

OPERA Analysis-Ready SAR and Optical Products for Mapping Water Extent, Disturbance, and Displacement at Continental to Near-Global Scales

Bradford

Leeds

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Government sponsorship acknowledged.



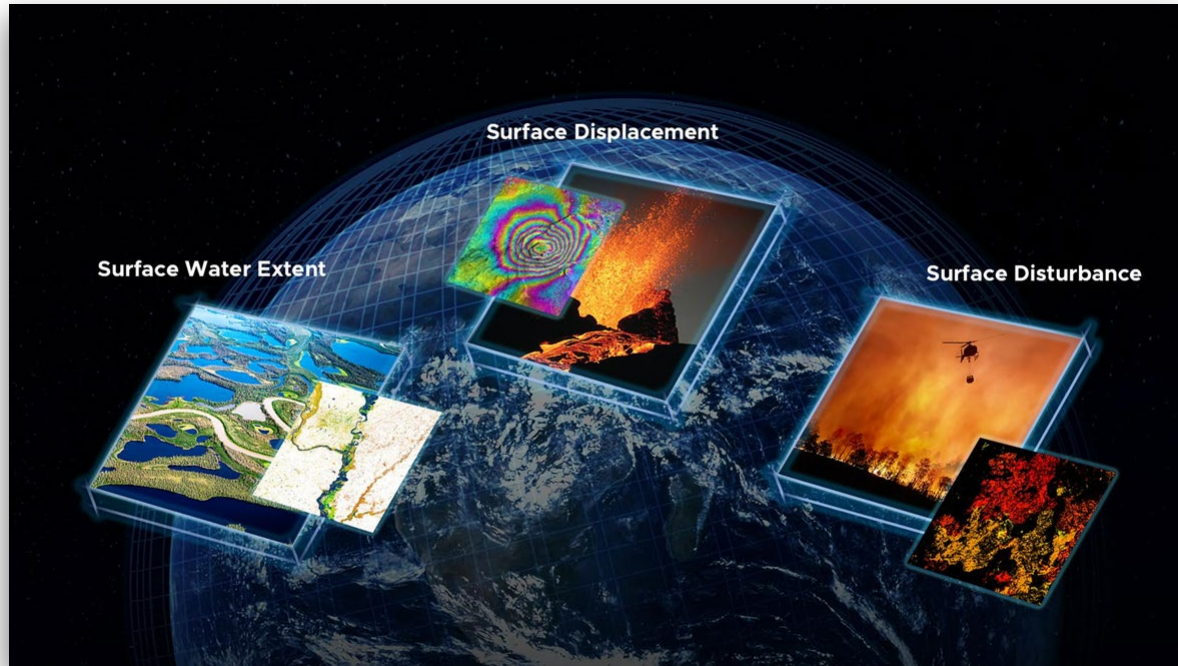
→ THE EUROPEAN SPACE AGENCY

Background

National Aeronautics and
Space Administration



*Our JPL team was funded via NASA to create **3 analysis ready data products** that directly address the needs of multiple U.S. Federal Agencies determined by 2018 Satellite Needs Working Group survey.*



OPERA

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



Jet Propulsion Laboratory
California Institute of Technology



SMU



EarthScope
Consortium

OPERA Team

National Aeronautics and
Space Administration



OPERA products

National Aeronautics and
Space Administration



DSWx

Surface Water Extent

Lake Mead, NV, USA
Lake level in 2016 (light blue) compared to 2022 lake level (dark blue).

- **Description:** Maps surface water using optical (HLS) and SAR imagery (S1, NISAR)
- **Coverage:** Near-global
- **Temporal resolution:** every few days
- **Spatial Resolution:** 30 m
- **Product Record Begins:** Apr. 2023 (HLS), Jul. 2024 (S1), May 2025 (NISAR)
- **Access:** PO.DAAC
- **Available now!**

DSWx-SWOT (delayed until further notice)

DIST

Surface Disturbance

Mosquito Fire, CA, USA
Red areas show vegetation loss from California's largest wildfire of 2022.

- **Description:** Maps vegetation disturbance using optical (HLS)
- **Coverage:** Near-global
- **Temporal resolution:** every few days
- **Spatial Resolution:** 30 m
- **Production Begins:** Feb. 2023 (HLS)
- **Product Record Begins:** Feb. 2023 (HLS)
- **Access:** LP DAAC
- **Available now!**

***NEW product*:** SAR disturbance from S1

DISP

Surface Displacement

Mauna Loa, HI, USA
Surface deformation map showing how much the ground moved following the 2022 eruption. Colors show contours of displacement.

- **Description:** Maps surface displacements in LOS from SAR (S1 and NISAR)
- **Coverage:** North America*
- **Temporal resolution:** 6, 12, or 24 days
- **Spatial Resolution:** ≤ 30 m
- **Product Record Begins:** Apr. 2014 (S1), TBD NISAR
- **Production Begins:** Oct. 2024(S1) Jul. 2025 (NISAR)
- **Access:** ASF DAAC

***Notional product*:** vertical + horiz. DISP products from S1 A/B

RTC

Radiometric Terrain Corrected

Los Angeles, CA, USA
RTC image showing radar backscatter variations in urban (white/pink), vegetated (green), and water (black) areas.

