Lower seismogenic depth model for western US earthquake ruptures

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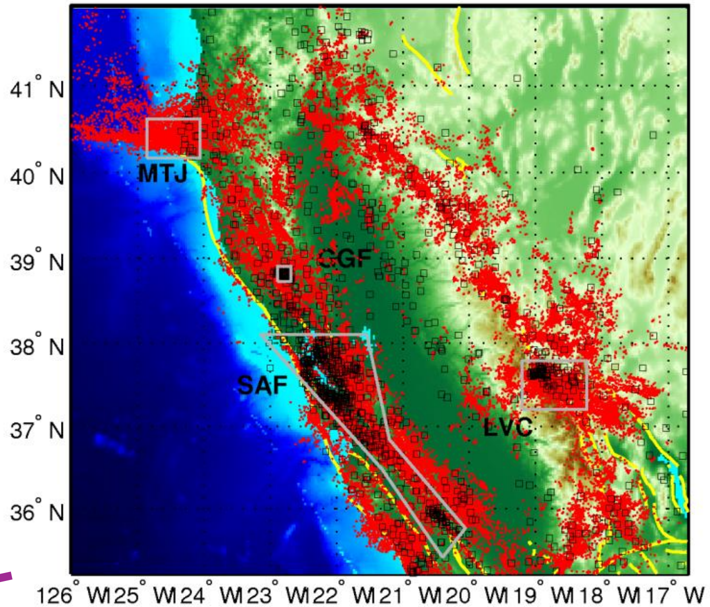
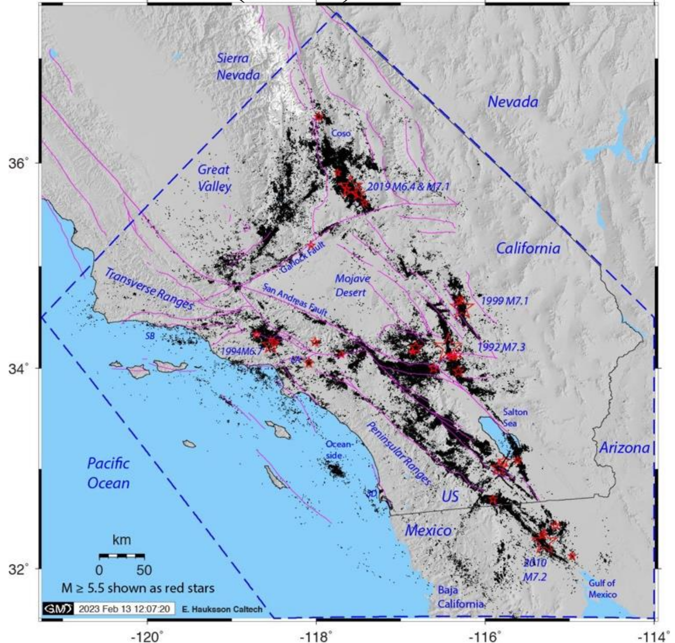
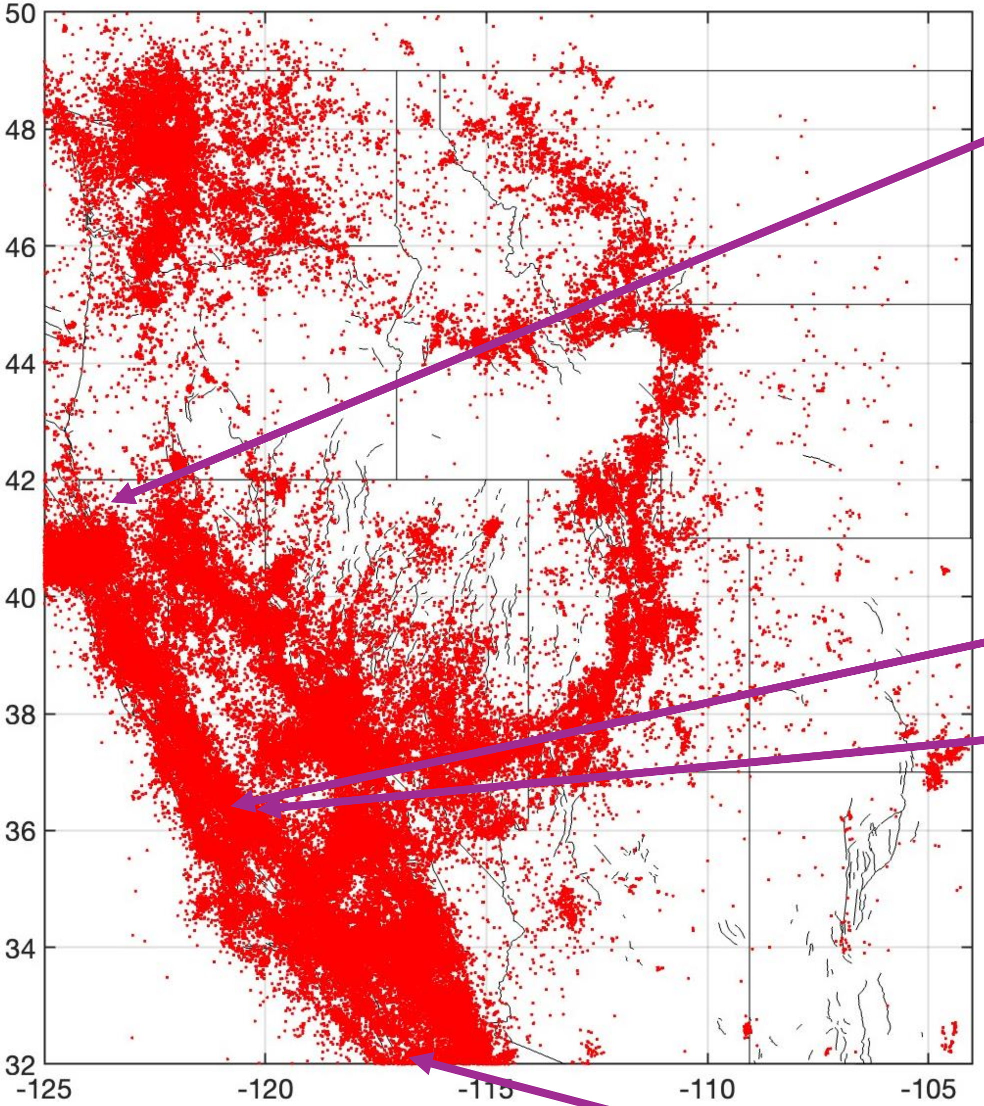
Waldhauser and Schaff (2008) from 1984 to 2024

