

InSAR training 2024

The screenshot displays the NASA EarthData ASF Data Search interface. The top navigation bar includes the NASA EarthData logo, a link to 'Other DAACs', and a 'Feedback' button. The main search area features a header with the ASF Data Search logo and a search bar. The search criteria are set to 'Geographic' search type, 'S1 InSAR (BETA)' dataset, and a polygon area of interest in Southern California. The search results show 250 scenes (250 of 9,632 files). A map of the United States is shown with a yellow box highlighting the search area in Southern California. Below the map, a table lists the search results, including scene IDs, dates, and download links. The table has four columns: Scene ID, Date, Download, and Citation. The first four rows show scenes from 2019. The 'Citation' column contains a link to the 'Data courtesy of ESA' page. The 'Download' column shows a download icon and a file size of 55.33 MB. The 'Scene Detail' section on the right shows a small thumbnail of the scene and a link to the 'Standard Product, NetCDF' file.

Search Type: Geographic
Dataset: S1 InSAR (BETA)
Area of Interest: WKT POLYGON((-125.0683593
Start Date: End Date: More
SEARCH Clear

250 of 9,632 Files

Results

250 Scenes (250 of 9,632 Files)

Scene ID	Date	Download	Citation
S1-GUNW-D-R-173-...3cd7-v2_0_2	Date • 7-23-2019	0/1	Aquisition Date • 7-23-2019 + Beam Mode • slc + Path • 173 + Flight Direction • descending + Polarization • VV + Campaign Name • S1 l-grams (BETA) - Southern CA + Data courtesy of ESA
S1-GUNW-D-R-173-...9445-v2_0_2	Date • 7-23-2019	0/1	
S1-GUNW-D-R-173-...28e6-v2_0_2	Date • 7-23-2019	0/1	
S1-GUNW-D-R-173-...7a14-v2_0_2	Date • 7-23-2019	0/1	

Standard Product, NetCDF
55.33 MB

Routine interferogram processing

Data processing for nonspecialists

InSAR data processing historically has been beyond the preserve of most geoscientists

- The software is typically difficult to install
- The codes are 'research grade' and not easy to use (many require use of the command line)
- The data volumes are large
- The computational requirements are prohibitive to many

To address some of these issues, several institutions and agencies have started to make custom data processing services available to users, or to share data that has already been processed.

Examples of pre-processed InSAR data

Probably of interest to this group:

- The Alaska Satellite Facility ‘Hybrid Pluggable Processing Pipeline’ (HyP3) system
- JPL’s ‘Advanced Rapid Imaging and Analysis’ (ARIA) system
- JPL/NASA’s Observational Products for End-Users from Remote Sensing Analysis (OPERA) project

Other efforts exist, including the Southern California Earthquake Center’s ‘Community Geodetic Model’ (SCEC CGM) and the COMET ‘Looking into the Continents from Space’ (LiCS) system, but these are regionally focused (the former) or mostly focused outside the US (the latter).

HyP3

- HyP3 (pronounced “hype”) is ASF’s in-house processing system, available to anyone with a NASA Earthdata account.
- It can be used to process Sentinel-1 interferograms, of whole frames or of individual Sentinel-1 bursts, of anywhere of the user’s choosing.
- There is currently a limit of 1000 processed products per month! (After April 1st, this will be reduced.)
- The processed data can be incorporated easily into time series processing with MintPy



ASF HyP3

Alaska Satellite Facility's Hybrid Pluggable Processing Pipeline

HyP3 (pronounced "hype") is a service for processing Synthetic Aperture Radar (SAR) imagery that addresses many common issues for users of SAR data:

- Most SAR datasets require at least some processing to remove distortions before they are analysis-ready
- SAR processing is computing-intensive
- Software for SAR processing is complicated to use and/or prohibitively expensive
- Producing analysis-ready SAR data has a steep learning curve that acts as a barrier to entry

HyP3 solves these problems by providing a free service where people can request SAR processing on-demand.

These processing requests are picked up by automated systems, which handle the complexity of SAR processing on behalf of the user. HyP3 doesn't require users to have a lot of knowledge of SAR processing before getting started;

users only need to submit the input data and set a few optional parameters. The final SAR products are just a few clicks away.

Table of contents

[Getting started](#)[Web Access](#)[Programmatic Access](#)[Public Visibility of Jobs](#)[What's New](#)[Contact Us](#)

Extensive documentation available at
<https://hyp3-docs.asf.alaska.edu/>

Full-frame Sentinel-1 processing with HyP3

- HyP3 can be used to process interferograms of full Sentinel-1 frames (approximately 180 km long by 250 km wide)
- These interferograms are processed using the GAMMA software
- They do not include 'connected components' information (useful for fixing unwrapping errors)
- Cost: 30 credits each

Individual burst processing with HyP3

- HyP3 can also be used to process interferograms from individual Sentinel-1 bursts (approximately 20 x 80 km)
- These interferograms are processed using the ISCE software
- They do include connected component information, so it is possible to fix any unwrapping errors in MintPy
- Cost: 1 credit each

ARIA

- ARIA is JPL's ISCE-based production system for interferograms, developed to prepare for the needs of the NISAR mission
- It produces Sentinel-1 Geocoded Unwrapped (S1 GUNW) standard product interferograms to a common specification (full, standardized frames, 90 m resolution, connected components included)
- The archive of S1 GUNW products is searchable on the ASF Vertex site, or using 'ARIA-tools', a set of Python-based codes developed by the ARIA team



Advanced Rapid Imaging and Analysis (ARIA)