- **Description:** S1 radar backscatter corrected for the topography. Basis for the DSWx-S1 products.
- **Coverage:** Near-global
- **Spatial Resolution:** 30 m
- **Product Record Begins:** Oct. 2023
- **Production Begins:** Oct. 2023

CSLC

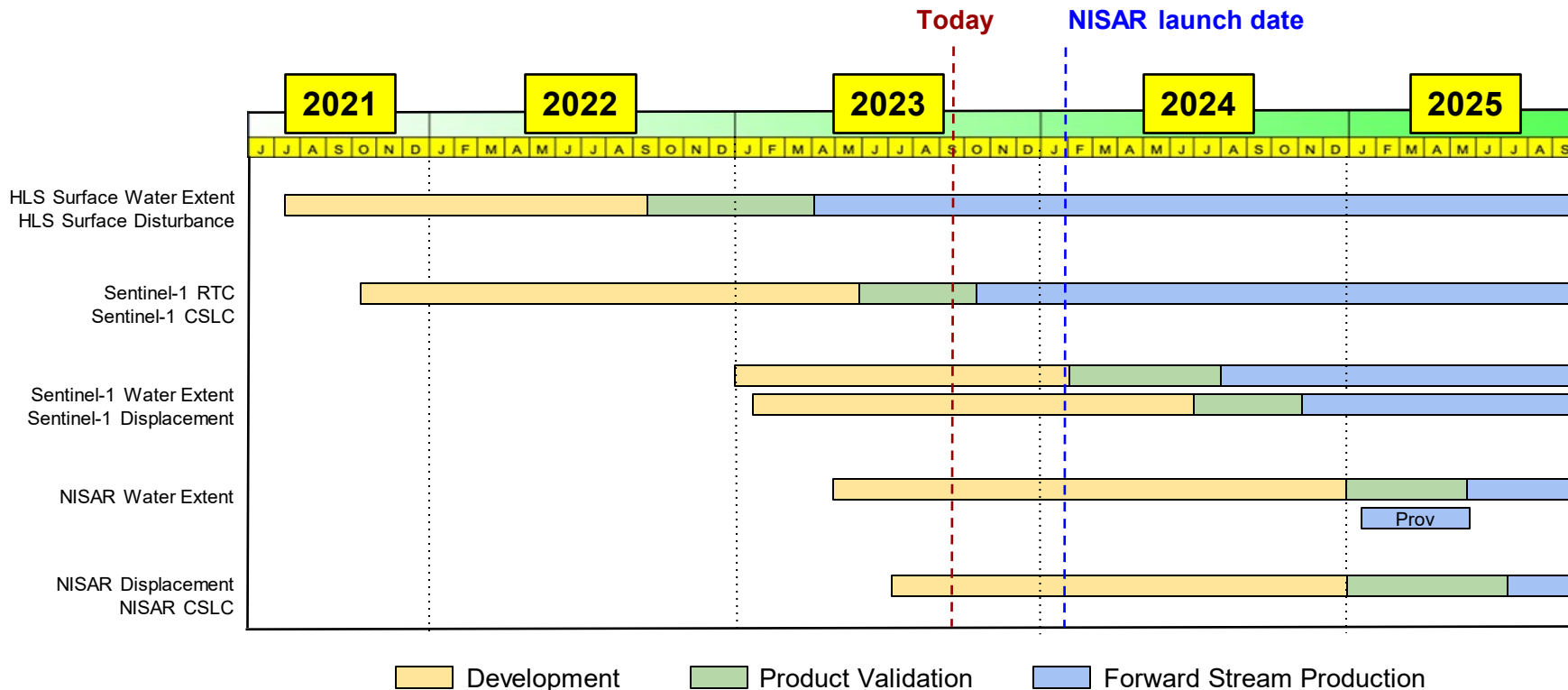
CSLC Coregistered Single-Look Complex

San Gabriel Mountains, CA, USA
CSLC radar intensity image covering a mountainous region.

- **Description:** Geocoded and coreg. S1 and NISAR SLC. Basis for all the DISP products.
- **Coverage:** North America*
- **Spatial Resolution:** ≤ 10 m
- **Product Record Begins:** Apr. 2014 (S1) and TBD (NISAR)
- **Production Begins:** Oct. 2023 (S1), TBD (NISAR)



OPERA Product Release Timeline*

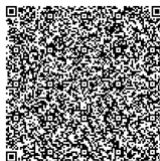


* To be updated to include the Sentinel-1 Disturbance product

Dynamic Surface Water Extent (DSW_x-HLS)

