National Aeronautics and Space Administration

OPERA

Observational Products for End-Users from Remote Sensing Analysis

Third OPERA Workshop

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OPERA Coregistered Single Look Complex (CSLC) Product & Initial Validation Results

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OPERA Coregistered Single Look Complex (CSLC) Product & Initial Validation Results

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National Aeronautics and Space Administration

- CSLC Product Suite
- Validation Approach
- Initial Validation Results
- OPERA Corner Reflectors
- Call for Your Participation

OPERA CSLC Team

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OPERA Algorithms Development Team for CSLC:
Virginia Brancato
Heresh Fattahi
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Liang Yu

OPERA Project Science Team for CSLC:
M. Grace Bato
Liang Kang
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Zhong Lu
Simran Sangha

Coregistered SLC (CSLC) Product Suite

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The OPERA CSLC product suite has a North America* geographical scope and is comprised out of 2 products derived from SAR sensors:

Description	Geocoded and coregistered Analysis-Ready SLC data.	**Sensor Temporal Sampling****	6-12 days for Sentinel-1 12 days for NISAR
Distribution	**Alaska Satellite Facility Distributed Active Archive Center (ASF DAAC)**	**Pixel Resolution (Northings x Eastings)**	10 m x 5 m (CSLC-S1) Approx. 5 m x 3.1/6.25 m (CSLC-NI, TBC)
		Beginning of Product Record	Apr 2014 (CSLC-S1) TBD 2024 (CSLC-NI)
Sensor	Sentinel-1 A/B & NISAR (SAR)	**Validated Release Date**	Sep 2023 (CSLC-S1) Jul 2025 (CSLC-NI)

CSLC product suite is frame-based for NISAR. A frame is about 250 km x 250 km.
Burst based for Sentinel-1, following ESA convention.

* USA and US Territories within 200 km from US border, Canada, and all mainland countries from the southern US border up to and including Panama.
***Based on Sensor input data availability*

The CSLC products will be the basis for all the OPERA L3 DISP products.

Coregistered SLC (CSLC) Product Suite

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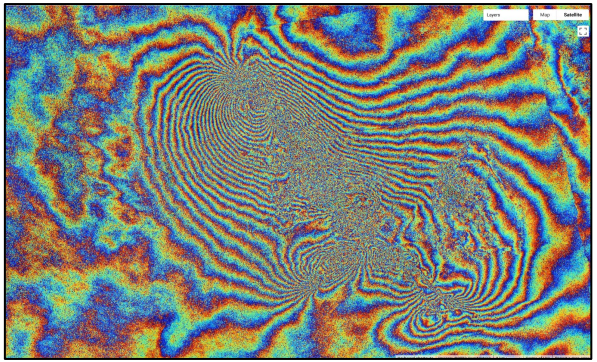
The CSLC datasets are geocoded to the same geographical grid and therefore result in aligned time-series of CSLC images.

The product includes:

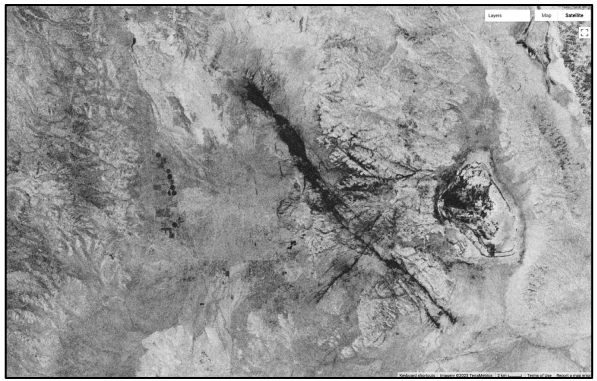
- Complex backscatter
  - Co pol: VV or HH polarization for S1 and HH polarization for NISAR resampled to a common grid
- Geometric data layers (Look vectors, slant range, incidence angle)
- CSLC-S1 products are corrected for:
  1) bistatic delay
  2) azimuth FM rate mismatch
  3) Doppler induced range shift
  4) range shift due to Solid Earth tides
  5) range delay due to dry troposphere (static model)
  6) range delay due to ionosphere

The CSLC products allow for direct interferogram generation.

