Complete fault kinematics of the creeping faults in central California - San Andreas and Calaveras fault

Li-Chieh J. Lin, Gareth Funning
University of California, Riverside

GitHub:
llin148@ucr.edu

LOS velocities and 3D decomposition

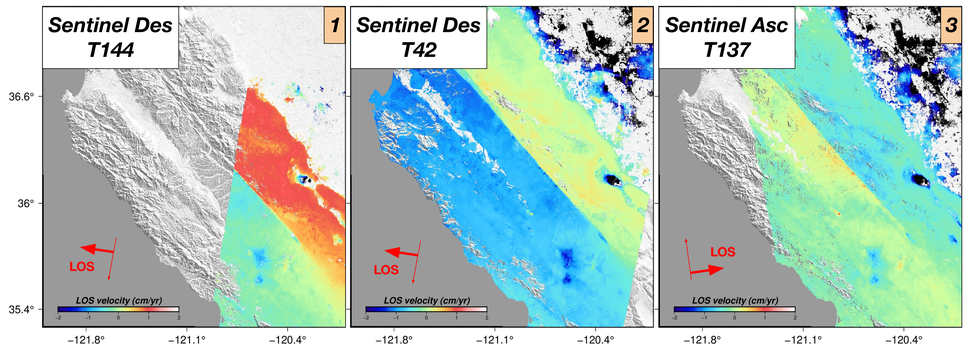


Figure 1 to 6. LOS velocity from Sentinel-1 and UAVSAR. Warm color: surface moving closer to sensor. Cool color: surface moving away from sensor.

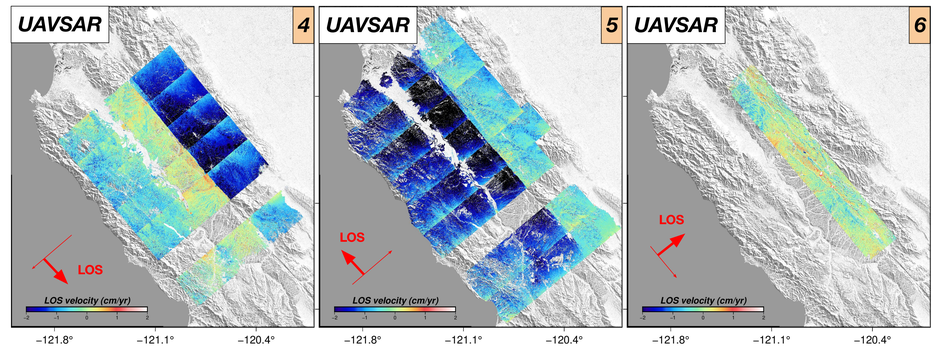
$$\bar{m} = [G^T \sum^{-1} G]^{-1} G^T \sum^{-1} d$$

$$\sum = \begin{bmatrix} \sigma_1^2 & \cdots & \cdots & 0 \\ \vdots & \sigma_2^2 & 0 & \vdots \\ \vdots & 0 & \sigma_3^2 & \vdots \\ 0 & \cdots & \cdots & \ddots \end{bmatrix}$$

$$G = \begin{bmatrix} sin\theta_1 cos\alpha_1 & sin\theta_1 sin\alpha_1 & cos\theta_1 \\ sin\theta_2 cos\alpha_2 & sin\theta_2 sin\alpha_2 & cos\theta_2 \\ sin\theta_3 cos\alpha_3 & sin\theta_3 sin\alpha_3 & cos\theta_3 \\ \vdots & & \end{bmatrix}$$

