Poster #077

Kinematics of Creep Events on the Imperial Fault

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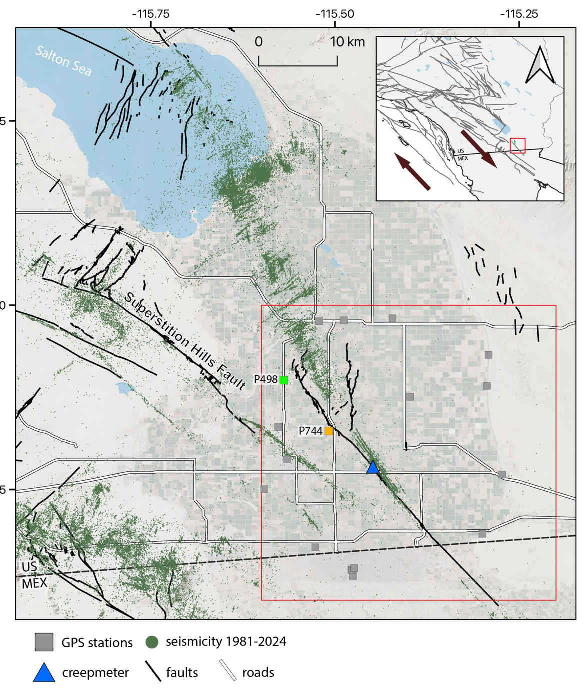
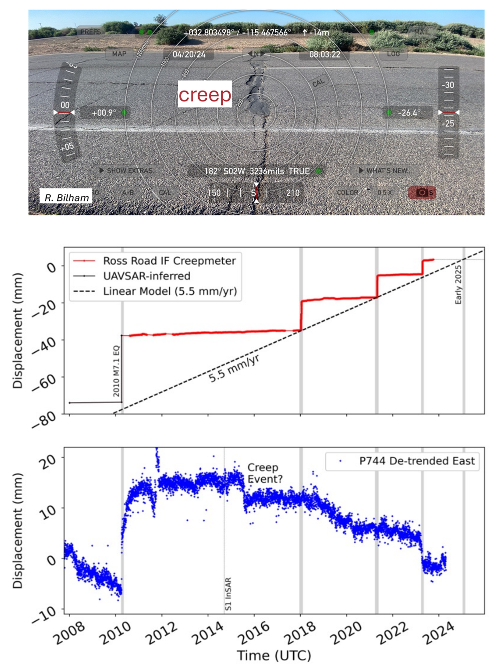
1. Introduction

- The Imperial Fault (IF) is one of the fastest partially-creeping faults in southern California, accommodating the Pacific-NA plate boundary near the US-MEX border
- Deformation models suggest right-lateral slip rates of 20-35 mm/yr, showing the IF poses a significant source of hazard
- Recent earthquakes: Mw7 in 1940 and Mw6.5 in 1979
- cm-scale episodic creep events occur several times a decade; GNSS and creepmeters have recorded eight creep events in the last 10 years