Wrapped phase (merged bursts)



Coherence



Validation Approach

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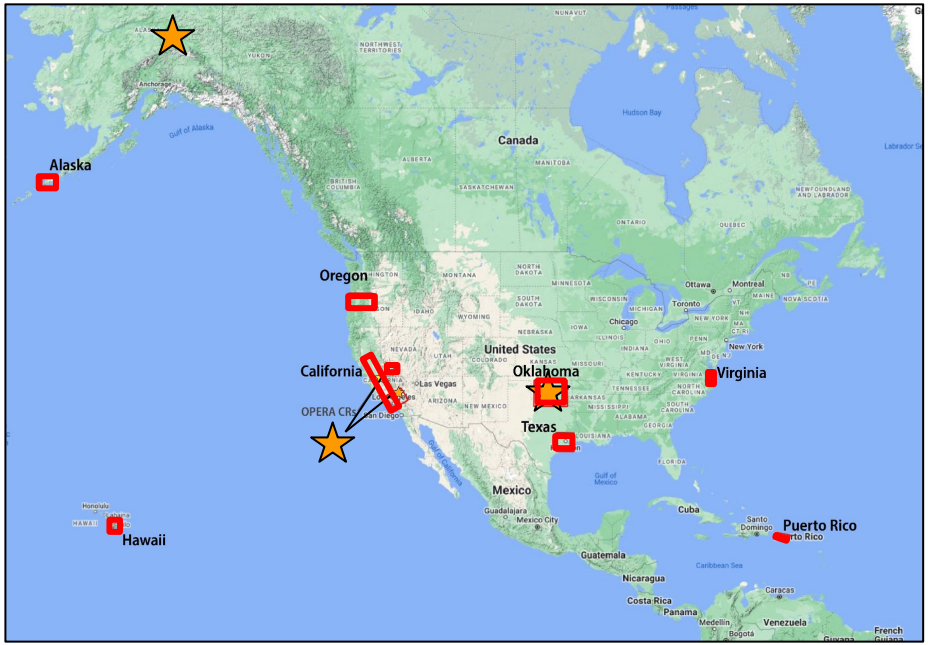
- **<u>Absolute location error estimation</u>** via point- target analysis using corner reflectors (★)
  - 1.5 m or better in both the ground range and azimuth directions

- **<u>Relative location error estimation</u>** analysis of pixel offsets in an image stack using cross-correlation over calval sites (▭)
  - 0.5 m and 0.75 m or better in ground range and azimuth directions

Validation sites



Initial Validation Results: Absolute Location Error

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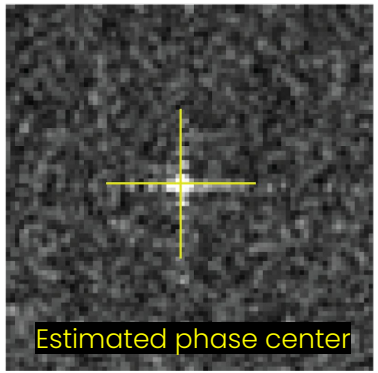
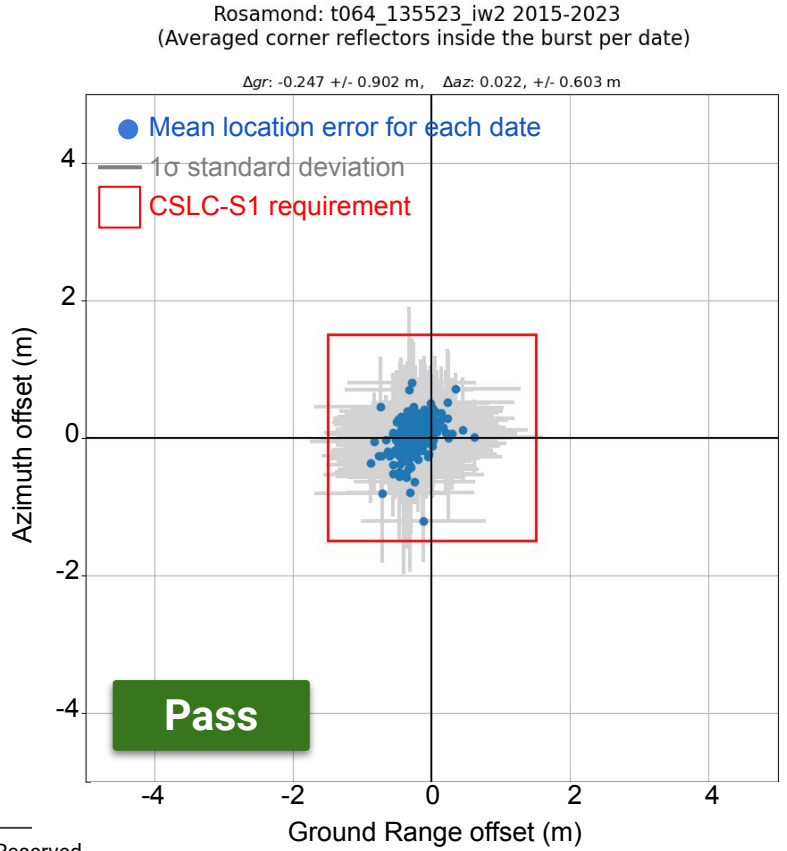
Through point-target analysis

