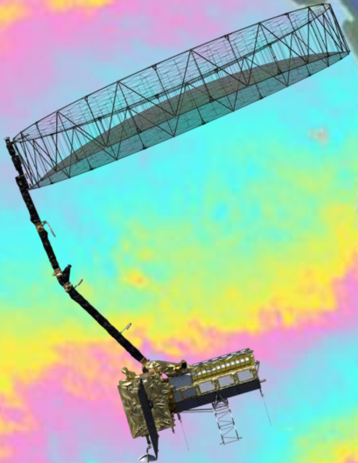
Better Earthquake Imaging Through NISAR



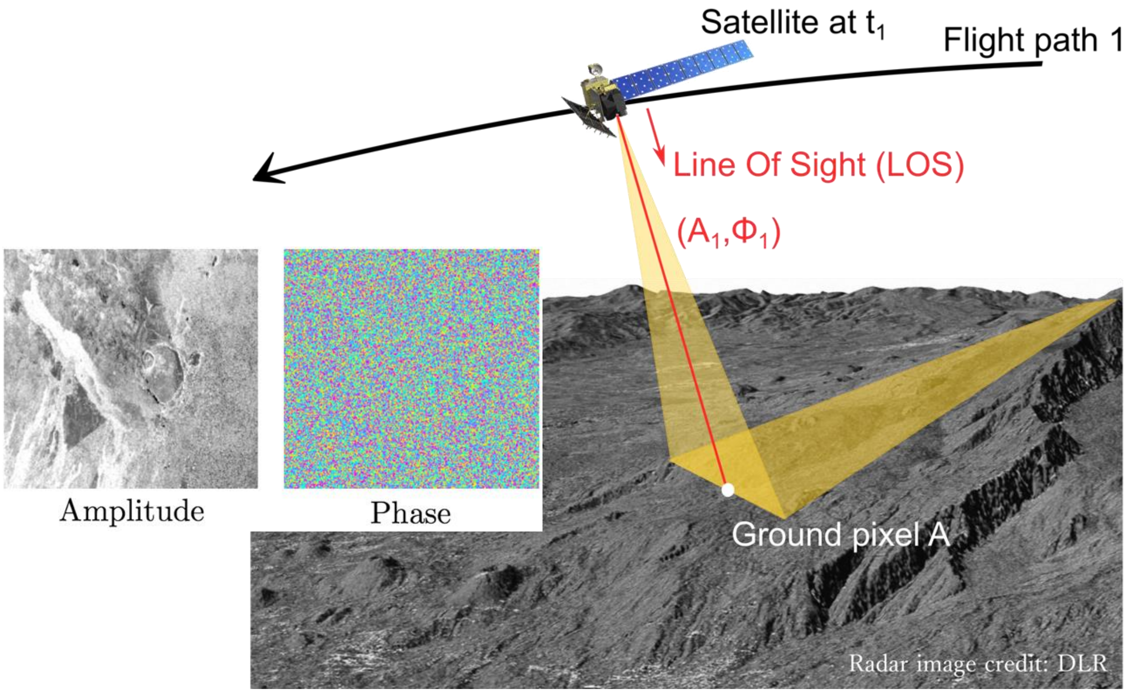
Molly Zebker

SCEC Annual Meeting

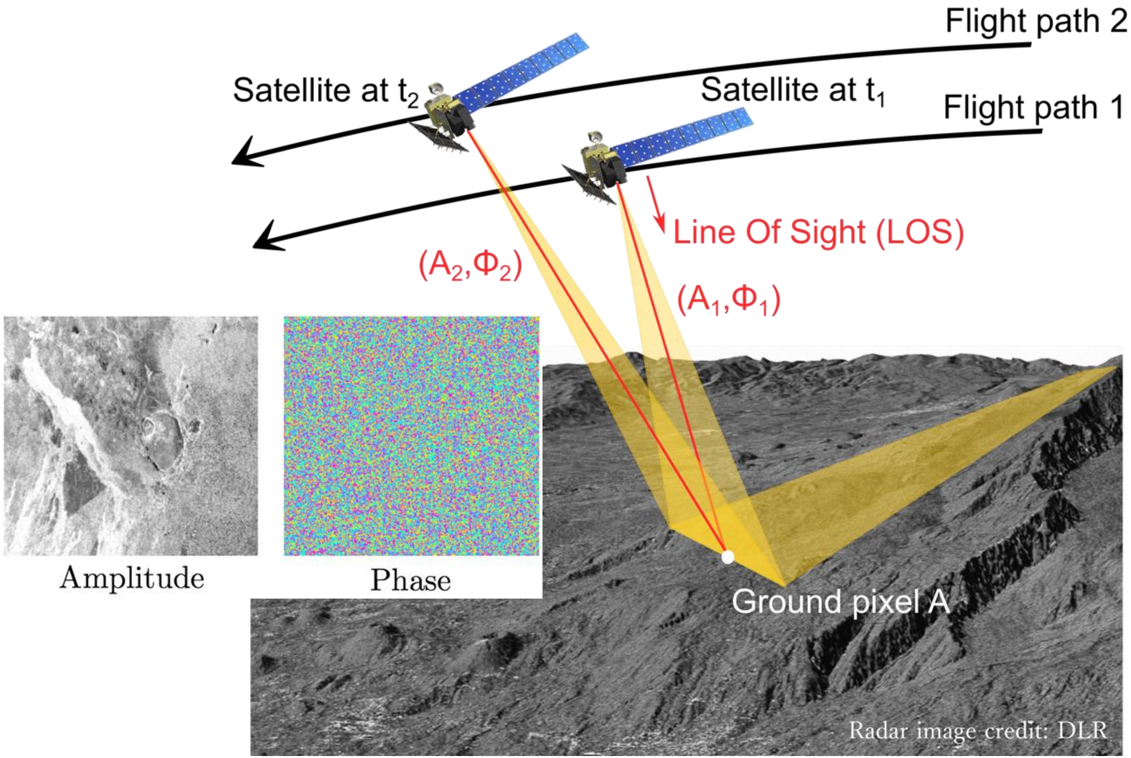
August 31, 2026

David Sandwell, Rubi Garcia Gonzalez, Matthew Brandin, Ekaterina Tymofyeyeva, Mark Simons, Adrian Borsa, Jingyi Chen, Eric Fielding, Marin Govorcin, Emre Havazli, Andrew Johnson, Franz Meyer, Soyeon Park, Matthew Pritchard, Yuankun Xu, Howard Zebker, Heresh Fattahi, Paul Rosen, and many others

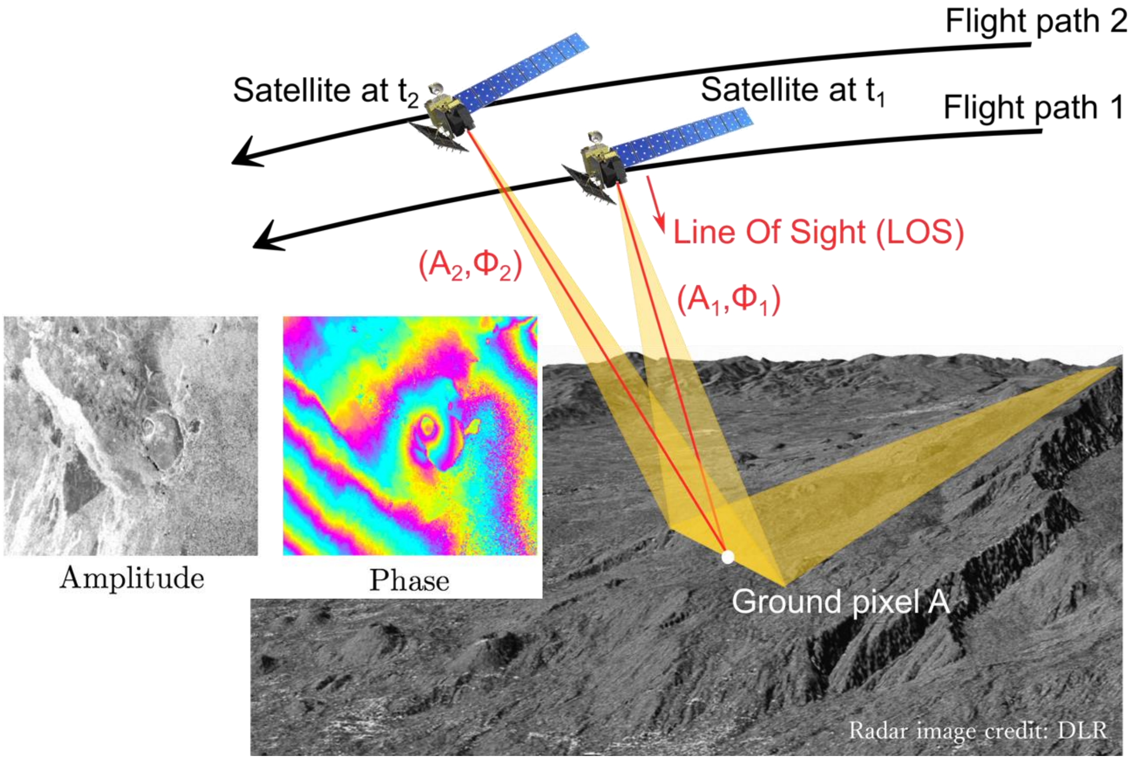
Interferometric Synthetic Aperture Radar (InSAR)



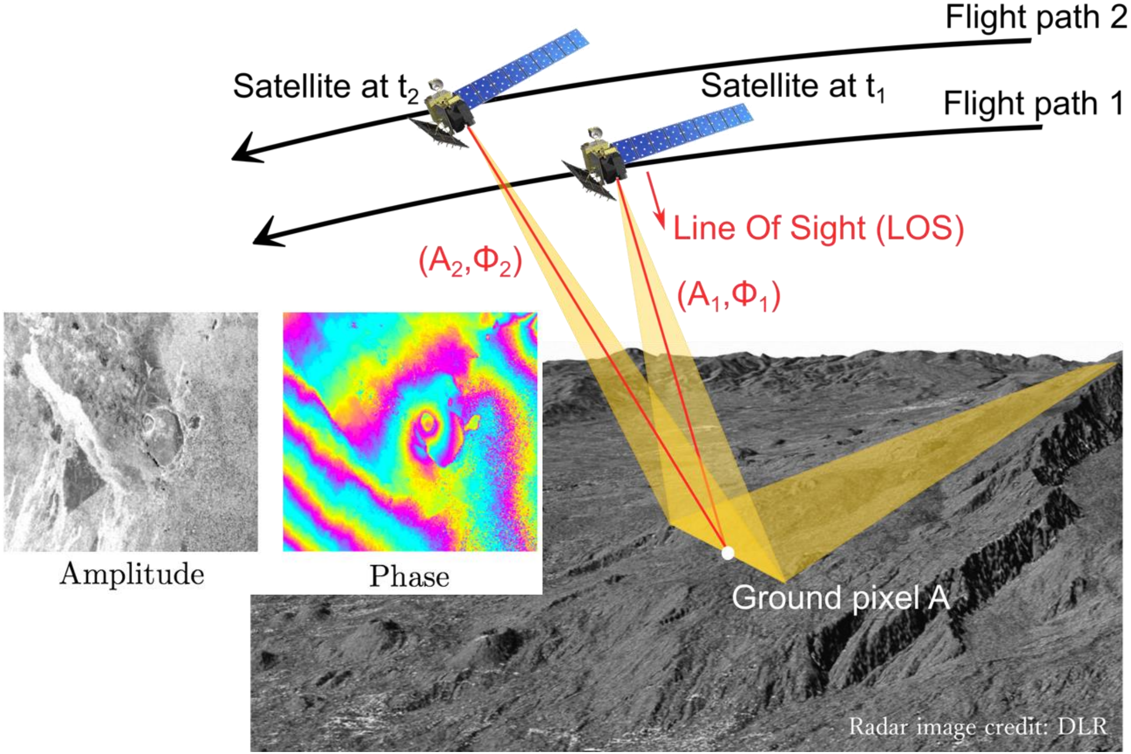
Interferometric Synthetic Aperture Radar (InSAR)



