Geodetic constraints on fault interactions and stressing rates in southern California

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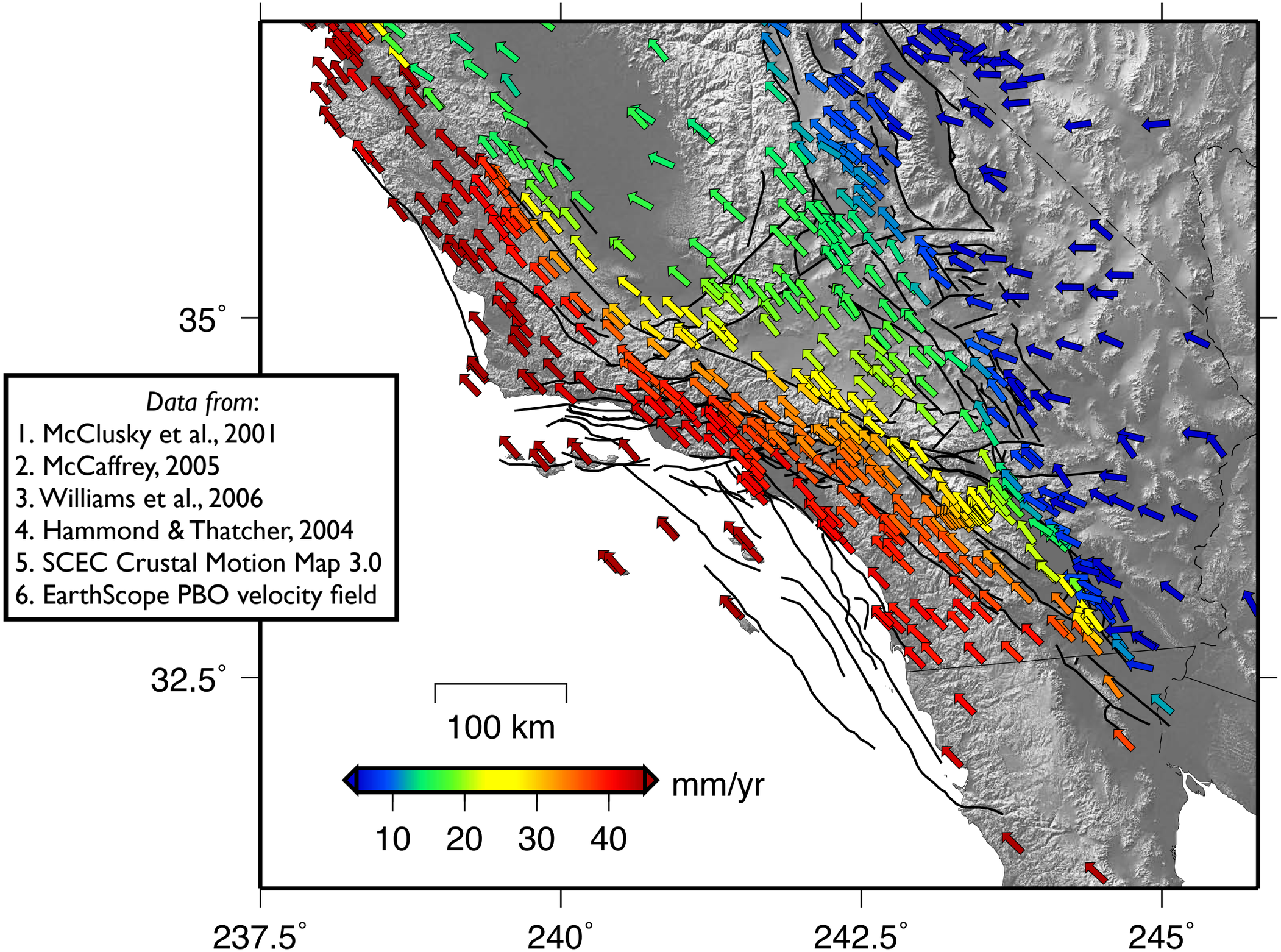
Imaging fault interactions in Southern California

