National Aeronautics and
Space Administration

NISAR

NASA ISRO Synthetic Aperture Radar Mission

OPERATIONAL PERFORMANCE FOR INTERFEROMETRIC SAR APPLICATIONS

Fringe 2026
June 18, 2026

Paul A. Rosen
NISAR Project Scientist (NASA)
Jet Propulsion Laboratory
California Institute of Technology

NISAR Science and Project Teams

https://science.nasa.gov/mission/nisar/

The US NISAR Team

India and US Teams At ISRO ISITE Facility

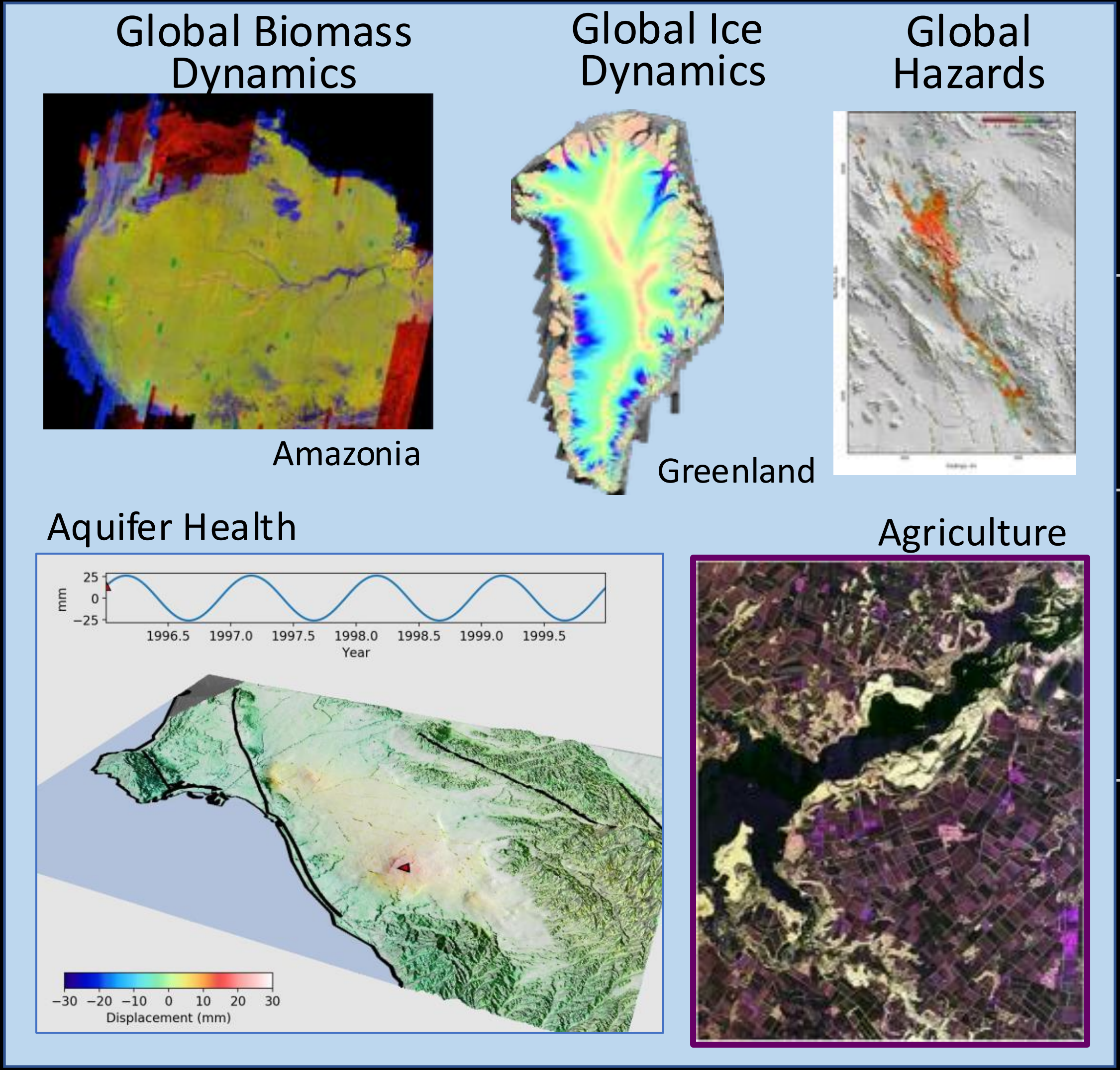
At the end of Integration and Test

For more information: ***https://science.nasa.gov/mission/nisar/***

Outline

- NISAR Mission Background
- NISAR Mission Status
- A Few Early Results
- Interferometric Performance
- Planned Products and Access
- Summary

2007 Decadal Science and Applications



- **Dynamics of Ice: Ice sheets, Glaciers, and Sea Level**
  - Will there be catastrophic collapse of the major ice sheets, including Greenland and West Antarctic and, if so, how rapidly will this occur?
  - What will be the resulting time patterns of sea-level rise?
  - How are alpine glaciers changing in relation to climate?