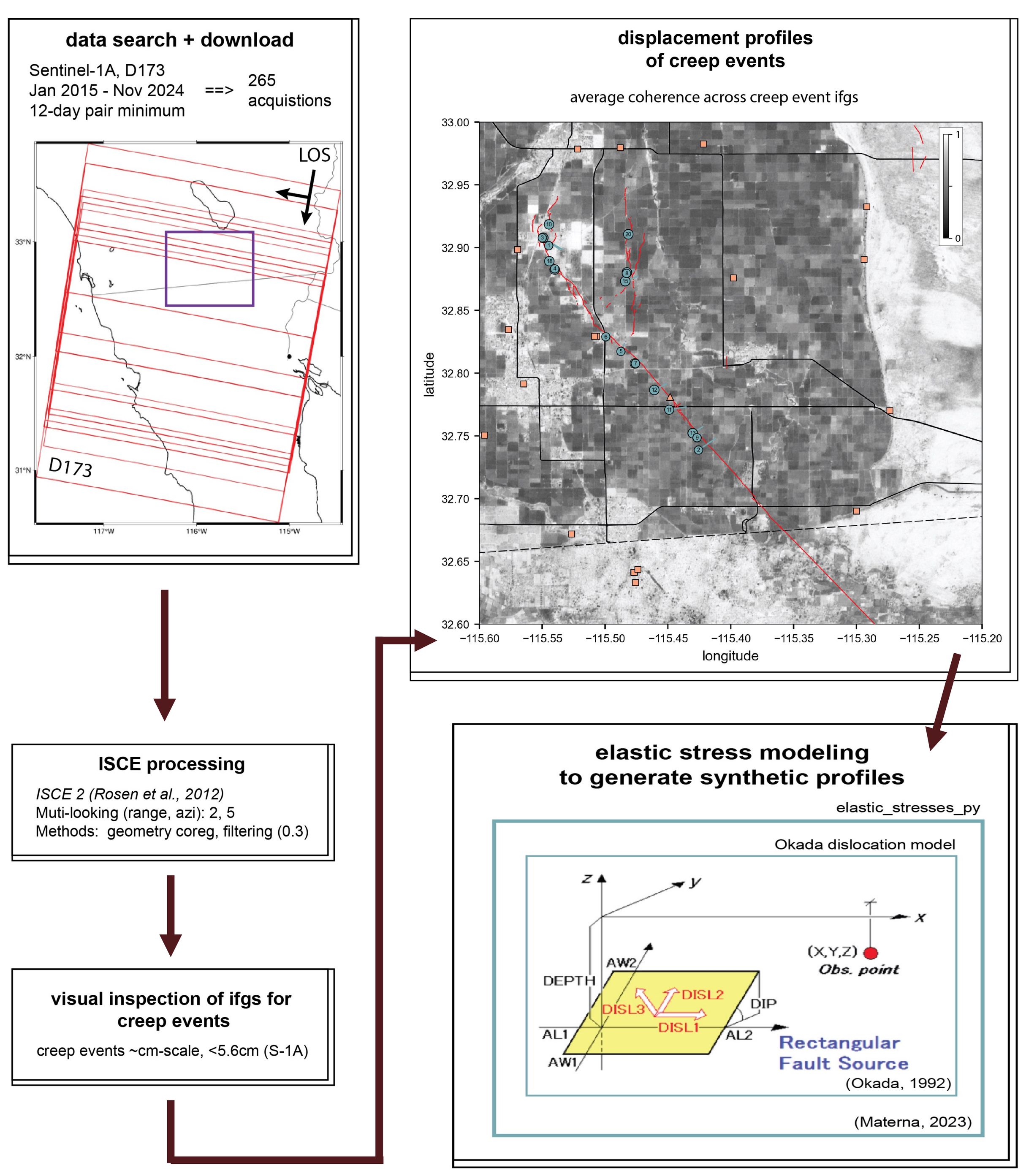


Aseismic slip is a frequent mode of seismic moment release on the IF. GNSS and creepmeters are able to record creep events, but more complete modeling of these events suffer from observational gaps.

We leverage ten years of Sentinel-1 InSAR data to identify and test kinematic models of creep events. This project builds a catalog of creep events and develops scaling relationships between slip and depth to constrain stress drop.