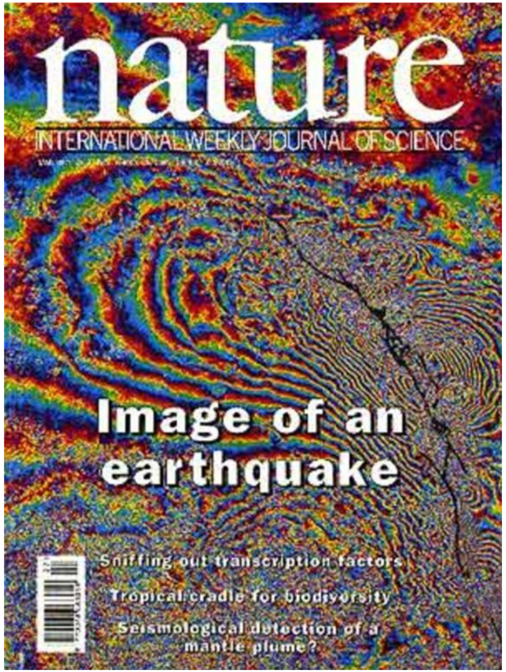
Interferometric Synthetic Aperture Radar (InSAR)



Interferometric Synthetic Aperture Radar (InSAR)



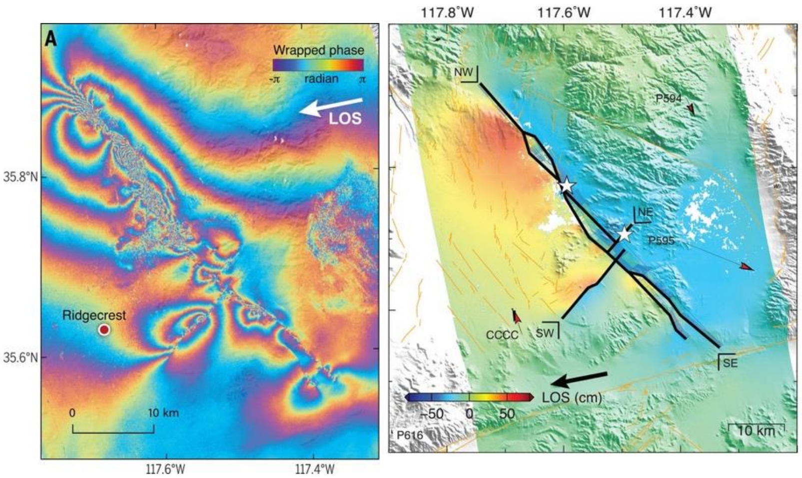
Mw 7.3 Landers Earthquake
June 28, 1992



Massonnet et al., 1993

InSAR for Earthquake Science

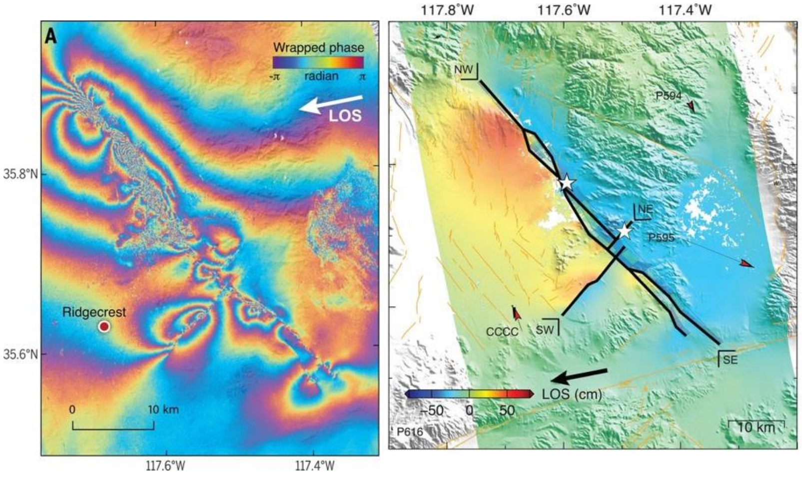
Mw 6.4 and 7.1 Ridgecrest Earthquakes
July 2019



Modified from Ross et al., 2019

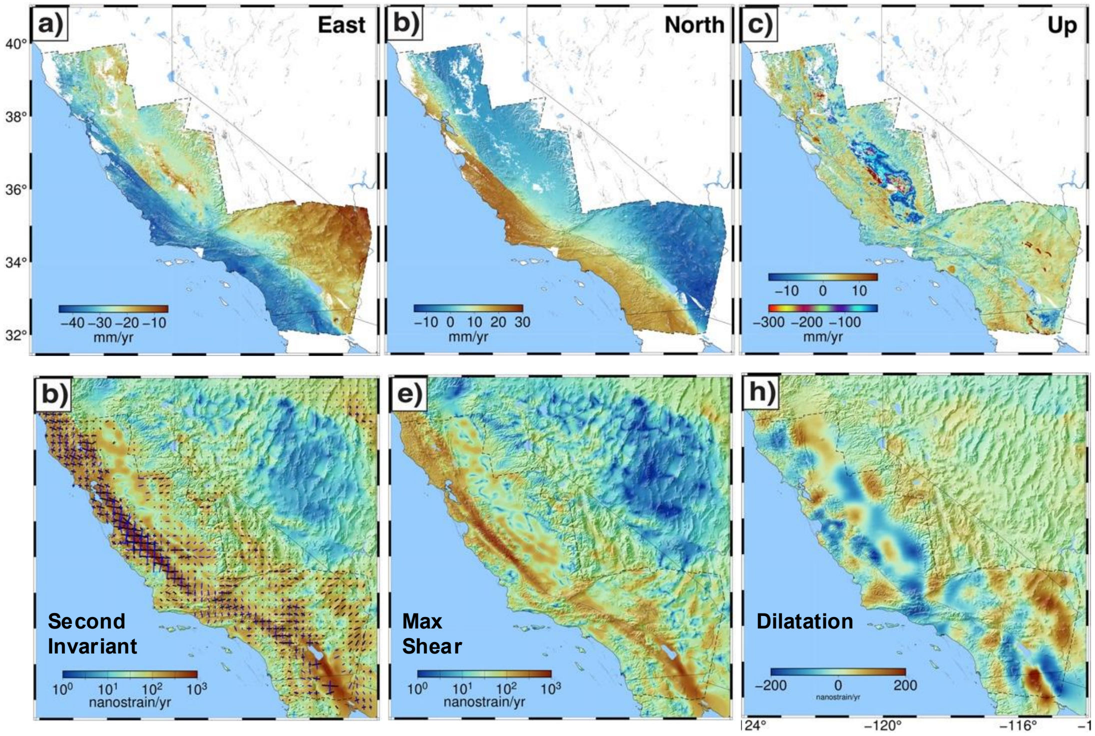
InSAR for Earthquake Science

Mw 6.4 and 7.1 Ridgecrest Earthquakes
July 2019



Modified from Ross et al., 2019

Large-scale strain rate derived from
InSAR + GNSS

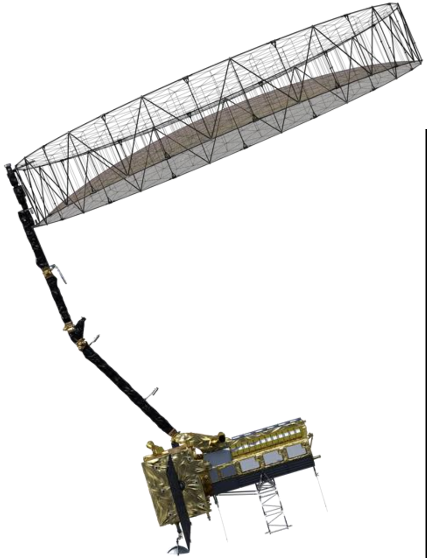


Modified from Xu et al., 2021

NISAR Launched July 30, 2025

NISAR will provide measurements of ground deformation along faults before an earthquake occurs, from the earthquake itself, and in the time following, all key information for understanding where and why earthquakes occur.

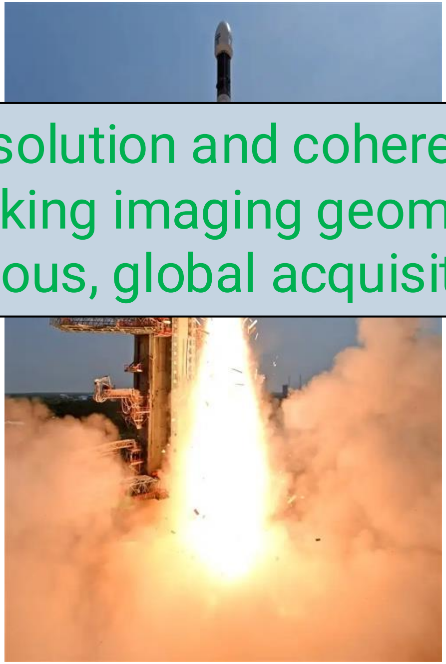




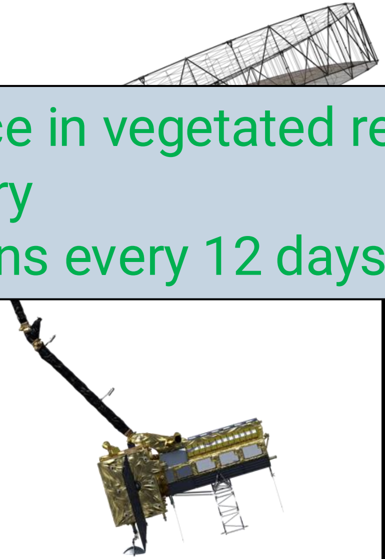

From Indian Space Research Organisation (ISRO)

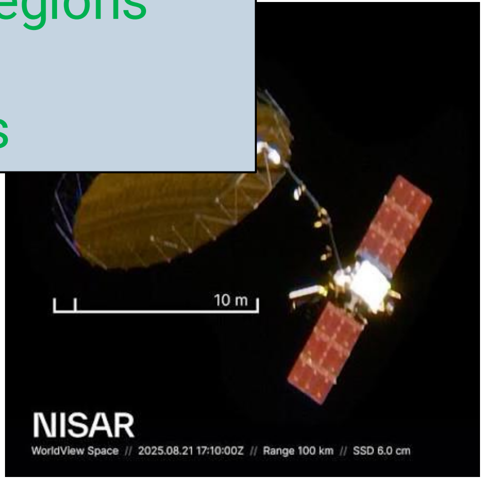
NISAR Launched July 30, 2025

NISAR will provide measurements of ground deformation along faults before an earthquake occurs, from the earthquake itself, and in the time following, all key information for understanding where and why earthquakes occur.