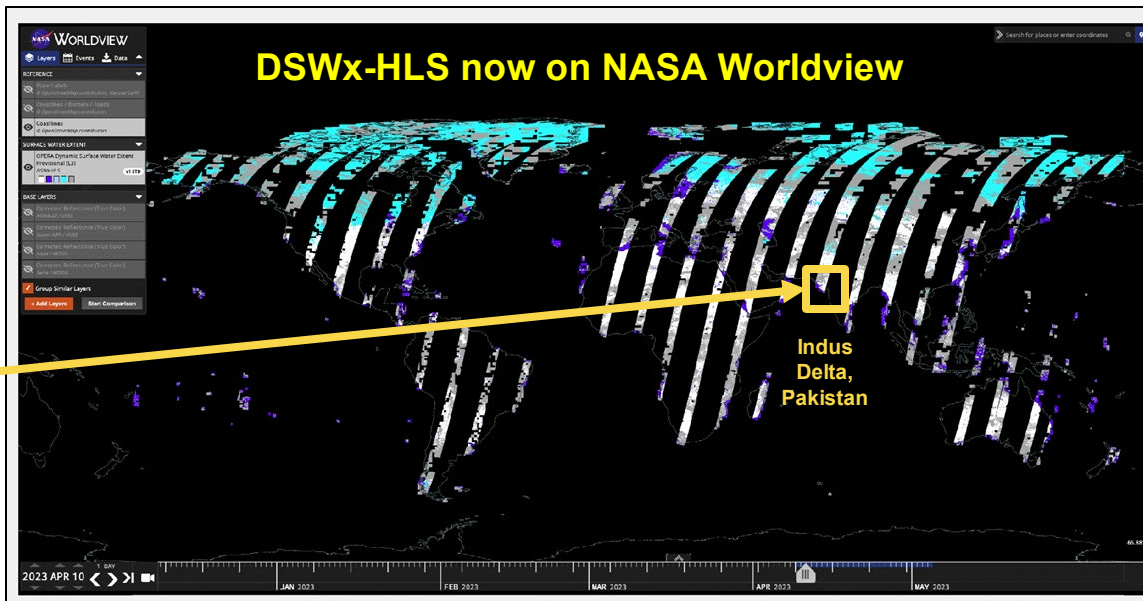
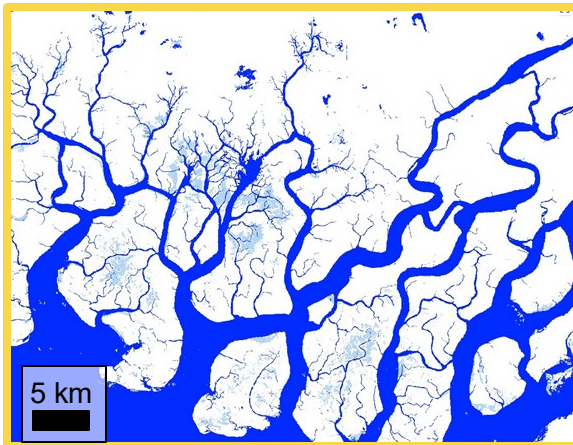


Worldview QR



DSW_x-HLS

- Partial Surface Water
- Open Surface Water
- Not Water



DSW_x-HLS now on NASA Worldview

Indus
Delta,
Pakistan

DSW_x-HLS available on PO.DAAC since Apr 2023



PO.DAAC QR

Dynamic Surface Water Extent (DSW_x-S1)



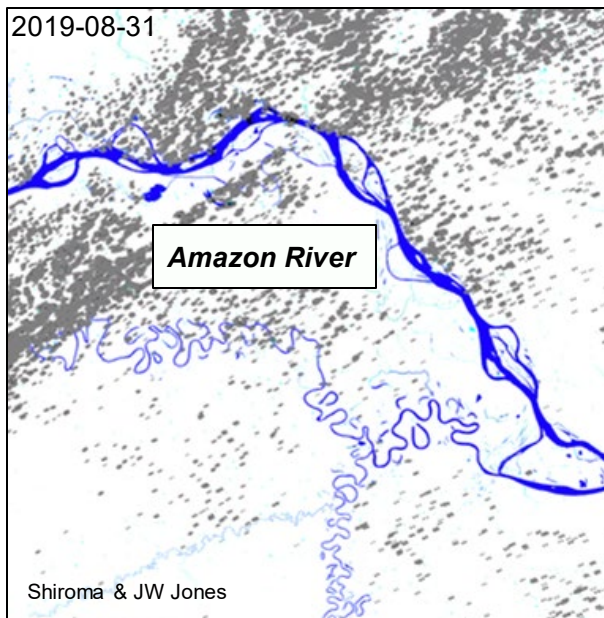
SAR provides a complementary view to optical:

- Provides retrievals under cloudy conditions
- Can partly penetrate through vegetation

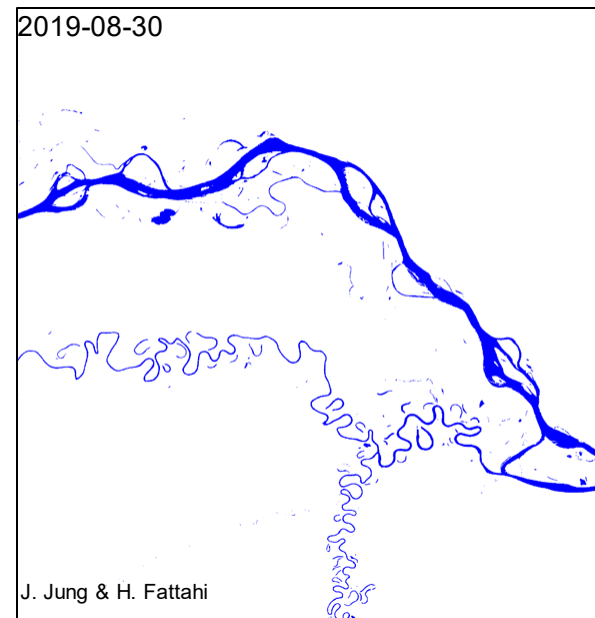
A note on inundated vegetation:

- DSW_x-S1 C-band data will detect inundated vegetation in herbaceous wetlands.
- DSW_x-NISAR L-band data will provide key information in ALL wetlands.

