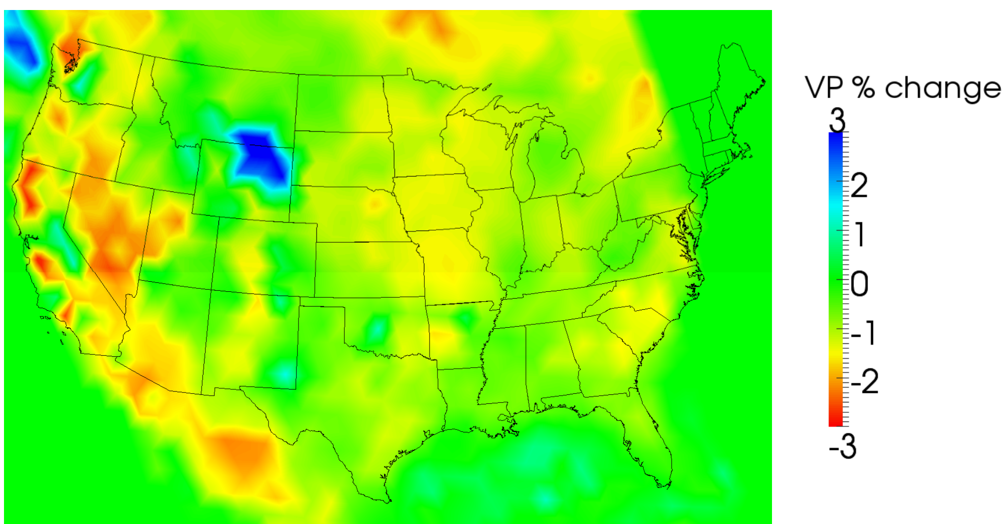
P Velocity of the Lower Crust

Crust 1.0

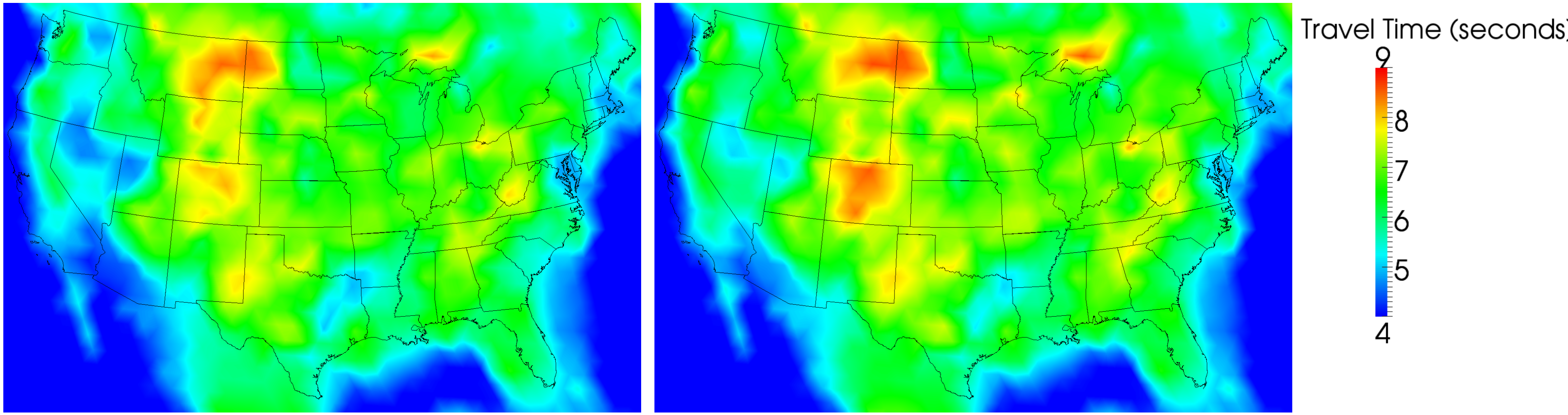


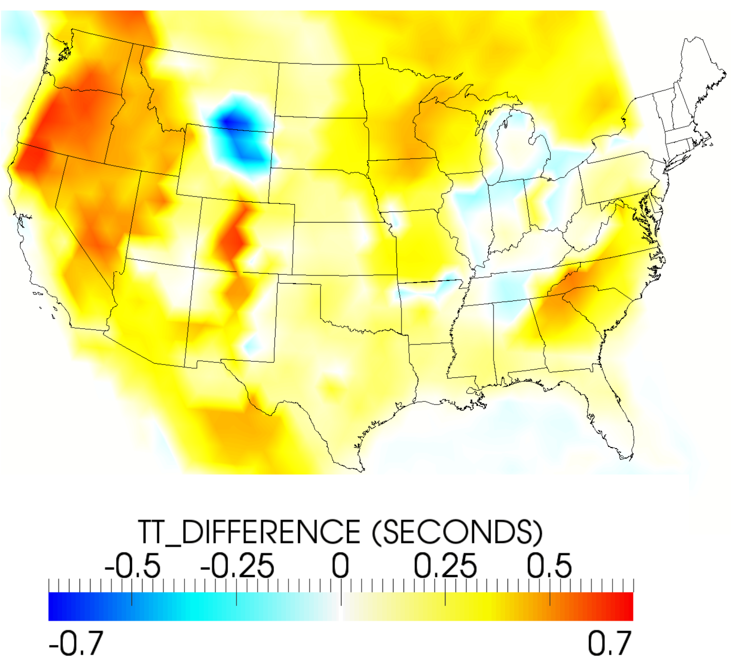
Tomography Model



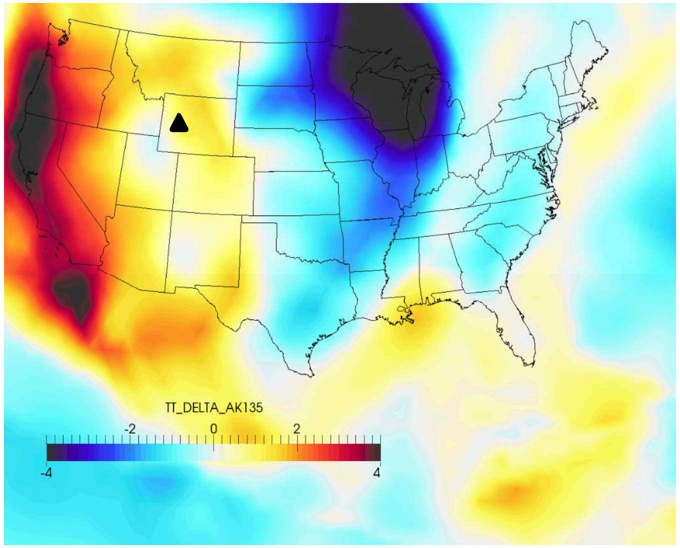


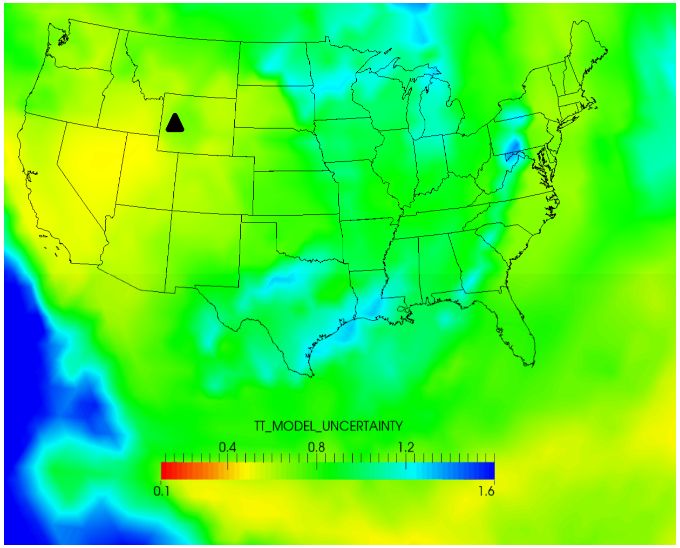
Vertical Travel Time Through the Crust

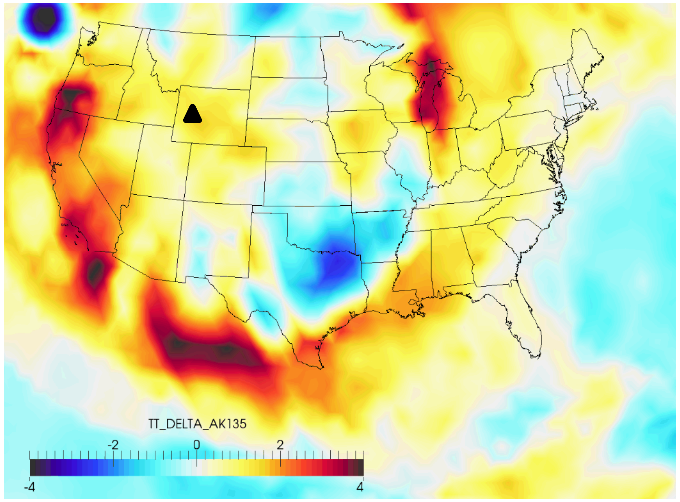


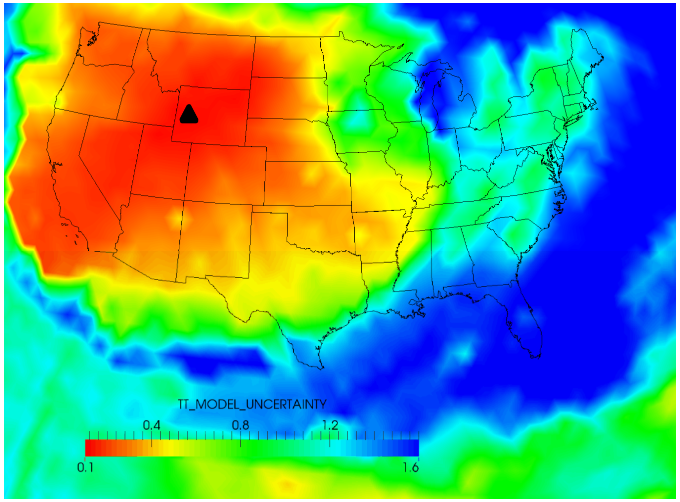


Travel Time and Travel Uncertainty for Station PDAR in Wyoming









Summary

- The goal of our study is to improve our ability to locate seismic events around the world.
- Locating seismic events with a 3D Earth model improves the accurracy and precision of computed seismic event locations.

Future Work

- Complete implementation of joint inversion of body waves, surface waves and gravity on a global scale.