Jet Propulsion Laboratory
California Institute of Technology

Radar
Sensors

GPS
Networks

Seismic
Networks

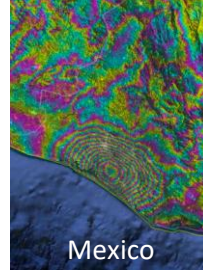
Optical
Sensors

Automated
Data
Collection
& Processing

Radar

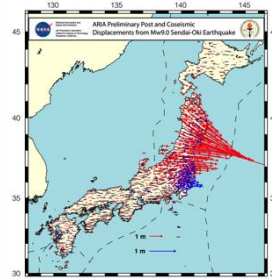


Kilauea

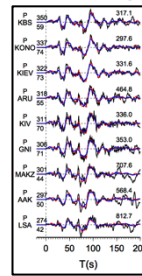


Mexico

GPS



Seismology



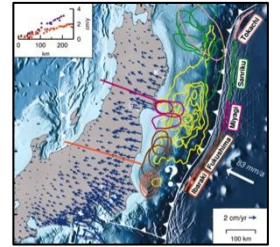
Monitoring &
Near Real-
Time
Assessment

Potential
Partners

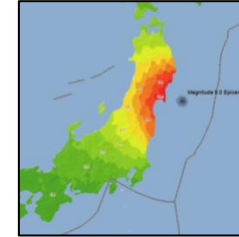
Building Damage
& Flood proxy



High-Resolution
Hazard
Assessment
from Fault
Models



Permanent
Ground Deformation



FEMA



Google

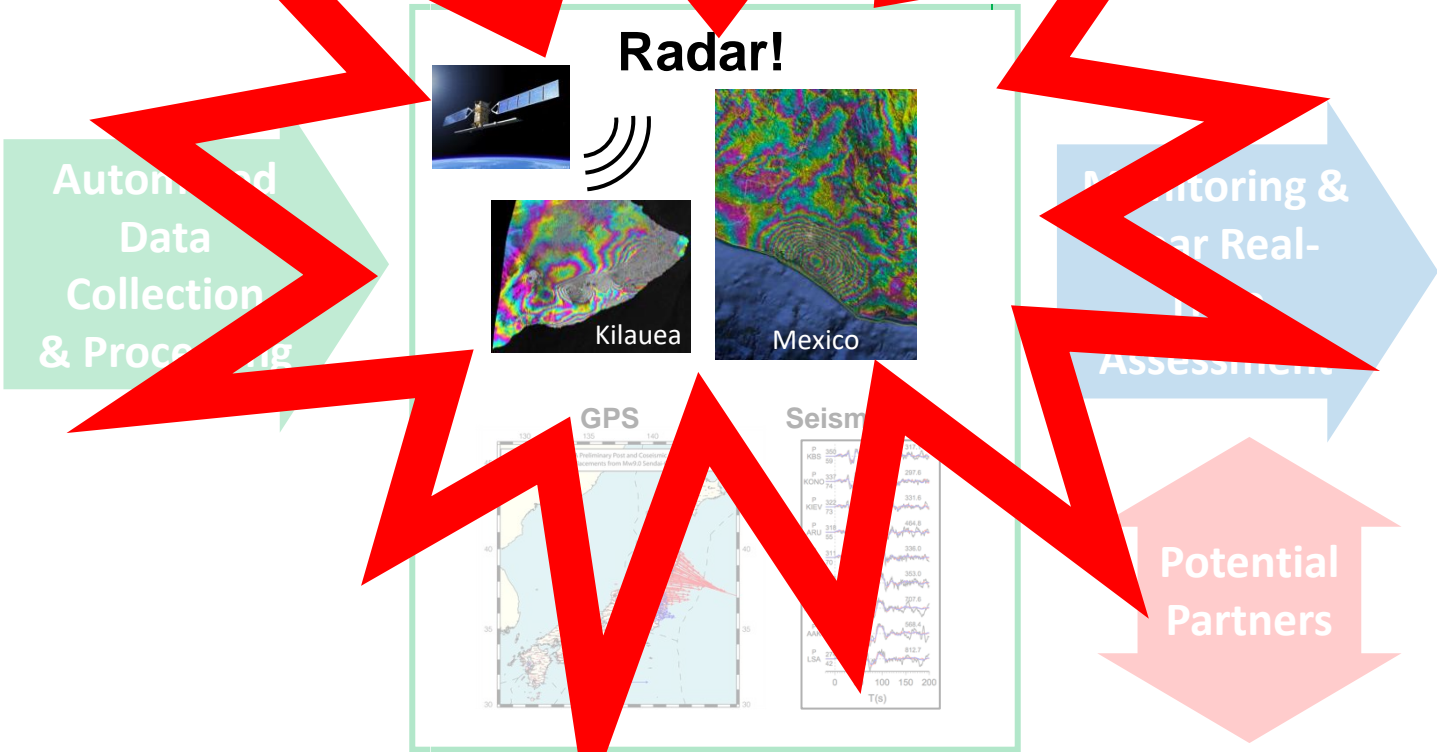


Advanced Rapid Imaging and Analysis (ARIA)




Jet Propulsion Laboratory
California Institute of Technology

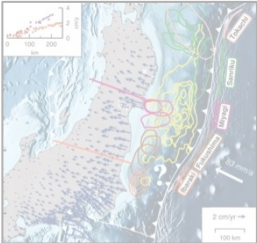
- Radar Sensors
- GPS Networks
- Seismic Networks
- Optical Sensors



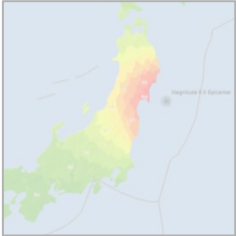
Building Damage & Flood proxy



High-Resolution Hazard Assessment from Fault Models



Permanent Ground Deformation





FEMA



Standard InSAR surface displacement map product

Home > Products > Standard Displacement Product

Standard Displacement Product

The **ARIA Standard Displacement Product** is a **Geocoded Unwrapped Interferogram (GUNW IFG)** product.

Product Requirements

Shall target:

- Earthquake community,
- Volcano community,
- Ground water community,
- Sea-level rise and subsidence community

Shall be defined:

- Spatial and temporal consistent, i.e. no gaps in space and time between products over a defined area of interest in ARIA
- Processed with precise orbits for Sentinel-1
- Geographical scope of 60°N-60°S latitude + USA
- GIS-compatible

Formatting and Content

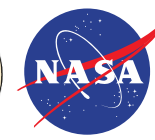
Product Specifications

Product Filename Convention

Standard Product Versions

Examples of Working with Standard Products

Best Practices



Jet Propulsion Laboratory
California Institute of Technology



<http://aria.jpl.nasa.gov/>



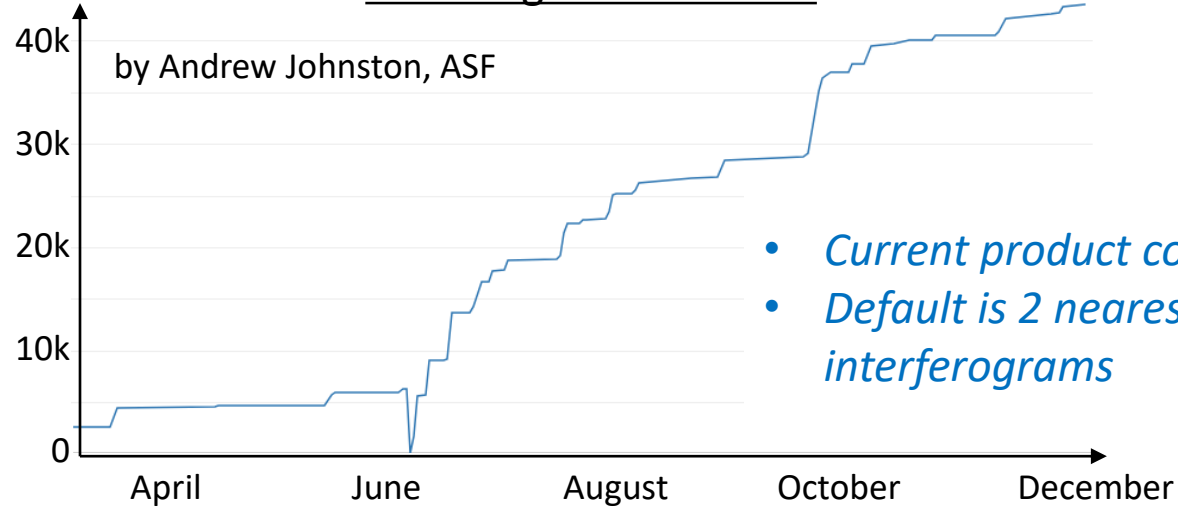
Pages with additional information

- Layer description and sampling
- Processing parameters
- Example of using sample products
- Best practices