σ^2: LOS variance

θ: incidence angle
α: heading angle



3D velocities

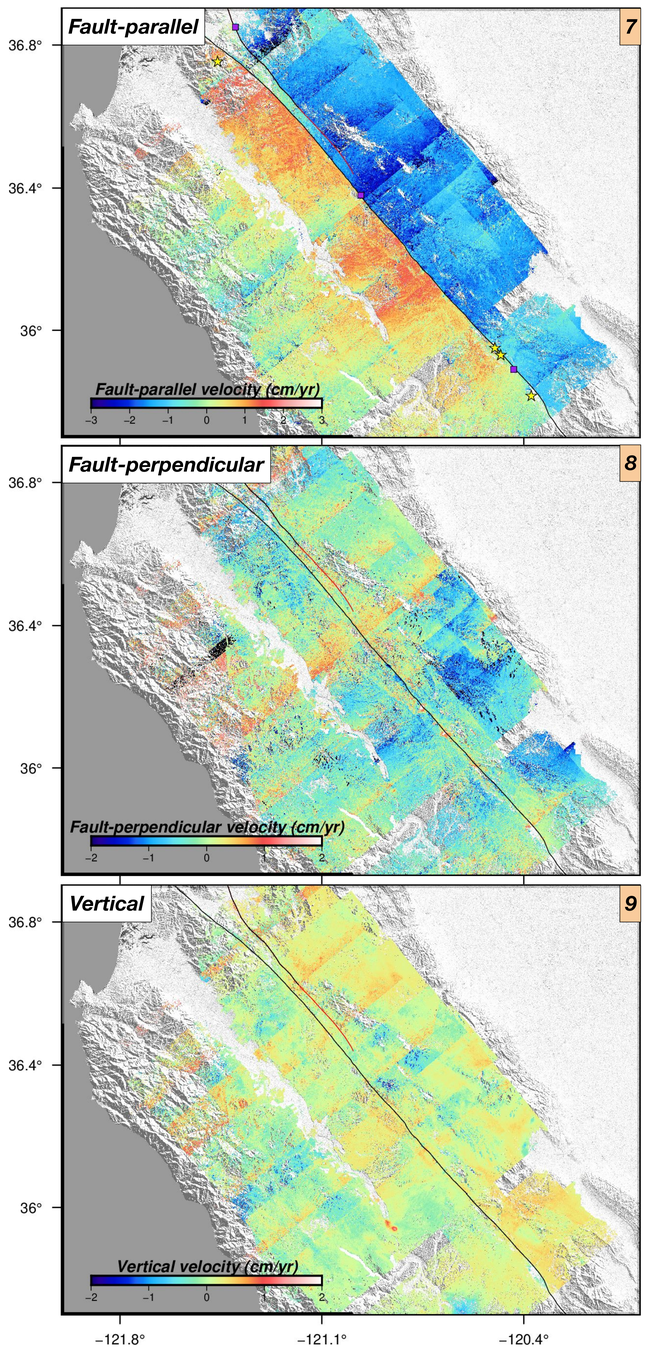
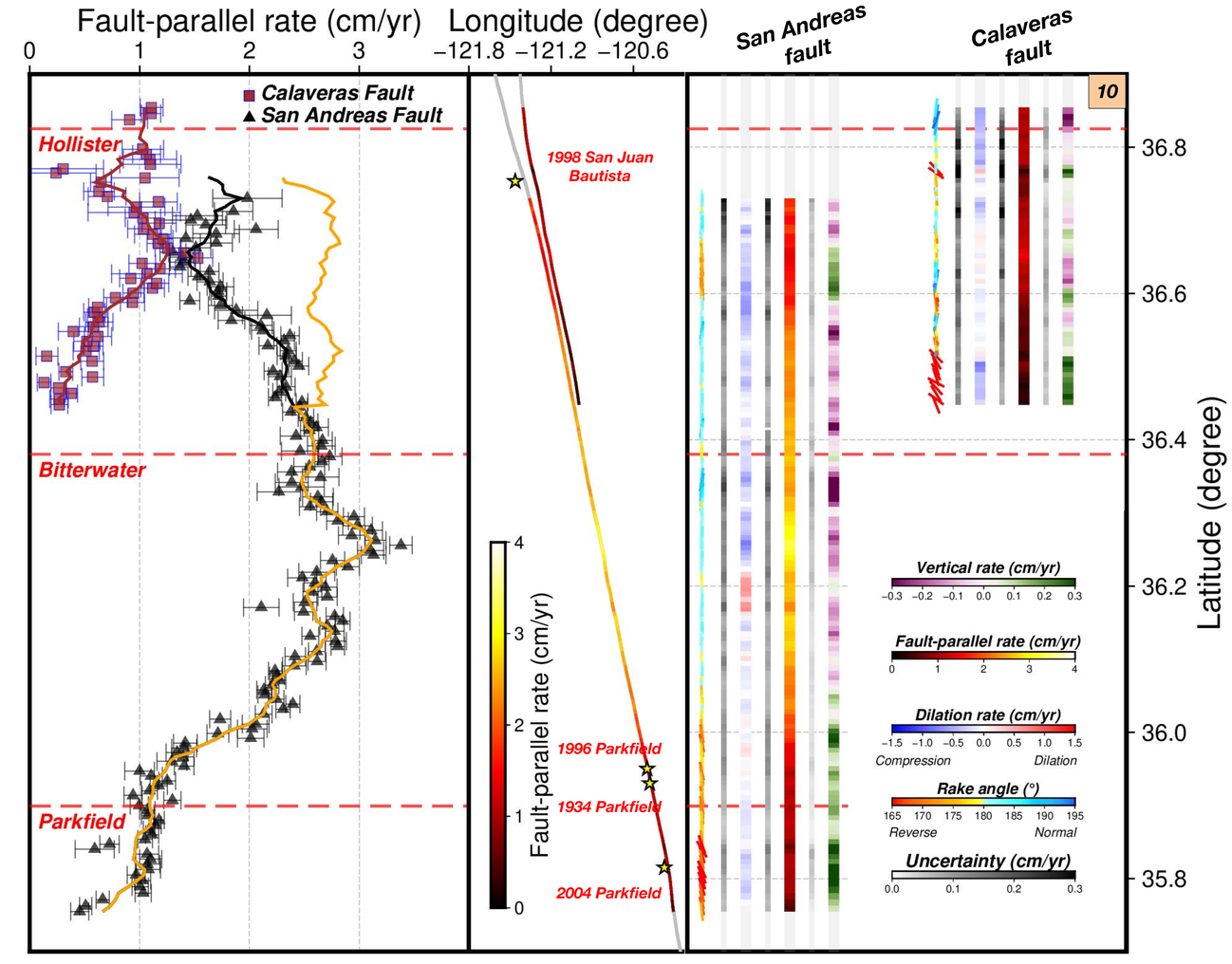