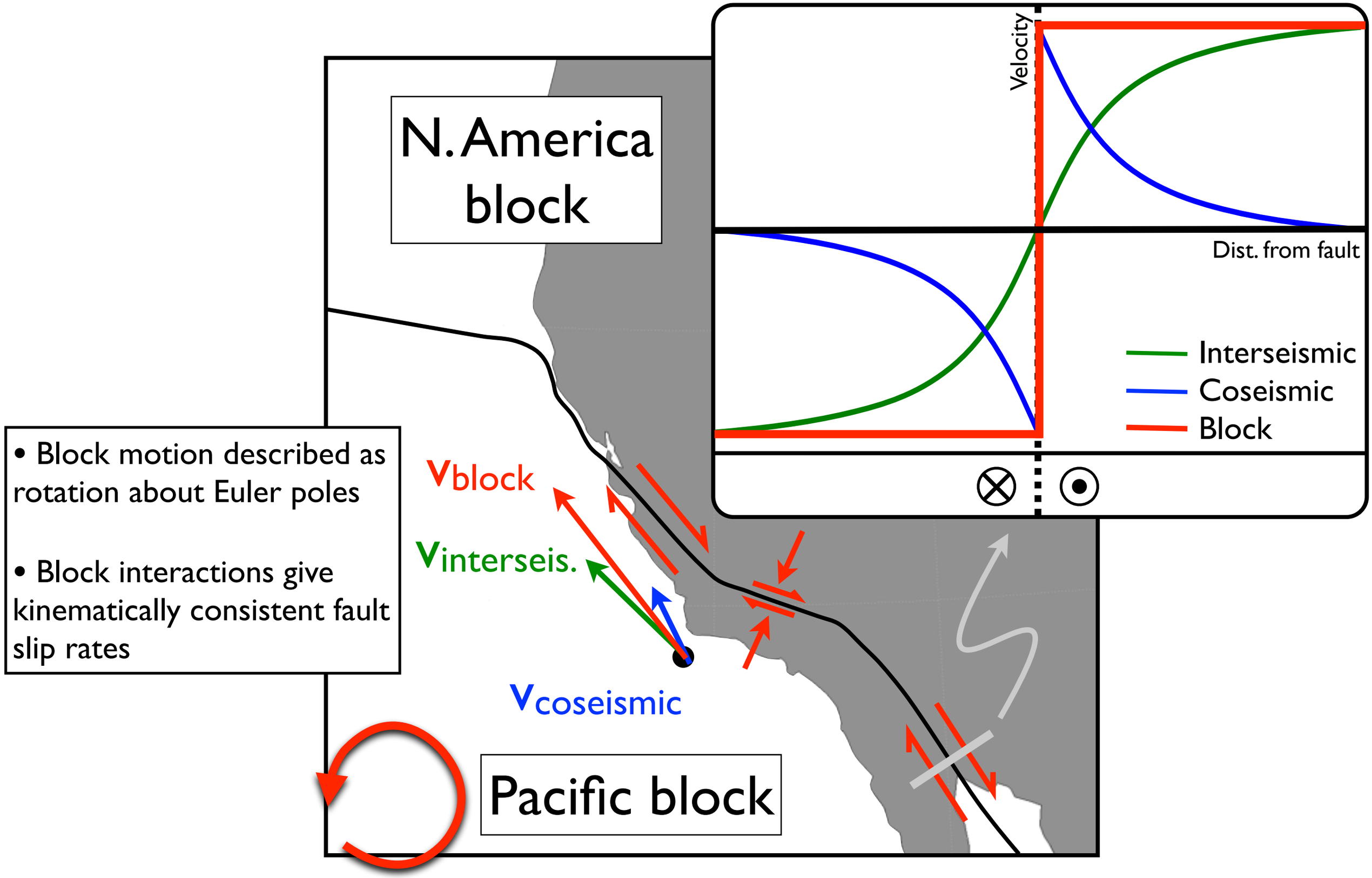
- Image interseismic fault system activity using an elastic block model (*Meade & Loveless*, 2009) constrained by GPS velocities and mapped fault system geometry derived from SCEC Community Fault Model (*Plesch et al.*, 2007)
- Use slip rate estimates to analytically calculate interseismic stressing rates resolved on the San Andreas fault
- How do faults interact during the interseismic part of the seismic cycle to modulate stress accumulation rates?
- How do fault system interactions influence long-term earthquake rupture patterns and seismic hazard assessment?