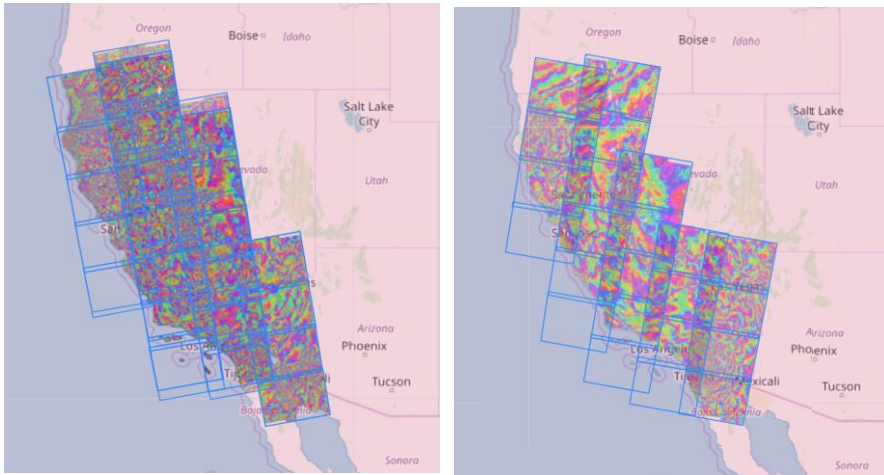
Standard Product Archive

Archive growth in 2019

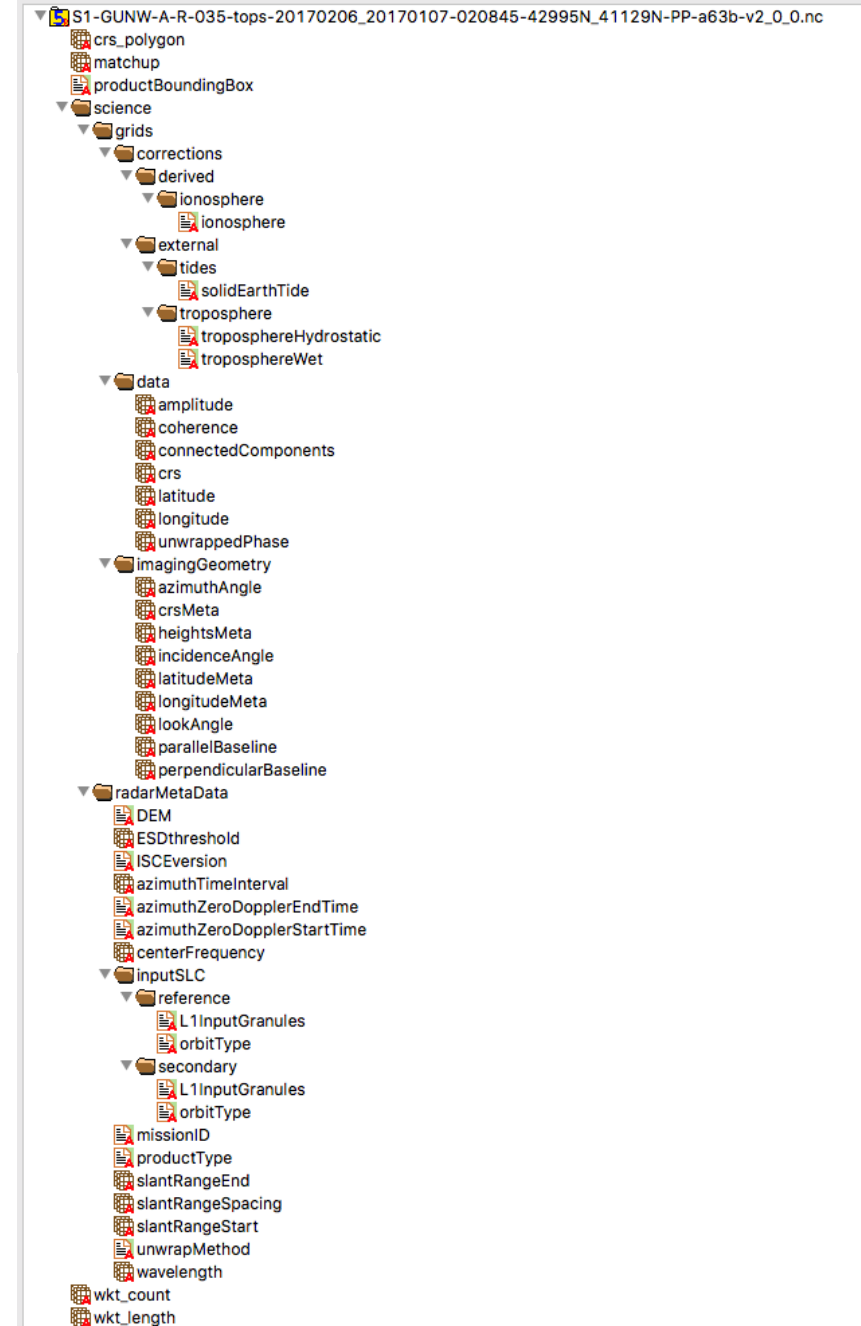
by Andrew Johnston, ASF



- Current product count is ~44,000
- Default is 2 nearest neighbor interferograms



- All CA tracks have been densified:
 - Nearest 3 neighbors
 - Annual pairs
 - 2014-current



How to get standard products?

ASF vertex page (<https://search.asf.alaska.edu/>)
ASF API (<https://www.asf.alaska.edu/get-data/api/>)

Option 1: ASF Vertex

The screenshot displays the ASF Data Search web application. The top navigation bar includes the NASA EarthData logo, a dropdown for 'Other DAACs', and a 'Feedback' link. The main search area features a 'Search Type' dropdown set to 'Geographic', a 'Dataset' dropdown set to 'S1 I-grams (BETA)', and an 'Area of Interest' field containing a WKT polygon. Search filters for 'Start Date' and 'End Date' are also present, along with a 'More' menu, a 'SEARCH' button, and a 'Clear' button. Below the search bar, a map of North America shows a yellow rectangular area of interest over the western United States, with a grid of blue squares representing the search area. The map includes zoom controls and a 'Results' dropdown. The results section shows '250 Scenes (250 of 9,632 Files)' and a 'Scene Detail' view. The scene detail view includes a 'Citation' section with the following information: 'Aquisition Date • 7-23-2019', 'Beam Mode • slc', 'Path • 173', 'Flight Direction • descending', 'Polarization • VV', 'Campaign Name • S1 I-grams (BETA) - Southern CA', and 'Data courtesy of ESA'. The 'Standard Product, NetCDF' section shows a file size of '55.33 MB'. A small thumbnail image of the scene is also visible.