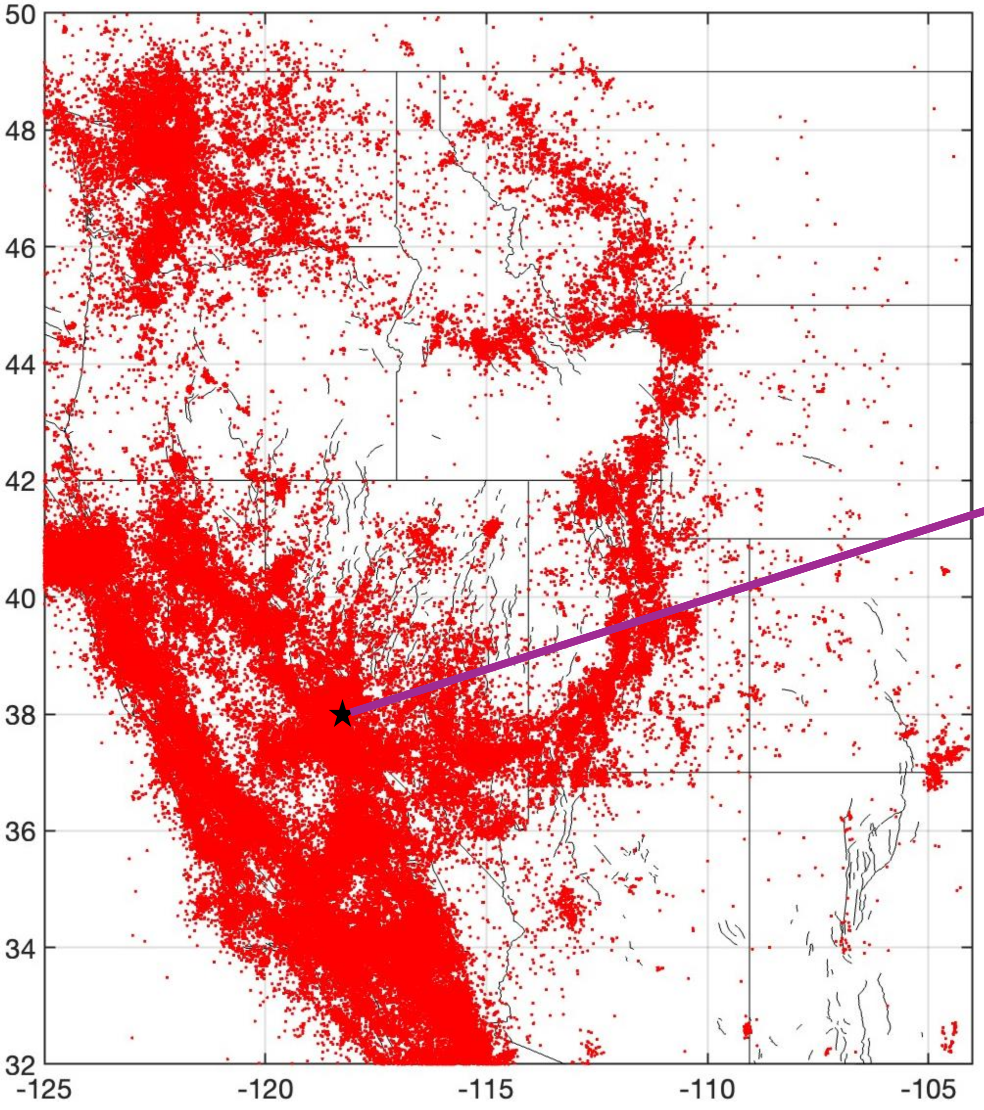


Hauksson et al. (2012) from 1981 to 2023





Spatial distribution of M>1.0 seismicity across the western US from 1850 to 2024.