GPS velocity field – 6 combined networks

1822 stations; 6-parameter (rotation + translation) velocity field combination



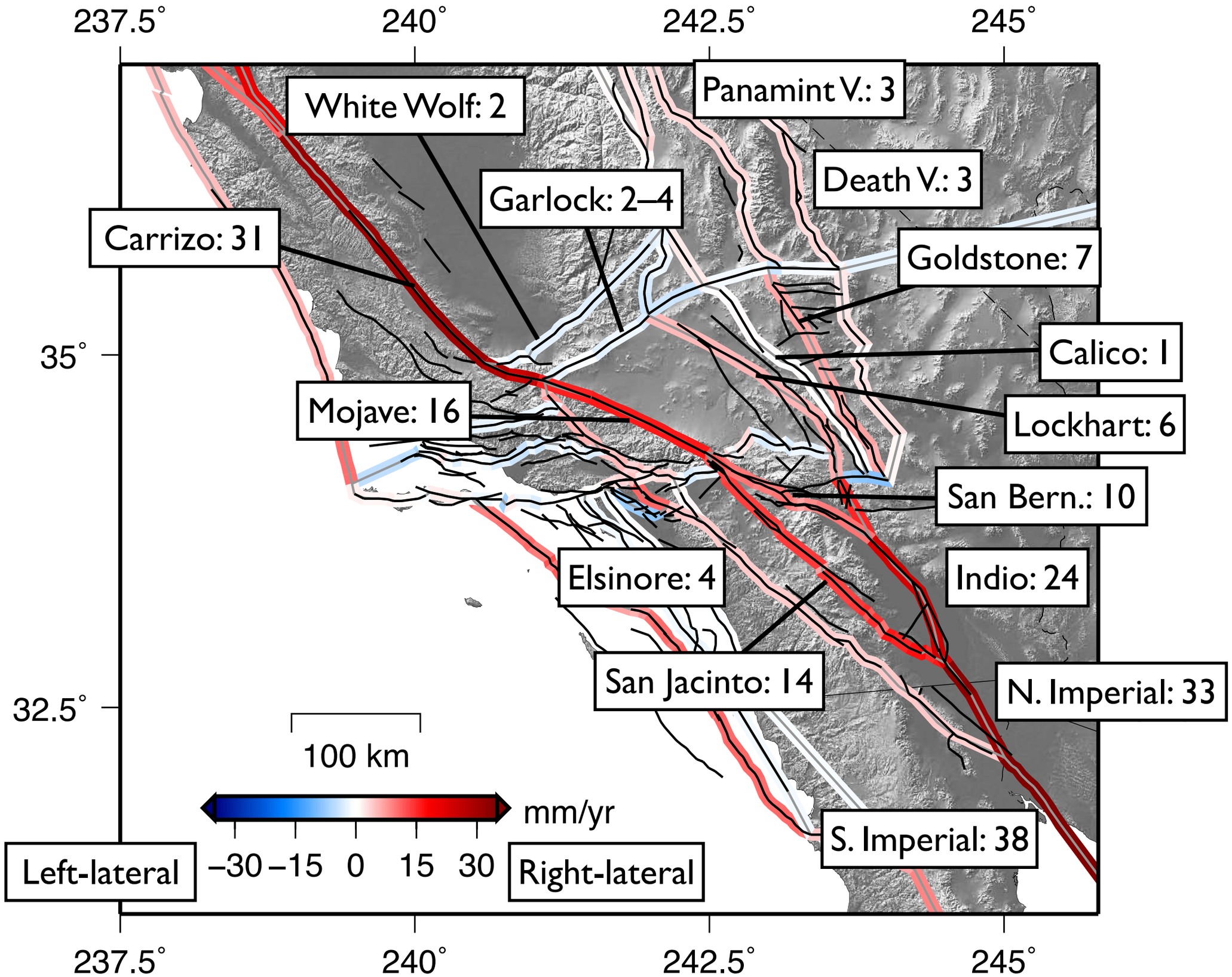