- Project the corner reflectors into the image
- Find the brightest pixel
  - Oversample and fit a paraboloid function to find the peak amplitude
- Measure offsets relative to the corner reflectors' locations in the image



OPERA CSLC-S1 impulse response from a 2.4-m corner reflector.



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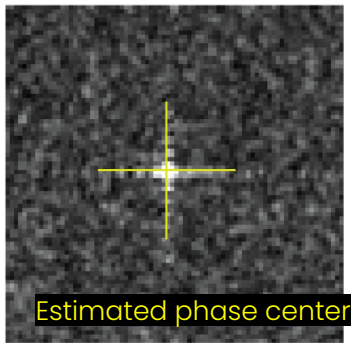
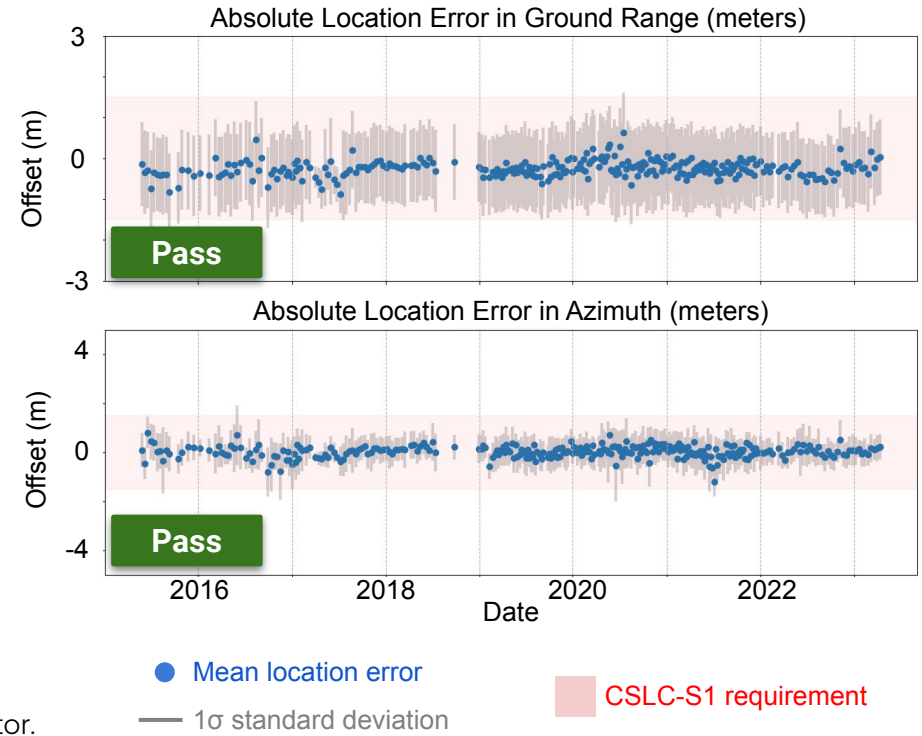


OPERA CSLC-S1 impulse response from a 2.4-m corner reflector.