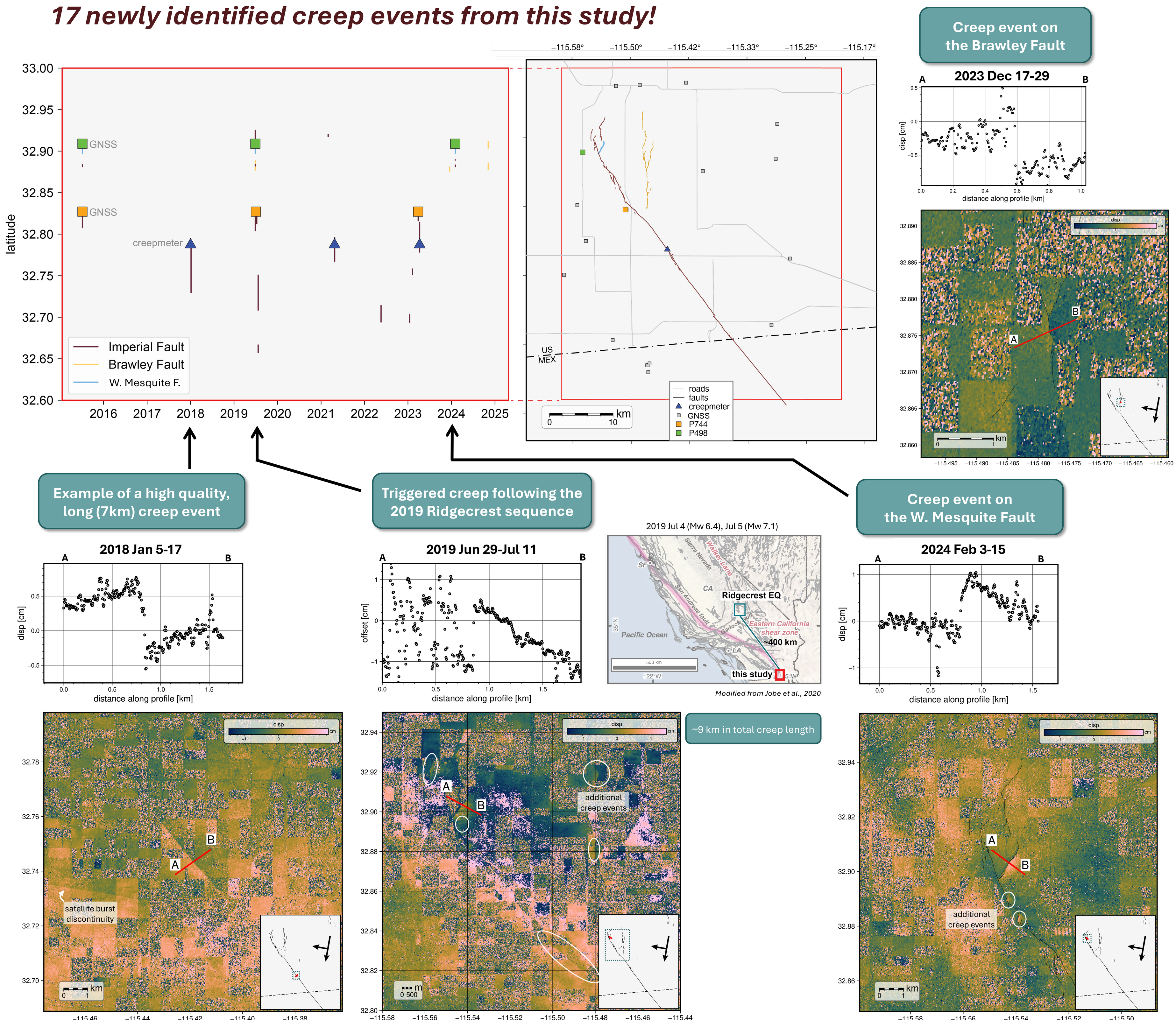
1. Do creep events correlate in space or time with each other? How frequent is dip-slip creep in this area?
2. What is the depth and slip of each creep event and the associated stress drop?

