

A satellite-style image showing the Pacific Northwest coastline of North America, including the Puget Sound and the surrounding land and ocean. The land is green and brown, with some snow-capped mountains. The ocean is blue, with visible bathymetry. The title text is overlaid on the upper part of the image.

Toward Linking Coseismic Slip to Interseismic Coupling at Cascadia

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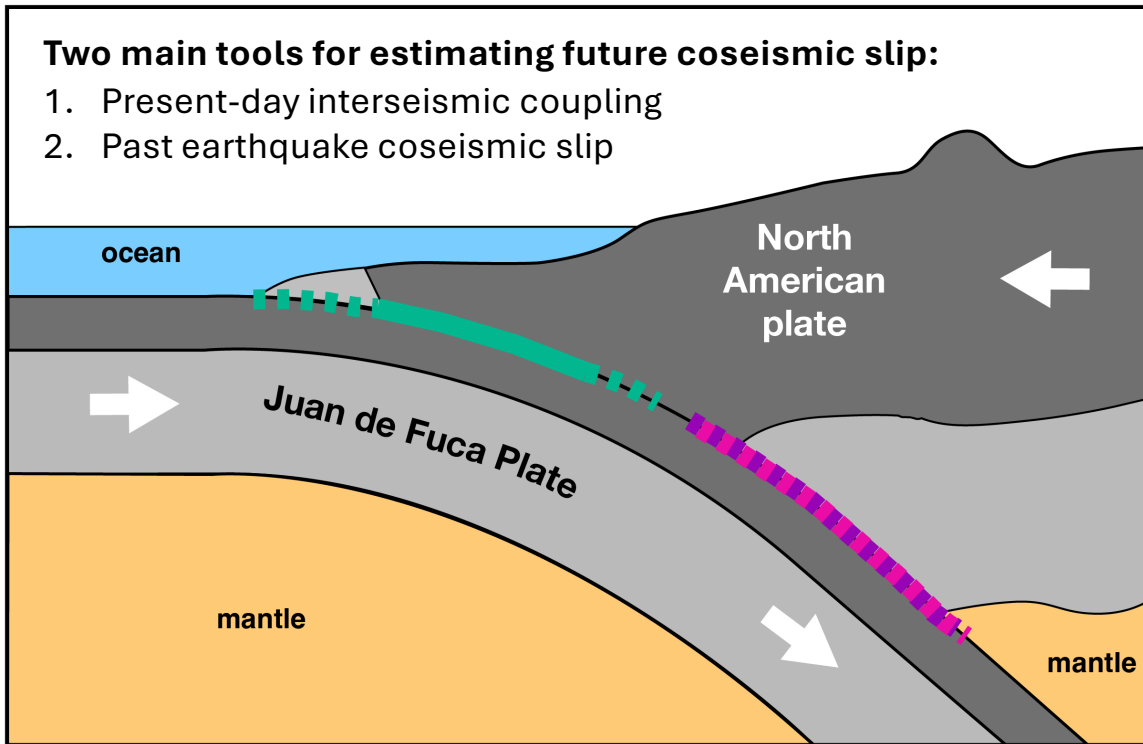
1 GEOMAR Helmholtz Centre for Ocean Research Kiel
2 Indiana University, Dept. of Earth & Atmospheric Sciences

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat/Copernicus
Data LDEO-Columbia, NSF, NOAA

Downdip Limit of Coseismic Slip

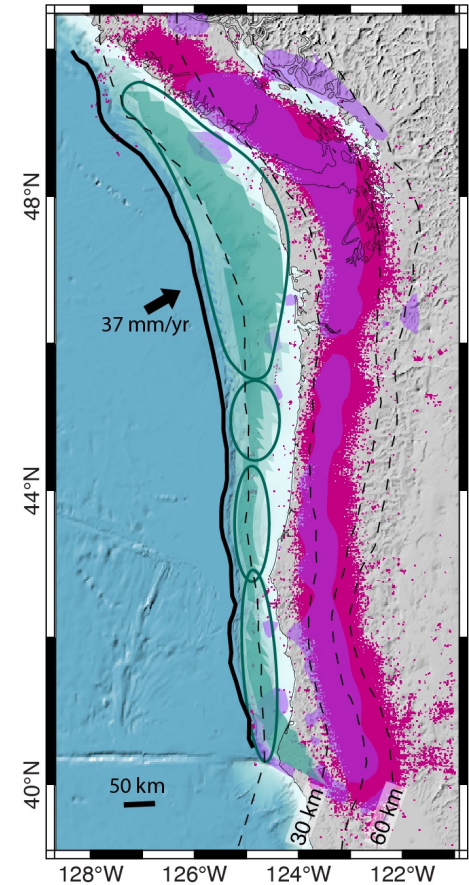
Two main tools for estimating future coseismic slip:

1. Present-day interseismic coupling
2. Past earthquake coseismic slip



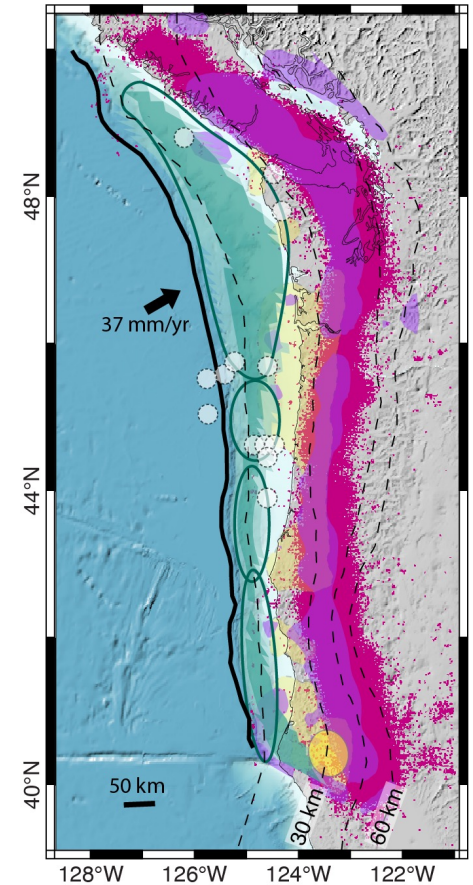
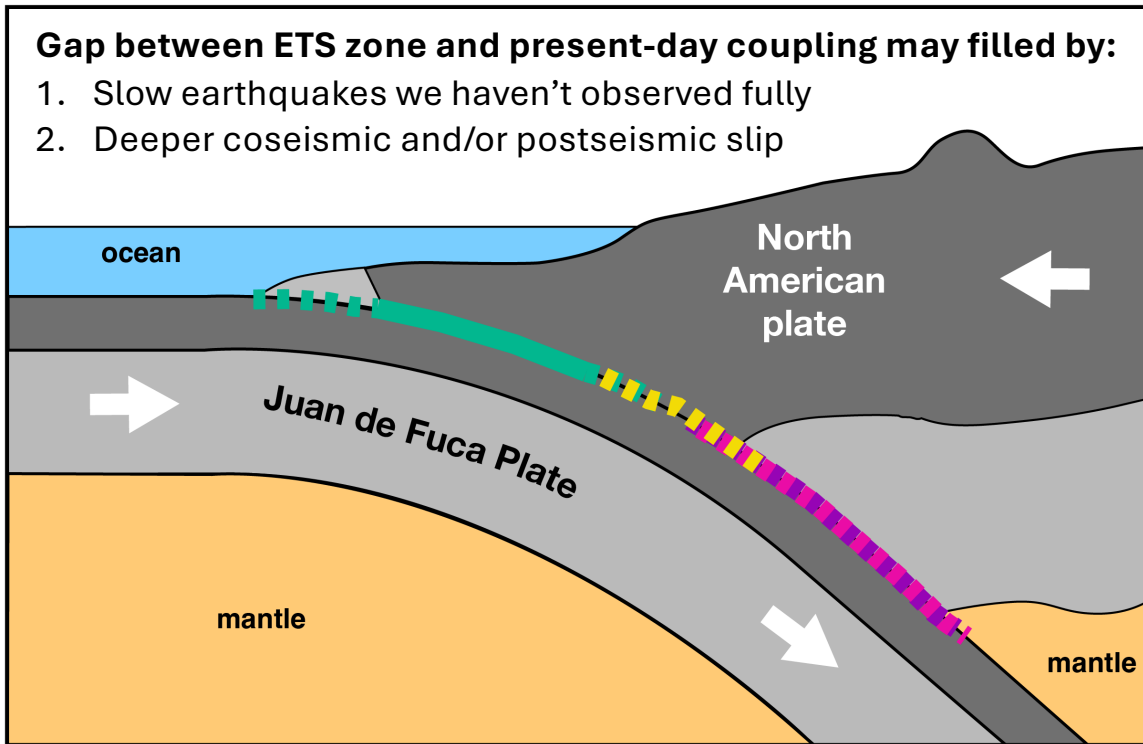
Coupling ratio