Time-series over Rosamond, CA



Initial Validation Results: Relative Location Error

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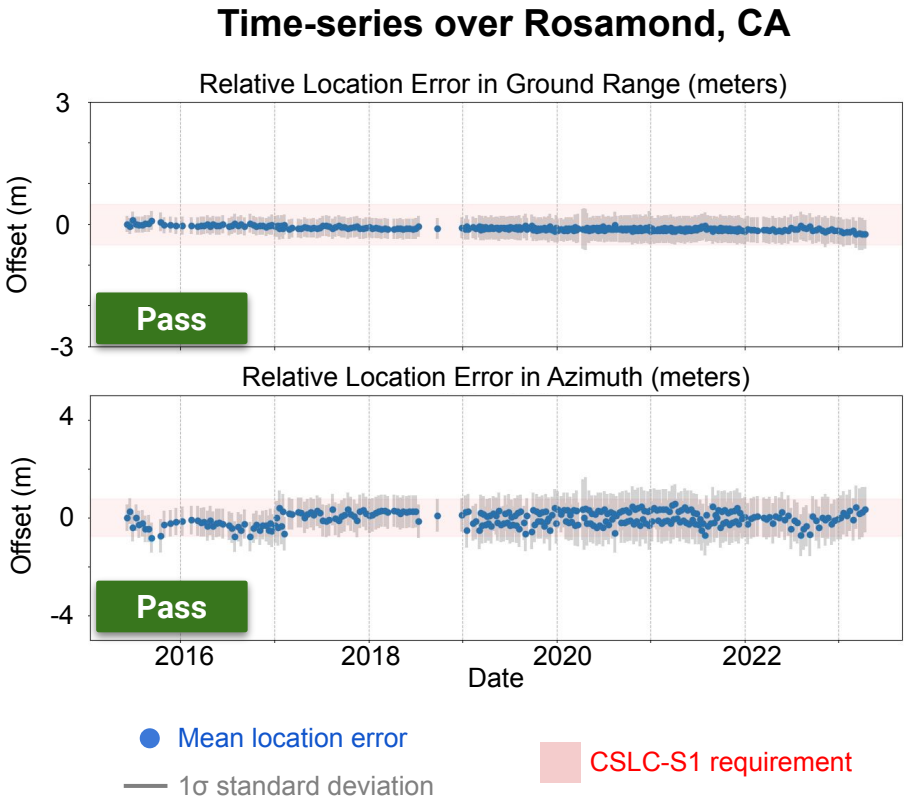
Through image cross-correlation

- Prepare the stack of CSLCs
  - e.g. , pairing of CSLCs has max temporal baseline of 365 days
- Perform cross-correlation
- Estimate mean and standard deviation of the offsets and compare to requirement



OPERA Corner Reflectors

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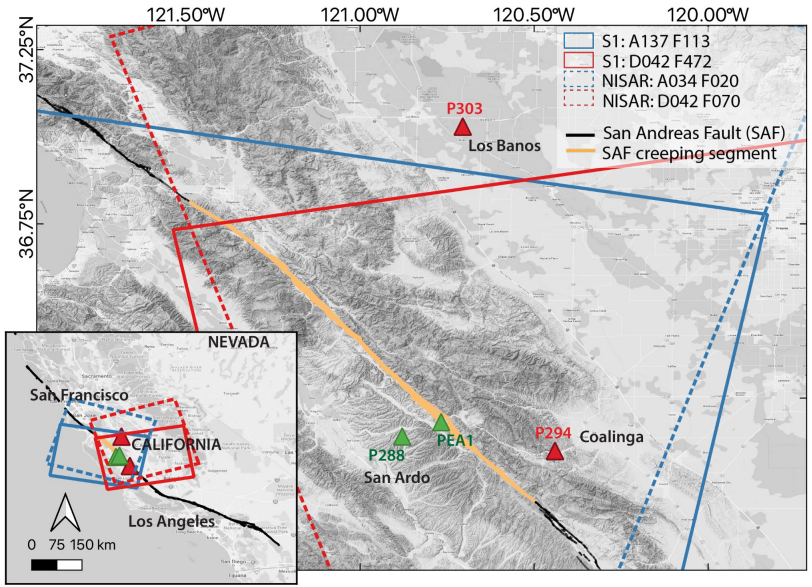

OPERA corner reflectors (▲deployed, ▲to-be-deployed), collocated with EarthScope-managed Continuous GNSS stations across the creeping segment of the San Andreas Fault and in Central Valley, CA

Corner reflectors support the OPERA CalVal and algorithm development activities for CSLC and DISP products (Sentinel-1 and NISAR).

- 7 x 2.4m reflectors
- 1 x 1.2m reflector

Deployments in partnership with EarthScope

- In central California, collocated with cGNSS
- 4 x 2.4m CRs deployed, rest to be deployed in the next months.