(1) High resolution and coherence in vegetated regions
(2) Left-looking imaging geometry
(3) Continuous, global acquisitions every 12 days



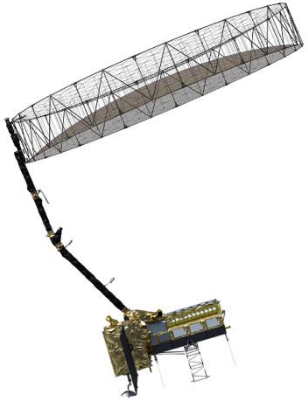


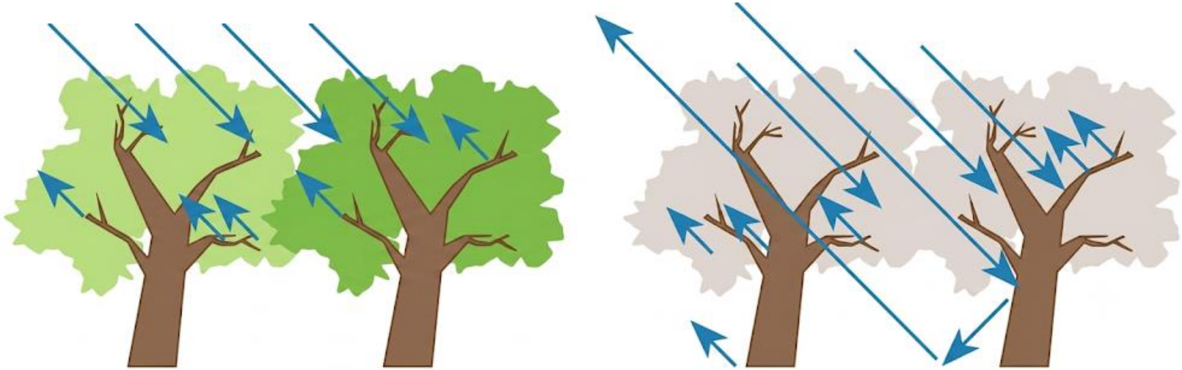
From Indian Space Research Organisation (ISRO)

Sentinel-1 NISAR

C-band 6 cm

L-band 24 cm





Sentinel-1 NISAR

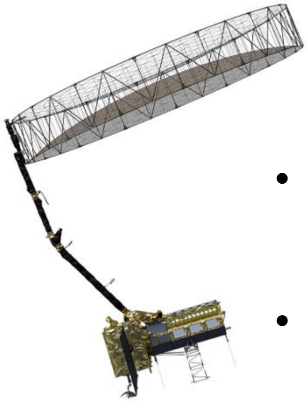
Sentinel-1

C-band 6 cm

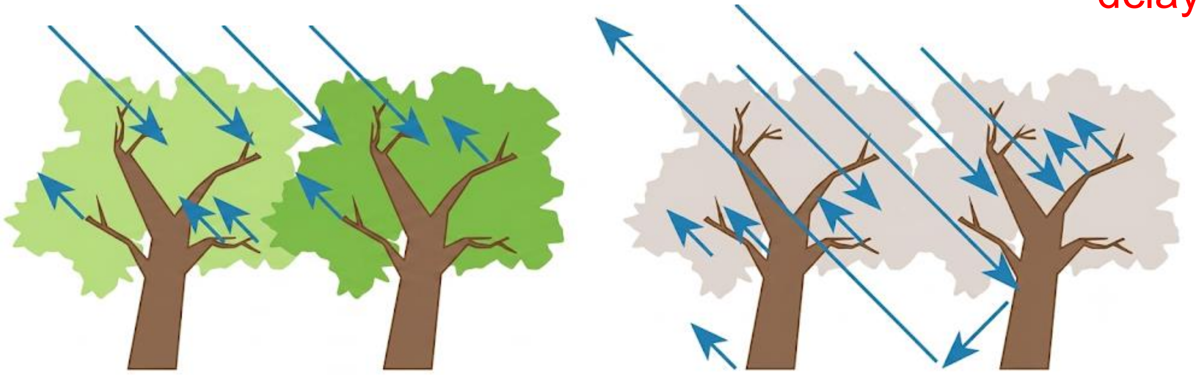
- Decorrelates in vegetated areas
- Less susceptible to ionospheric phase delays

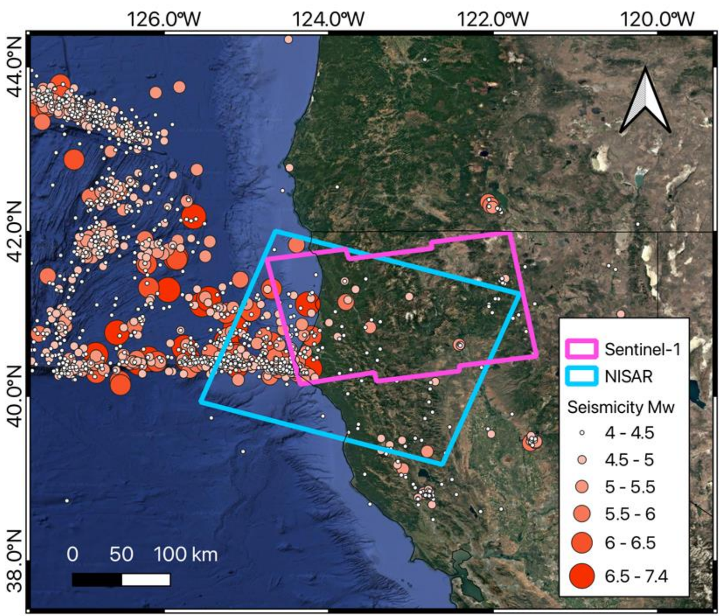
NISAR

L-band 24 cm



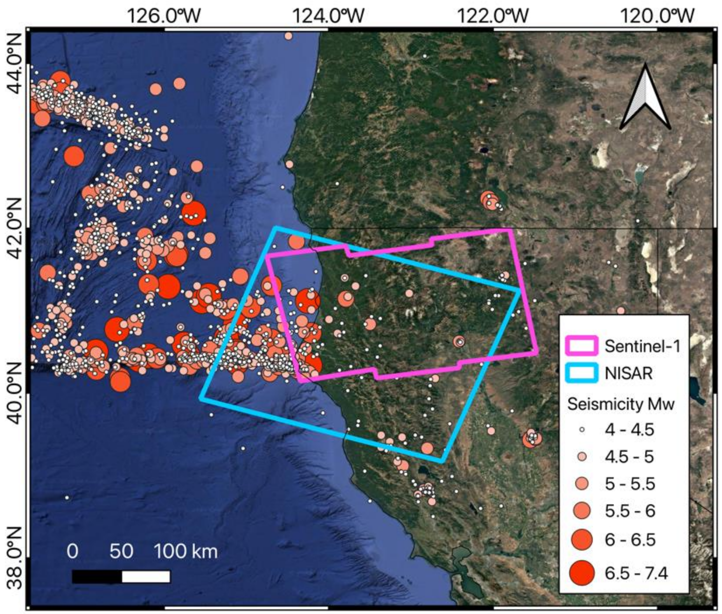
- Maintains coherence in vegetated areas
- More susceptible to ionospheric phase delays