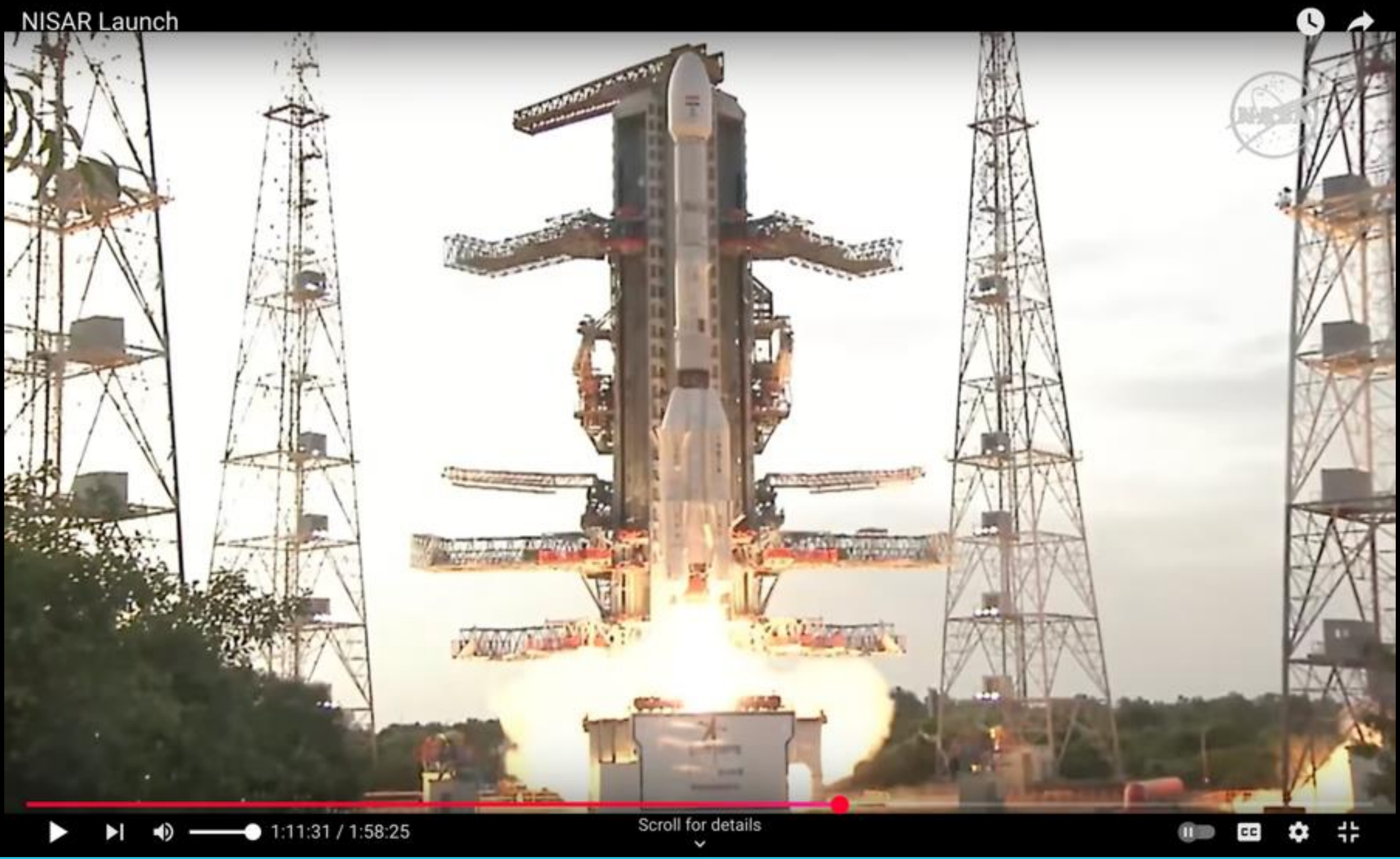
- **Ecosystems and Biomass Change**
  - How do changing climate and land use in forests, wetlands, and agricultural regions affect the carbon cycle and species habitats?
  - What are the effects of disturbance on ecosystem functions and services?

- **Solid Earth Deformation: Hazard Response**
  - Which major fault systems are nearing release of stress via strong earthquakes?
  - Can we predict future eruptions of volcanoes?
  - What are optimal remote sensing strategies to mitigate disasters and monitor/manage water and hydrocarbon extraction and use

- **Coastal Processes: India**
  - What is the state of important mangroves?
  - How are Indian coastlines changing?
  - What is the shallow bathymetry around India?
  - What is the variation of winds in India's coastal waters?