Interseismic elastic block modeling



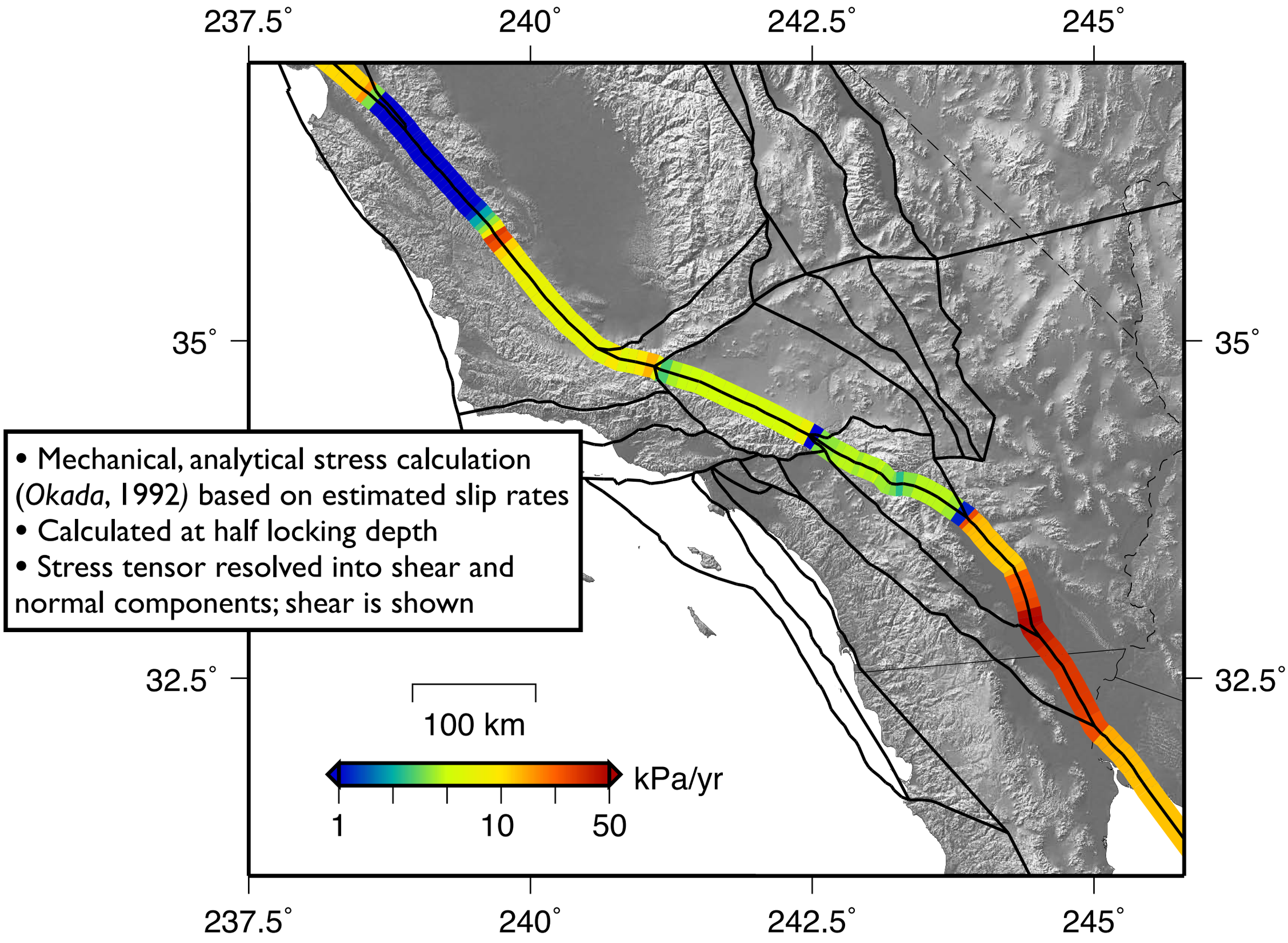
- Block motion described as rotation about Euler poles
- Block interactions give kinematically consistent fault slip rates