- >80%
- >50%
- coseismic slip
- short-term slow slip
- tremor



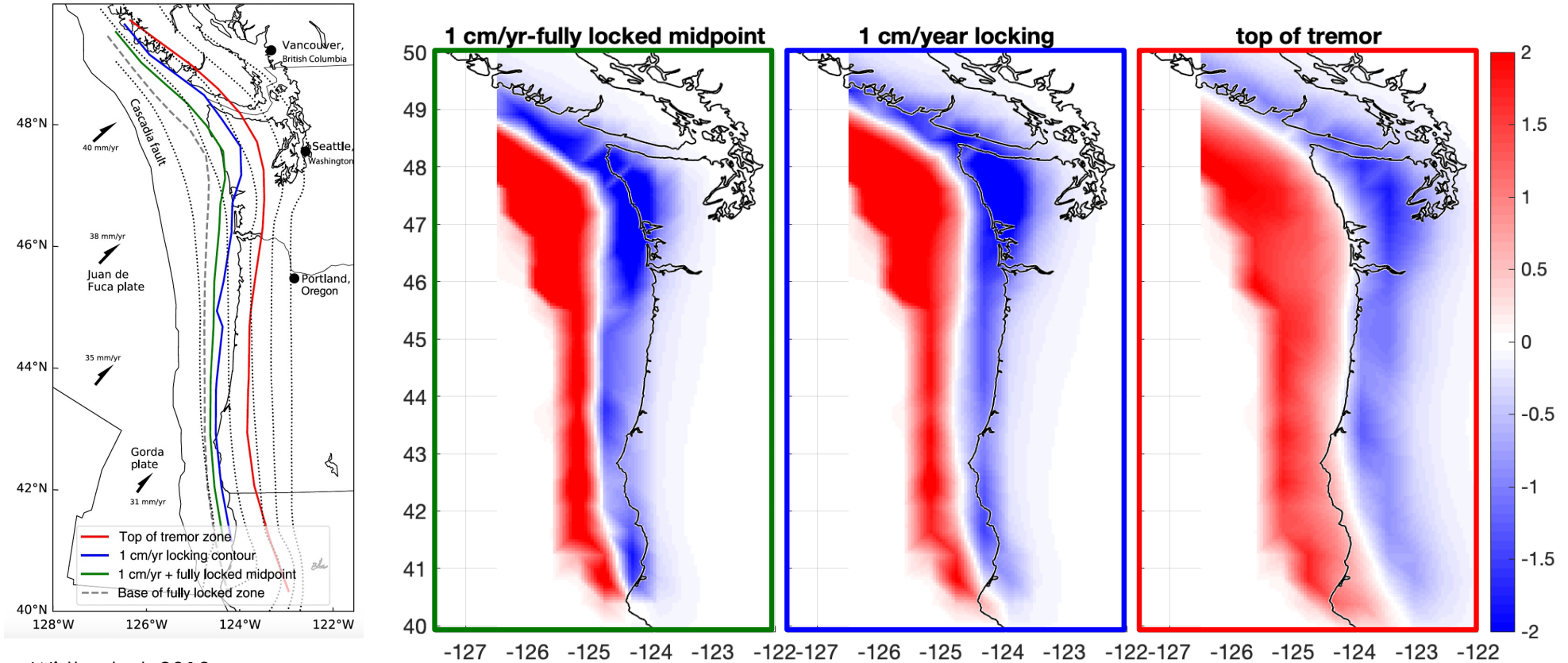
Wang et al., 2013; Sherrill et al. 2024; Wech, 2021; Bartlow, 2020