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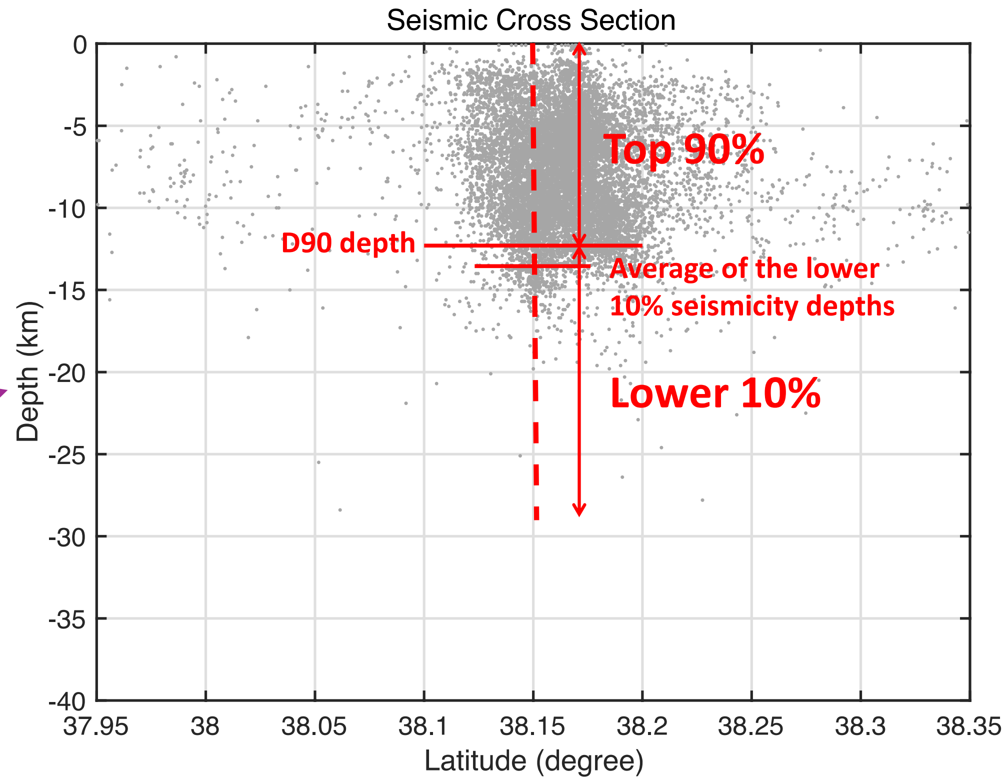
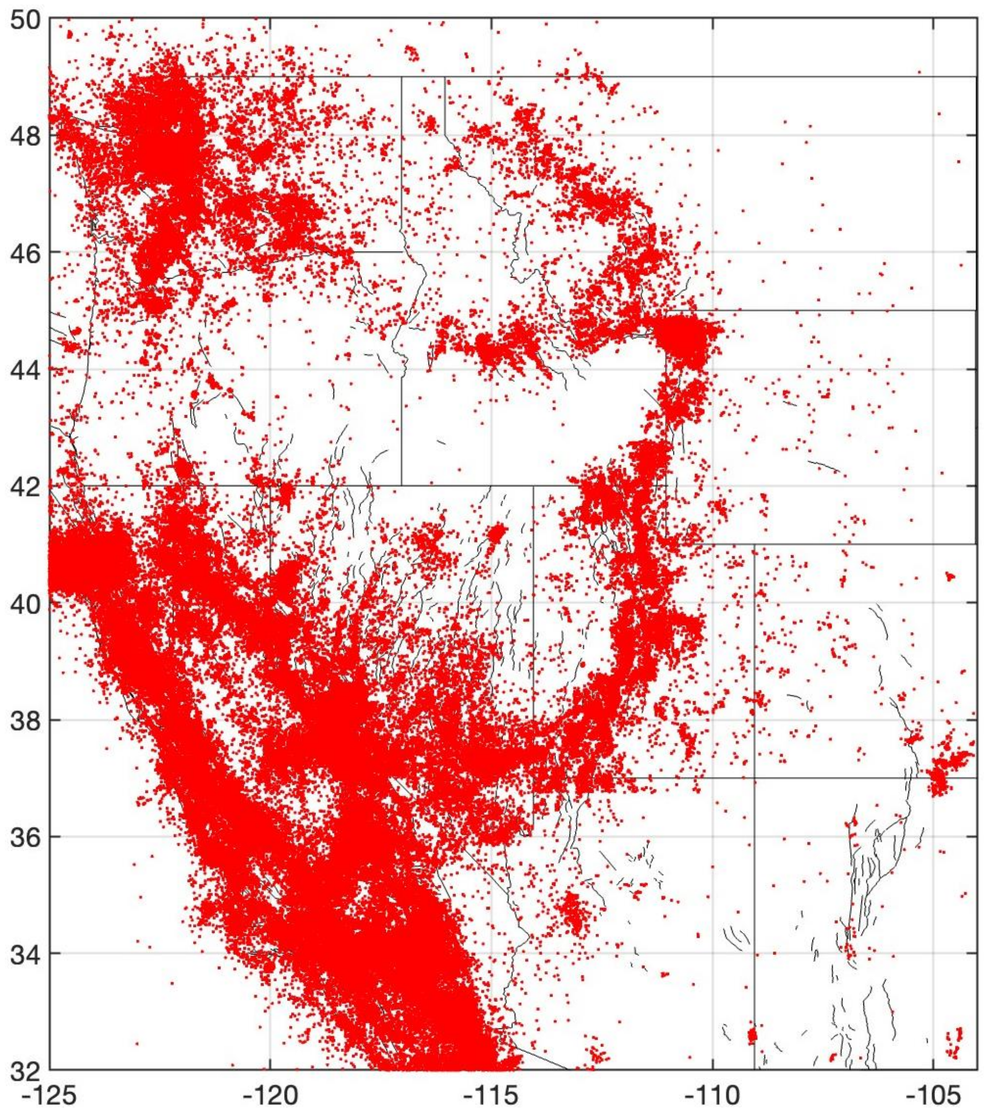


An example of a seismicity cross-section at a grid point in Nevada. The blue dots are seismicity. We count the seismicity within a 50 km distance from the grid point. We then averaged the depth of the seismicity below the 90^{th} percentile seismicity depths (D90) and define the sum of that depth and its uncertainty averaged across the whole region as our lower seismogenic depth (Zeng *et al.*, 2022).