Optical: DSW_x-HLS



SAR: DSW_x-S1



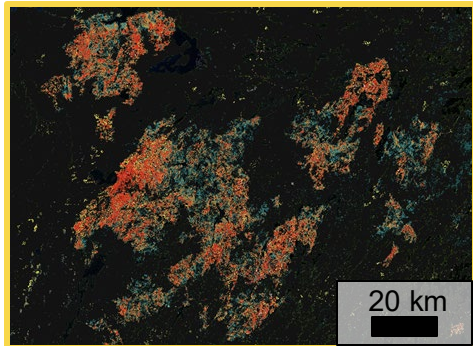
Open Water

Cloud Mask

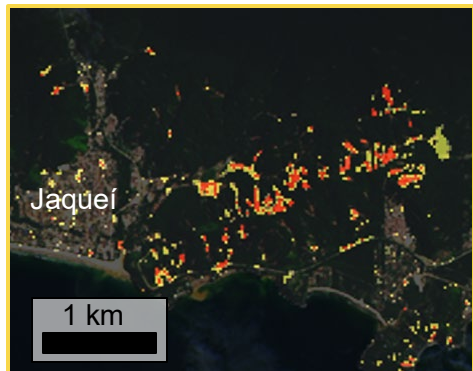
Surface Disturbance (DIST-HLS)