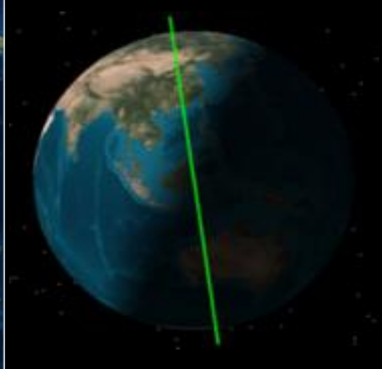
SeaSAT – NASA SAR in Space in 1978

NISAR is in Orbit – July 30, 2025 ~1800 IST

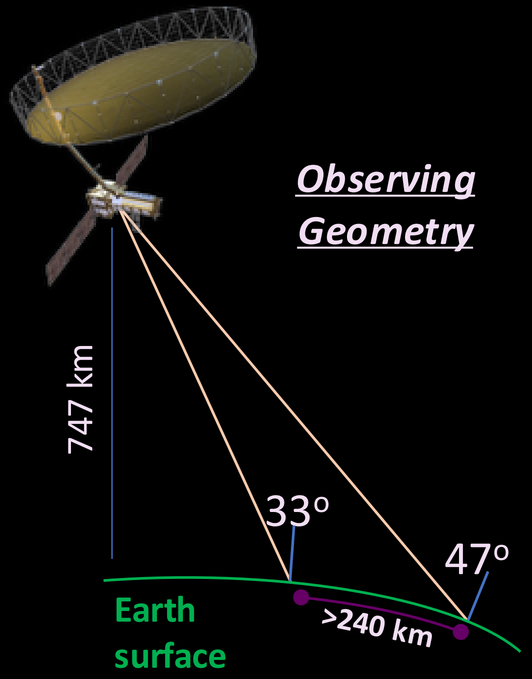


NISAR: A New Unique Observing System

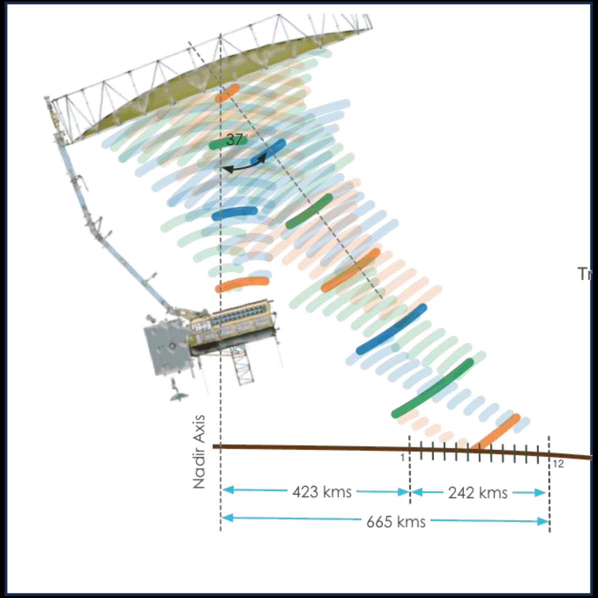
NISAR Characteristic:	Would Enable:
L-band (24 cm wavelength)	Low temporal decorrelation and foliage penetration
S-band (9.4 cm wavelength)	Sensitivity to light vegetation
SweepSAR technique with Imaging Swath > 240 km	Global data collection
Polarimetry (Single/Dual/Quad)	Surface characterization and biomass estimation
12-day exact repeat	Rapid Sampling
3 – 10 meters mode-dependent SAR resolution	Small-scale observations
3 yrs (NASA) / 5 yrs (ISRO) science operations	Time-series analysis
Pointing control < 273 arcseconds	Deformation interferometry
Orbit control < 500 meters	Deformation interferometry
> 10% (S) / 50% (L) observation duty cycle	Complete land/ice coverage
Left-only pointing (Left/Right capability)	Uninterrupted time-series Rely on Sentinel-1 for Arctic



6 AM / 6 PM



Observing Geometry



NISAR Mission Status – L-SAR Focused

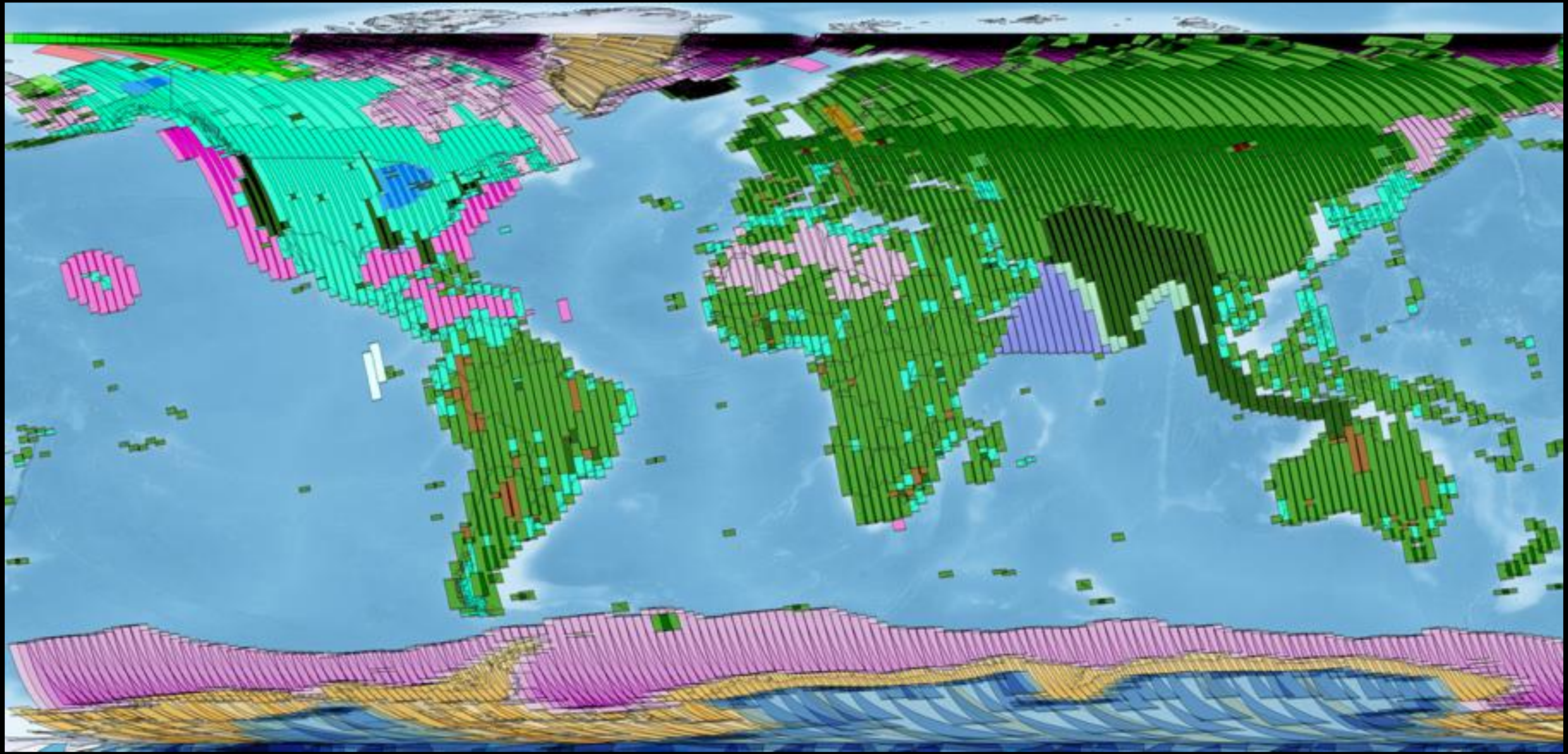
- NISAR officially transitioned to Science Operations on December 29, 2026
- Project has been collecting data using the Reference Observation Plan since early November – 20 complete 12-day cycles collected globally
- Over 1.4 million images produced
- Key spacecraft resources are nominal, with no observed degradation
  - Pointing is stable over time, and meeting requirements
  - Maintaining required repeating orbits 100% of the time
- L-SAR and S-SAR hardware are healthy
- Processing of L-SAR data in the cloud is nominal
  - Released 107,000 products to the science community end of February 2026 – precalibrated with known issues
  - Plan to begin release of ”forward processed” data in early July 2026
  - Plan to reprocess data acquired prior to July 2026 thereafter
- Joint L-band and S-band data acquired over India, Antarctica, Greenland and selected global site.
- Early observatory hardware/software/firmware issues have been resolved