NASA EARTHDATA Other DAACs Feedback

ASF Data Search

Search Type Geographic Dataset S1 I-grams (BETA) Area of Interest • WKT POLYGON((-125.0683593 Start Date End Date More SEARCH Clear

250 of 9,632 Files

250 Scenes (250 of 9,632 Files)

Scene Detail 1 File

S1-GUNW-D-R-173-...3cd7-v2_0_2 Date • 7-23-2019

S1-GUNW-D-R-173-...9445-v2_0_2 Date • 7-23-2019

S1-GUNW-D-R-173-...28e6-v2_0_2 Date • 7-23-2019

S1-GUNW-D-R-173-...7a14-v2_0_2 Date • 7-23-2019

Citation

Aquisition Date • 7-23-2019

Beam Mode • slc

Path • 173

Flight Direction • descending

Polarization • VV

Campaign Name • S1 I-grams (BETA) - Southern CA

Data courtesy of ESA

Standard Product, NetCDF 55.33 MB

How to get standard products?

Option 2: ARIA-tools

- Command line download of deformation products
- Manipulation of products
 - ✓ Merging
 - ✓ Cropping
 - ✓ Layer extraction
- Plotting
- Time-series preparation => not processing!
 - ✓ Users decide on preferred time-series tool



Compatible with **Miami INsar Time-series software in PYTHON (MintPy)** due to *contribution by H. Fattahi, Y. Zhang, E. Havazli*

Documentation and training:

- Jupyter notebooks available:
[see ARIA-tools and MintPy github pages for material](#)
- UNAVCO short courses, NASA Solid Earth Team
[recorded material and lectures to be posted online soon](#)

ARIA-tools <https://github.com/aria-tools/ARIA-tools>

python 3.5+ license GPL code quality A PASSED

ARIA-tools is an open-source package in Python which contains tools to manipulate ARIA standard InSAR products. This software is open source under the terms of the GNU General Public License. Its development was funded under the NASA Sea-level Change Team (NSLCT) program and the Earth Surface and Interior (ESI) program.

For a full overview of available ARIA standard products and their specification see the products page on the [ARIA website](#). Currently, support for the ARIA Geocoded Unwrapped Interferogram (GUNW) product is included. Products can be download for free from the [ARIA-products page](#) and the [ASF DAAC vertex page](#) under missions and beta-products, but require log-on using the NASA Earthdata credentials. The ARIA-tools package includes functionality to crop/merge data and meta-data layers for multiple standard products, extraction of data and meta-data layers from these products, and the set-up and the preparation for time-series.

Actual time-series processing is not supported in ARIA-tools. However, outputs are compatible with thrid-party time-series InSAR packages such as the "Generic InSAR Analysis Toolbox" ([GIAnt](#)) and the "Miami INsar Time-series software in PYthon" ([MintPy](#)).

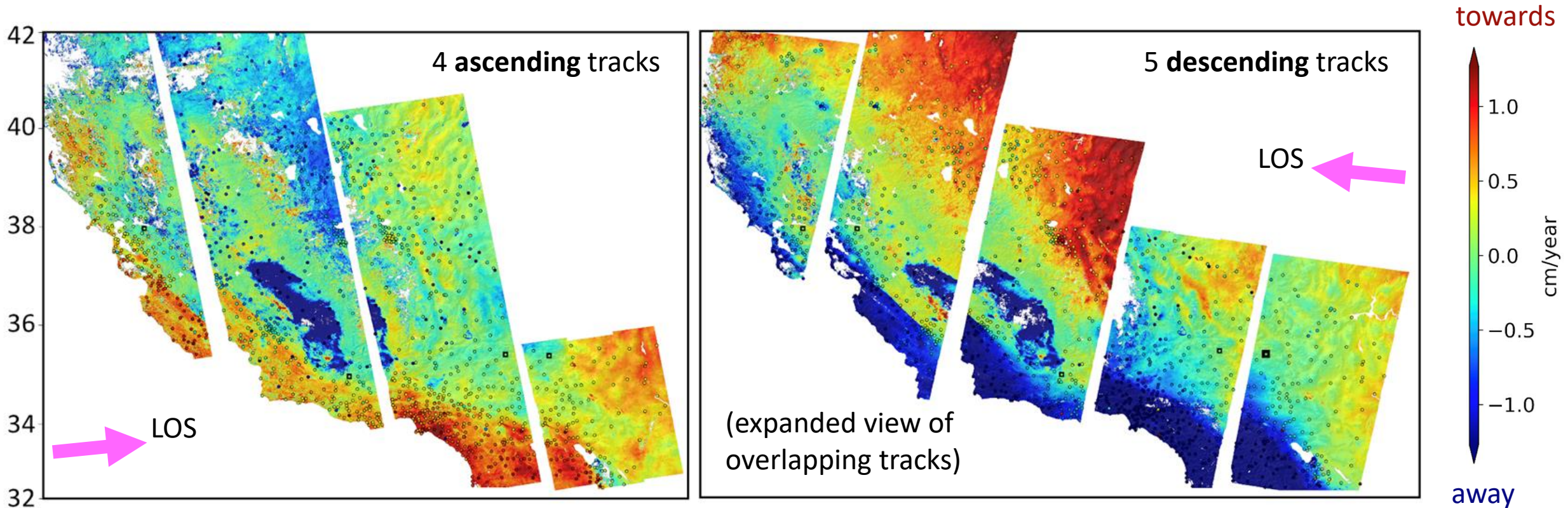
MintPy <https://github.com/insarlab/MintPy>

python 3.5+ docs passing build passing latest version v1.2 license GPLv3 forum Google Group DOI: 10.31223/osf.io/9sz6m