Meade & Loveless, *BSSA*, 2009

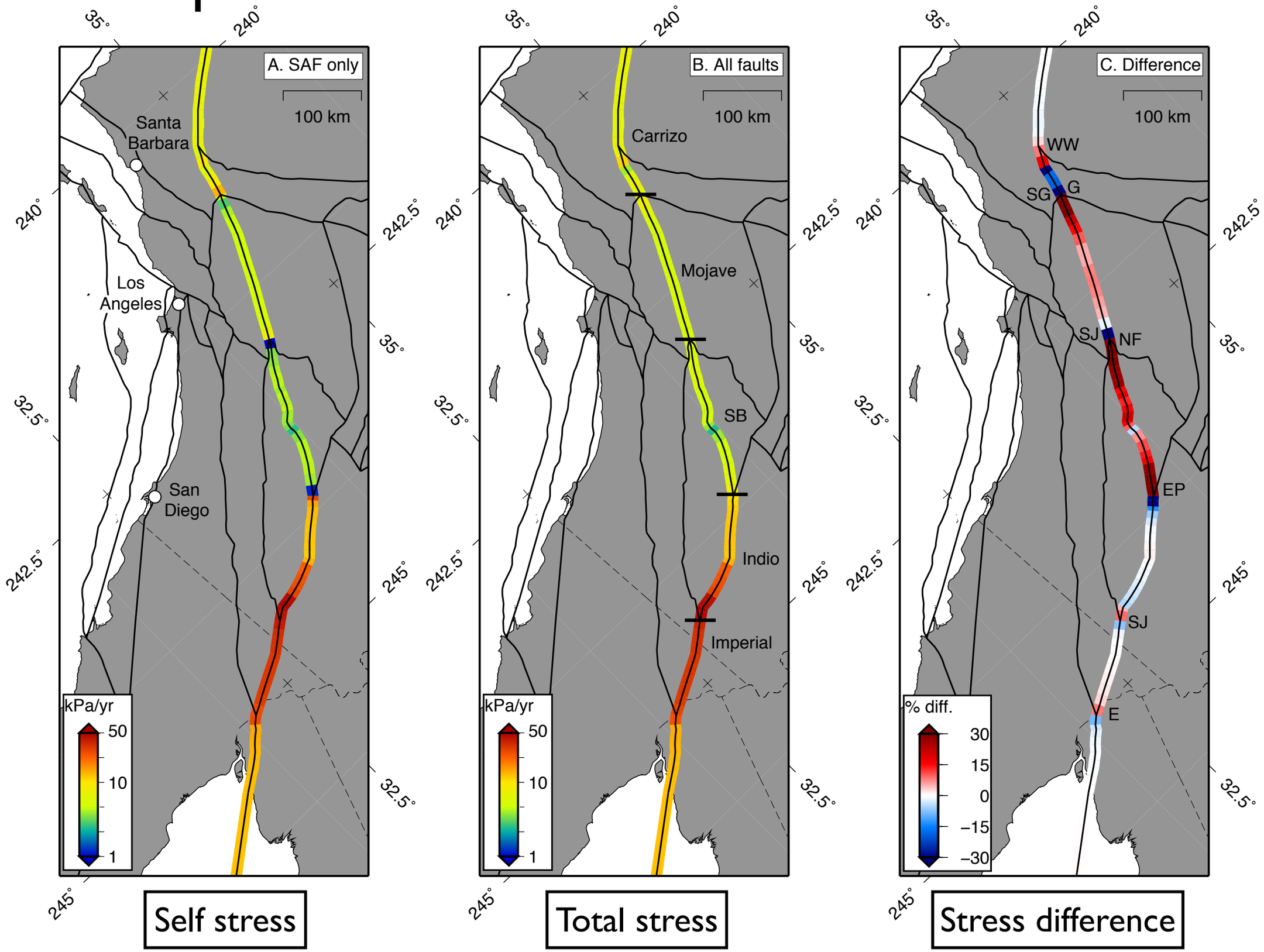
Geodetically constrained strike-slip rates