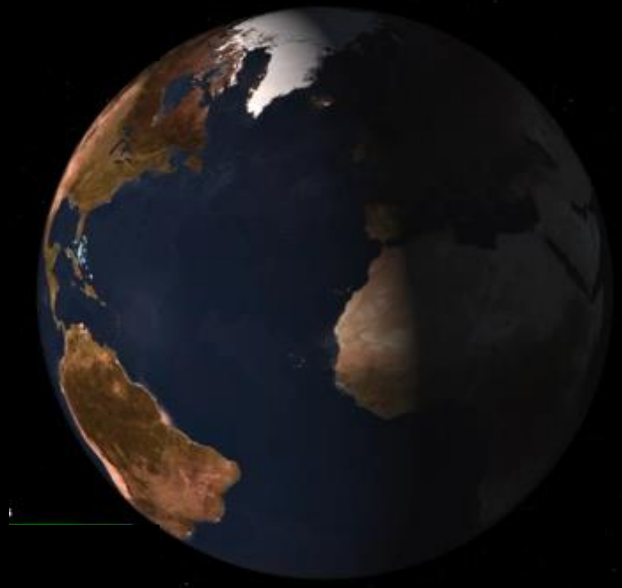
NISAR Monthly Scorecard, 6/1/2026

Cumulative # of Images	SDS Automate Ops Pipeline ≈ 1,426,524
Cumulative # of Interferograms	SDS Automate Ops Pipeline ≈ 235,891
Cumulative L-SAR Science Mode Time	≈2820 hrs of high-rate data collection
Weekly L-SAR Data Volume	≈287.2 Tb (L0A)
Weekly CARA or RMM events	None

Complete Ascending/Descending Coverage in 12 days

Land and ice-covered surfaces, plus selected coastal areas



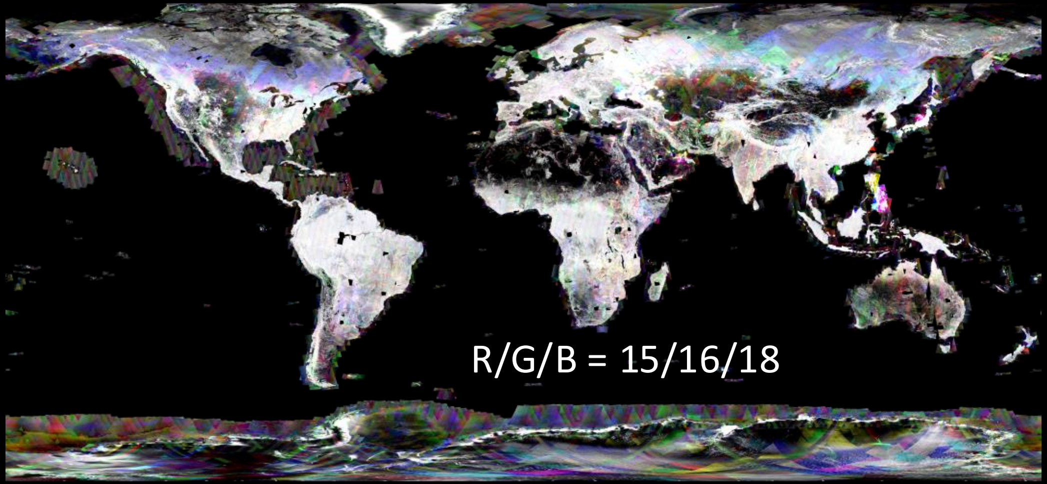


Sun-synchronous 6 am / 6 pm orbit

Colors indicate specific radar modes (resolution, polarization, L/S/L+S-band), repeated every 12 days