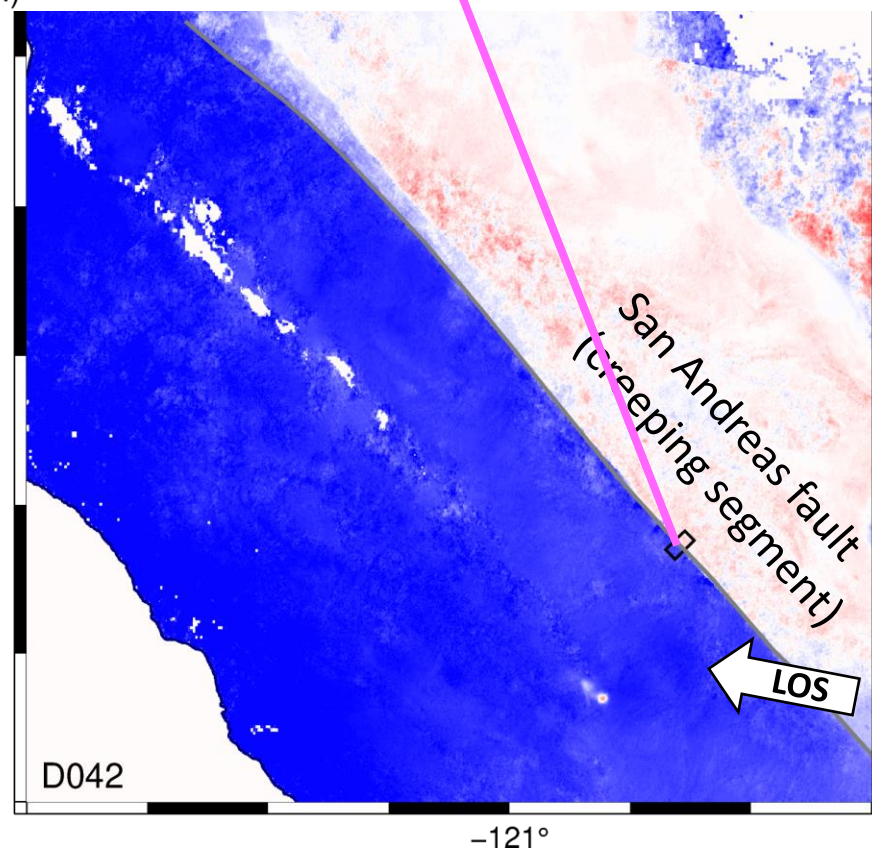
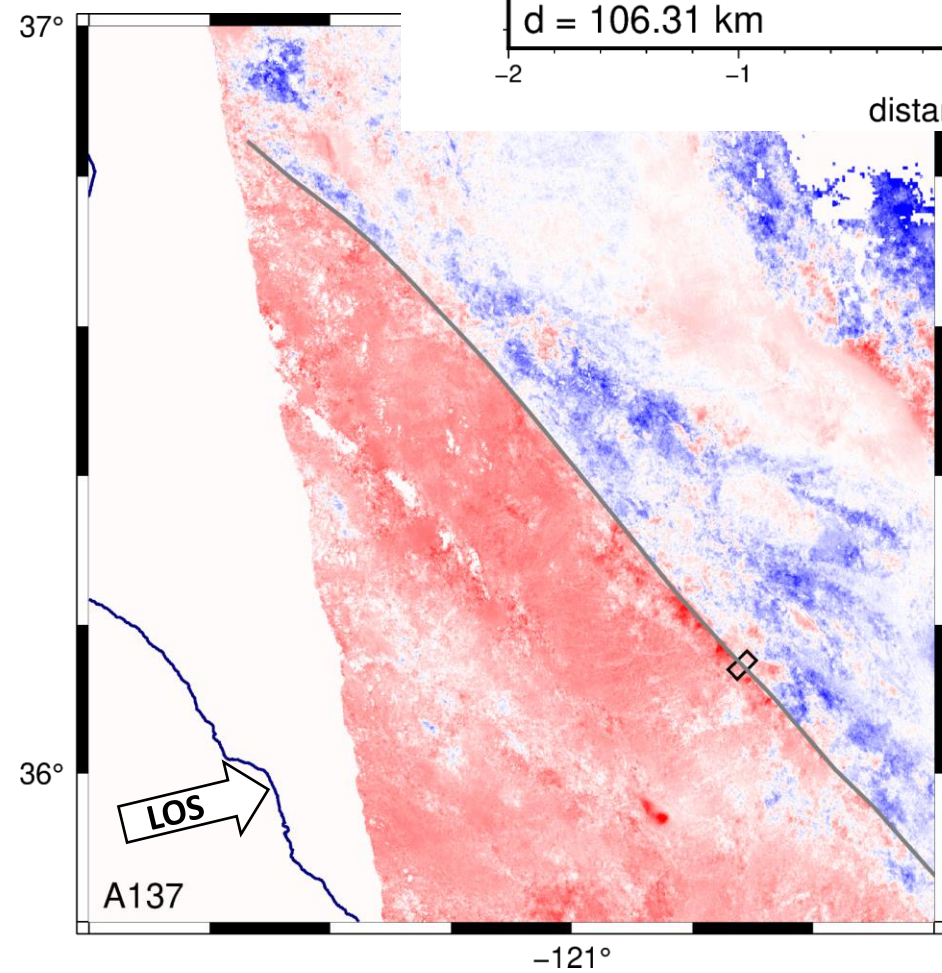
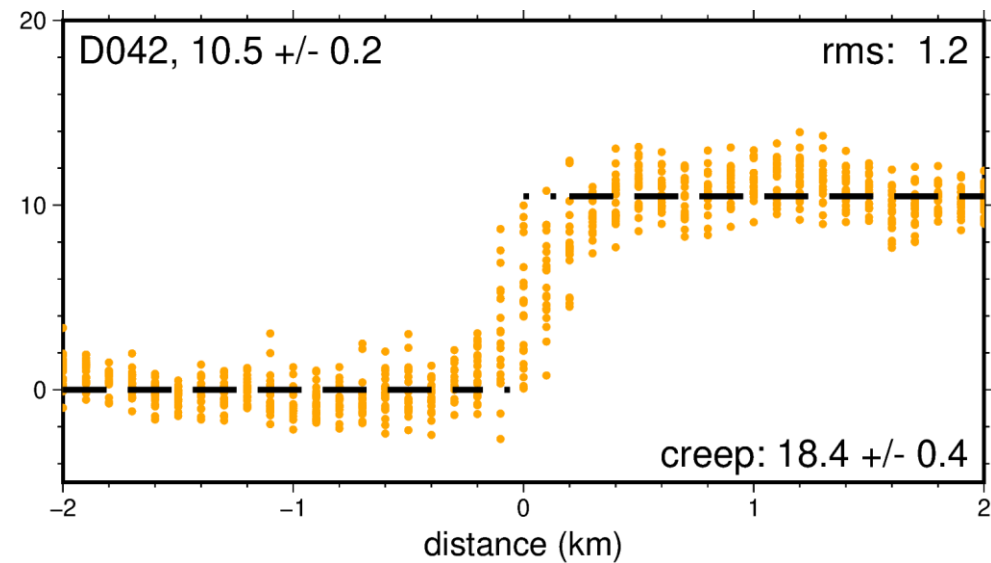
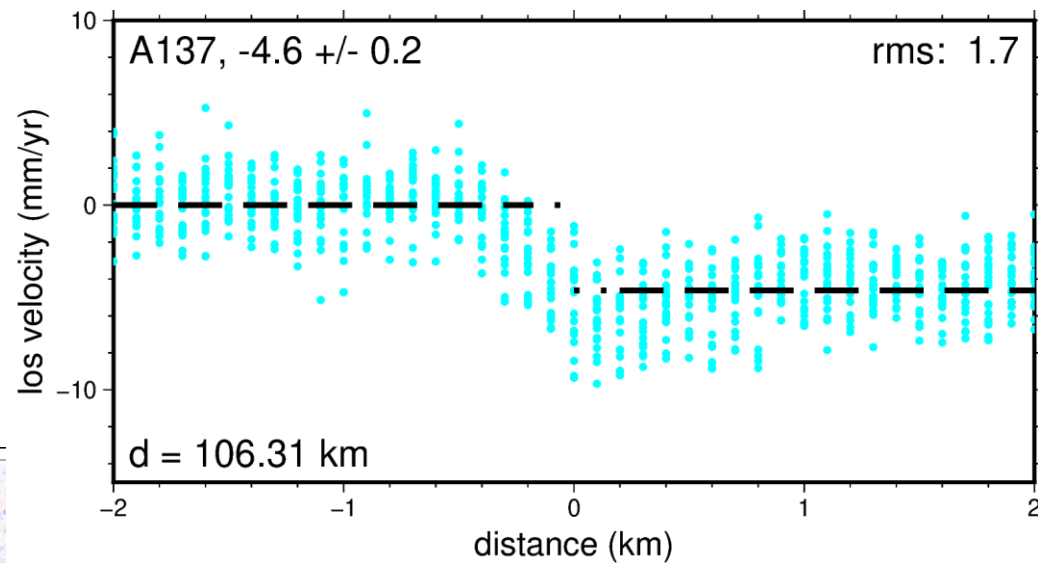
The Miami INsar Time-series software in PYTHON (MintPy) is an open-source package for Interferometric Synthetic Aperture Radar time series analysis. It reads the stack of interferograms (coregistered and unwrapped) in [ISCE](#), [GAMMA](#), [ARIA](#), [SNAP](#) or [ROI_PAC](#) format, and produces three dimensional (2D in space and 1D in time) ground surface displacement. It includes a routine time series analysis (`smallbaselineApp.py`) and some independent toolbox.