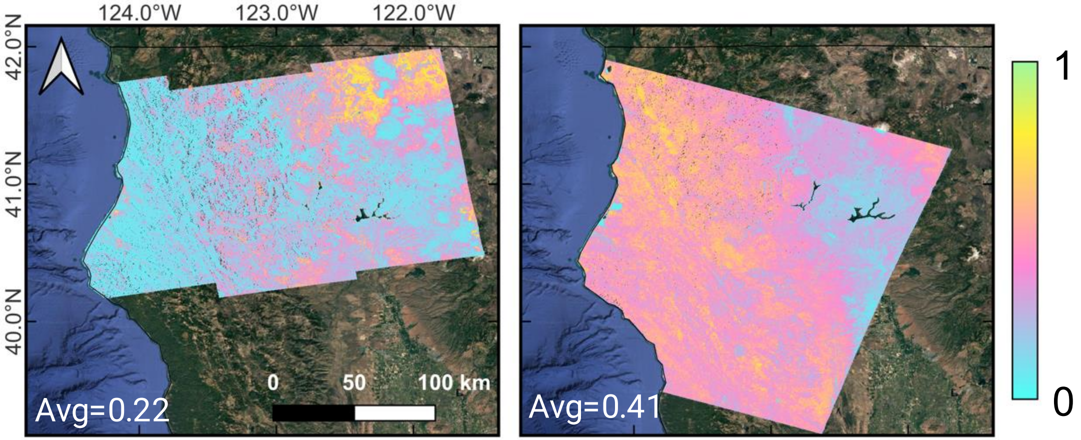


Sentinel-1

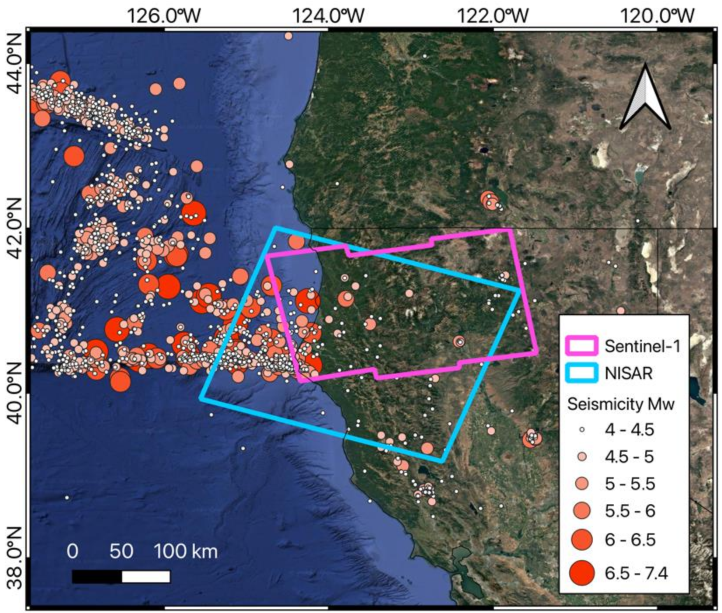
NISAR



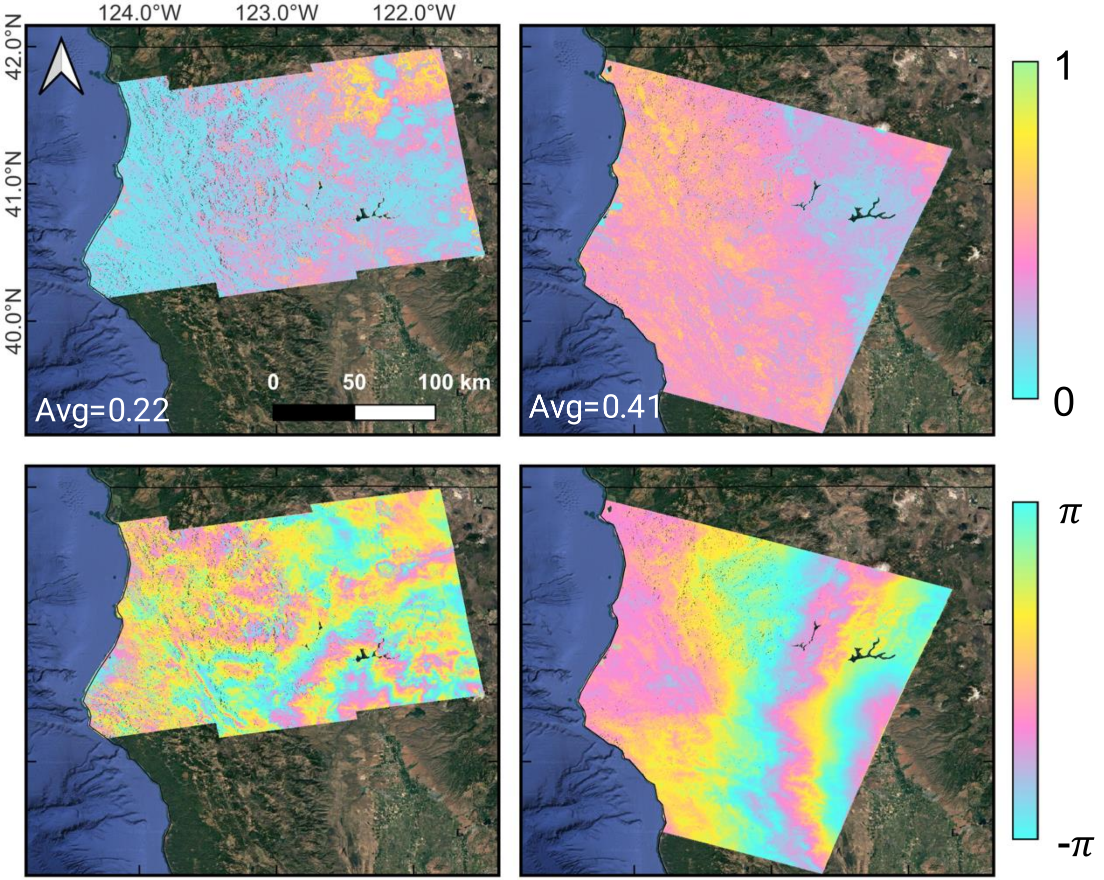
Sentinel-1 NISAR



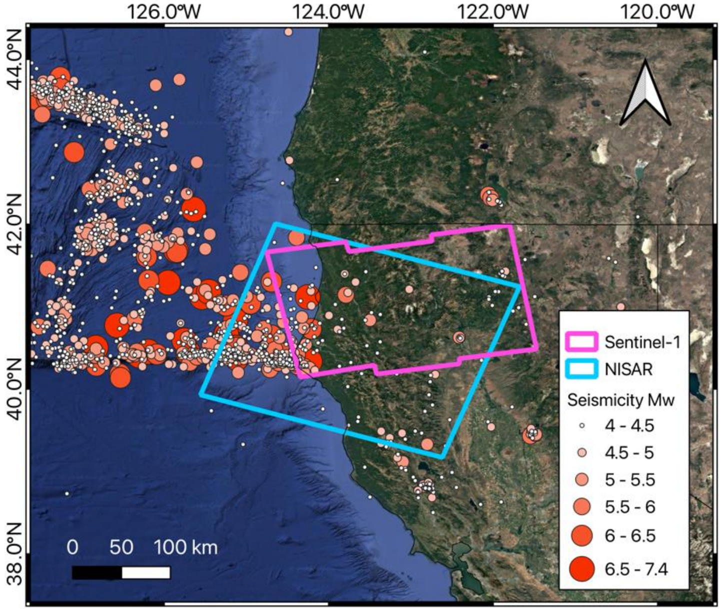
Sentinel-1: 24 days 20251028 - 20251121
NISAR: 24 days 20251022 - 20251115



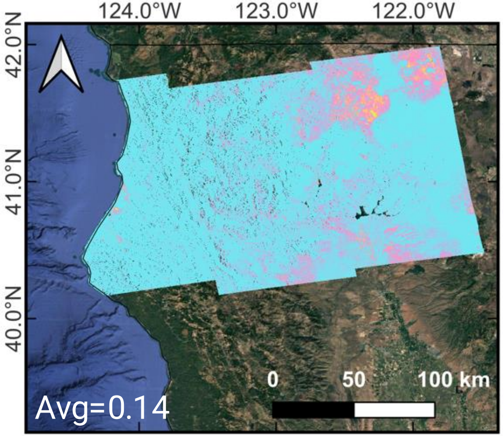
Sentinel-1 NISAR



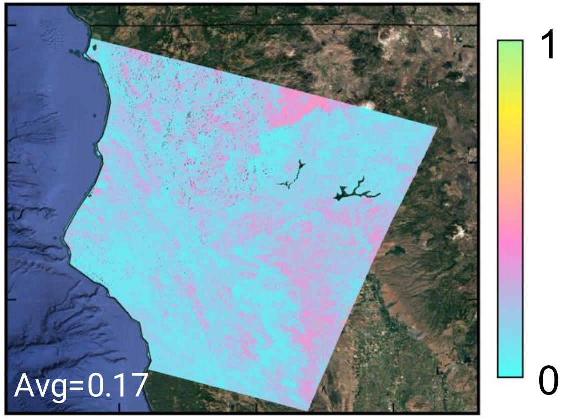
Sentinel-1: 24 days 20251028 - 20251121
NISAR: 24 days 20251022 - 20251115