Global Mosaic of NISAR HH Backscatter

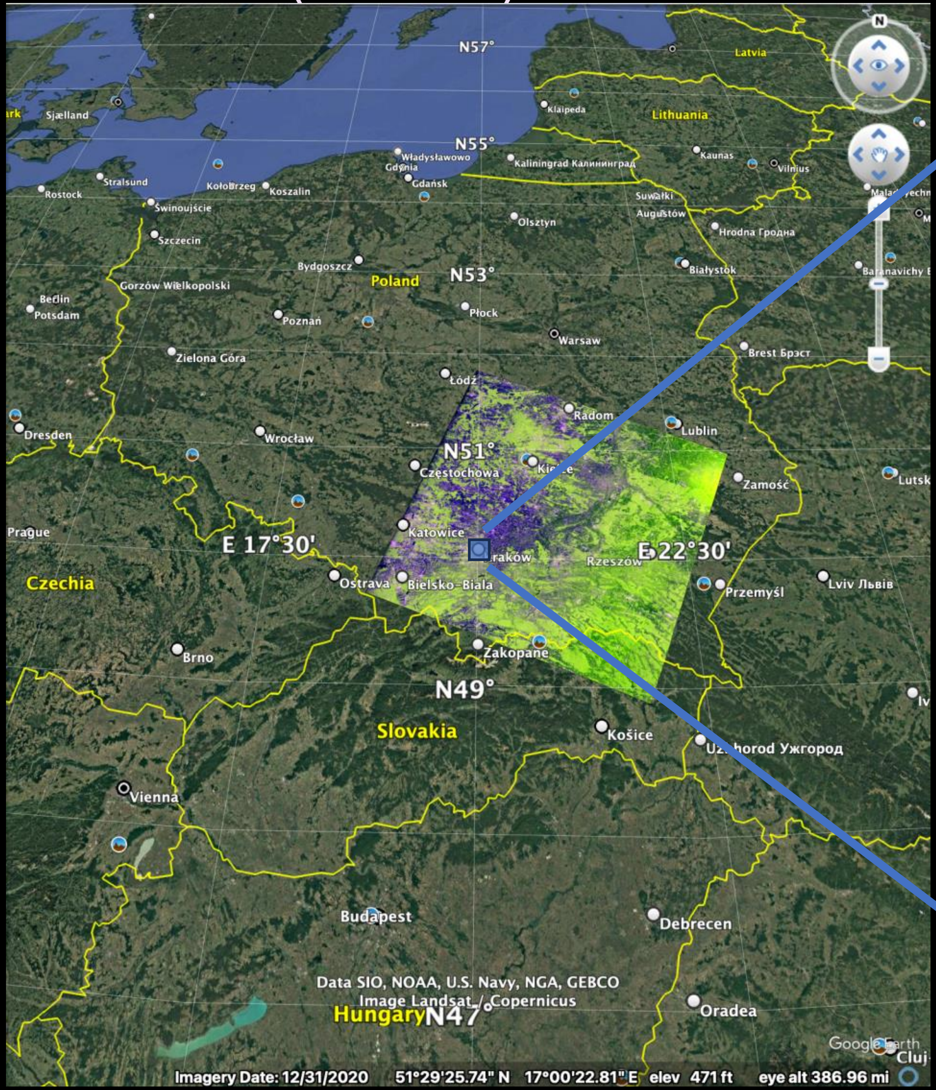
12-day cycle mosaics of complete Earth's land and ice