2. Data and Methods



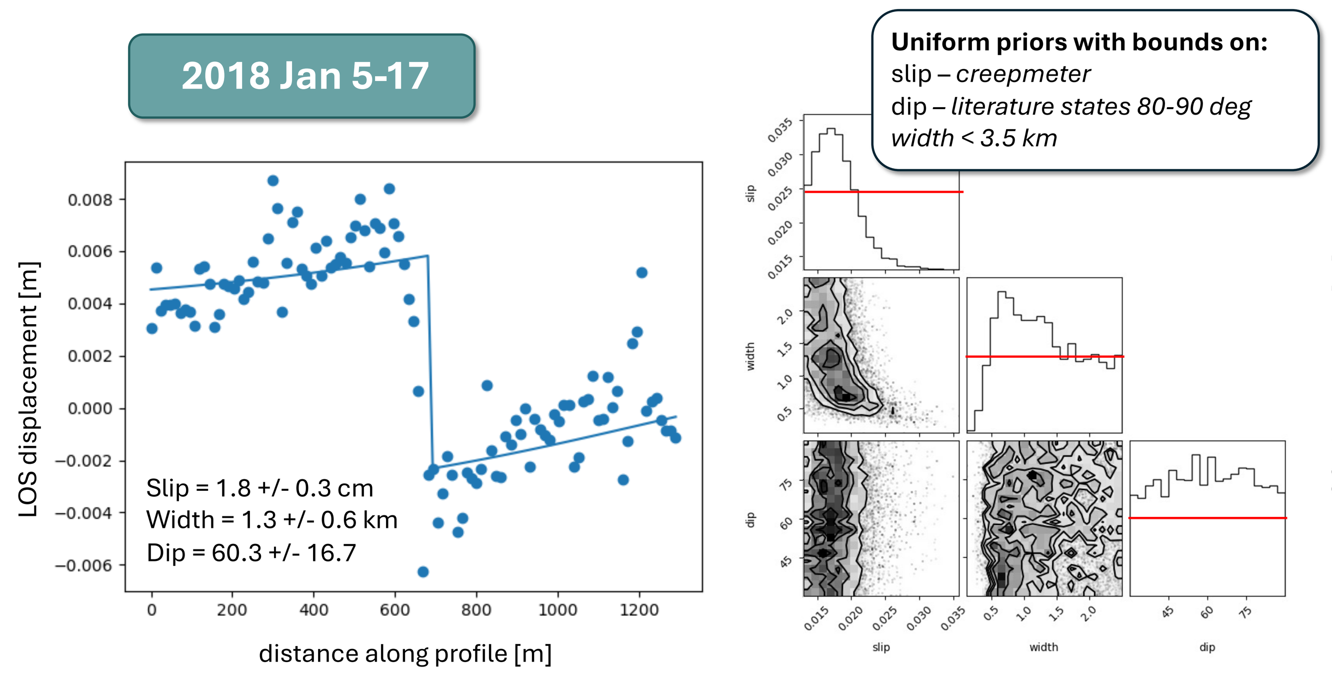
3. Identified Creep Events