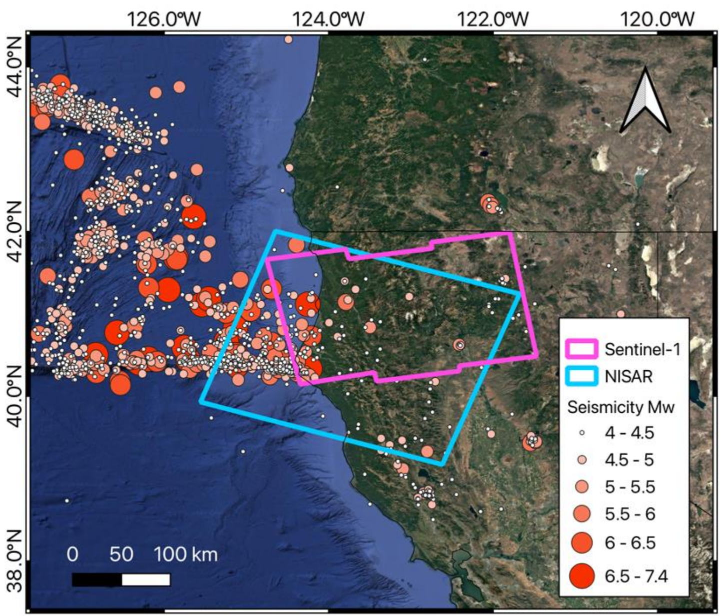
Sentinel-1

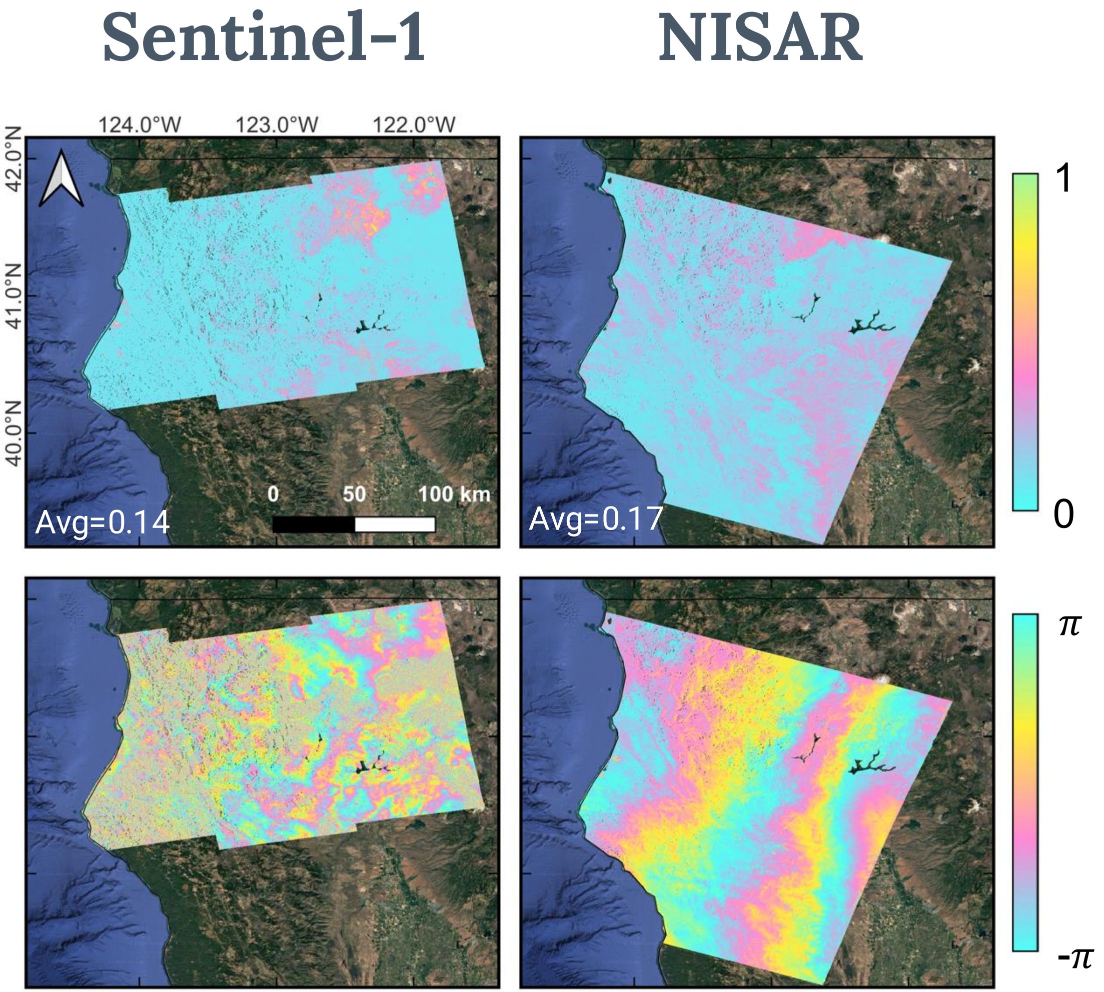


NISAR

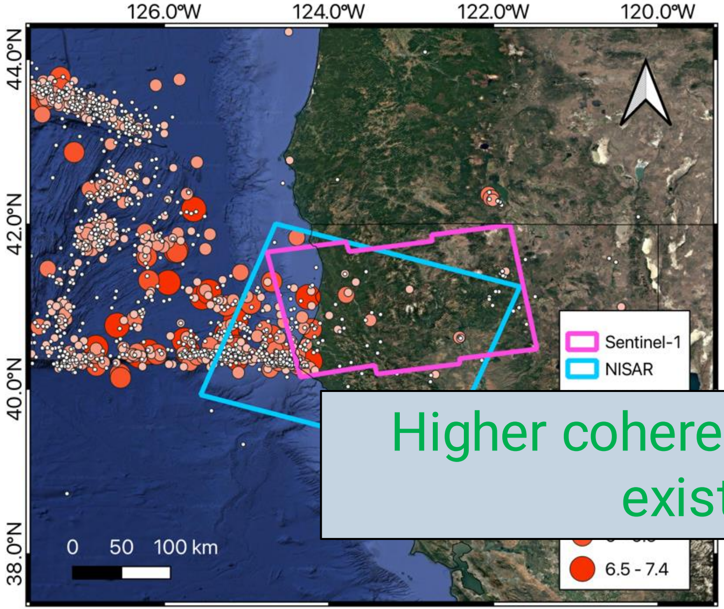


Sentinel-1: 72 days 20251028 - 20260108
NISAR: 72 days 20251022 - 20260102

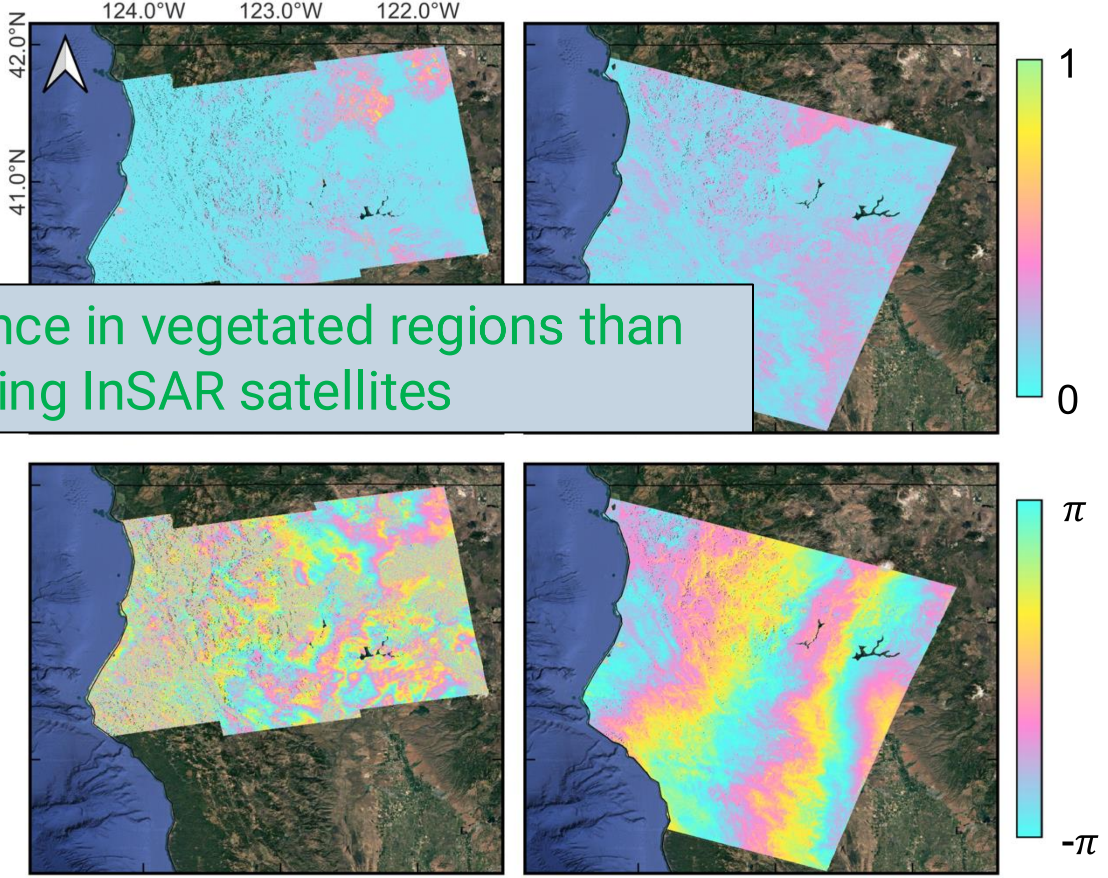




Sentinel-1: 72 days 20251028 - 20260108
NISAR: 72 days 20251022 - 20260102



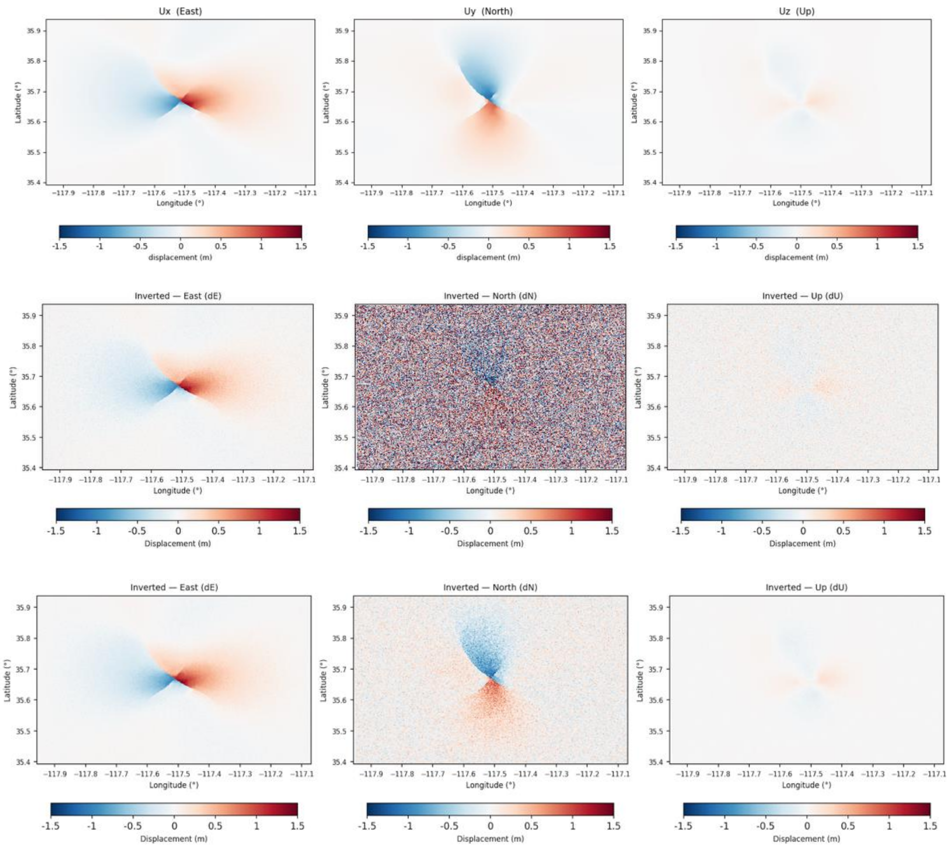
Sentinel-1 NISAR



Higher coherence in vegetated regions than existing InSAR satellites

Sentinel-1: 72 days 20251028 - 20260108
NISAR: 72 days 20251022 - 20260102

NISAR’s Left-Looking Imaging Geometry



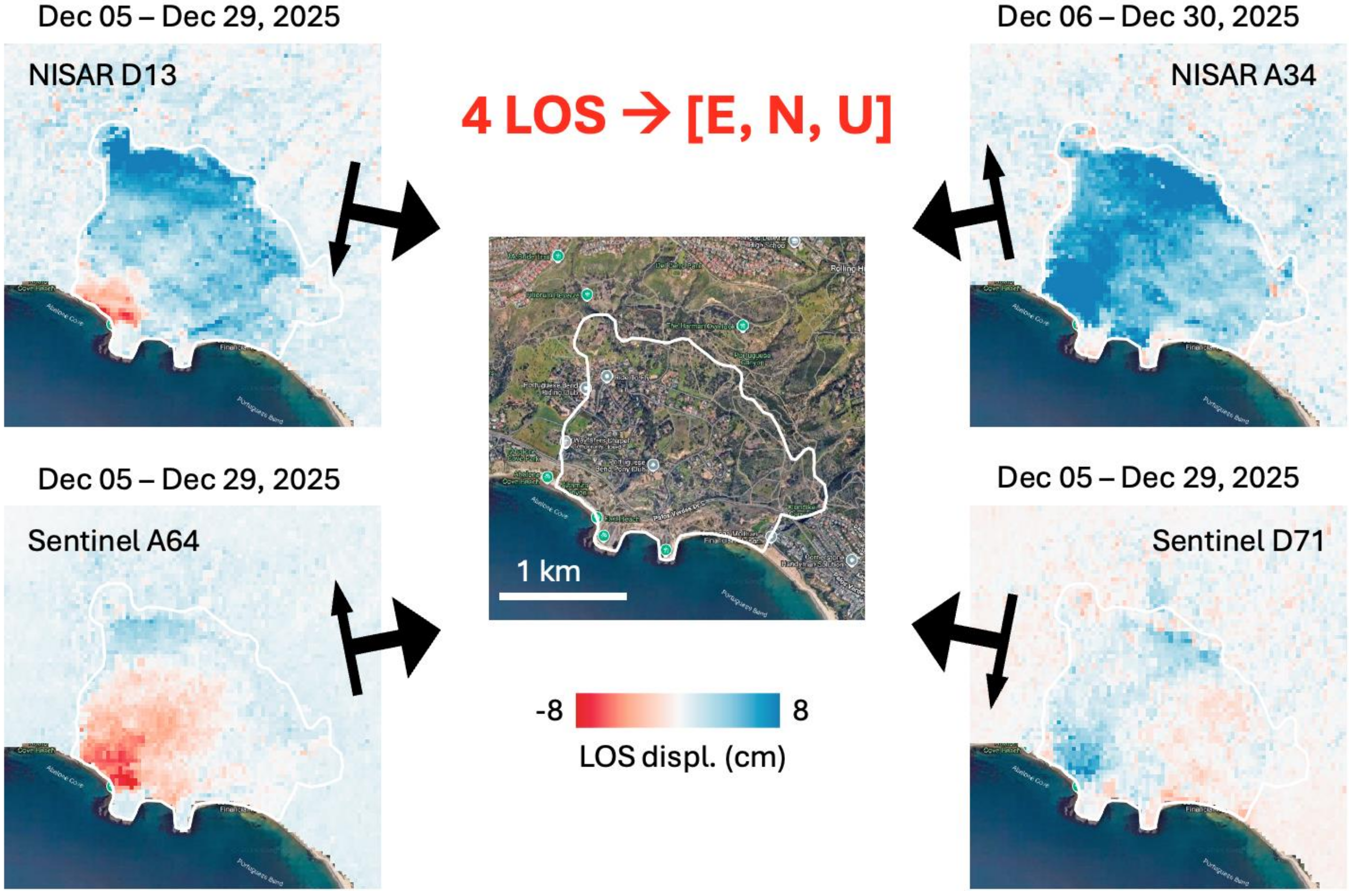
Modeled displacements from the 2019 Ridgecrest Earthquakes. From Uphoff et al. 2022 and Nevitt et al. 2023.