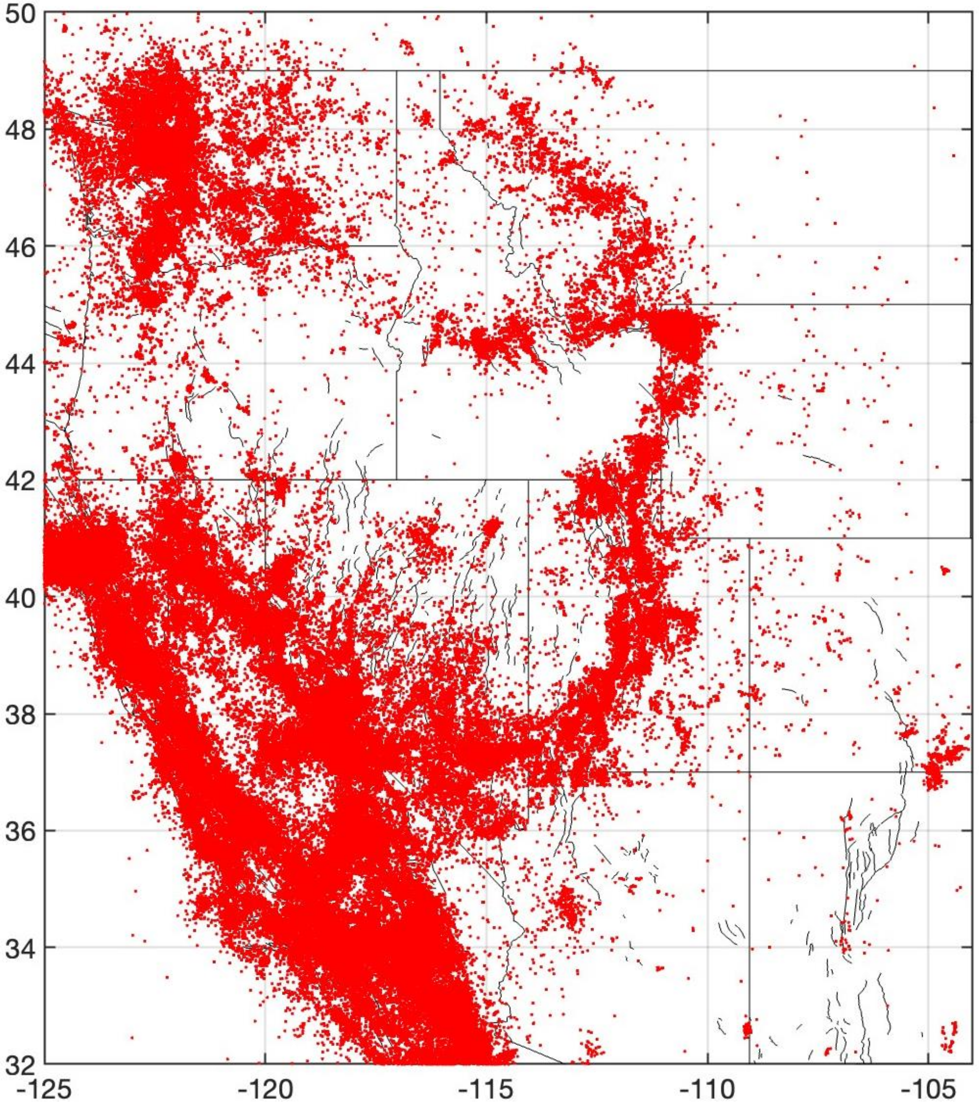


Spatial distribution of M>1.0 seismicity across the western US from 1850 to 2024.

A lower seismogenic depth model is developed based on seismicity for the western U.S.

$$d_{seis}(\boldsymbol{x}) = \frac{1}{N} \sum_i [d(\boldsymbol{x}_i; |\boldsymbol{x} - \boldsymbol{x}_i| < r_{samp}) > D_{90}] + \sigma$$

where d_{seis} is the lower seismogenic depth at a grid point $\boldsymbol{x}$, d is the event focal depth, $\boldsymbol{x}_i$ is the event focal location, r_{samp} is the sampling distance, N is the total event count for events below D_{90} within r_{samp}, and σ is one standard deviation of the mean seismogenic depth of events below D_{90} within r_{samp}.



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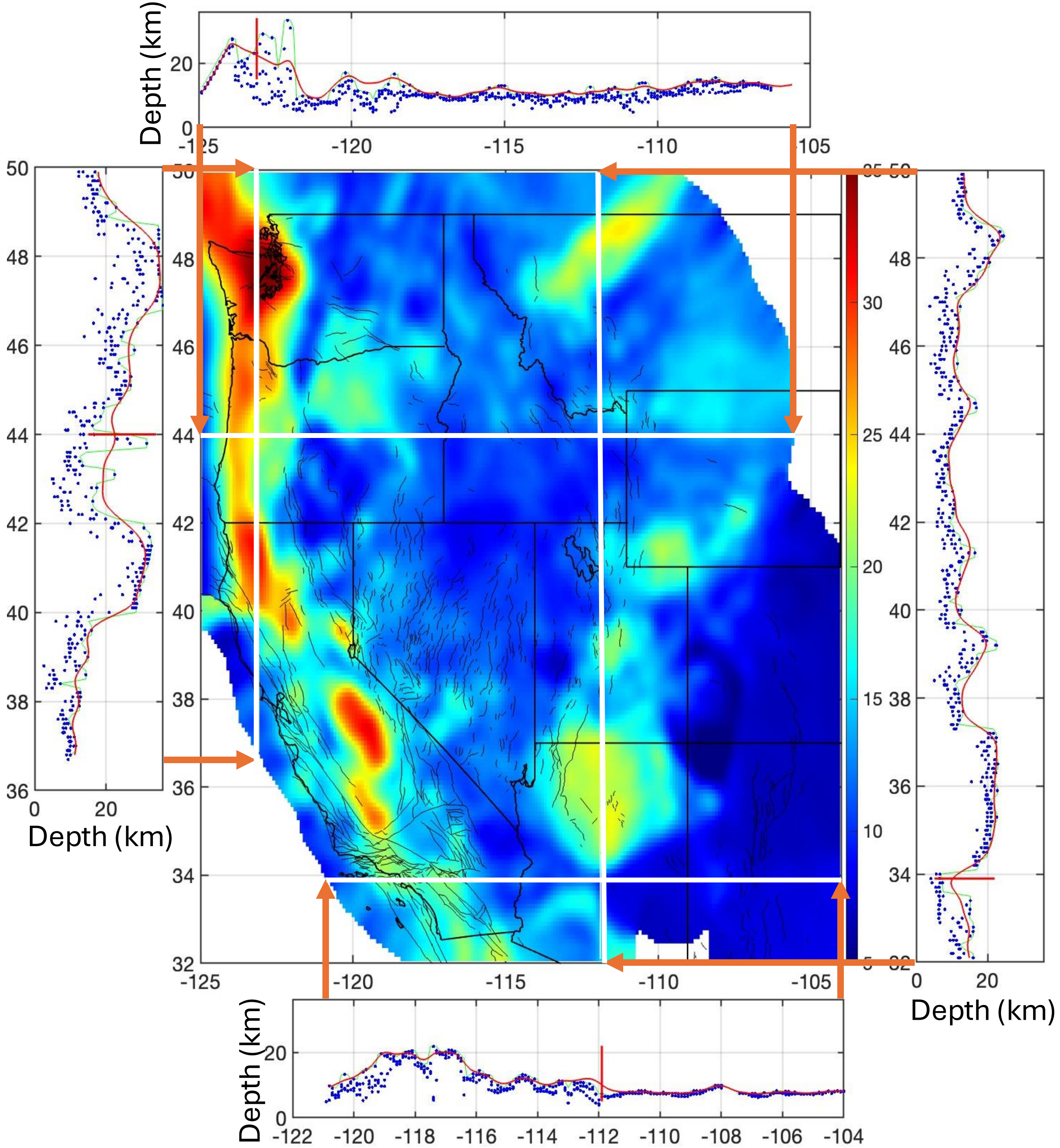
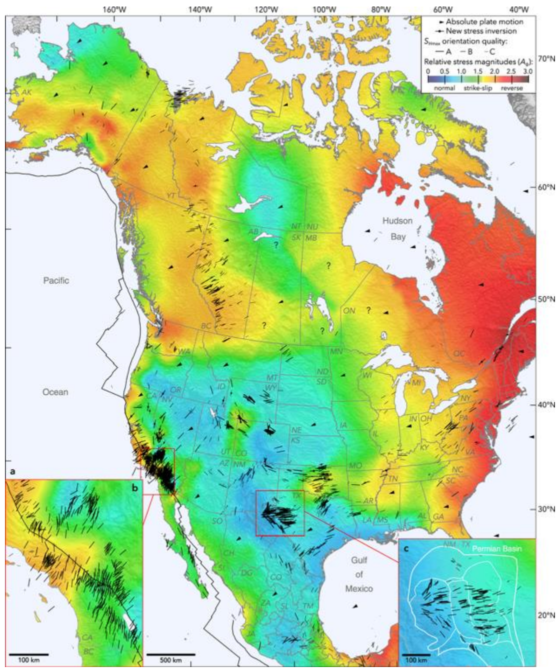
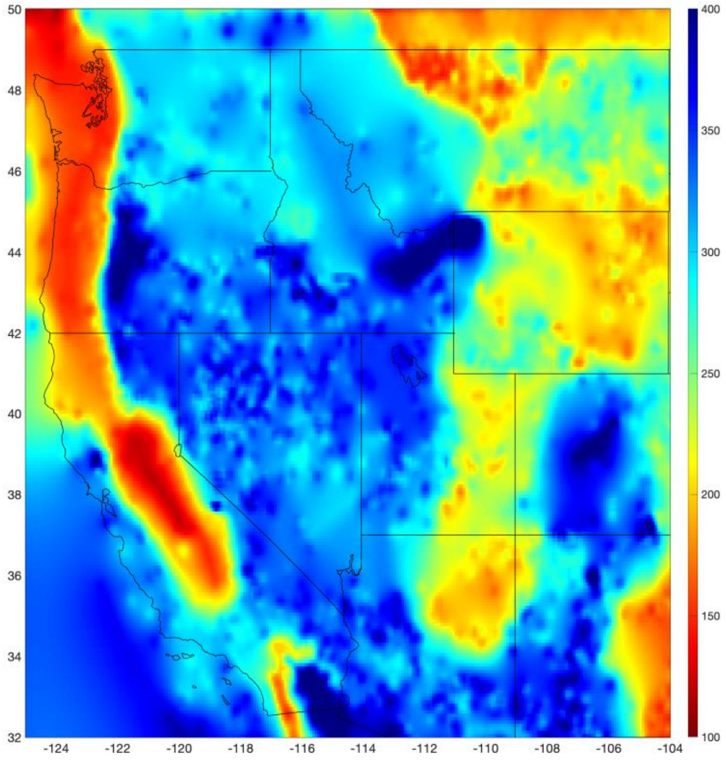
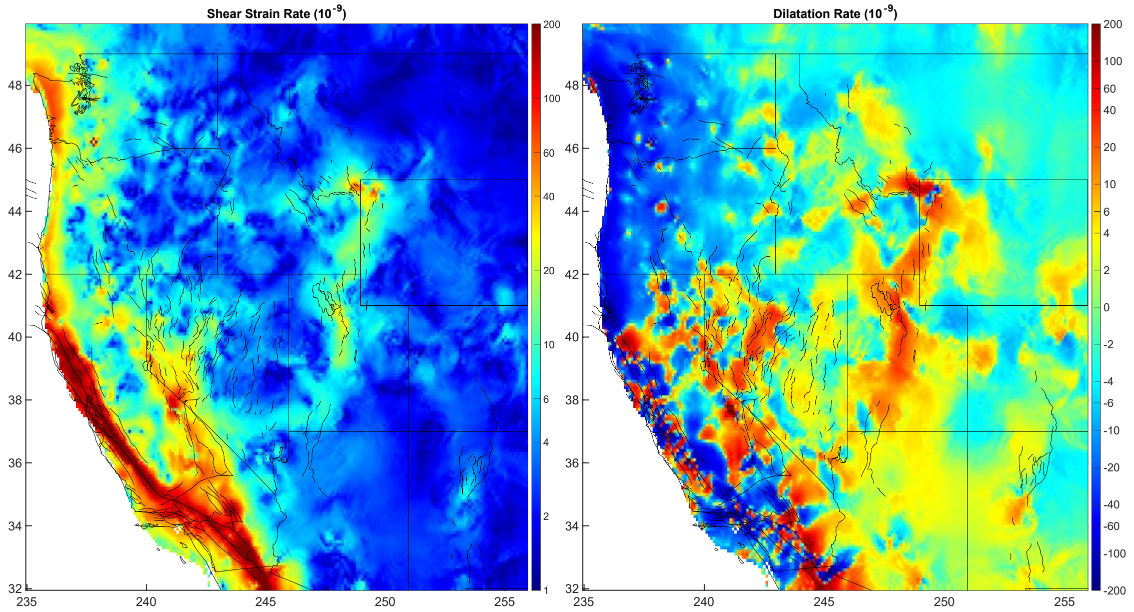