Pre-release mosaics produced by G. Shiroma, JPL, from standard GCOV product

Standard NISAR product over Krakow

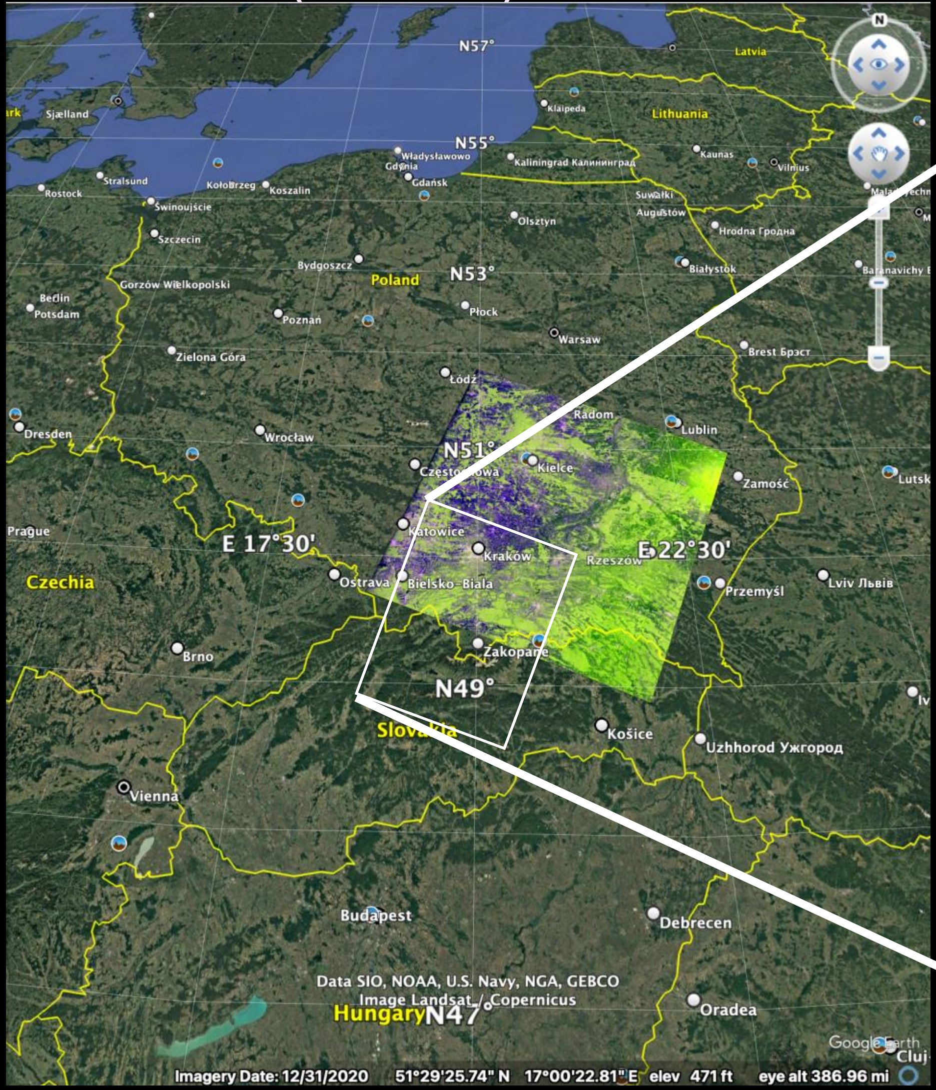
Dual Pol (HH/HV) Variable PRF



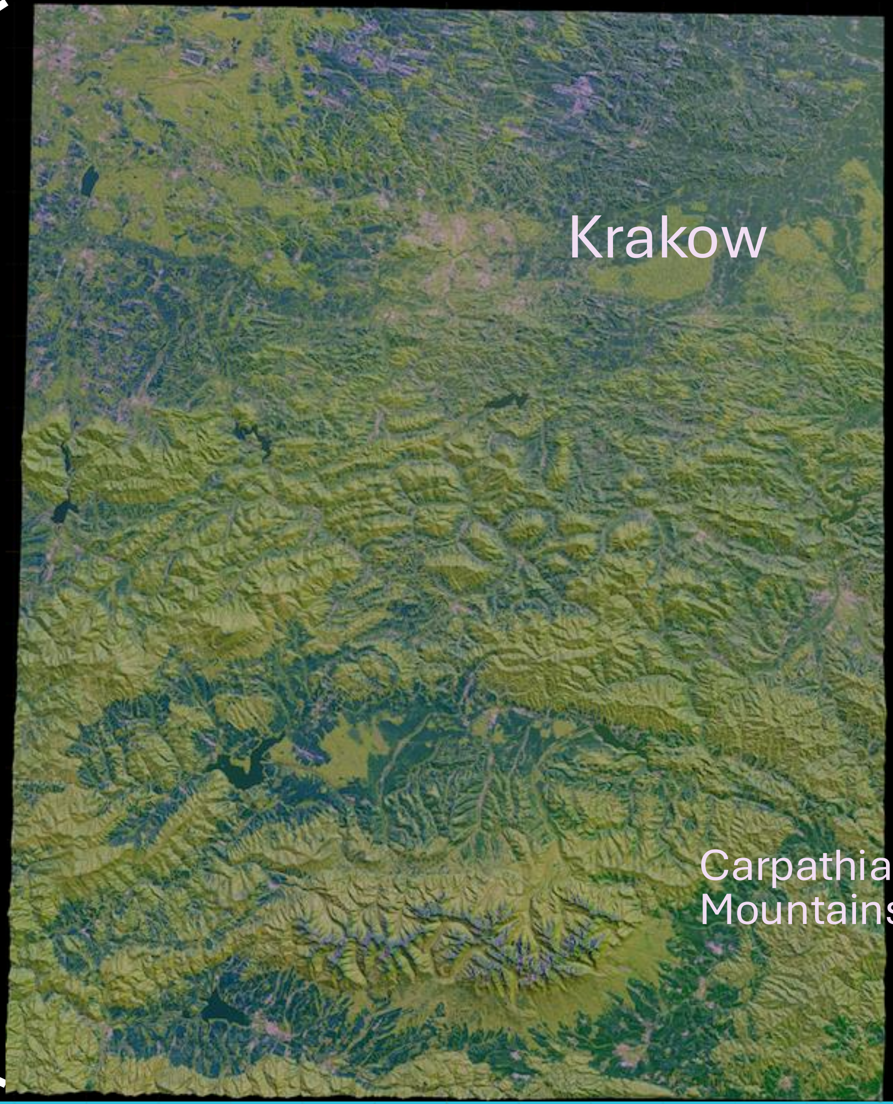
Detail rendered around Krakow

Standard NISAR product over Krakow

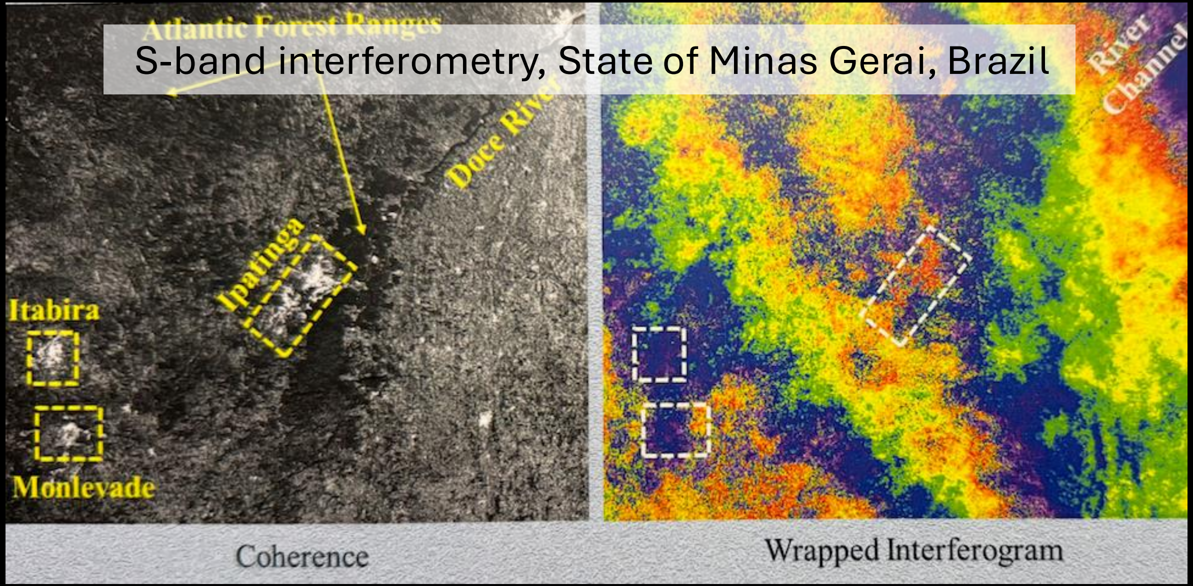
Dual Pol (HH/HV) Variable PRF