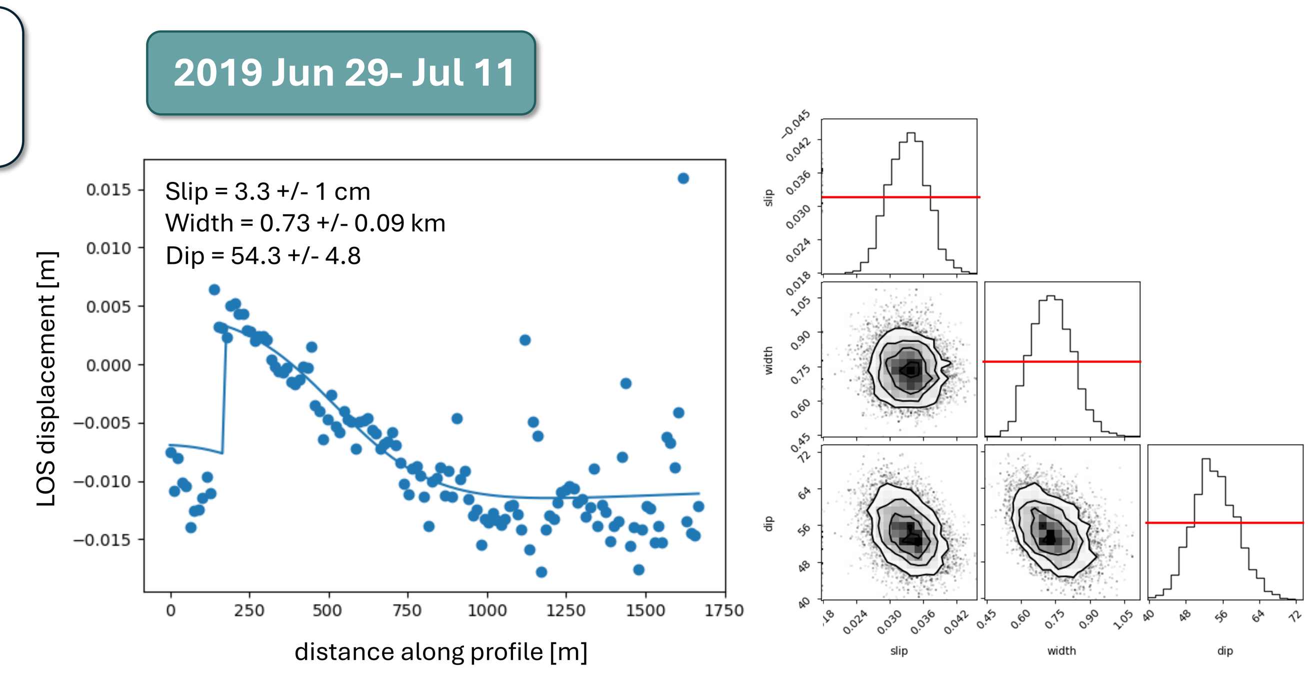
17 newly identified creep events from this study!