LOS deformations were inverted back to ENU using ascending and descending tracks from **ALOS-2 and Sentinel-1.** The North component of deformation is very poorly resolved.

Adding **NISAR LOS** deformation leads to a significant improvement in vector diversity, allowing for the resolution of the North deformation component.

From Katia Tymofyeyeva, JPL

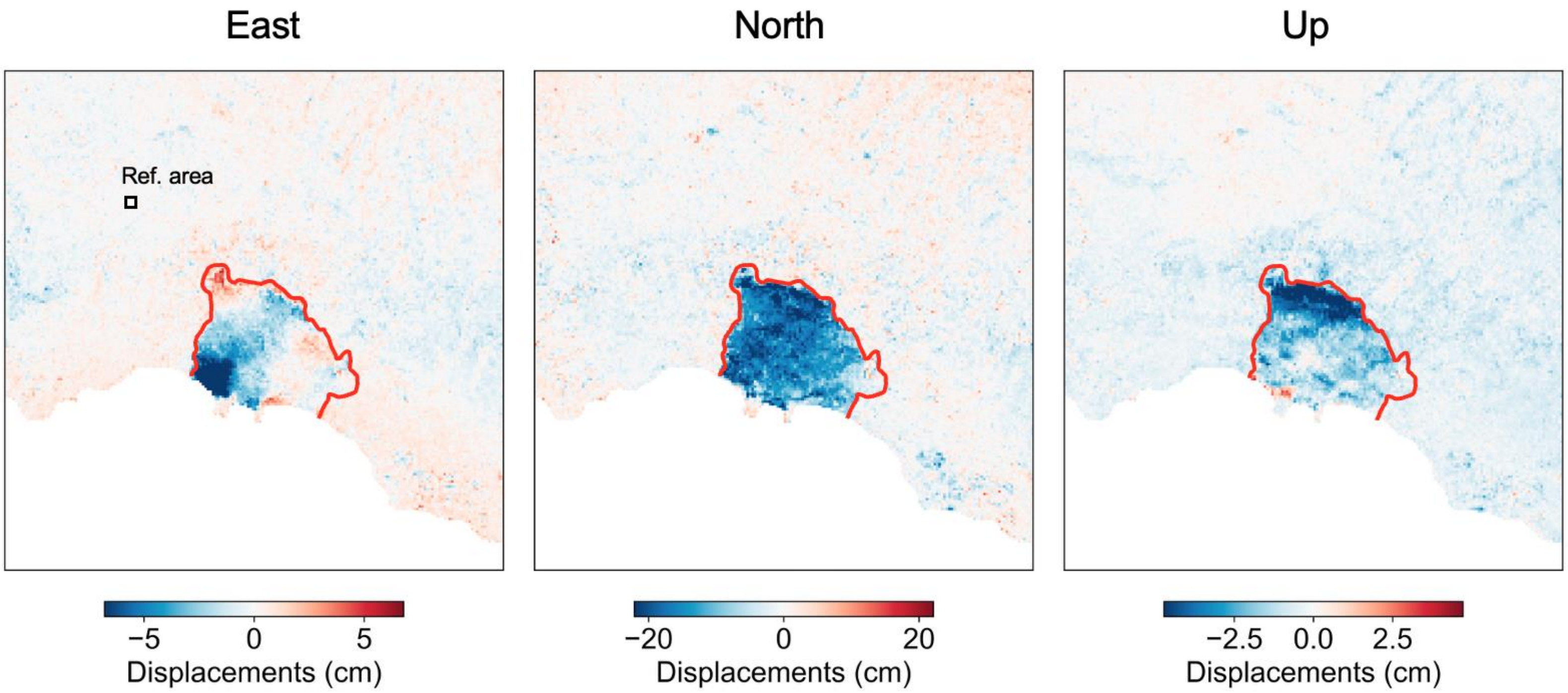
Palos Verde Landslide



From Yuankun Xu, CalTech

Palos Verde Landslide

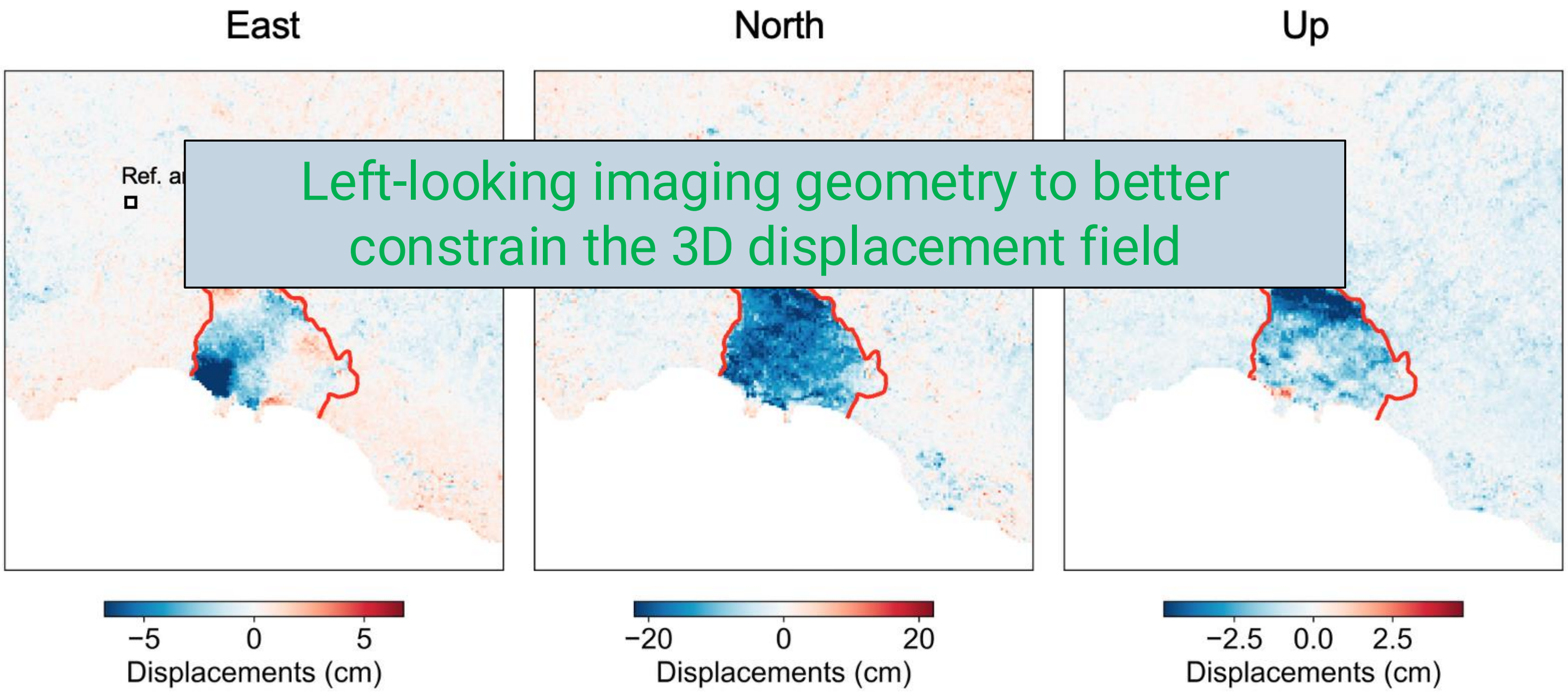
3+ imaging geometries allows us to can solve for the 3D displacement field