Downdip Limit of Coseismic Slip



Wang et al., 2013; Sherrill et al. 2024; Wech, 2021; Bartlow, 2020; Chaudhuri & Ghosh, 2022; Fan et al., 2022; Materna et al., 2019; Nuyen & Schmidt, 2021



Vertical Signature of Coseismic Slip

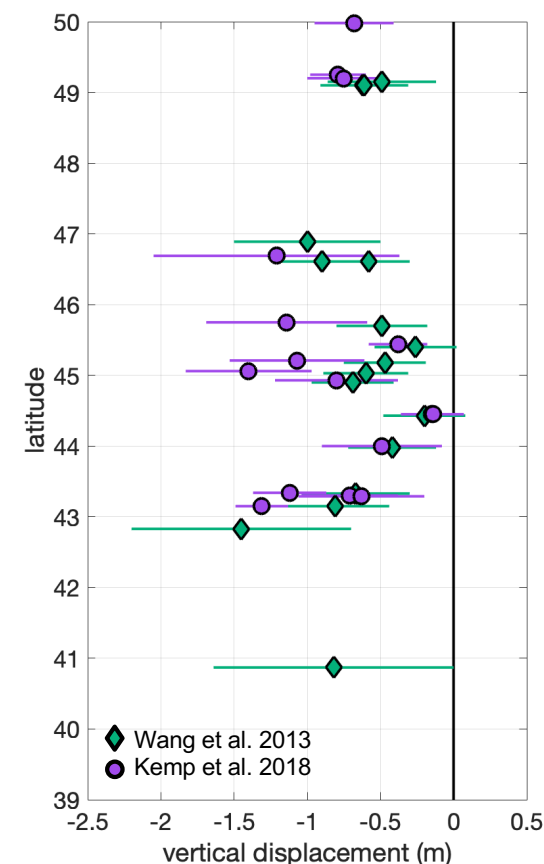
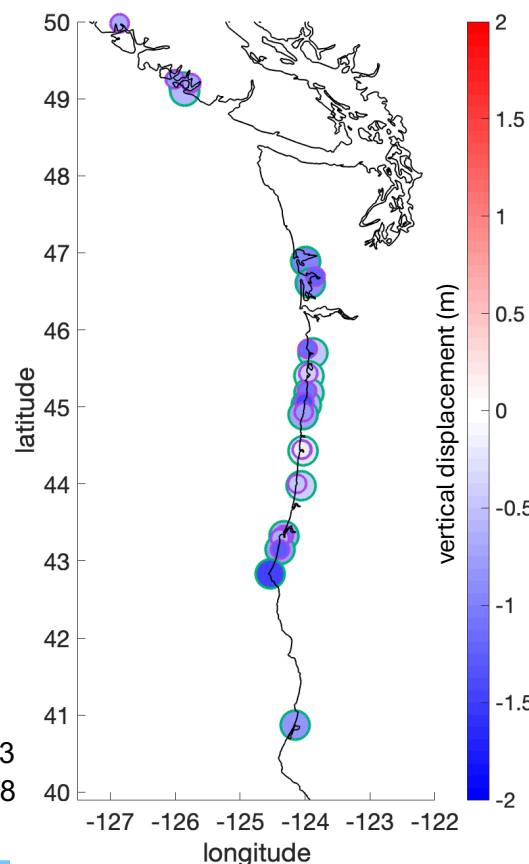