Stress model of Lund Snee and Zoback (2020)

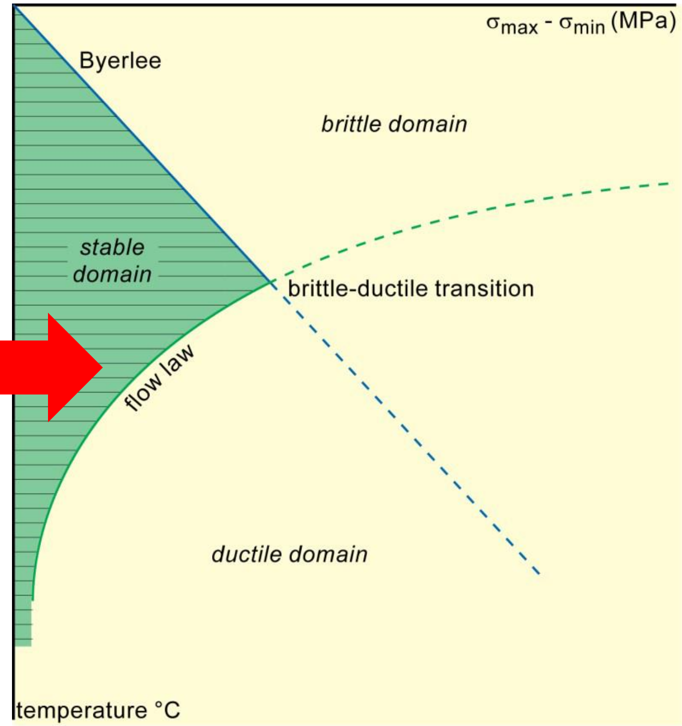




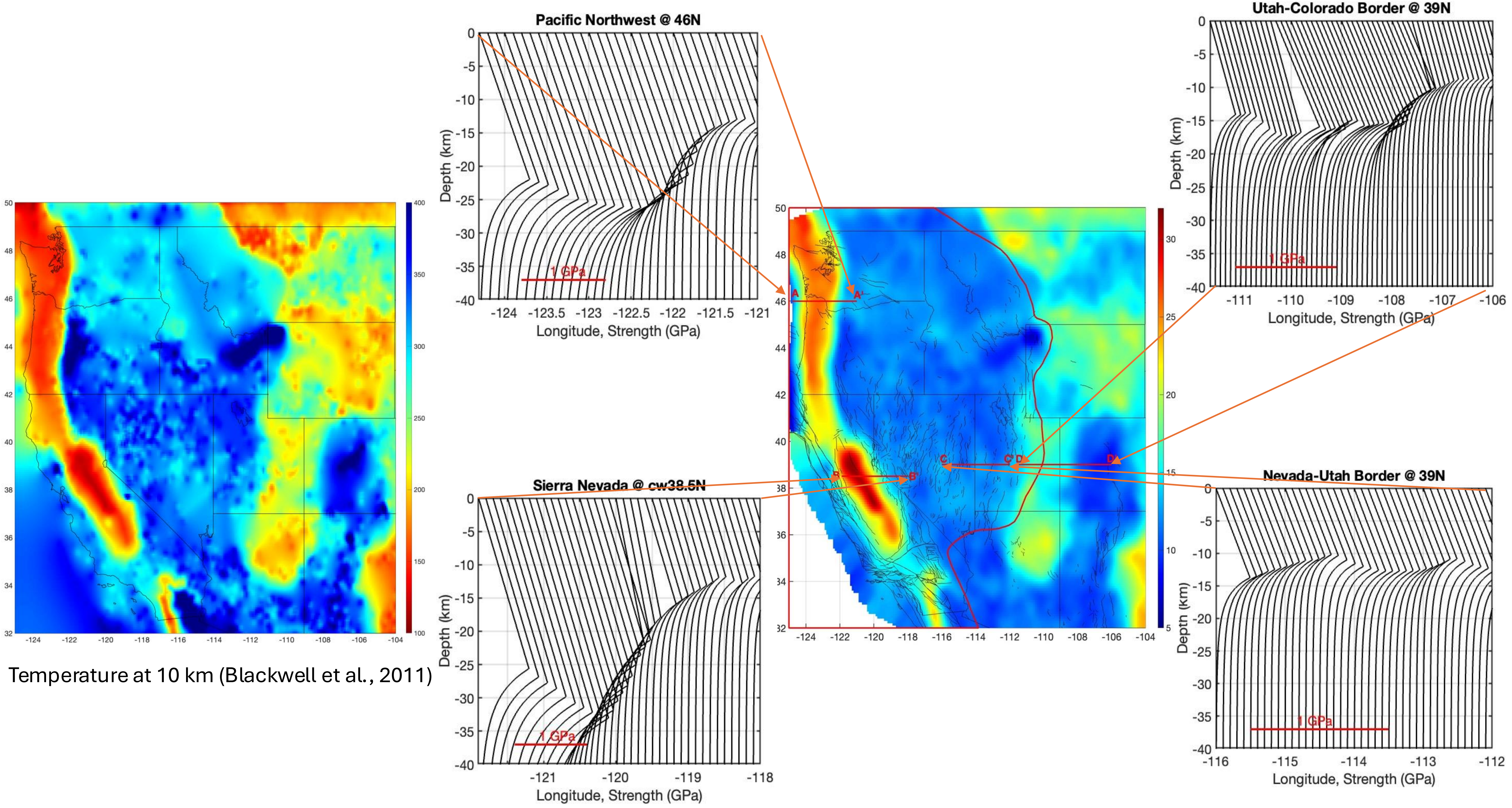
Temperature at 10 km (Blackwell et al., 2011)



Strain rate model of Zeng (2022)



Elementary construction of a rheological profile



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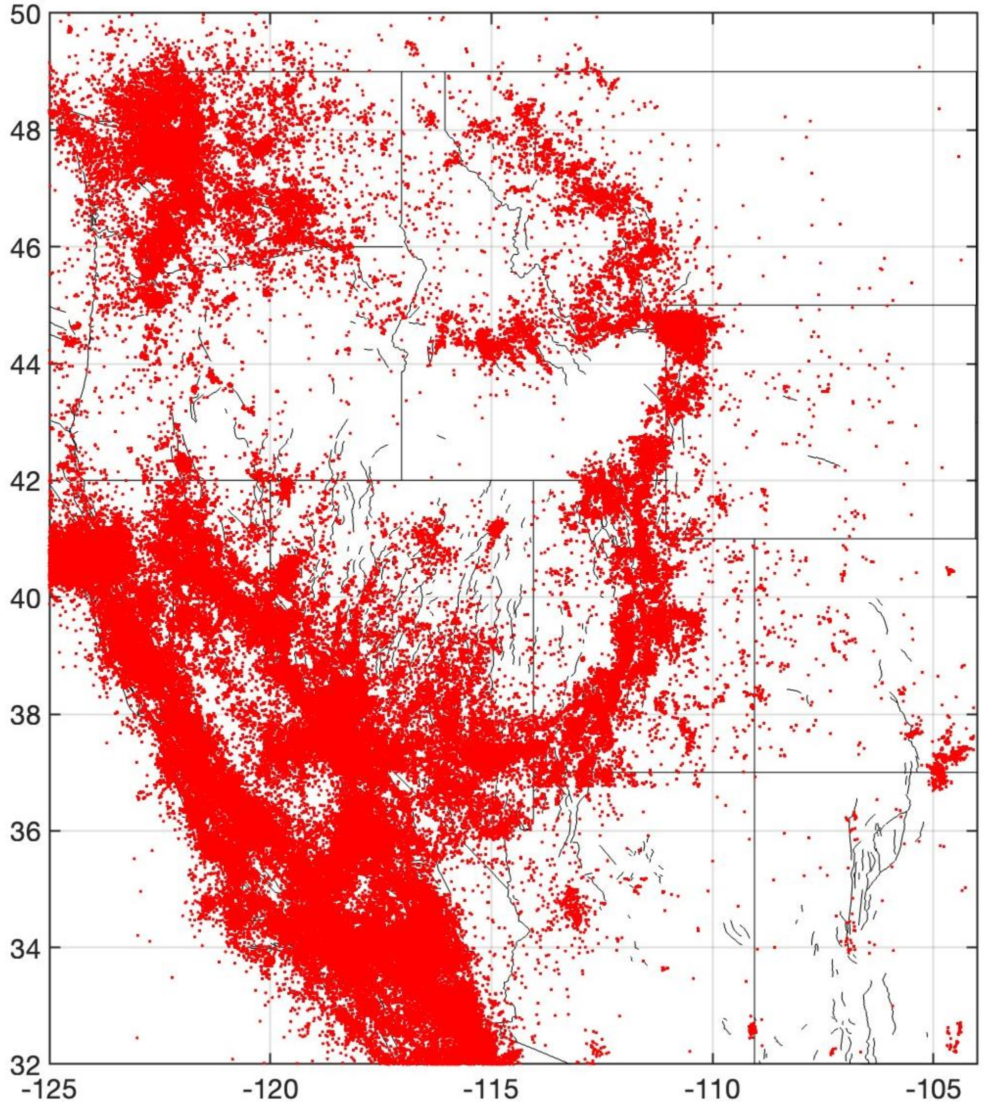

