Parallel InSAR Streams for the Community Geodetic Model: Evaluating Statewide Kinematics using Customizable Level-2 ARIA, Standardized Level-3 OPERA DISP-S1 Archives, and Preliminary NISAR Data

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Overview

- **Level-2 ARIA GUNW**: JPL's Advanced Rapid Imaging and Analysis (ARIA) project produces Geocoded Unwrapped Phase (GUNW) interferograms. They give experts control over network inversion.
- **Level 3 OPERA DISP:** NASA's Observational Products for End-Users from Remote Sensing Analysis (OPERA) project delivers an out-of-the-box displacement (DISP) time series, bypassing heavy user processing. Leveraging Sentinel-1, we present updated California deformation maps ahead of the NISAR (DISP-NI) release in February 2027.
- **Preliminary NISAR Integration**: ARIA Sentinel-1 GUNWs (ARIA-S1-GUNW) share the NISAR format (NISAR_L2_GUNW), so our open source workflows support both. We seamlessly bridge these parallel InSAR streams with early NISAR data to demonstrate continuous geodetic monitoring.

Level 2 GUNW Product Suites

Ideal for tailored research and rapid disaster response, these single-pair interferograms empower users to design custom networks for surface deformation monitoring. For regions lacking existing coverage, new pairs can be generated seamlessly on-demand using **ARIA-tools**.

Description	Maps surface deformation via single-pair interferogram measurements in the radar line-of-sight (LOS) direction	**Sensor Temporal Sampling**	6-24 days (ARIA-S1-GUNW) 12 days (NISAR_L2_GUNW)
Distribution	ASF DAAC	**Pixel Resolution (Northings x Eastings)**	90m
		File Format	CF-compliant NetCDF
Sensor	Sentinel-1 A/B/C/D & NISAR	**Start of Product Record**	Oct. 2014 (ARIA-S1-GUNW) Sept. 2025 (NISAR_L2_GUNW)
Geographic scope	Target regions globally*		

** ARIA-S1-GUNW products are generated over targeted global regions of interest.*

ARIA Links of Interest

📖 **Our ARIA Publication** tinyurl.com/ARIA-pub

▶️ **ARIA-tools Video Tutorial** tinyurl.com/ARIA-tools-vid

🛠️ **ARIA-tools Software** tinyurl.com/ARIA-tools

🌐 **ARIA Product Guide** tinyurl.com/ARIA-home

Level 3 OPERA DISP Product Suite

Equipping a broad spectrum of users with actionable data, this automated archive eliminates manual processing. It provides a standardized continuous time series to track deformation (such as tectonic strain & subsidence) without maintaining independent workflows.

Description	Maps surface displacement from InSAR time series in radar LOS direction	**Sensor Temporal Sampling**	6-24 days (DISP-S1) 12 days (DISP-NI)
Distribution	ASF DAAC	**Pixel Resolution (Northings x Eastings)**	30 m or better
		File Format	HDF5
Sensor	Sentinel-1 A/B/C/D & NISAR	**Start of Product Record**	Jul. 2016 (DISP-S1) **Jun. 2026 (DISP-NI)**
Geographic scope	North America*	**Validated Release Date**	May 2025 (DISP-S1) **Feb. 2027 (DISP-NI)**

** USA, US Territories, parts of Canada, and all mainland countries south to Panama.*

OPERA DISP Links of Interest

📖 **Our DISP-S1 Publication** tinyurl.com/DISP-pub

🗺️ **ArcGIS Storymap** tinyurl.com/DISP-ASF-tools

👀 **Interactive Visualization Portal** displacement.asf.alaska.edu/

🌐 **OPERA DISP Landing Page** tinyurl.com/DISP-home

Methodology

To demonstrate the utility of DISP-S1 products, we processed **5,000+ products** (spanning **July 2016 – December 2025**) in the descending LOS **across California**. To bridge this with the NISAR mission, we also conducted manual time-series analysis on **>300** preliminary NISAR GUNW products (**October 2025 – July 2026**) using ARIA-tools. Together, these datasets reveal deformation signals like groundwater hydrology, gas extraction, fault motion, and slope instability.

Time-Series Inversion Model:

$$Vt + C + A_1 \sin(2\pi t) + B_1 \cos(2\pi t) + A_2 \sin(4\pi t) + B_2 \cos(4\pi t) + \sum_{k=1}^{N} S_k H(t - t_k),$$

Where:

- V & C: Secular displacement rate (velocity) & constant offset.
- A_1, B_1 & A_2, B_2: Amplitudes for annual and semiannual periodic terms.
- S_k & $H(t - t_k)$: Amplitude & Heaviside step function for coseismic events at time t_k (yellow stars).

In Practice: This functional form helps prevent velocity bias and more reliably isolate distinct deformation signals of interest (V). Constraining V per frame (~350 unique dates) takes ~10 mins, with 18 frames spanning this study area. *Note: Due to its short ~9-month duration, preliminary NISAR data was modeled using a simple linear velocity fit; apparent trend deviations (e.g., **Fig. 4C**) are likely artifacts of seasonal aliasing in short, uncalibrated datasets.*