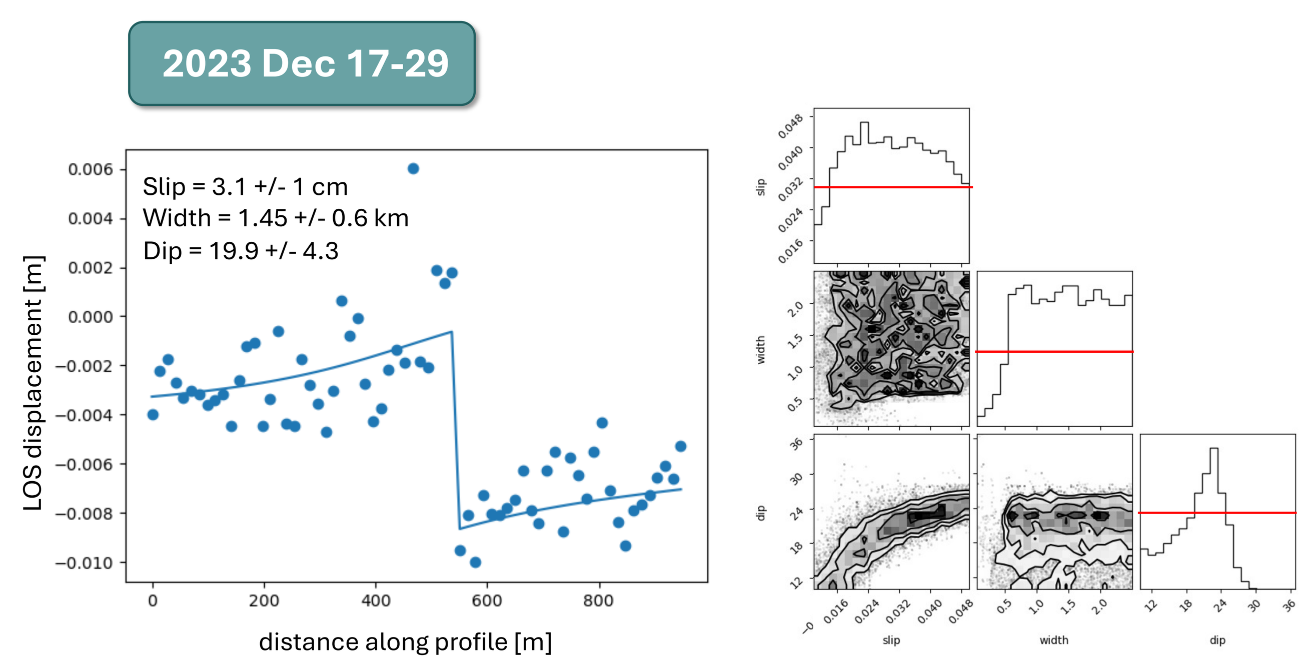


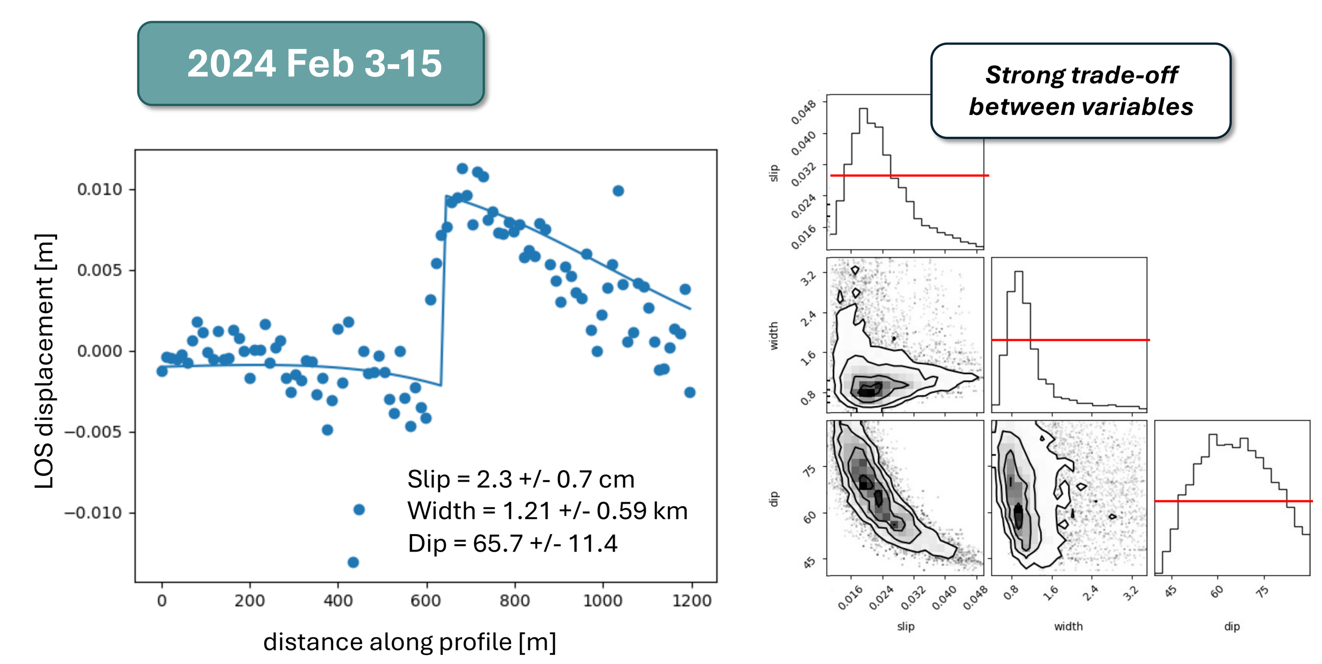
4. Modeling

Uniform priors with bounds on:
slip – *creepmeter*
dip – *literature states 80-90 deg*
width < 3.5 km