Wirth et al. 2019

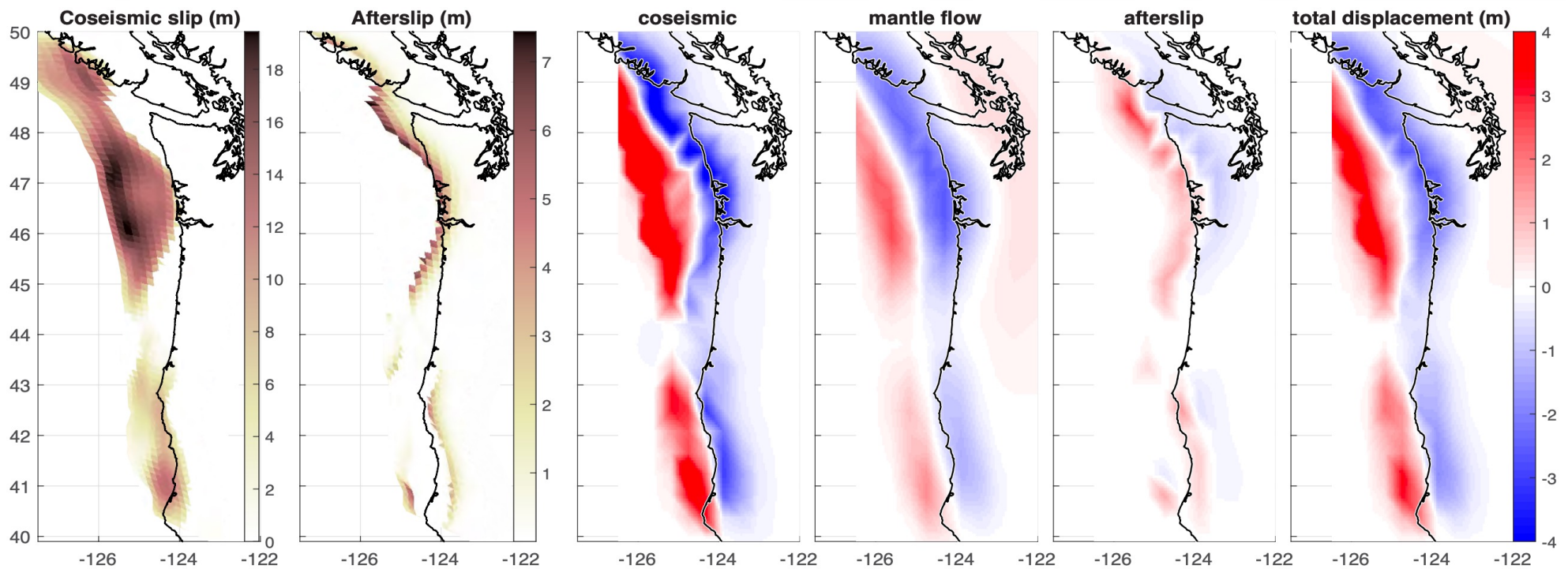
Foraminifera Subsidence Data

- Foraminifera along the coastlines of Cascadia recorded subsidence from 1700AD earthquake.
- However, there is **at least an 11 month (and up to 24 month) delay** in when coseismic subsidence occurs and when the foraminifera respond (Horton et al., 2018).