From Yuankun Xu, CalTech

Palos Verde Landslide

3+ imaging geometries allows us to can solve for the 3D displacement field

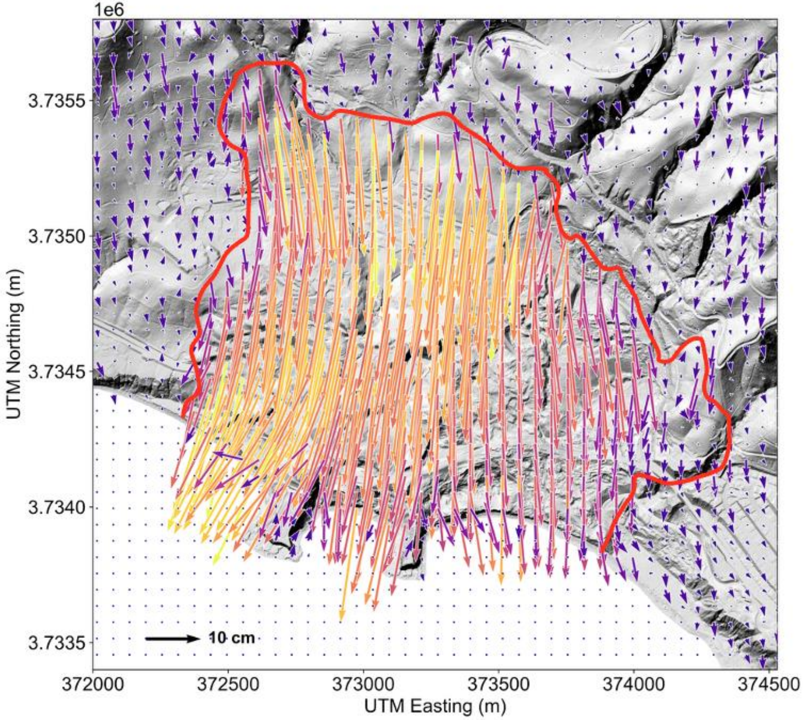


Left-looking imaging geometry to better constrain the 3D displacement field

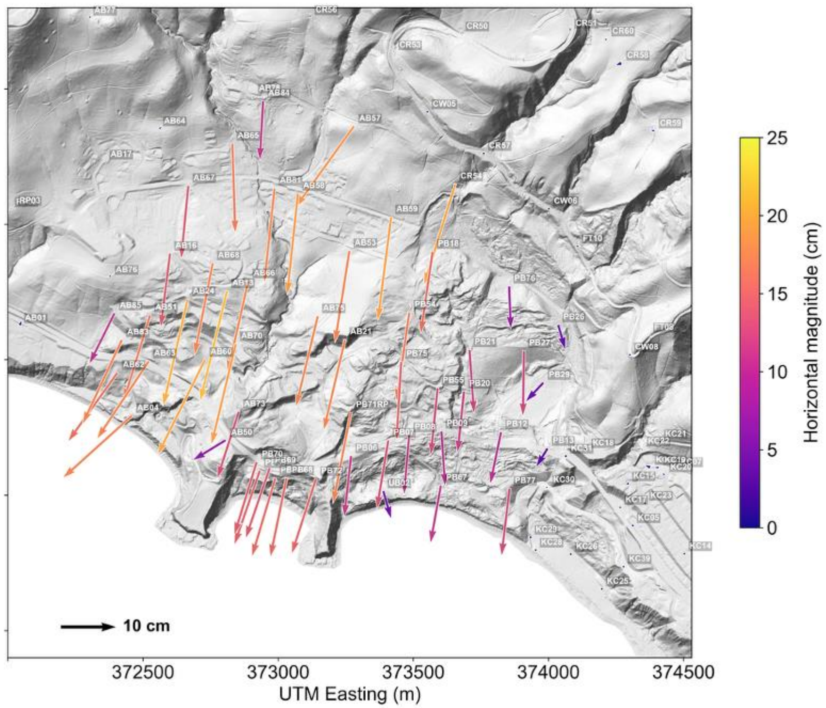
From Yuankun Xu, CalTech

Palos Verde Landslide

InSAR



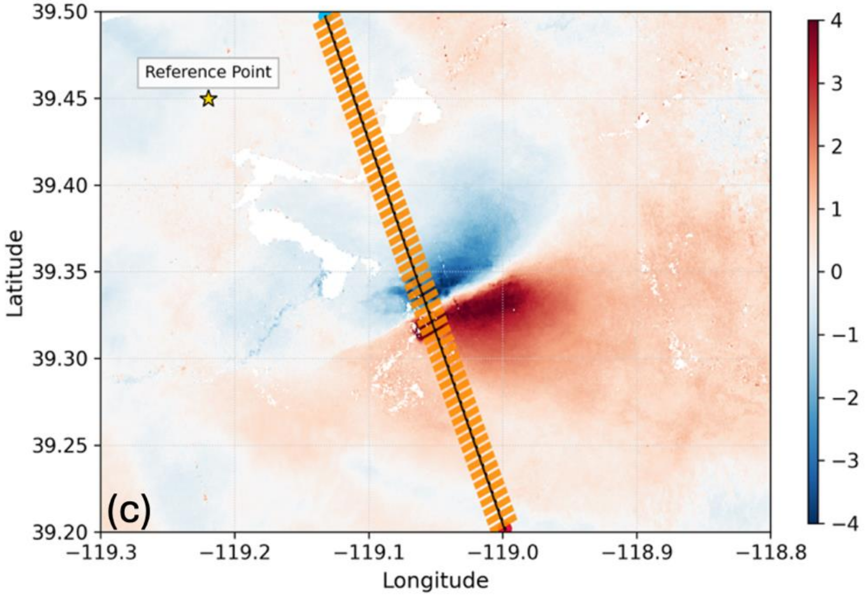
GPS

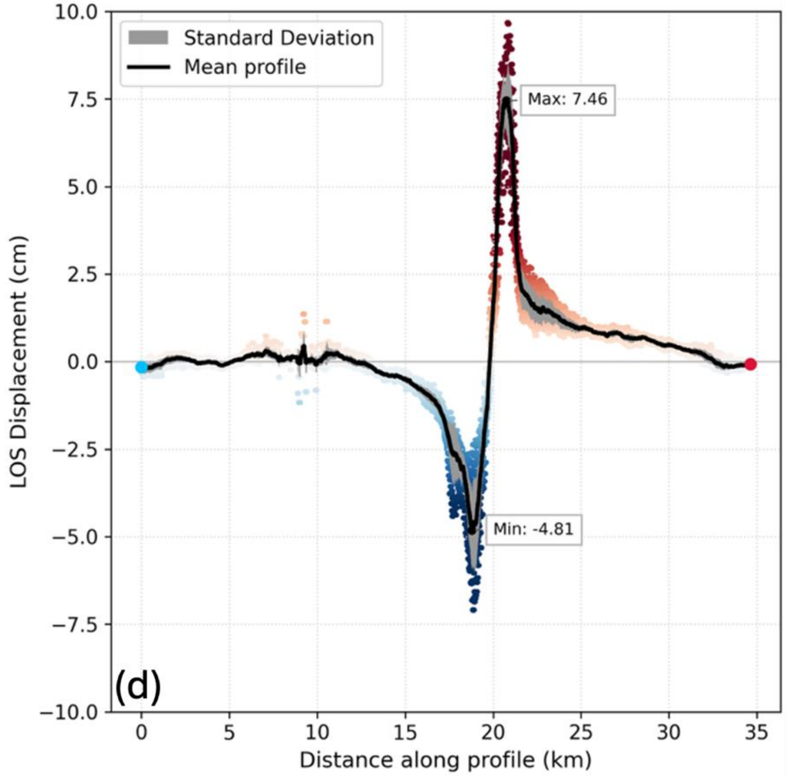


From Yuankun Xu, CalTech

M5.7 Silver Springs earthquake, Nevada

April 14, 2026

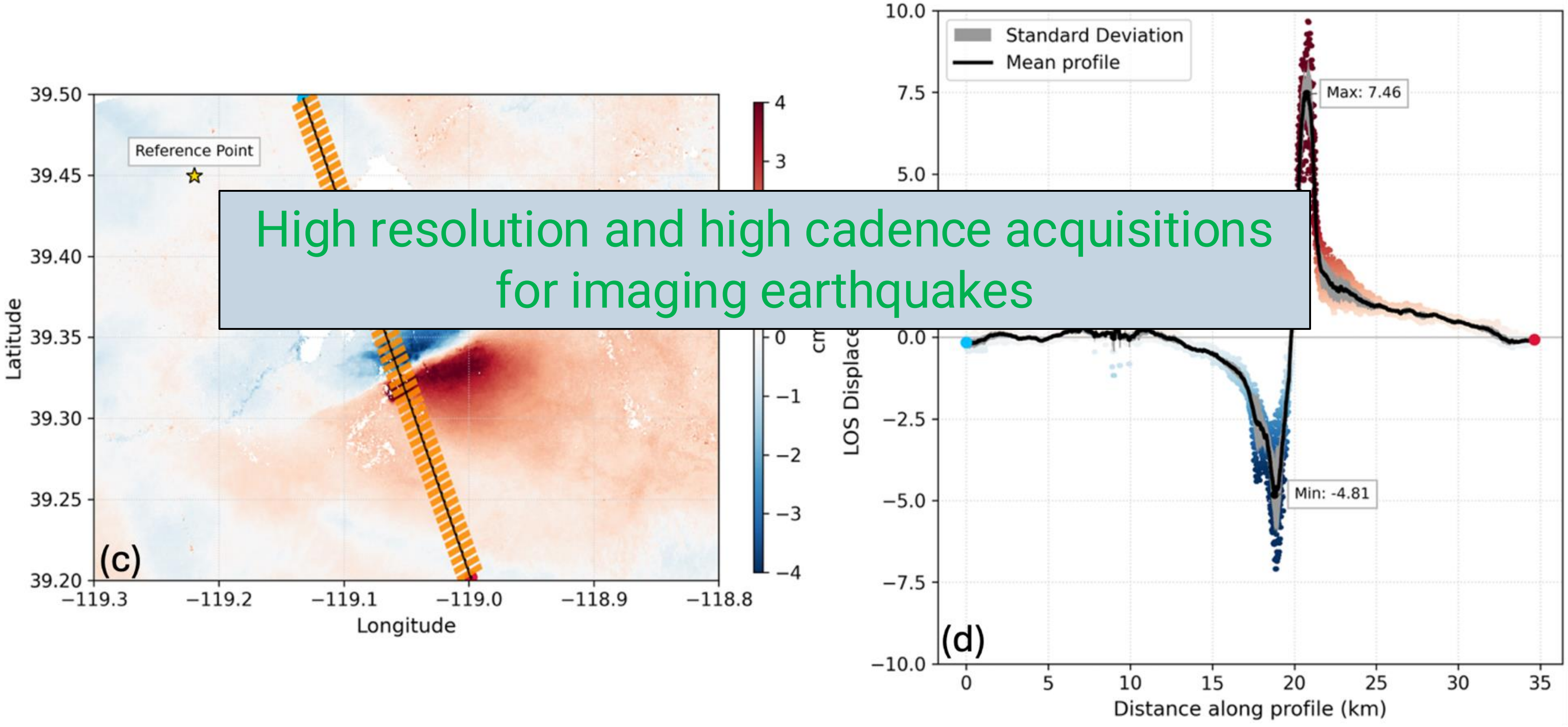




From Emre Havazli, JPL

M5.7 Silver Springs earthquake, Nevada

April 14, 2026

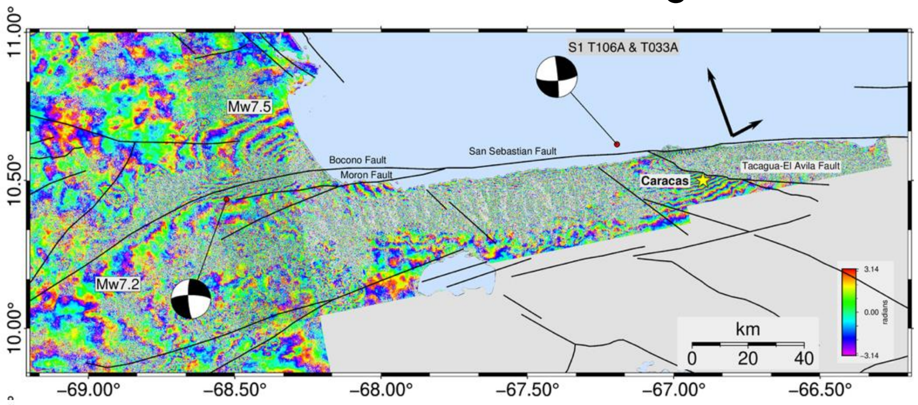


High resolution and high cadence acquisitions for imaging earthquakes

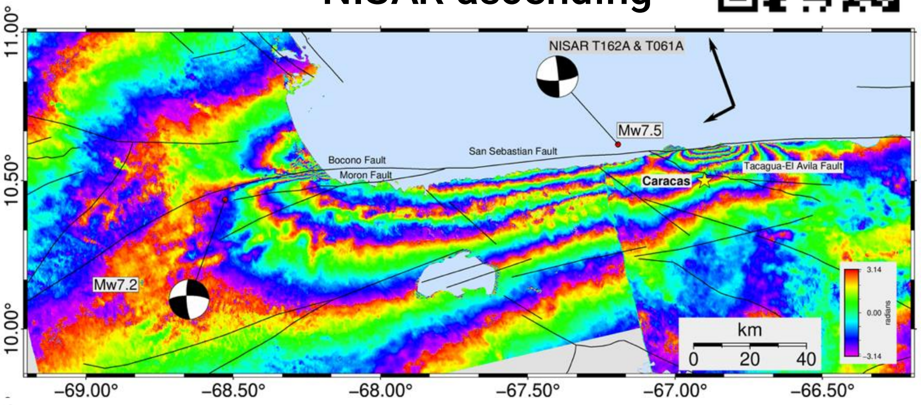
From Emre Havazli, JPL

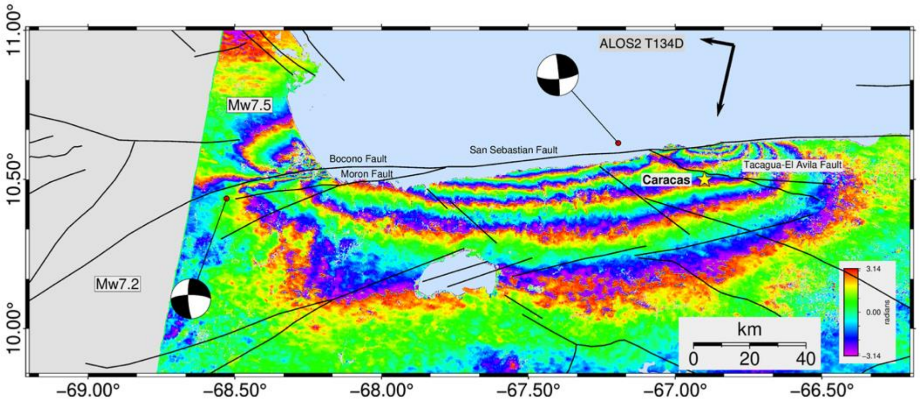
M7.5 Venezuela Earthquake

Sentinel-1 ascending

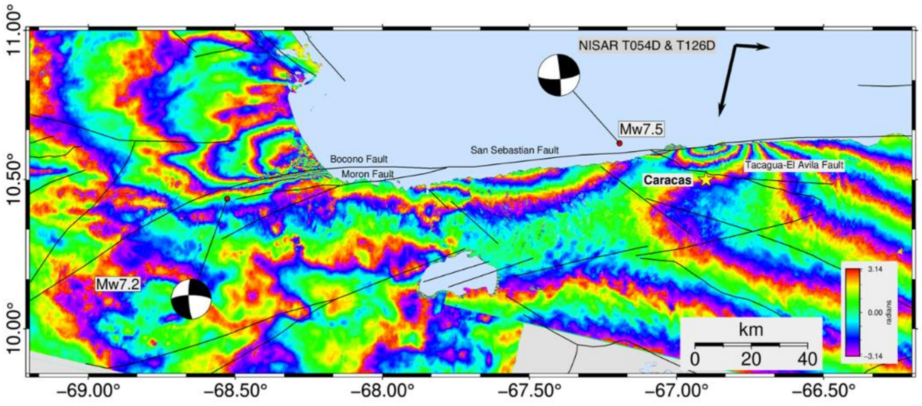


NISAR ascending





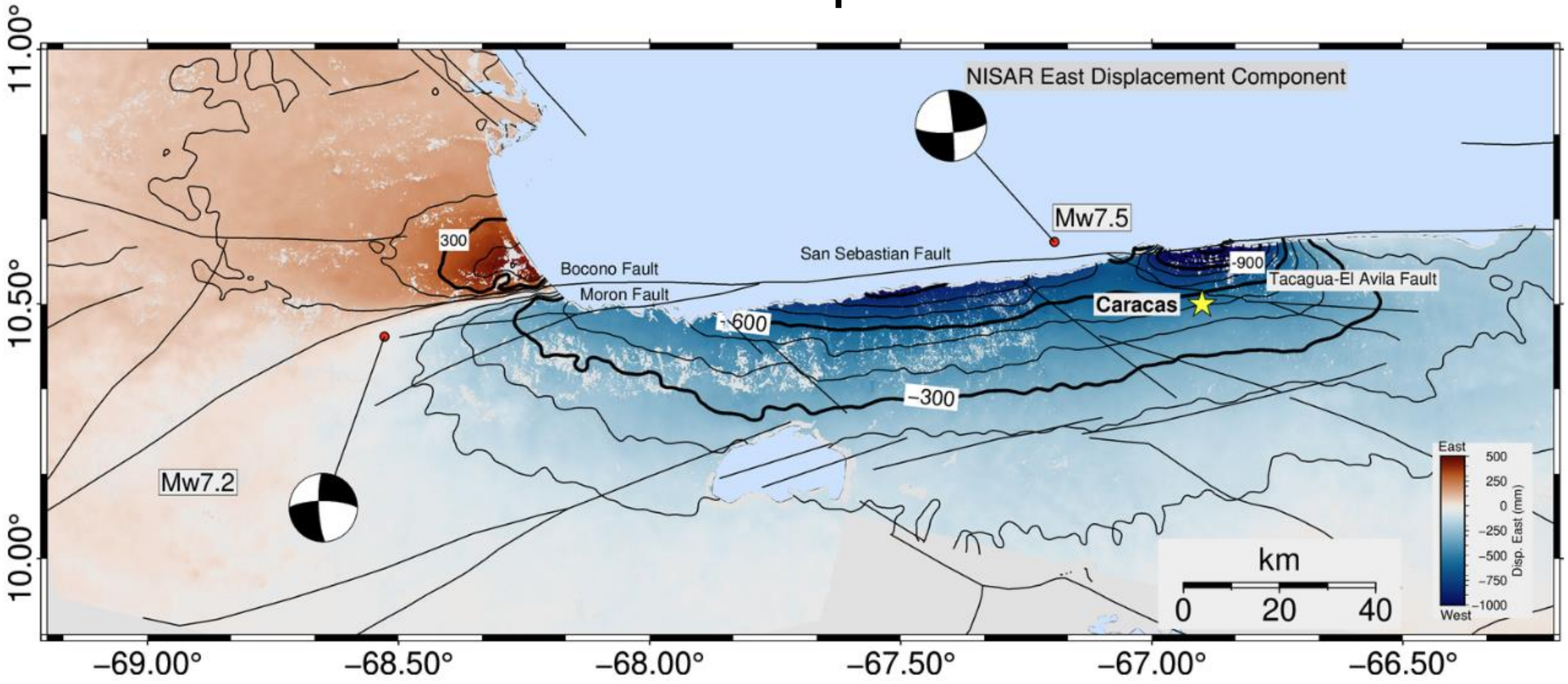
ALOS-2 descending



NISAR descending

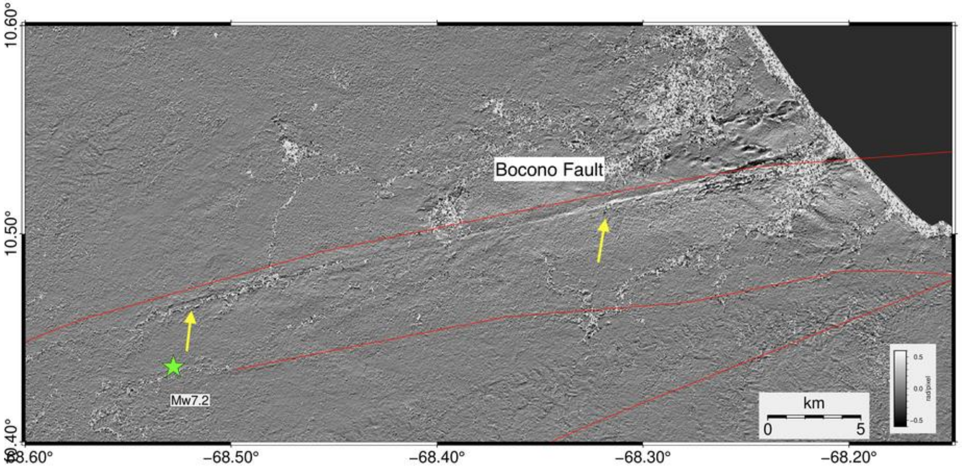