San Andreas interseismic stressing rate

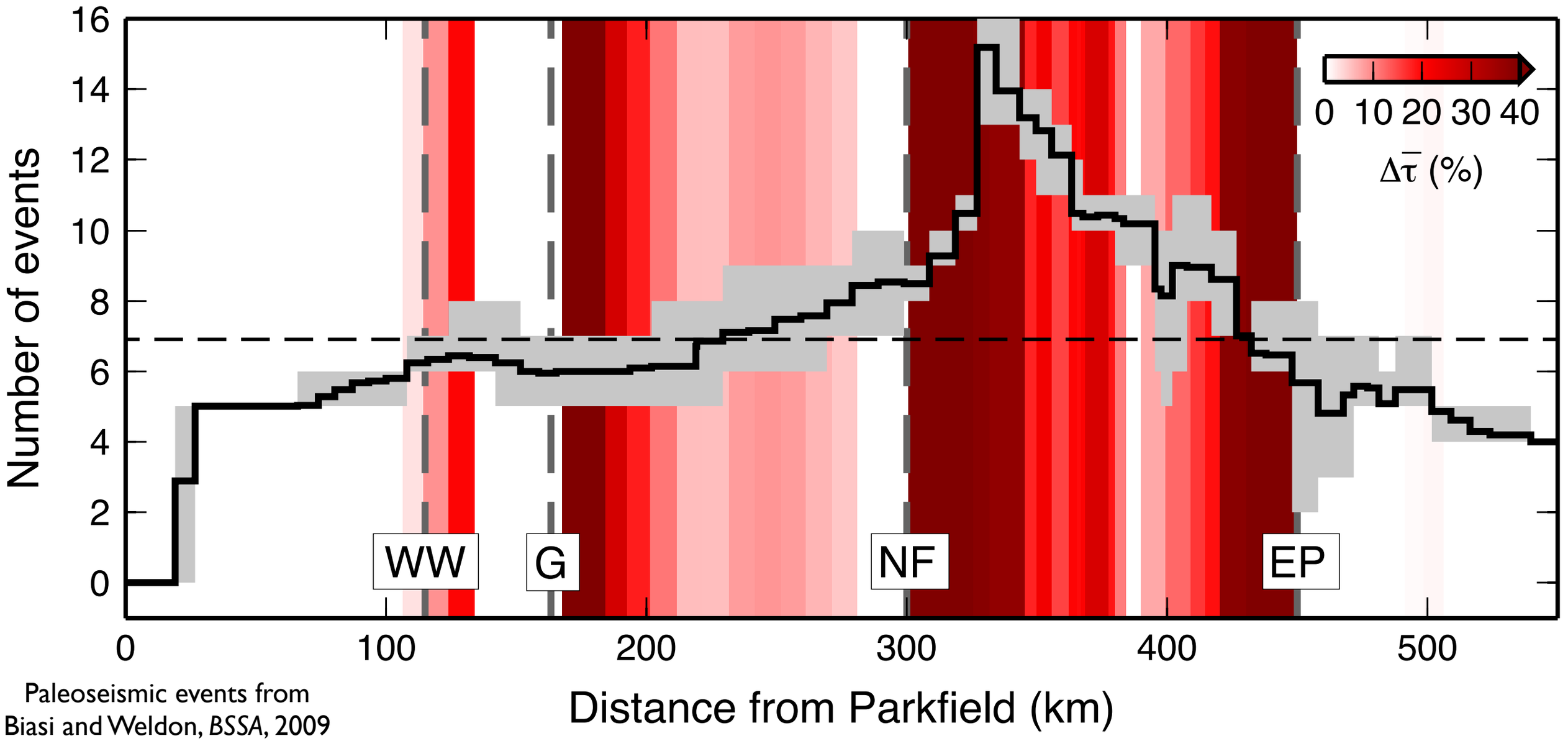


Stress amplification from interseismic fault interactions



Coulomb stress changes are similar in spatial distribution and magnitude

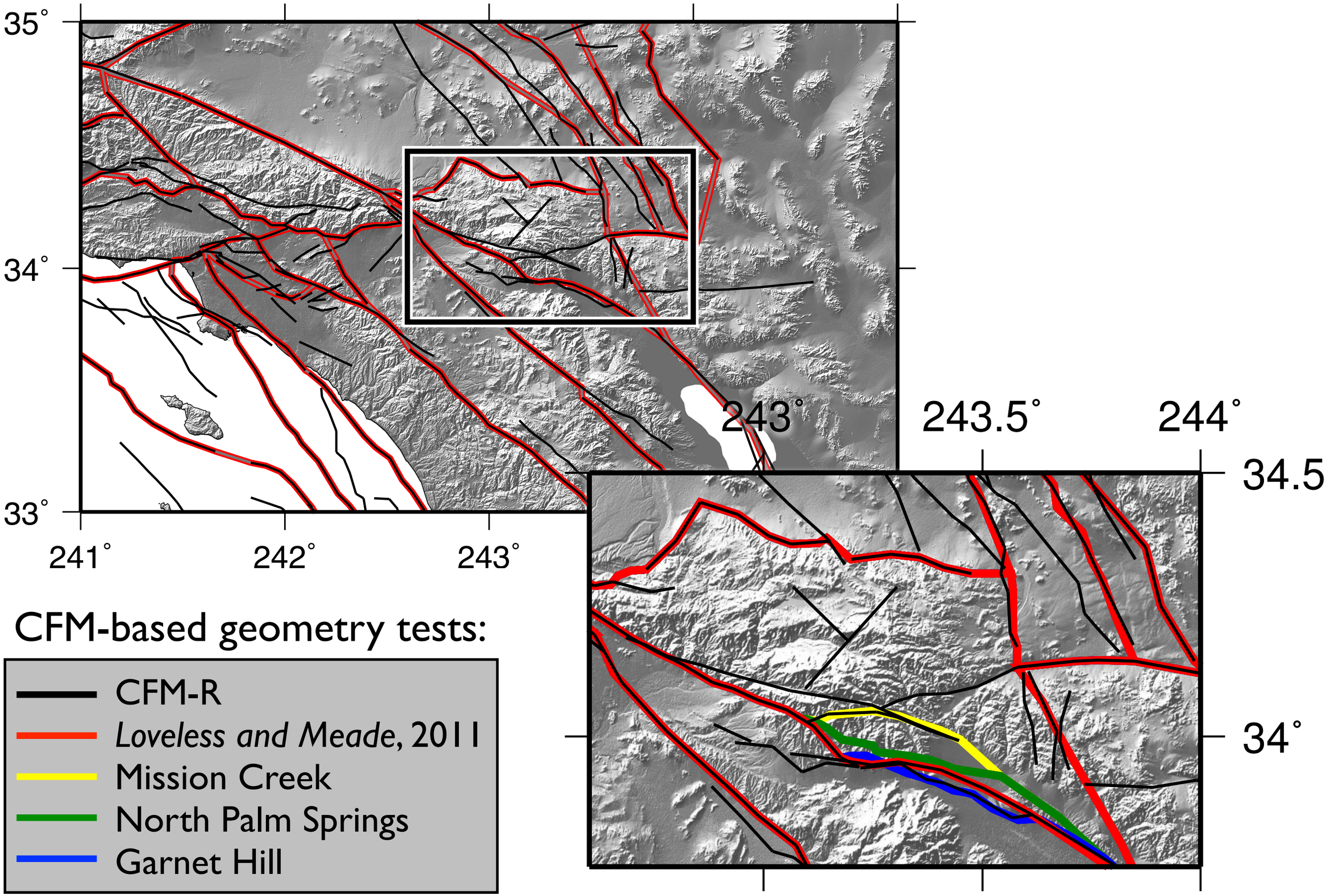
Stress amplification and paleoseismicity



Paleoseismic events from
Biasi and Weldon, *BSSA*, 2009

Interseismic stresses along the Mojave and San Bernardino segment of the SAF induced by slip on all other faults, when integrated over 150 years, exceed co- and post-seismic stress changes from the Landers-Hector Mine earthquake sequence

Modeling GPS data near San Gorgonio Pass



CFM-based geometry tests:

- CFM-R
- *Loveless and Meade*, 2011
- Mission Creek
- North Palm Springs
- Garnet Hill