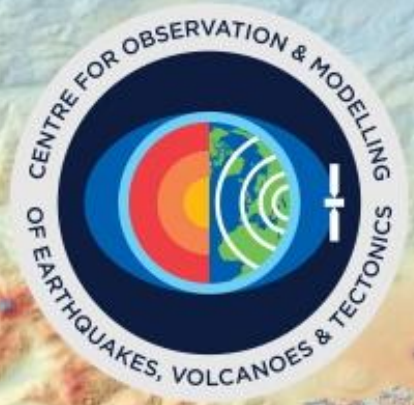
This package was called PySAR before version 1.1.1. For version 1.1.2 and onward, we use MintPy instead.

Example: California statewide deformation maps



- Over 2300 ARIA GUNW Sentinel-1 standard product interferograms, 2014-2020
- Time series analysis with MintPy, GACOS atmosphere correction

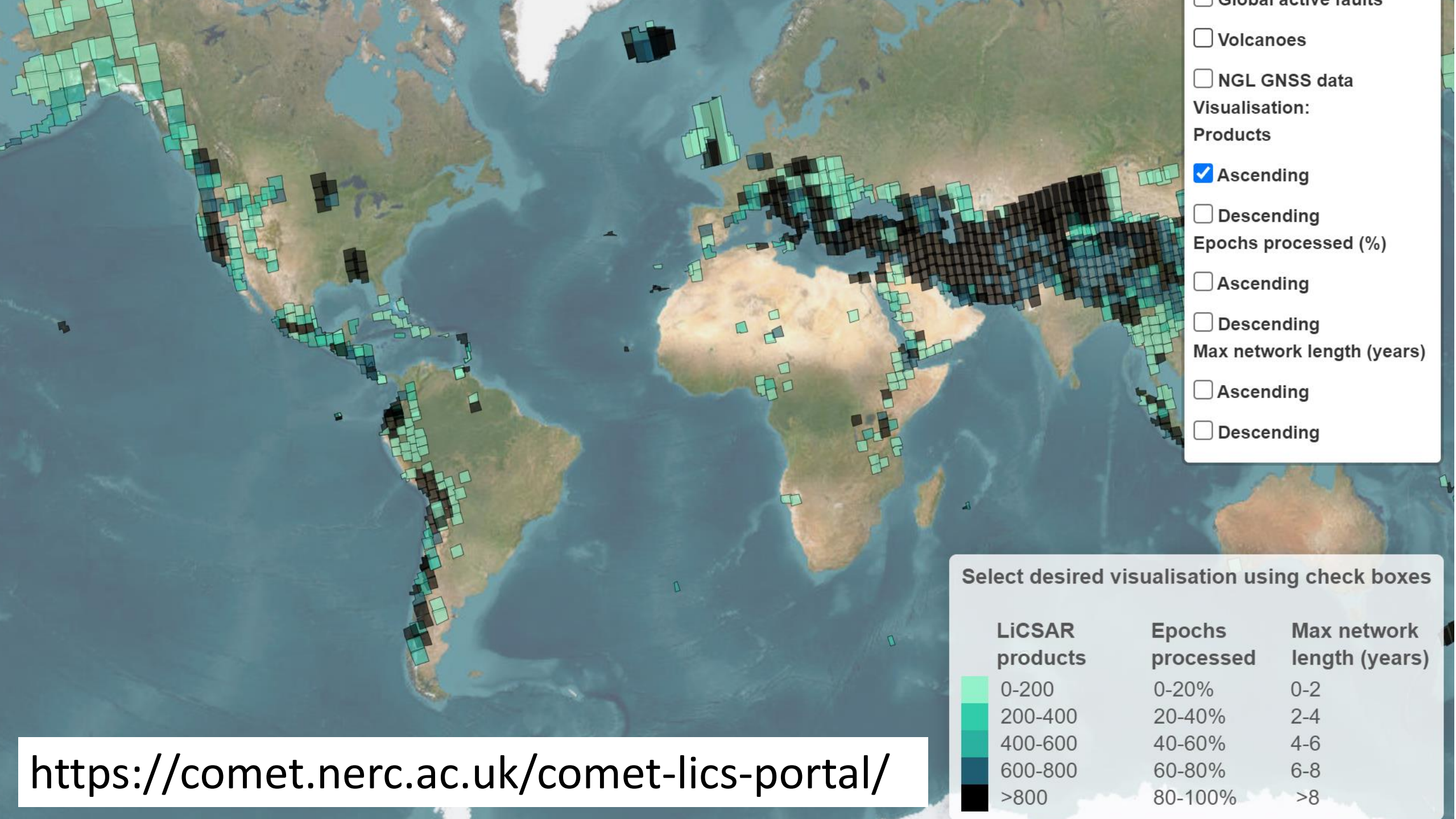




LiCS

- LiCS is an operational InSAR processing system maintained by COMET in the UK
- Its main focus is seismic and volcanic hazards in Europe, South America, Africa and Asia
- It is GAMMA based, and its output is very similar to HyP3 full frame products
- It has a built-in SBAS solver