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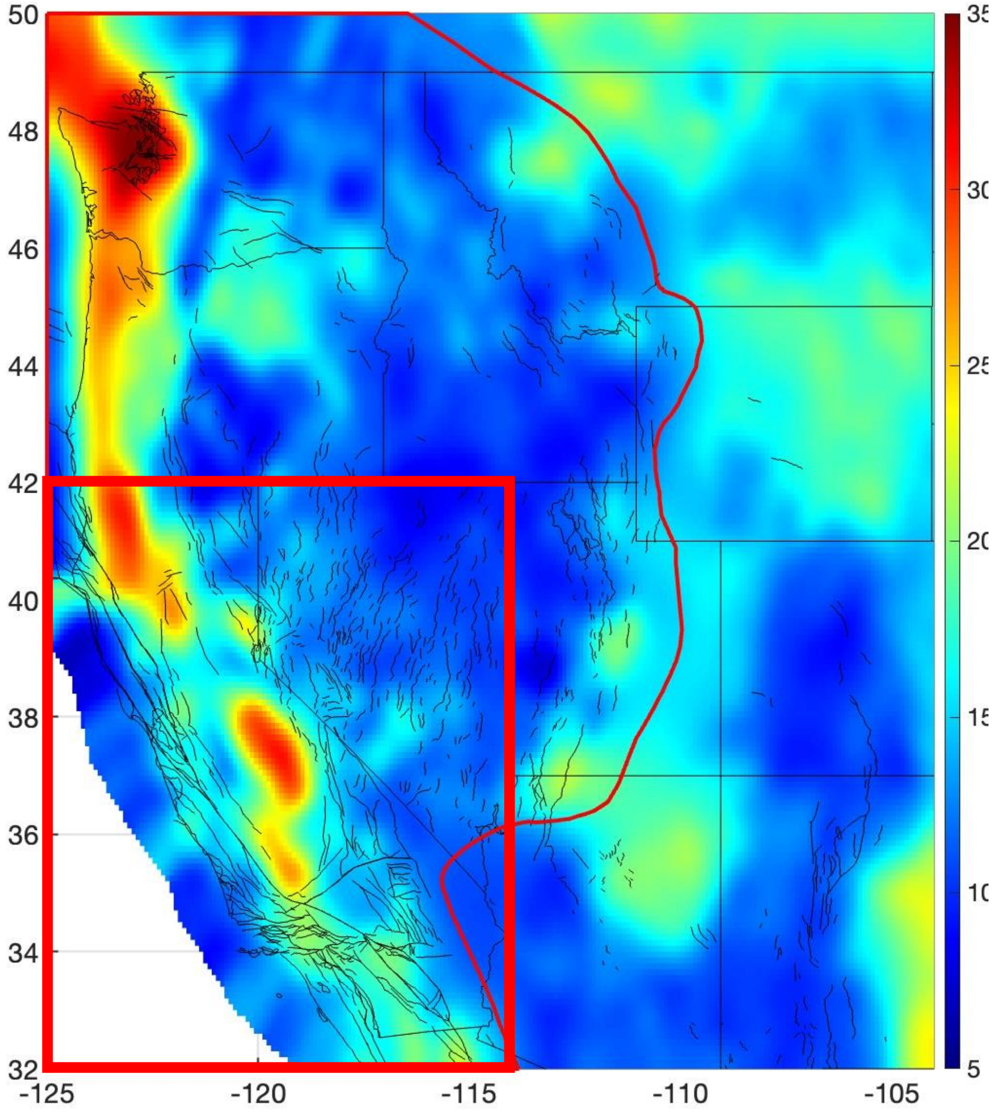
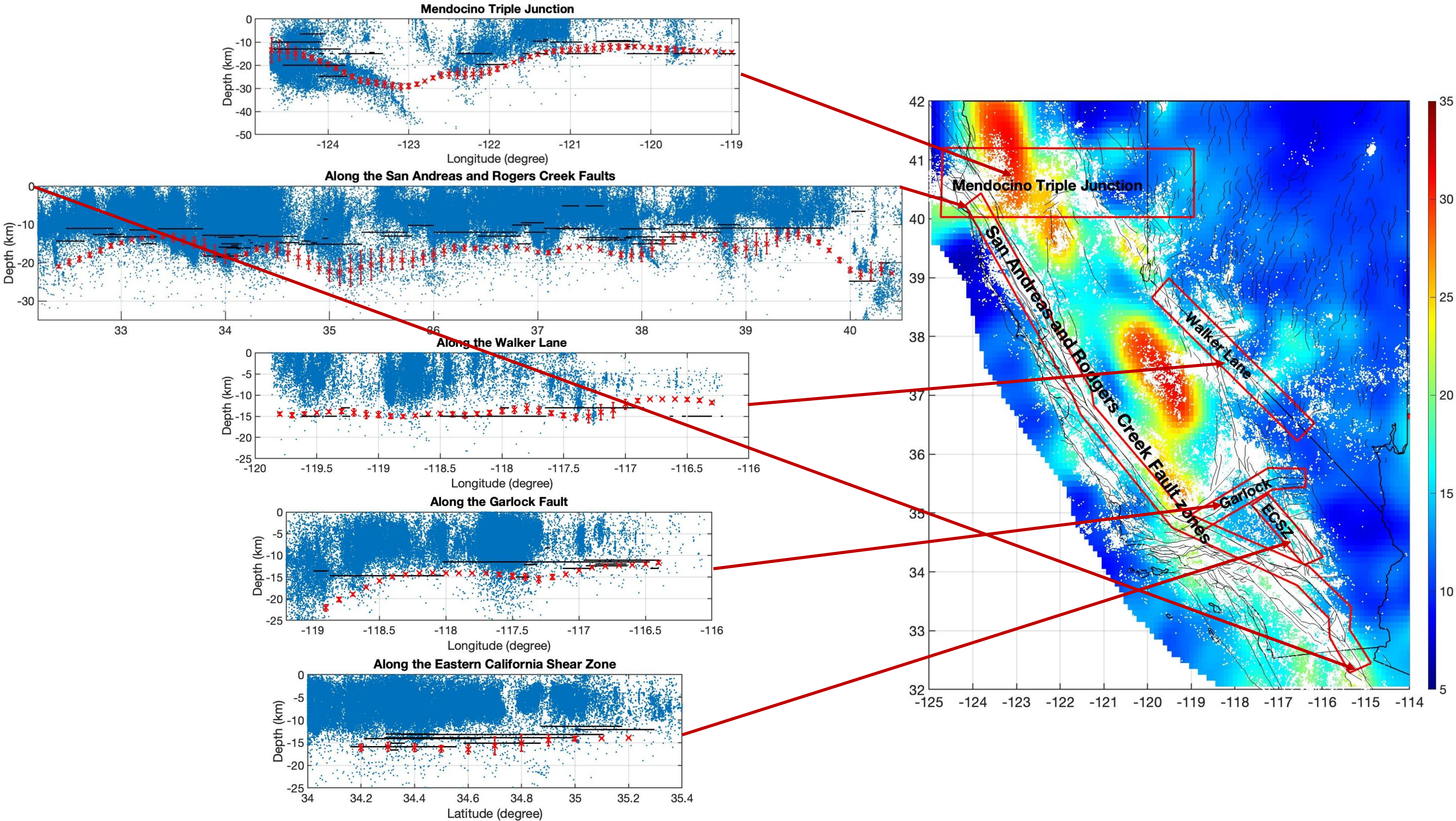