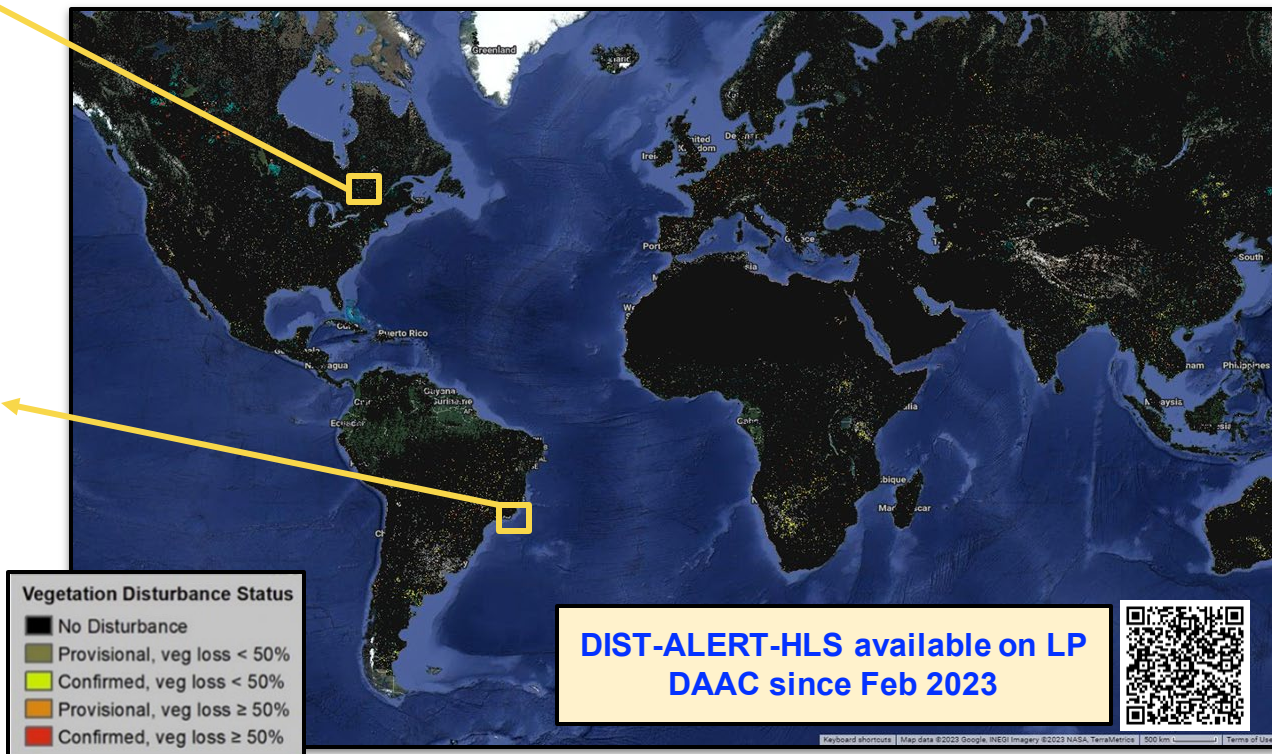
2023 Forest fires in Quebec



2023 Landslides in Brazil



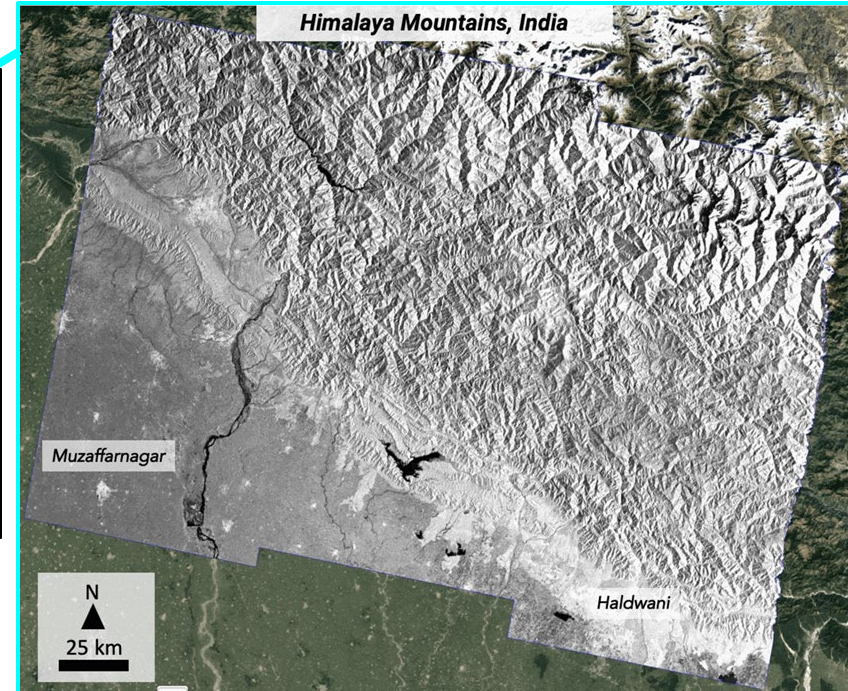
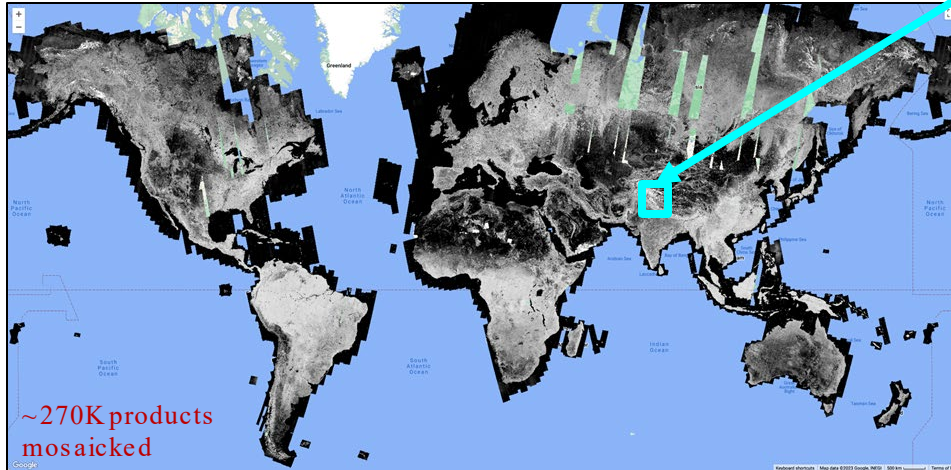
DIST-ALERT-HLS



Radiometric Terrain Corrected (RTC-S1)



Sentinel-1 RTC Radar Backscatter mosaicked on a Global Scale



RTC-S1 will be available on ASF DAAC in Oct 2023

- OPERA is working towards CEOS CARD4L analysis ready data format (ceos.org/ard/).

Coregistered Single Look Complex (CSLC-S1)

National Aeronautics and
Space Administration



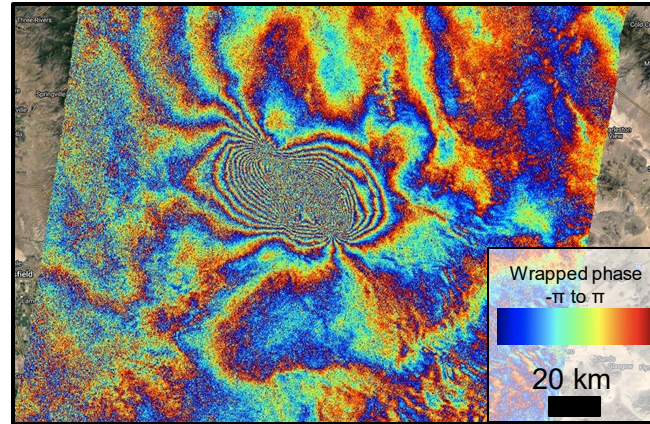
**Sentinel-1 CSLC radar amplitude
showing North America* coverage**



CSLC-S1 will be available on ASF DAAC Oct 2023

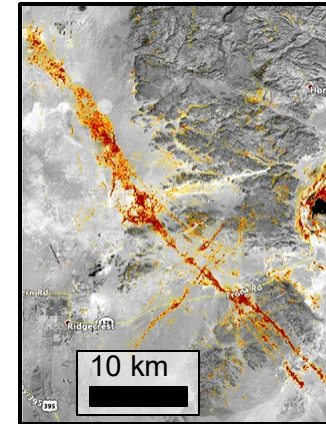
2019 Ridgecrest Earthquake in California