←Design of the OPERA 2.4-m corner reflectors (*L. Ortiz*)

OPERA Corner Reflectors

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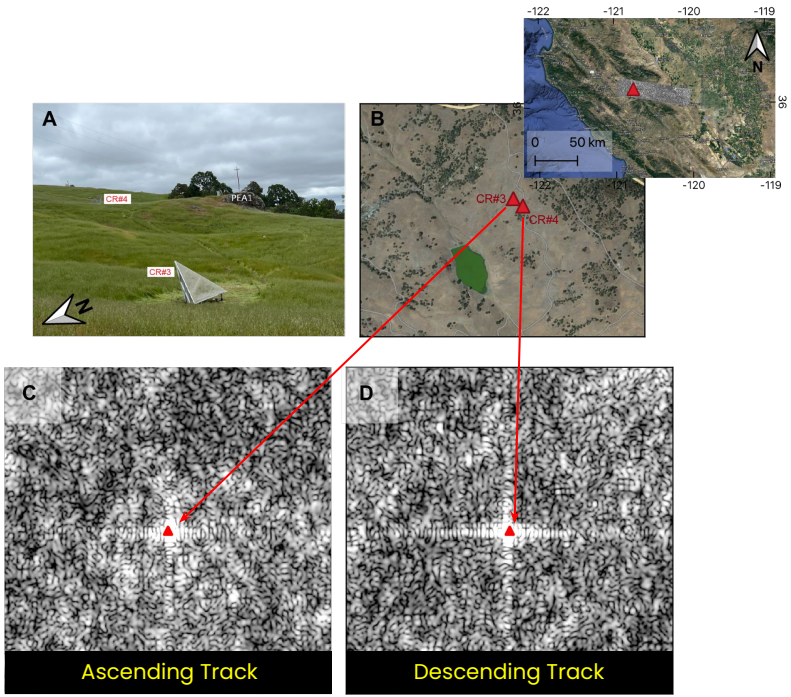

OPERA Corner Reflector Team: M. Grace Bato, Bruce Chapman, Annemarie Peacock, Simran Sangha, and the EarthScope team (Andre Basset, Matt Burgess, James Downing, Karl Feaux, Bill Funderburk, Shawn Lawrence, Doerte Mann, Glenn Mattioli).

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We Invite YOU to Participate!

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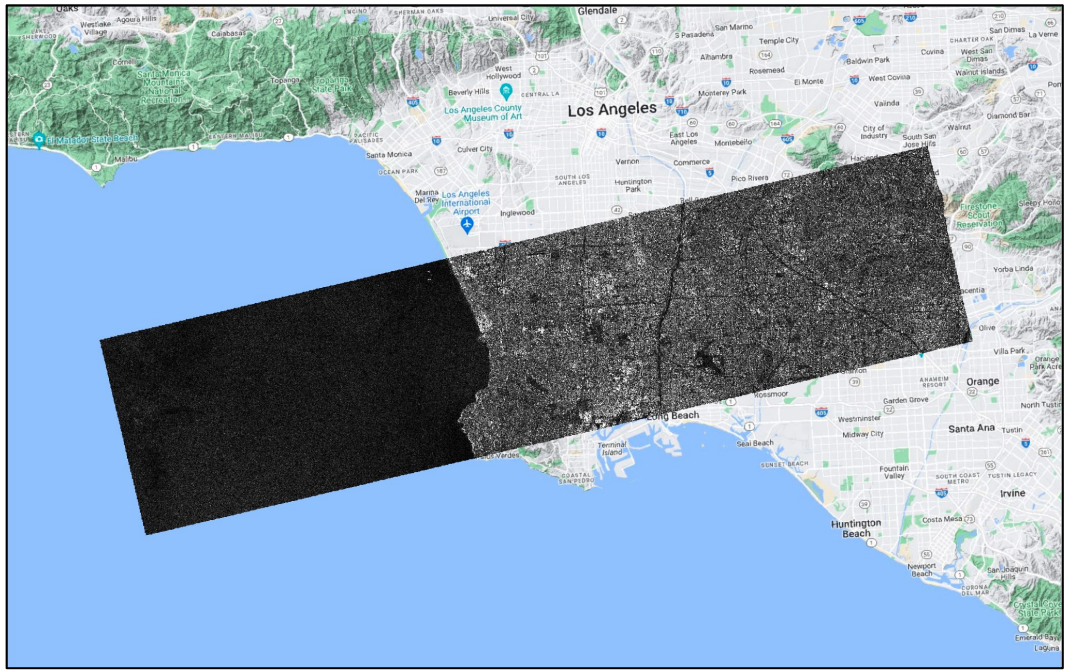
- Will you evaluate sample CSLC-S1 data?
- Will you use CSLC-S1 data for trial applications?
- Will you provide feedback?
- Do you have any areas of interest in mind for CSLC-S1 sample products?

Access sample products here:

https://tinyurl.com/CSLCprod



OPERA CSLC-S1 Sample Data over Los Angeles