Final crustal earthquake rupture model of Zeng et al. (2024).



Mendocino Triple Junction
Depth (km)
Longitude (degree)
Along the San Andreas and Rogers Creek Faults
Depth (km)
Along the Walker Lane
Depth (km)
Longitude (degree)
Along the Garlock Fault
Depth (km)
Longitude (degree)
Along the Eastern California Shear Zone
Depth (km)
Latitude (degree)
Mendocino Triple Junction
San Andreas and Rodgers Creek Fault Zones
Walker Lane
Garlock
ECSZ

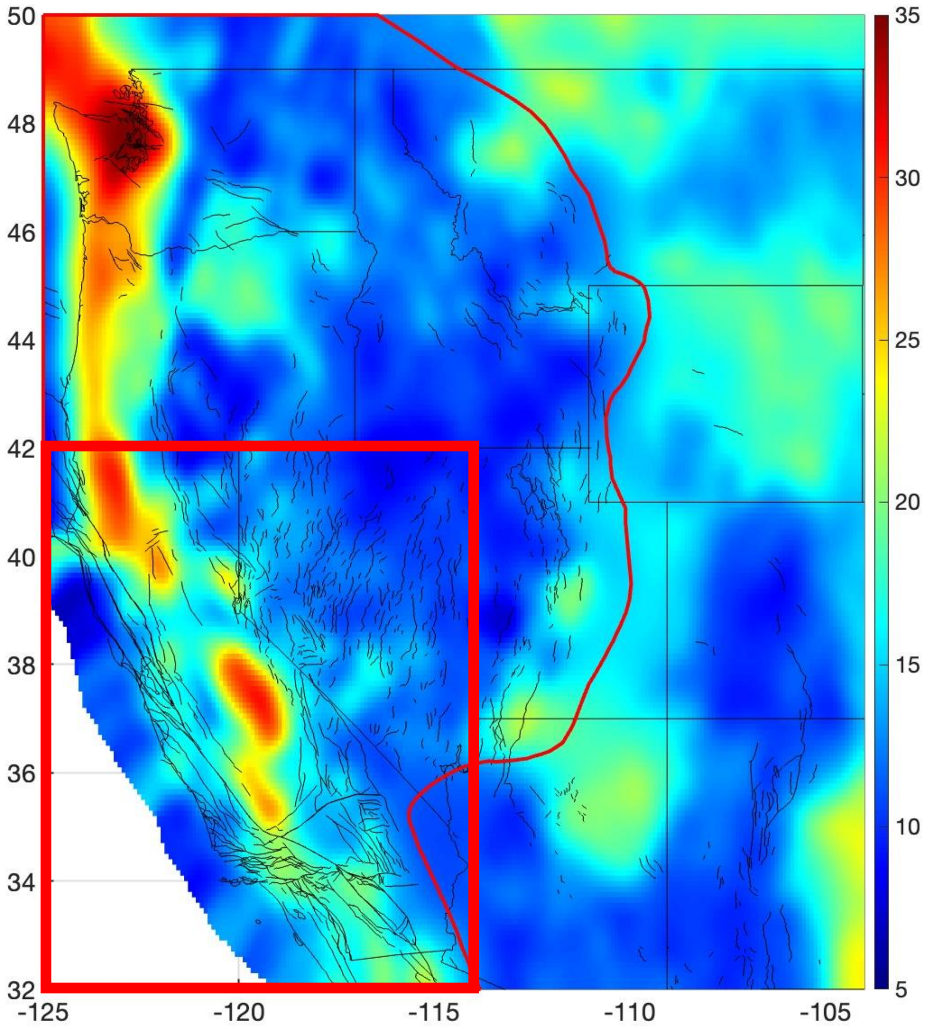
Conclusion:

(1) A lower seismogenic depth model for the WUS is developed and updated based on seismicity.

(2) This seismogenic depth model agrees well with rupture depths of large earthquake sources in California based on inversion of geodetic and seismic-waveform observations.

(3) The model correlates well with the temperature/heat flow model of Blackwell et al., 2011. A Brittle-ductile transition model based on their temperature profiles is developed to supplement the east part of the seismogenic depth model with low seismicity.

(4) This depth depths can be used to recalibrate the geologic fault depths and applied to the background seismicity source model in the western US to improve national seismic hazard estimates.



The final seismogenic depth model for the western US with the low seismicity region east of the Intermountain West Seismic Belt supplemented by a brittle–ductile transition model based on heatflow data and other stress/strain input and constraint by the Moho and the Cascadia subduction slab surfaces.(Zeng *et al.*, 2024).