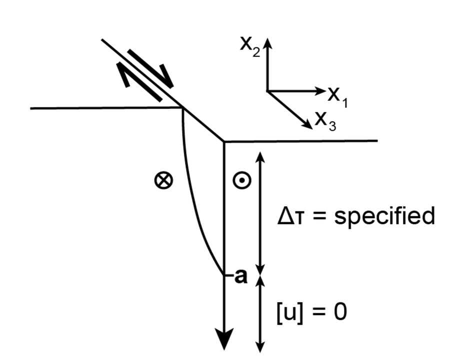






Strain drop

$$\frac{\Delta\tau}{\mu} = \frac{slip_{z=0}}{2a}$$

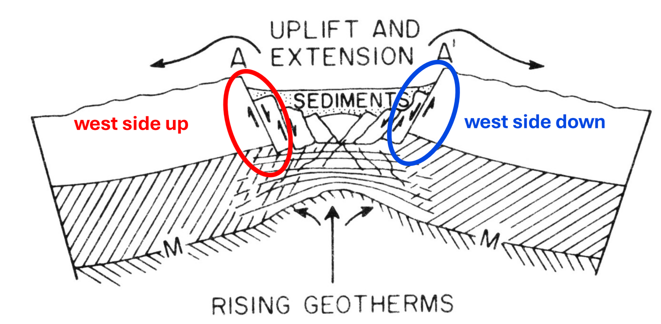


Segall, 2010

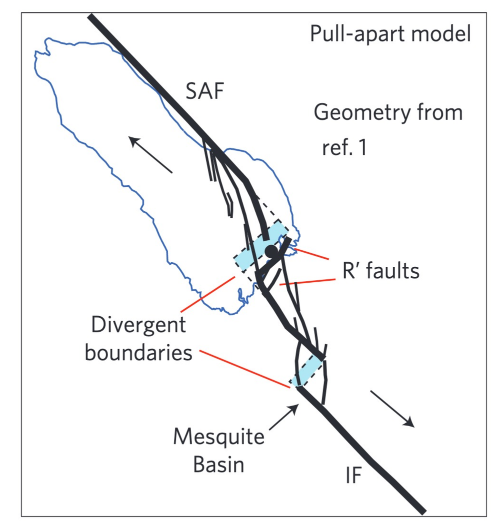
event	$\frac{\Delta\tau}{\mu}$
2018	$6.86 * 10^{-6}$
2019	$2.26 * 10^{-5}$
2023	$7.76 * 10^{-6}$
2024	$9.72 * 10^{-6}$

5. Discussion

- **Creep events on the IF overlap each other, suggesting that creep on the IF is not segmented**
- **Dip-slip creep identified in three interferograms (4.5 year spacing), highlighting the W. Mesquite fault is more active than previously known**
- **Depth of slip is shallower for the W. Mesquite Fault than the IF, while slip is larger**
- **Creep event strain drop ranges from 6.9-22.6 microstrain. Imperial Valley strain rate is ~600 nanostrain/year.**



Modified from Elders, 1979 Fig. 4



Brothers et al., 2009 Fig. 3

- InSAR observations from triggered creep following the 2010 Mw 7.2 El Mayor-Cucapah EQ (UAVSAR) and from this study show us where uplift and lateral extension regions might be. Small, unmapped faults show evidence of creep! ***[see K. Materna SCEC Poster #070 for more]***

Ongoing Research:

- Run models for the remaining creep events
- We need a rupture process that moves slowly up and down the fault, starts spontaneously, propagates spontaneously, and yet never ruptures the whole fault. What facilitates this?

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Brothers et al., 2009, *Nature Geoscience*, doi:10.1038/ngeo590; **Elders, 1979**, UC Riverside Report 79/24; **Field et al., 2015**, *BSSA*, doi:10.1785/0120140093; **King & Thatcher, 1998**, *JGR*, doi:10.1029/98jb00575; **Lindsey & Fialko, 2016**, *Geology*, doi:10.1002/2015JB012516; **Materna, 2023**, doi:10.5281/zenodo.79751979; **Maurer & Materna**, 2023, *GJI*, doi:10.1093/gji/ggad191; **Okada, 1992**, *BSSA*, doi:10.1785/BSSA0820021018; **Pollitz, 2022**, *SRL*, doi:10.1785/0220220137; **Rockwell & Klinger, 2013**, *BSSA*, doi:10.1785/0120120192; **Segall, 2010**, Earthquake and Volcano Deformation. Princeton University Press. Data: Copernicus Sentinel data [2015-2024] for Sentinel data.
Processing: Rosen, P.A., Gurrola, E., Sacco, G.F., & Zebker, H. (2012). The InSAR scientific computing environment. In EUSAR 2012; 9th European conference on synthetic aperture radar (pp. 730-733); Abril-Pla et al. (2023). PyMC: A Modern and Comprehensive Probabilistic Programming Framework in Python. doi: 10.7717/peerj-cs.1516