Interferogram



Wrapped Interferogram shows LOS displacement between two CSLC-S1 pairs

Damage proxy map



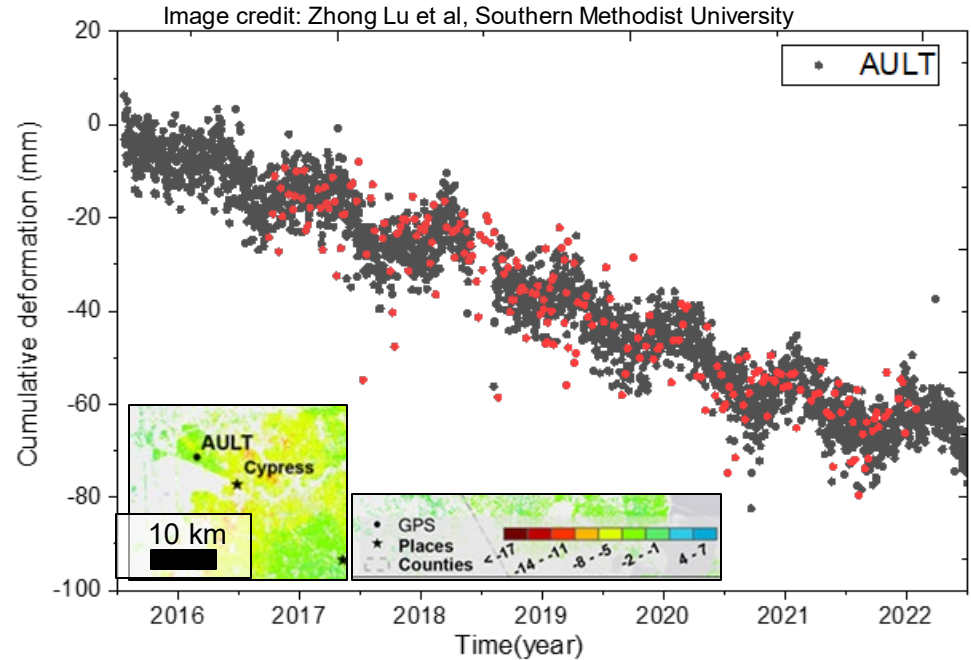
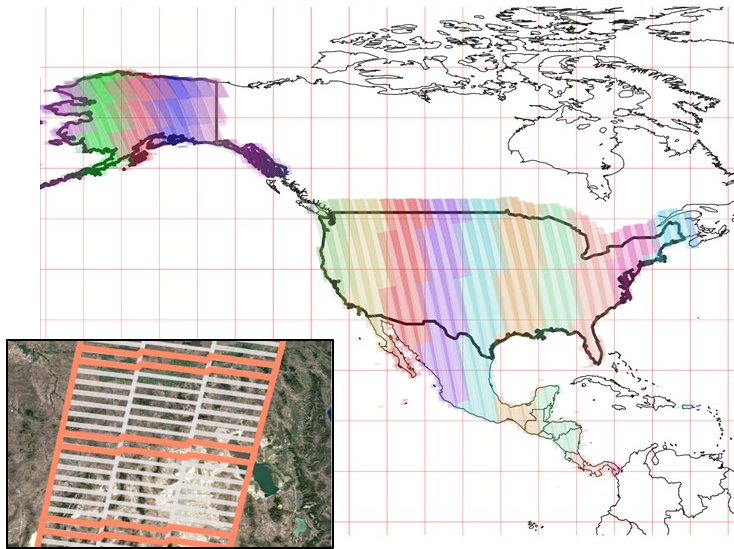
Credit: JPL-Caltech's ARIA team

Damage proxy map shows areas that experienced major damages (red colors).

Displacement product (DISP-S1)



Sentinel-1 DISP frames showing North America* coverage



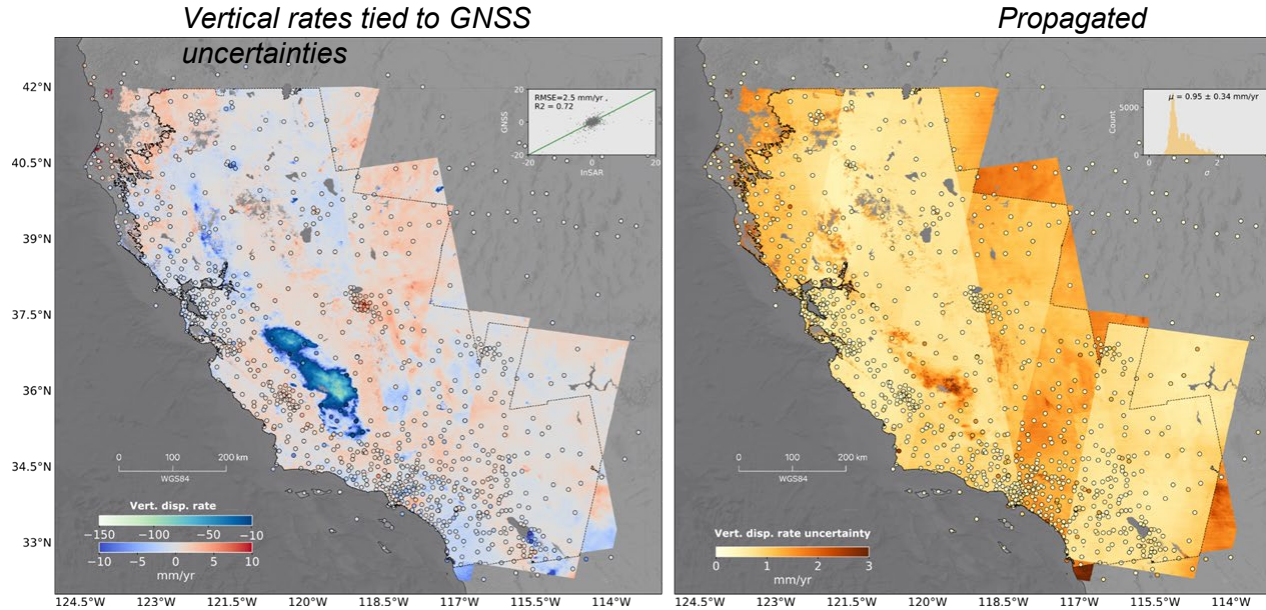
DISP-S1 will be available on ASF DAAC in Oct 2024