Results

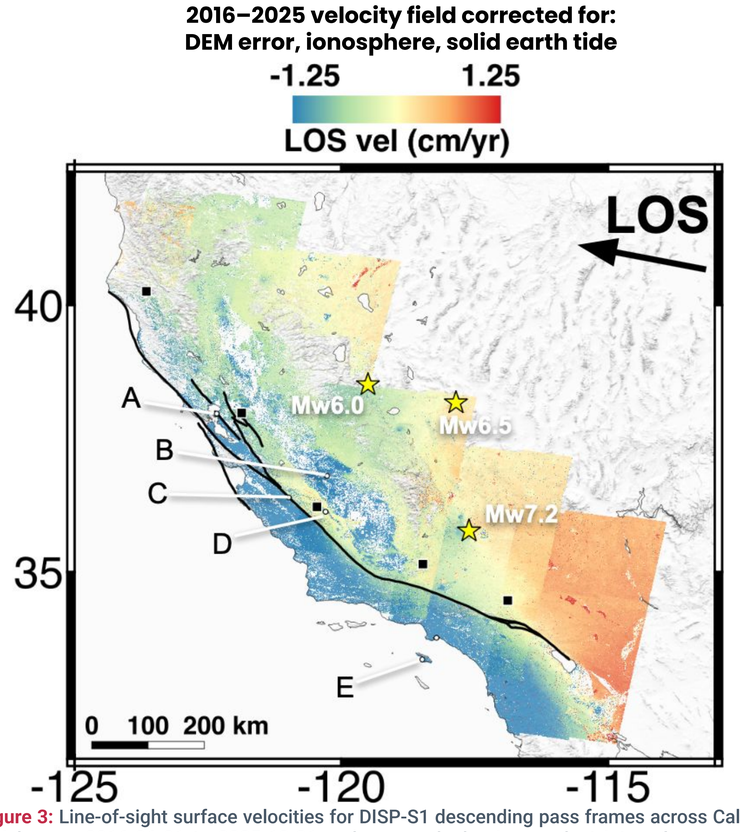

Figure 3: Line-of-sight surface velocities for DISP-S1 descending pass frames across California, which span 2016-06-01 to 2025-12-31 and are masked using product internal recommended mask. Each frame is referenced WRT GNSS stations (black squares); features of interest are marked (white circles + corresponding letters); faults (black lines) from USGS fault database (USGS 2026). Positive motions indicate motion of the ground towards the satellite, and vice-versa. Letter labels correspond to time-series plots in **Fig. 4**.

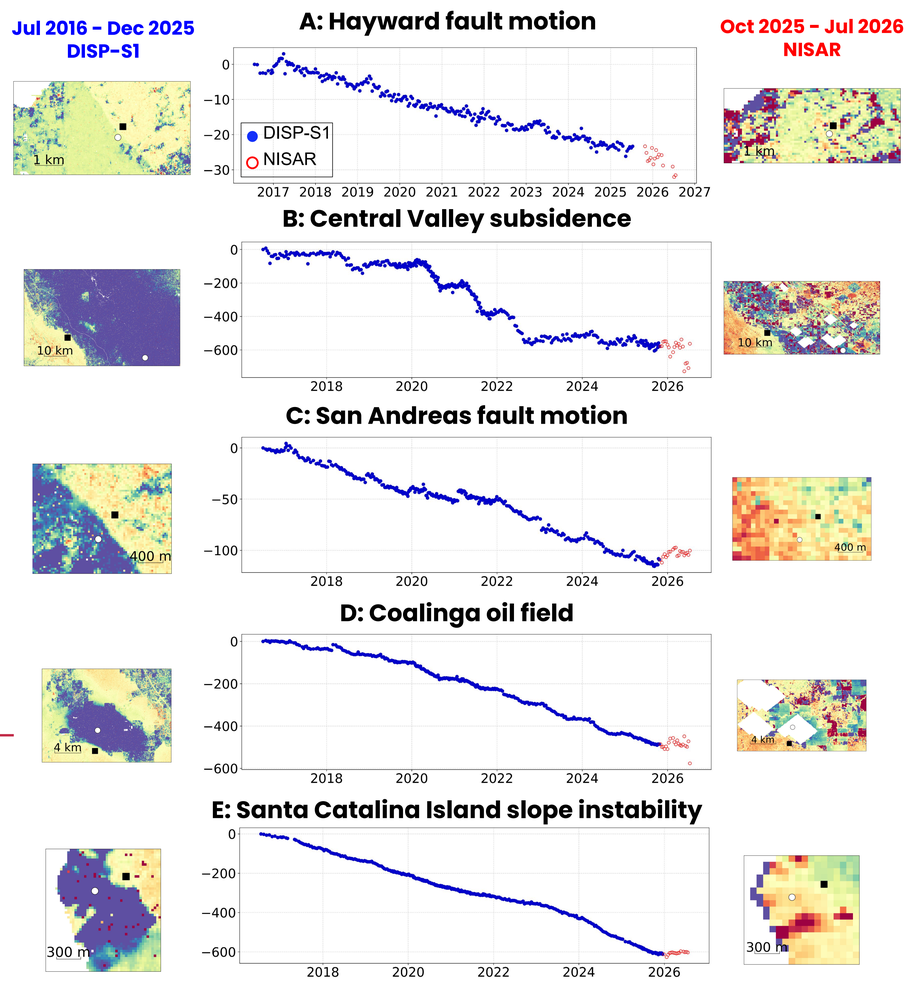

Figure 4: Time-series histories cross-comparison, with DISP-S1 data denoted by blue and NISAR GUNW in red. Associated labels (from **Fig. 3**) denoted at the top of each plot. Insets of DISP-S1 and NISAR GUNW velocity fields visualized to the left and right, respectively (features = white circles, local reference points = black squares).

Save the Date: Virtual 2026 OPERA Workshop
Sept 10, 2026 | 8:30 AM – 1:00 PM PDT

Join us for stakeholder and project staff talks highlighting SAR-derived deformation time series, regional land subsidence monitoring, disaster response acceleration, and sneak peeks at upcoming DISP-NISAR and Vertical Land Motion (VLM) products.

Free RSVP: tinyurl.com/2026-OPERA

References

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Looking for ARIA, NISAR, and OPERA data in production? Find them via ASF data search!

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