Figure 7 to 9. 3D velocities decomposed from above LOS velocities. Warm color: surface moving northwest, southwest and uplift, respectively.

Fault kinematics modeling



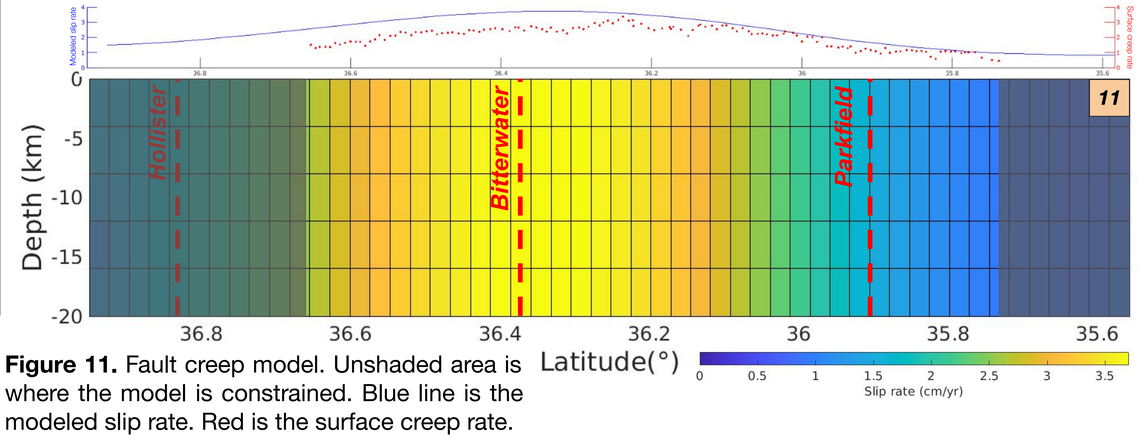


Figure 11. Fault creep model. Unshaded area is where the model is constrained. Blue line is the modeled slip rate. Red is the surface creep rate.

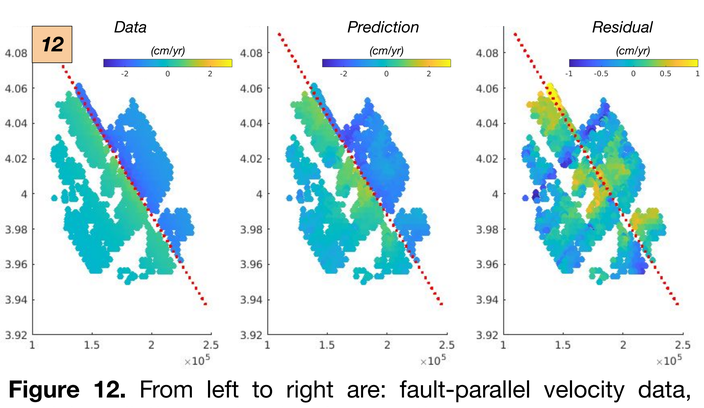


Figure 12. From left to right are: fault-parallel velocity data, model prediction, and residual, respectively.

Remarks

- We observe secular **fault-perpendicular contraction** along both creeping faults
- We observe **creep partitioning** where both faults are parallel
- **Vertical offset rates** are non-negligible on both faults
- **Rake angles** change significantly along the **Parkfield segment**

Model setup

- Length: 208km
- Strike: 318°
- Width: 20km
- Dip: 90°
- Solver:
  - LSQ. with Laplacian smoothing
- Fitting: [*Weights*]
  1. Fault-parallel offset rate [*1*]
  2. Fault-perpendicular offset rate [*0.25*]
  3. Vertical offset rate [*0.5*]
  4. Fault-parallel velocity [*1*]