 Wang et al. 2013
 Kemp et al. 2018



Postseismic Contributions to Vertical Deformation



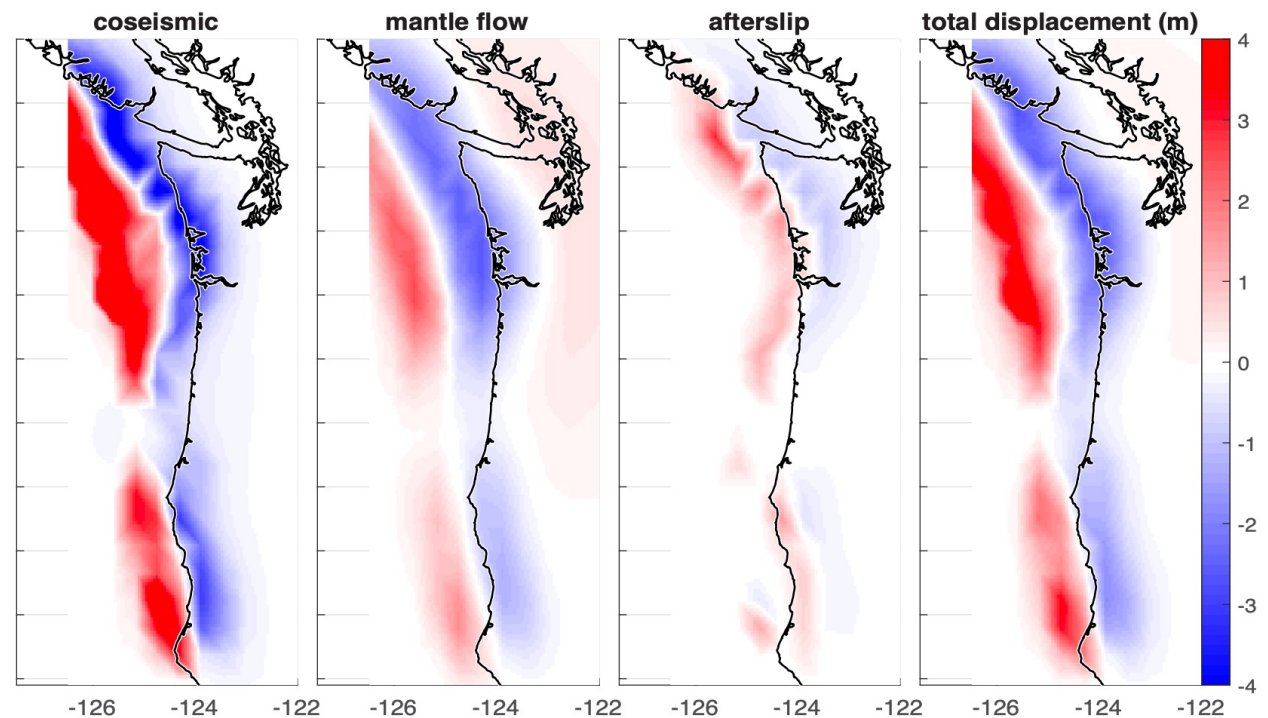
Postseismic Contributions to Vertical Deformation

After slip but no viscous flow

- Coseismic subsidence $>$ subsidence recorded by microfossils
- Bigger earthquake magnitude

Viscous flow but no afterslip

- Coseismic subsidence $<$ subsidence recorded by microfossils
- Smaller earthquake magnitude



Modeling Methodology

1 Generate Static Coseismic Slip Distributions

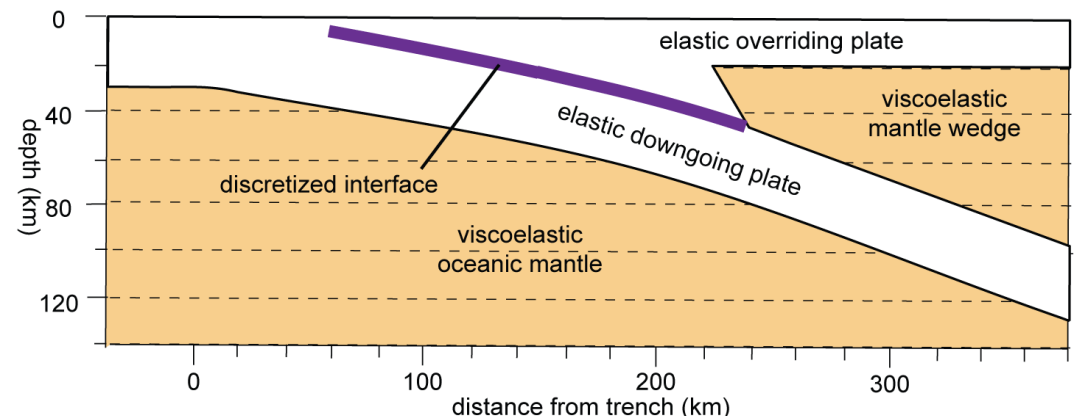
- Define upper and lower boundaries where slip is allowed
- Specify a range of magnitudes (M_w 8.6-9.2)