☐ Global active faults

☐ Volcanoes

☐ NGL GNSS data

Visualisation:

Products

☒ Ascending

☐ Descending

Epochs processed (%)

☐ Ascending

☐ Descending

Max network length (years)

☐ Ascending

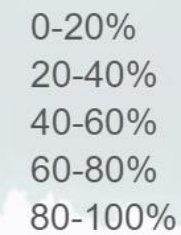
☐ Descending

Select desired visualisation using check boxes

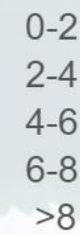
LiCSAR
products



Epochs
processed



Max network
length (years)



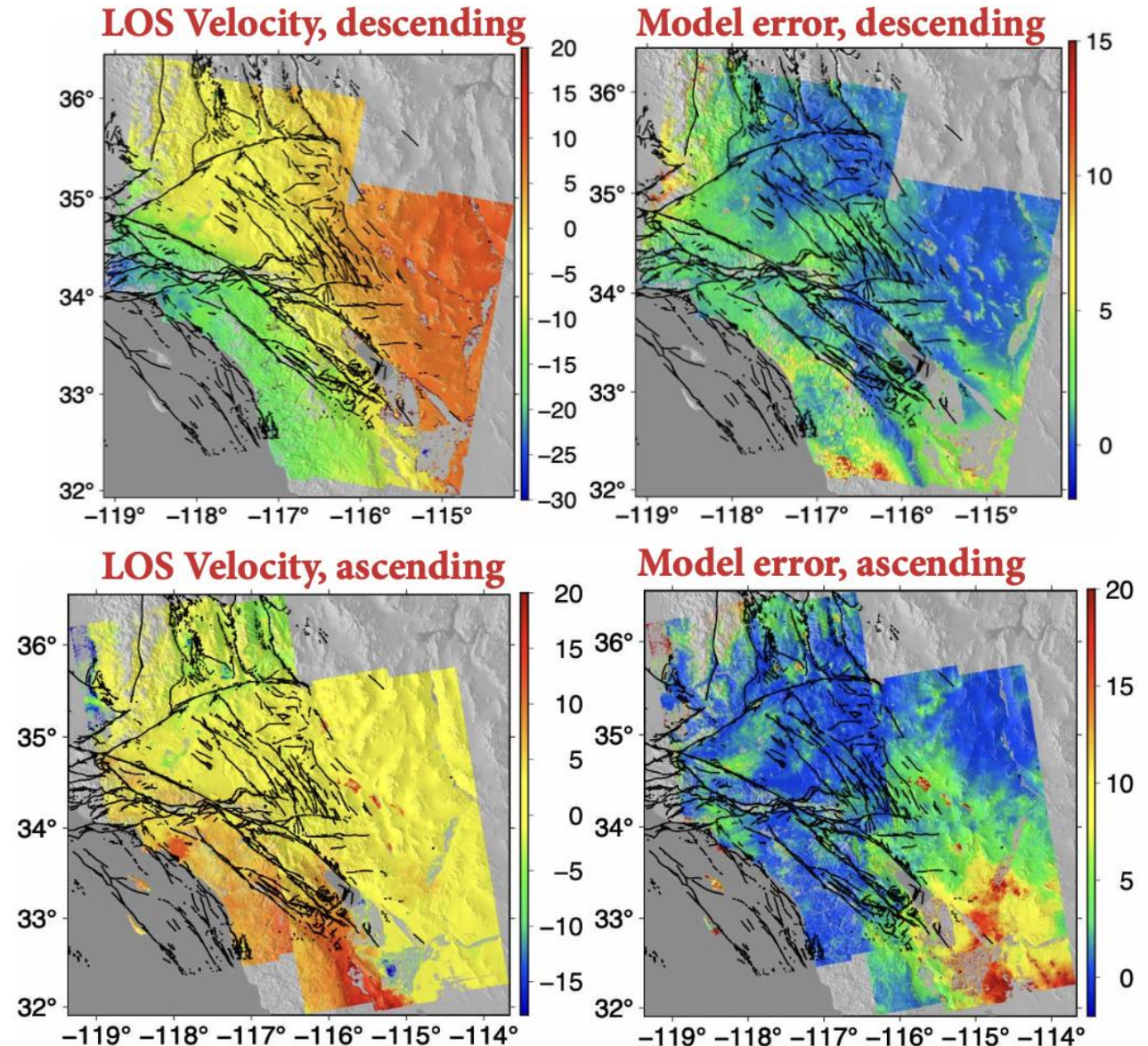
<https://comet.nerc.ac.uk/comet-lics-portal/>

SCEC CGM

The SCEC CGM is an attempt to produce a consensus InSAR deformation product for California

There are 5 contributing groups (including me, and ARIA) trying different time series approaches

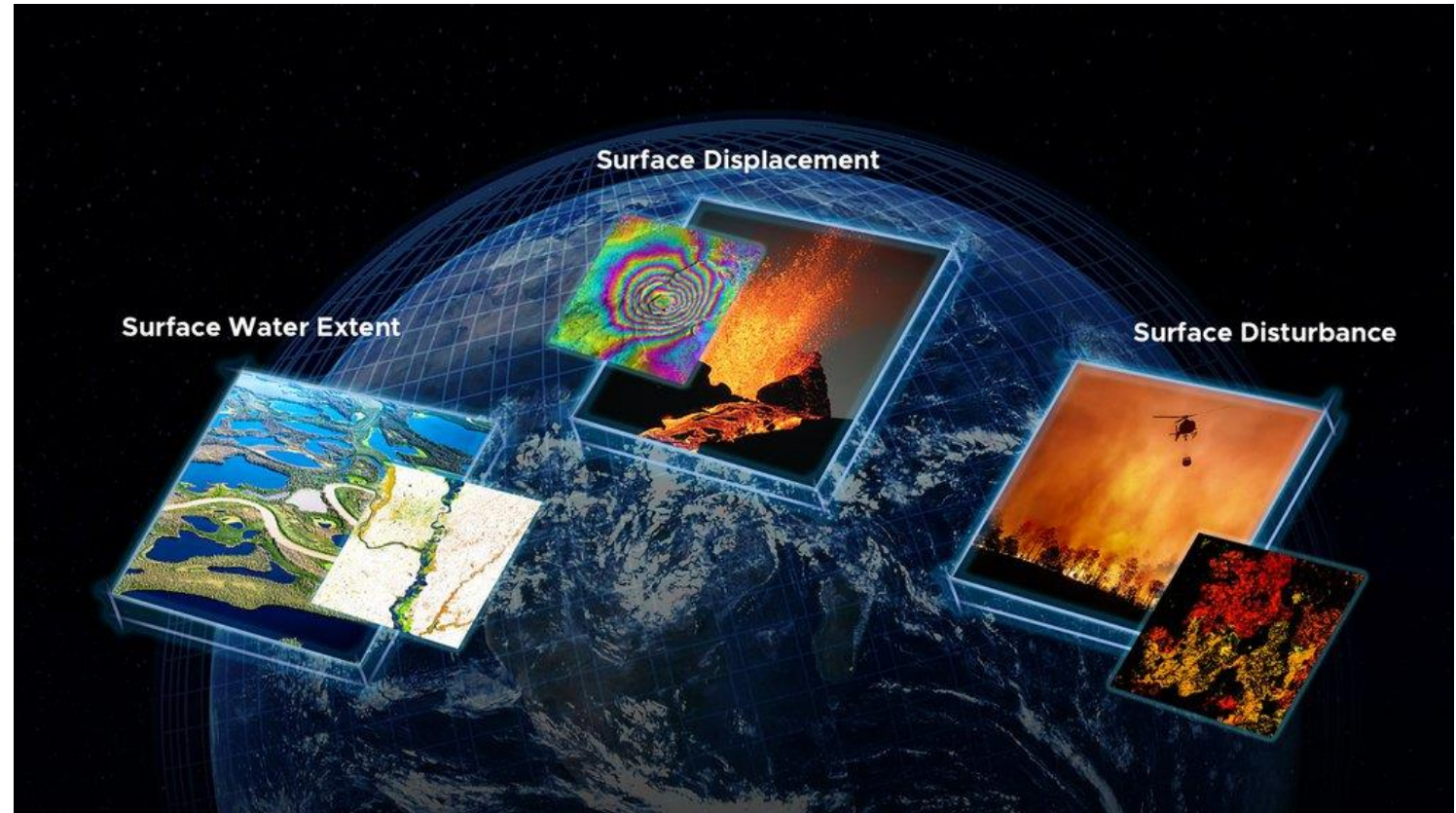
The average of the contributed models is less noisy and agrees better with GNSS data