- DISP can be used to generate displacement time-series

Vertical Land Motion from S1 (Notional Product)



Resolving Large-Scale Vertical Land Motion from Sentinel-1 time-series InSAR Displacements.

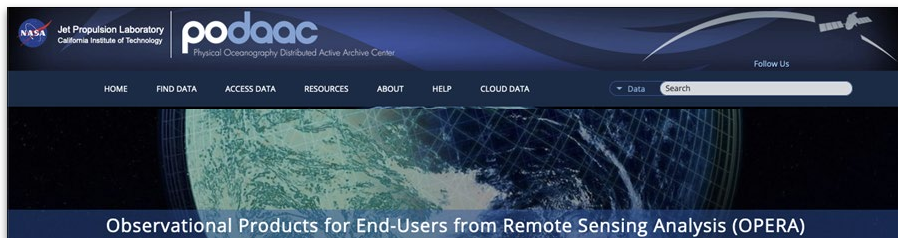


[Marin Govorcin, David Bekaert and Simran Sangha, JPL]



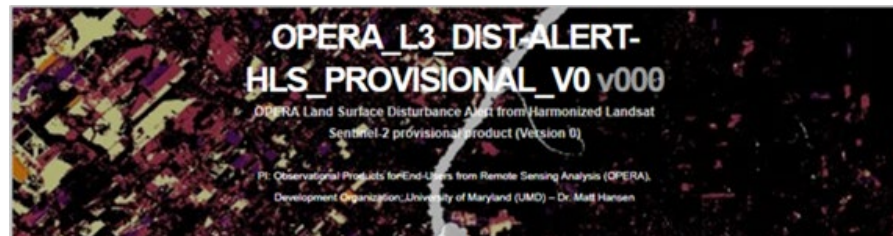
DSW_x at PO.DAAC

- PO.DAAC OPERA Mission page:
<https://podaac.jpl.nasa.gov/OPERA?sections=data>
- OPERA DSW_x-HLS:
https://podaac.jpl.nasa.gov/dataset/OPERA_L3_DS_WX-HLS_PROVISIONAL_V1



DIST at LP DAAC

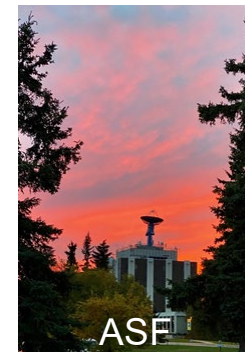
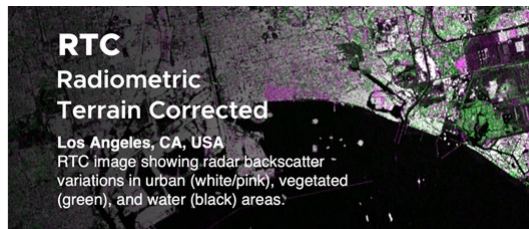
- LP DAAC Search Data Catalog:
https://lpdaac.usgs.gov/product_search/
- OPERA DIST-HLS:
https://doi.org/10.5067/SNWG/OPERA_L3_DIST-ALERT-HLS_PROVISIONAL_V0.000





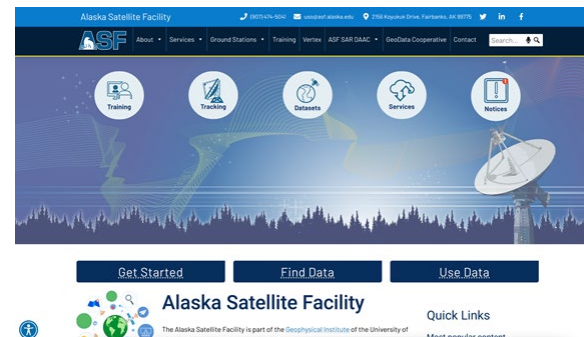
RTC/CSLC at ASF DAAC

RTC/CSLC



About ASF <https://asf.alaska.edu>

- ASF is the DAAC contracted by NASA to archive Synthetic Aperture Radar (SAR) imagery
- ASF provides user support and develops tools and services specific to SAR and SAR-derived products, including the OPERA RTC and CSLC products





Search & Get Access endpoints with Earthdata Search

- NASA Earthdata Search <https://search.earthdata.nasa.gov/>
- [Earthdata Search APIs](#)