2 Compute After slip Evolution for Each Coseismic Slip

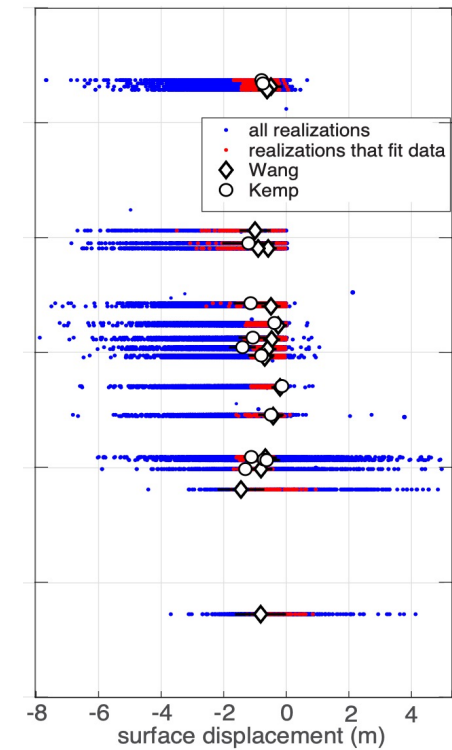
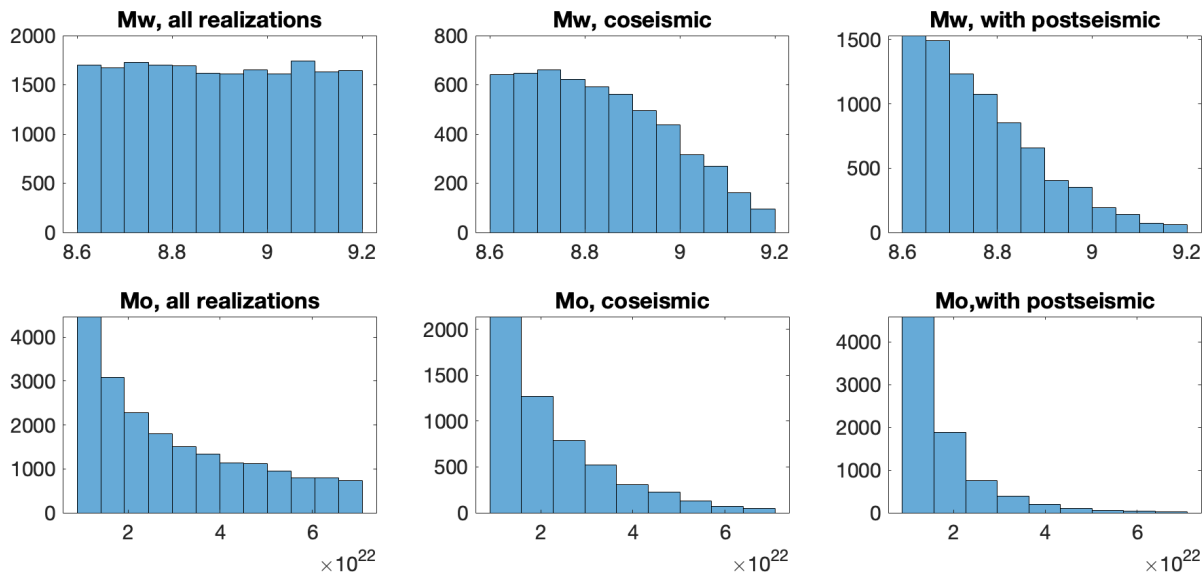
- Stress-driven using a rate-strengthening creep law
- Assume afterslip will occur in areas of high coseismic stress change
- Specify the rate-strengthening parameter σ_{a-b} (0.2, 0.5, and 0.9)