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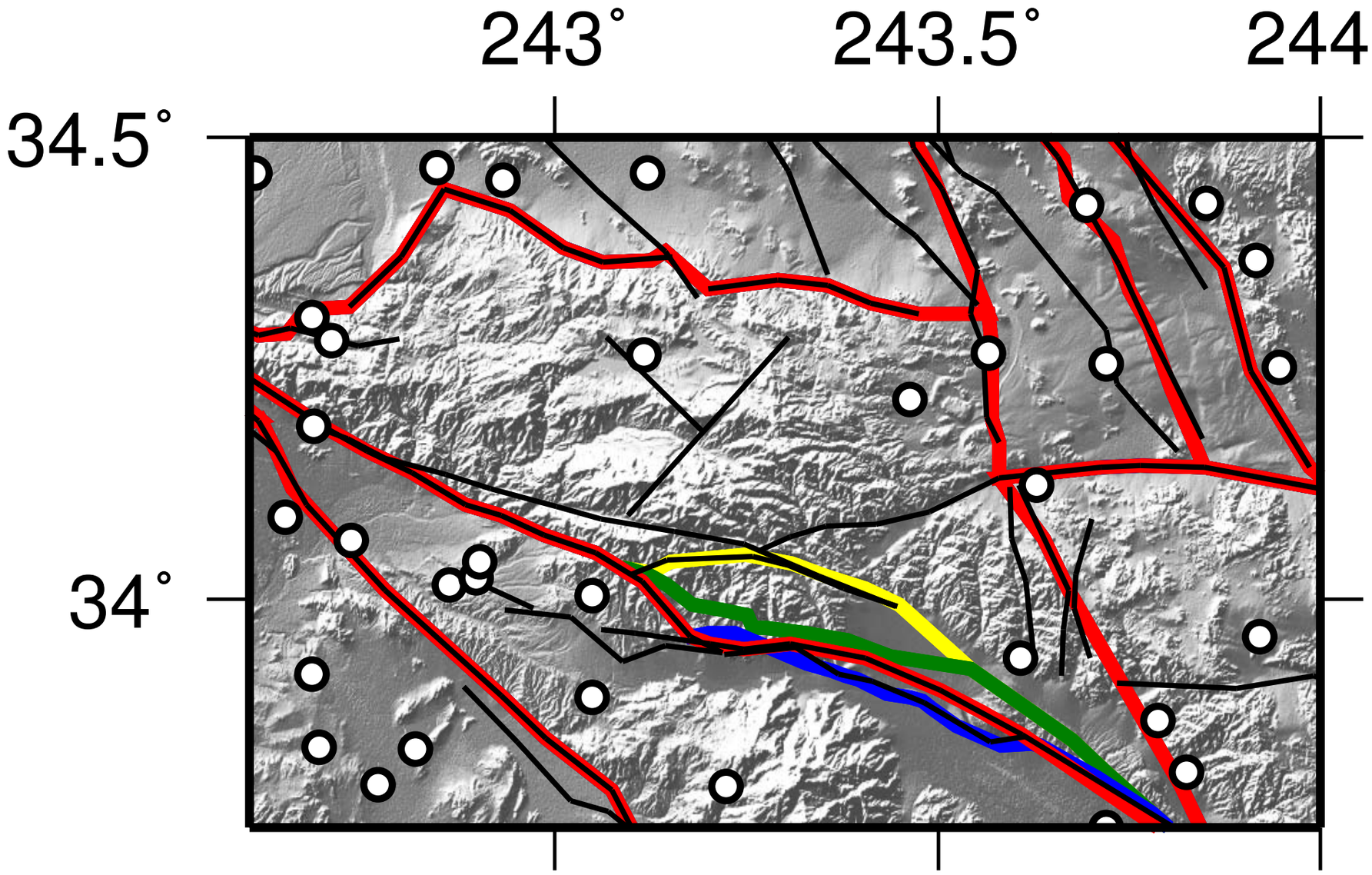

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Main results:

- Euler poles statistically identical
- Mean. resid. of local GPS: all ~1.8 mm/yr
- Dextral slip rates statistically identical
- Reverse slip rates up to 19 mm/yr (Garnet Hill, North Palm Springs models)

Conclusions

- Along-strike variation in San Andreas fault slip rate (10–34 mm/yr) results from anastomosing fault system geometry
- Interseismic stressing rates can be determined analytically using elastic dislocation theory and estimated fault slip rates
- Interseismic stressing rates are amplified by up to 30% along the Big Bend section of the SAF due to the activity of the nearby San Jacinto, Garlock, Eureka Peak, and ECSZ faults
- The distribution of stress amplification correlates with inferred frequency of paleoseismically recorded earthquakes, with a maximum along the Mojave and San Bernardino segments
- The effect of interseismic fault interactions should be considered in stress-based seismic hazard assessment

Future related work at SGP

- Integrate campaign GPS and other geodetic data to resolve relative activity of SGP fault strands
  - Crustal Motion Map 4.0 provides more stations around SGP than velocity fields used in this study
- Explore impact of Eureka Peak fault on SGP slip rates
  - Eureka Peak partitions slip from southern San Andreas into Eastern California Shear Zone and San Bernardino regions
  - Including the Eureka Peak fault or similar structure is required for elastic block models to provide a good fit to GPS data