Tips:

- Search for OPERA keyword and wait for project info to show up, then select Project: SNWG/OPERA or
- Use quotes to narrow down to exact collection or
- Change Sort filter from *Usage* (default) to *Relevance* to narrow down to collection of interest.
- Use *Advanced Search* to search for AOI e.g. HUC

Explore and Visualize in Worldview

DSWx

RTC

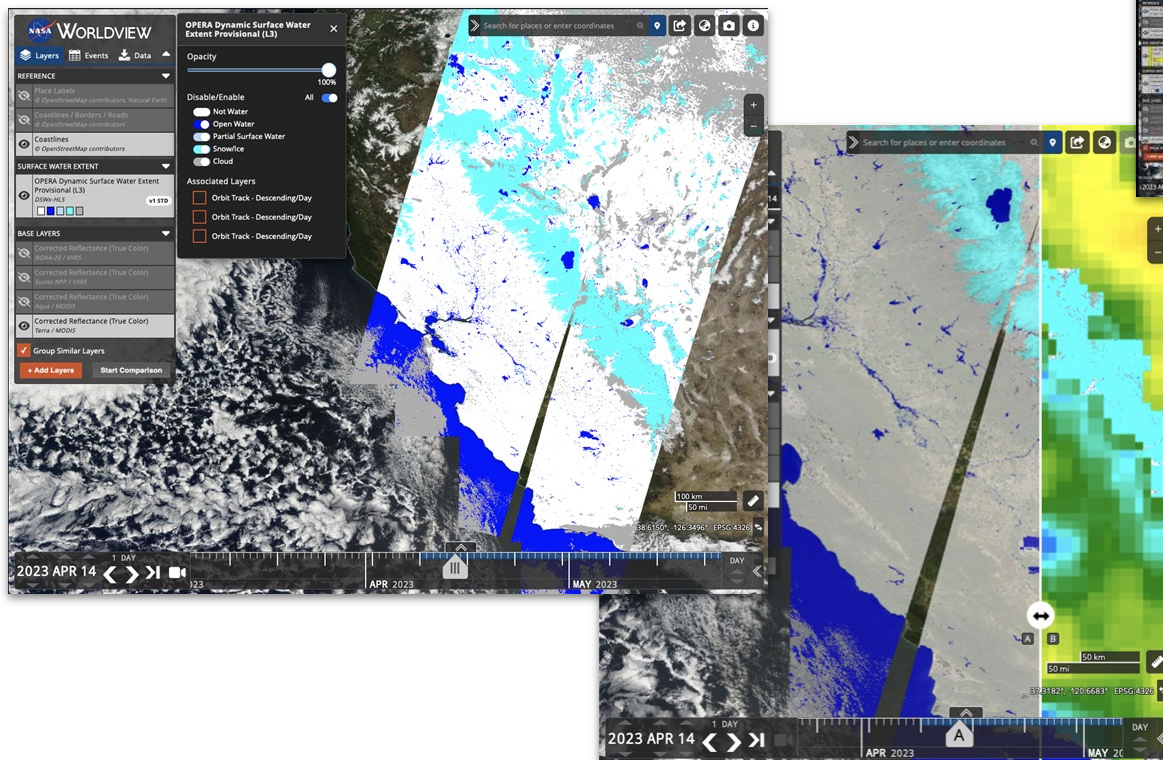
National Aeronautics and
Space Administration



<https://worldview.earthdata.nasa.gov/>

Explore & Access DSWx in NASA Worldview

- Visual display, data preview/coverage in space & time
- Image layer comparison
- Overlay other NASA data layers:
- Adjust transparency, layers/ variables selection
- Download explored data selection via smart handoff to Earthdata Search



Video tutorial:
<https://podaac.jpl.nasa.gov/OPERA?sections=data%2Bresources>



Resources

OPERA Code Repositories and Resources

Code Repositories and Resources →

Partner Organizations

ARIA [↗](#)

Satellite Needs Working Group [↗](#)

Global Land Analysis and Discovery group at
the University of Maryland [↗](#)

Water Resources mission area under the
United States Geological Survey (USGS) [↗](#)

UAF (University of Alaska Fairbanks) [↗](#)

ASF DAAC (Alaska Satellite Facility Distributed
Active Archive Center) [↗](#)

PO.DAAC (Physical Oceanography Distributed
Active Archive Center) [↗](#)

LP DAAC (Land Processes Distributed Active
Archive Center) [↗](#)

OPERA Code Repositories and Resources

The OPERA Project is dedicated to open source development, and all of our code is kept in open source repositories within GitHub. The repositories for each of the 4 main teams within the OPERA project can be found via the links below.

OPERA Project Science Team

<https://github.com/OPERA-Cal-Val>

JPL Algorithm Development Team (ADT)

<https://github.com/opera-adt>

JPL Science Data System (SDS)

<https://github.com/orgs/nasa/repositories?q=opera-sds>

UMD-GLAD Algorithm and Production System

<https://github.com/gladumd/>

PO.DAAC

https://podaac.github.io/tutorials/quarto_text/OPERA.html

<https://www.jpl.nasa.gov/go/opera/resources/opera-code-repositories-and-resources>

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