M7.5 Venezuela Earthquake

NISAR East Displacement

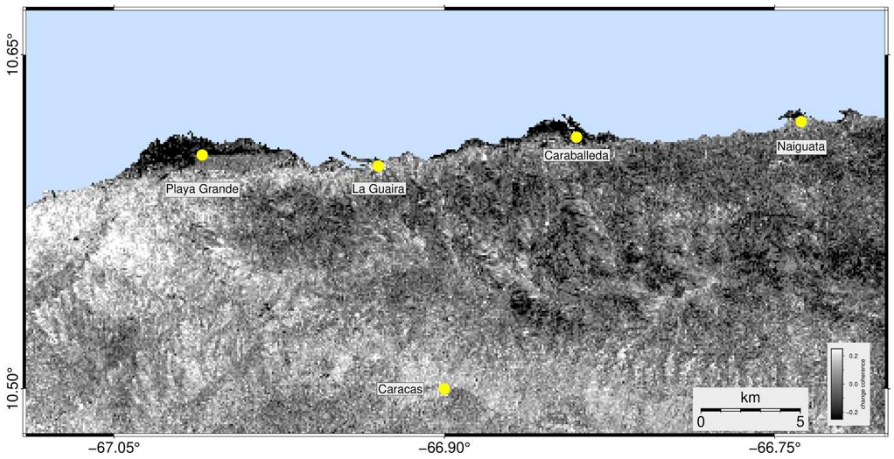


M7.5 Venezuela Earthquake

Strain from Phase Gradient

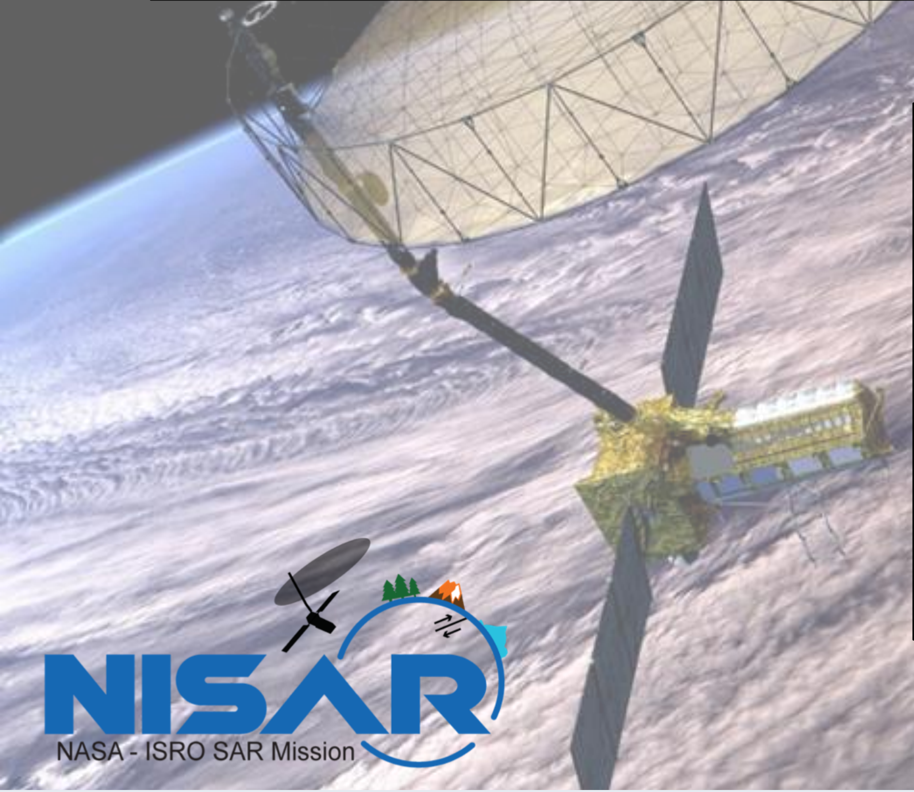


Damage from Coherence Change



More analysis on posters 023, 055, and 220!

Takeaways and Acknowledgements



- High coherence allows us to study fault systems in densely vegetated regions
- Left-looking imaging geometry provides additional constraints on 3D displacement fields
- Regular 12-day acquisitions globally will provide images throughout the earthquake cycle

- Data are available at the Alaska Satellite Facility
- Software and tools are available through ISCE3 and GMTSAR

This research was supported by the Statewide California Earthquake Center (Contribution No. 26092). SCEC is funded by NSF Cooperative Agreement EAR-2225216 and USGS Cooperative Agreement G24AC00072. Additional support was provided by the NASA Earth Surface and Interior program (80NSSC23K0744), the NSF Office of Advanced Cyberinfrastructure program (OAC 2209808), and the National Geodetic Survey (NA23NOS4000334).