OPERA

OPERA is the planned operational successor to ARIA, and will produce InSAR products from Sentinel-1 and NISAR data that will be extremely useful

- A North America-wide displacement product (planned for Fall 2024)
- Geocoded SLCs at full resolution (10 x 10 m) that will greatly simplify InSAR processing



<https://www.jpl.nasa.gov/go/opera>

OPERA Surface Displacement (DISP) Product

National Aeronautics and
Space Administration



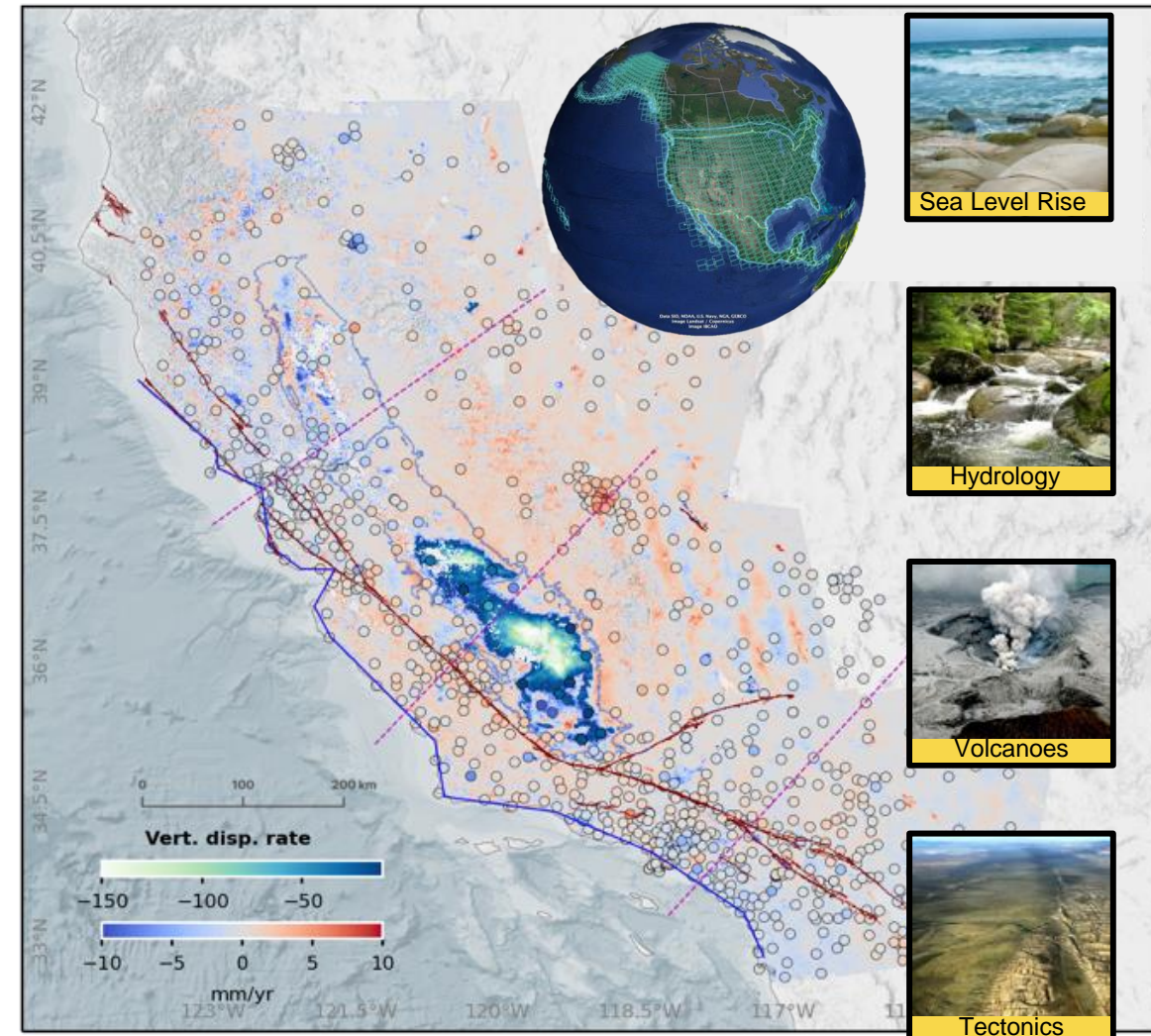
The Observational Products for End-Users from Remote Sensing Analysis (OPERA; jpl.nasa.gov/go/opera) is developing a North America Displacement (DISP) product suite.

DISP product suite - *To be distributed by ASF DAAC*

- InSAR time series generated from Sentinel-1 A/B & NISAR
- Production planned starting Nov 2024 for S1 and Jul 2025 for NISAR
- Displacement in LOS
- Predefined frames with 30 m spacing or better

Product coverage

North America (All US states + 14 US Territories, all mainland countries between US CONUS south to and including Panama, and Canada within 200 km from US border)



Govorcin and Bekaert, in prep