3 Compute Viscous Mantle Flow Due to Slip

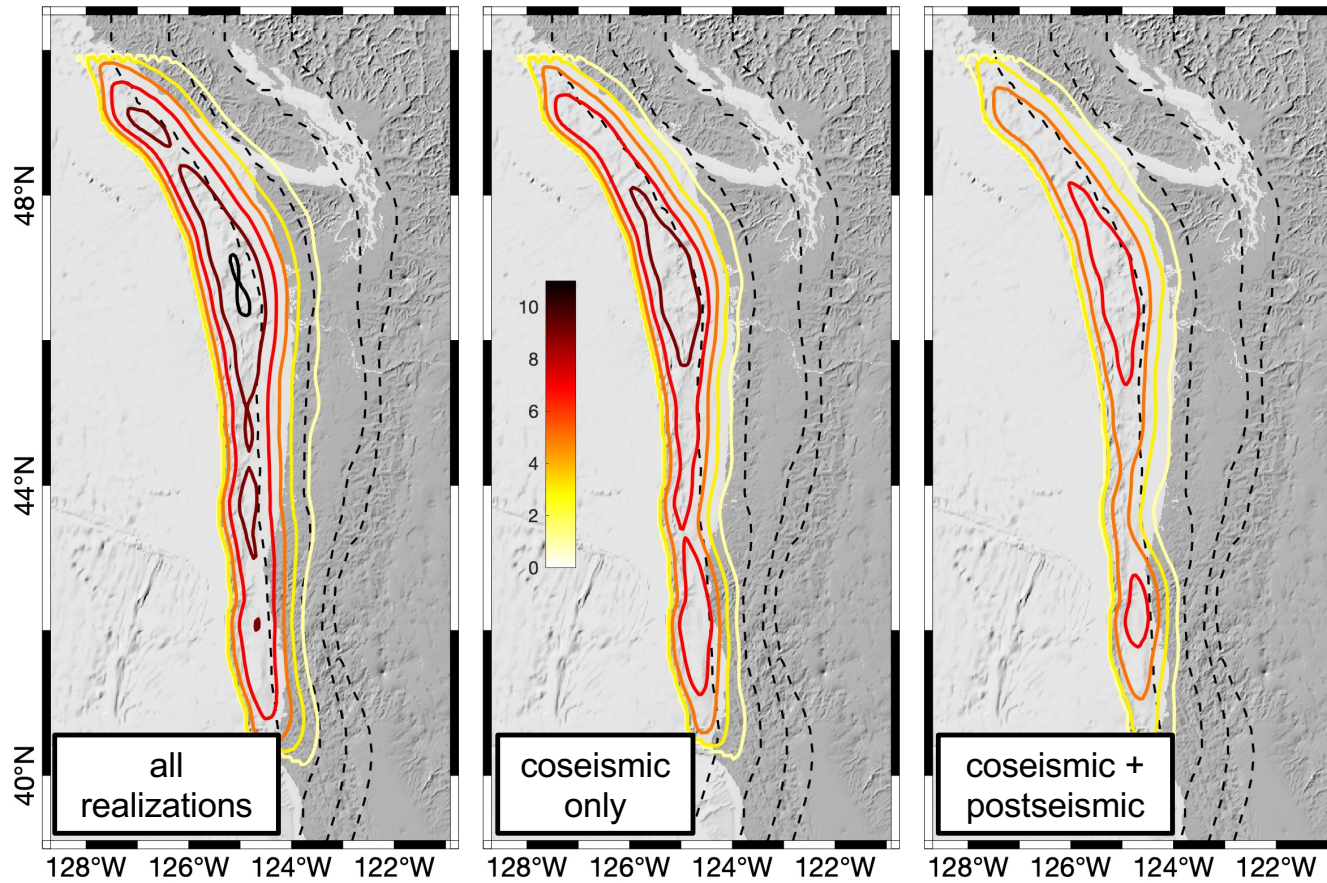
- Spectral element code visco3d (Pollitz, 2025).
- Elastic overriding and elastic downgoing plates surrounded by viscous mantle
- Viscosities tested - 1×10^{17} , 3×10^{17} , and 1×10^{18} Pa s



Magnitude and Moment



Mean Coseismic Slip



Conclusions

1. In most cases that fit the data, subsidence due to viscous flow is greater magnitude than uplift due to afterslip. Thus, magnitude and moment estimates are lower when the postseismic deformation is included versus when it is not.
2. Because the vertical patterns (and hinge locations) of coseismic slip and viscous mantle flow are similar, incorporating postseismic deformation does not change the location of the downdip edge of coseismic slip as much as anticipated.
3. More constraints on rate-strengthening parameters and viscosity to further assess model viability.