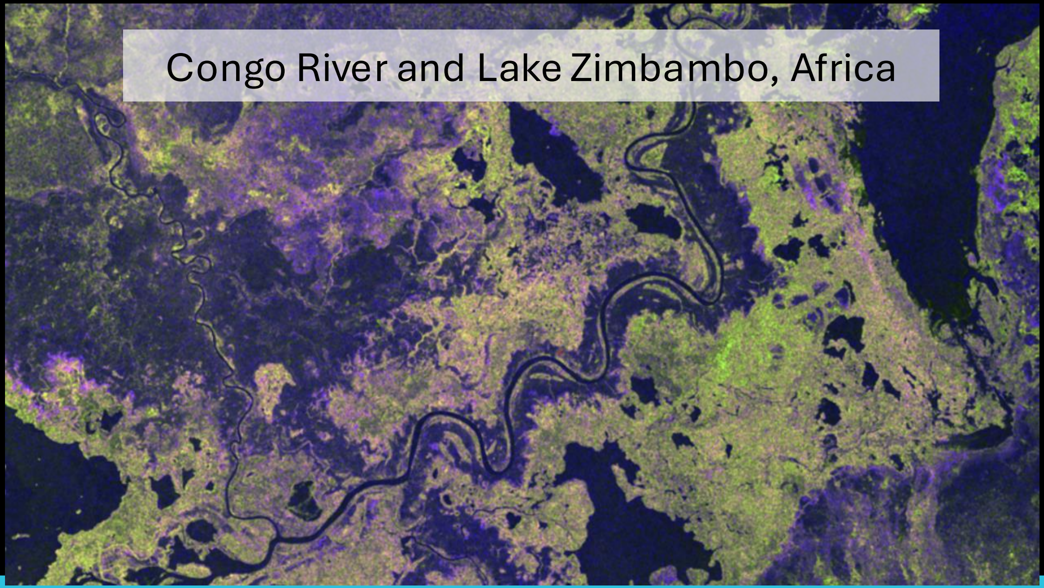


Larger area rendering



S-band compact-pol images released by ISRO



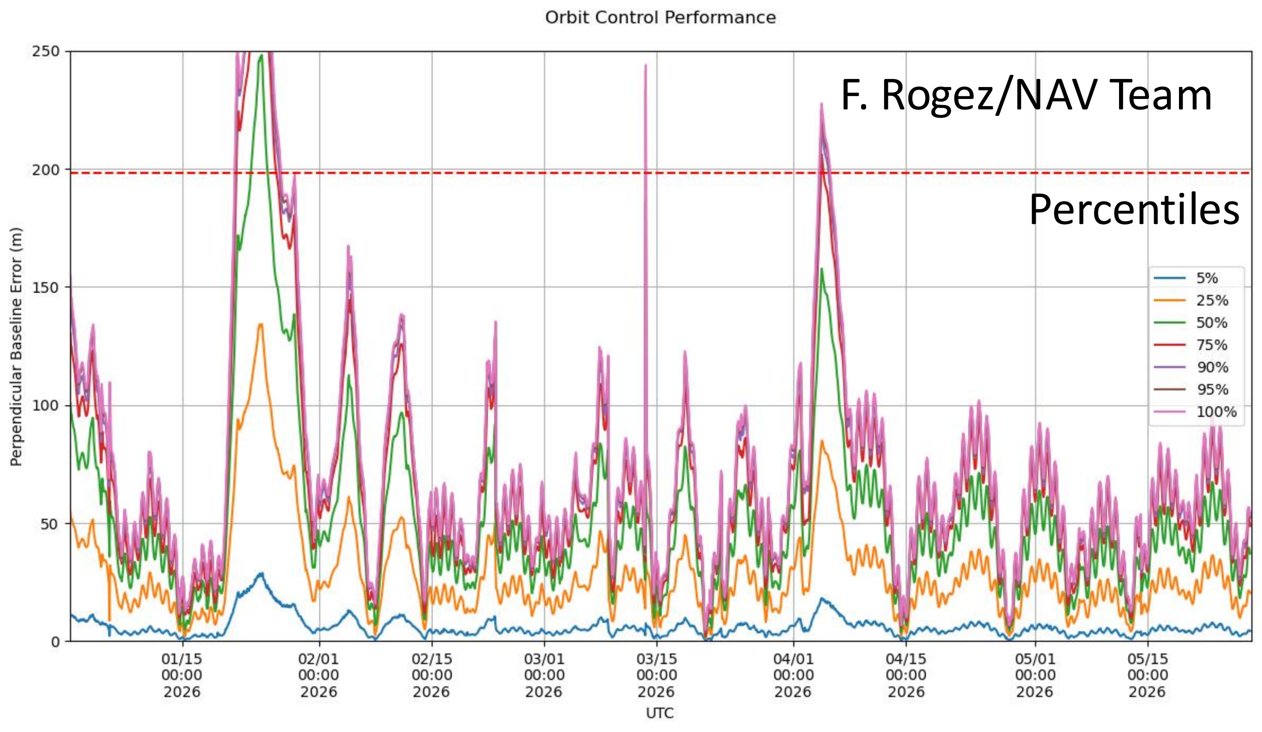


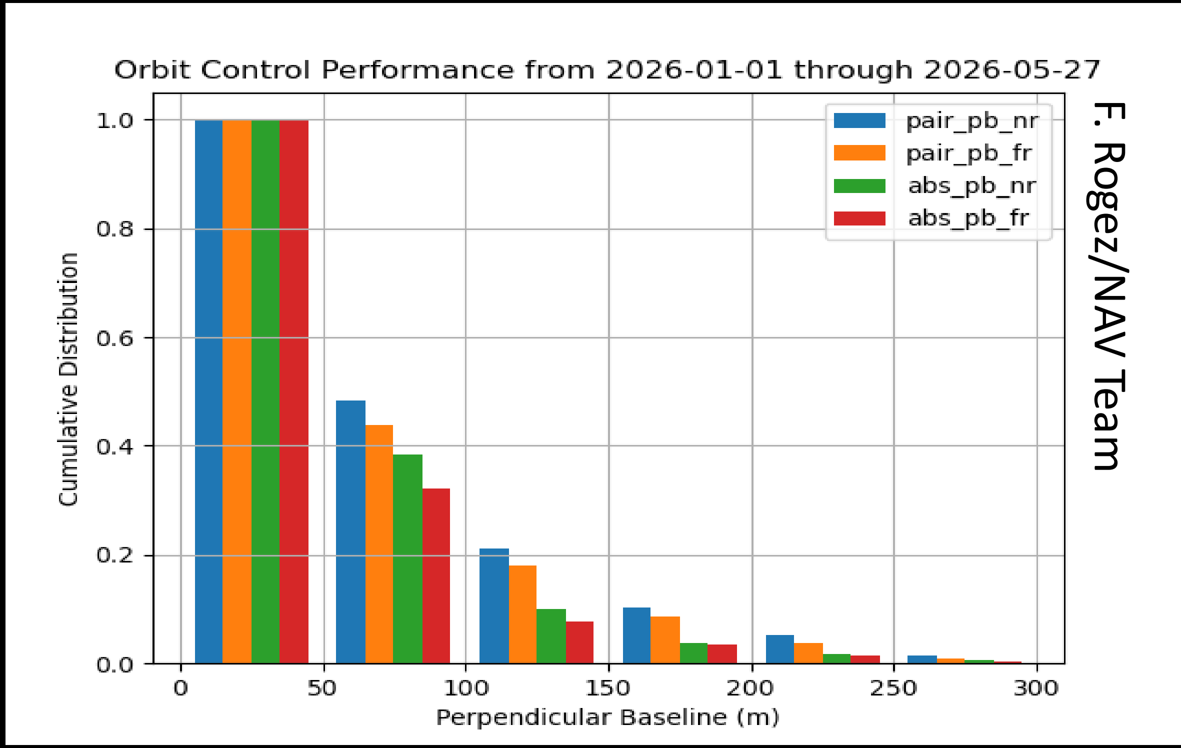
Joint L- and S-Band Analysis is Beginning

NISAR: InSAR Performance

- To date, the mission team has been able to maintain a 100-200 m interferometric baseline nearly everywhere, nearly all the time (except for rare collision avoidance maneuvers and solar storms)
- The quasi-zero-Doppler pointing (0.9 deg for L-band; -0.3 deg for S-band) is within 1/15 deg point requirements nearly everywhere, all the time.
- L-band coherence is as expected: good to great often; poor when surface temporally decorrelates

NISAR Baseline Performance

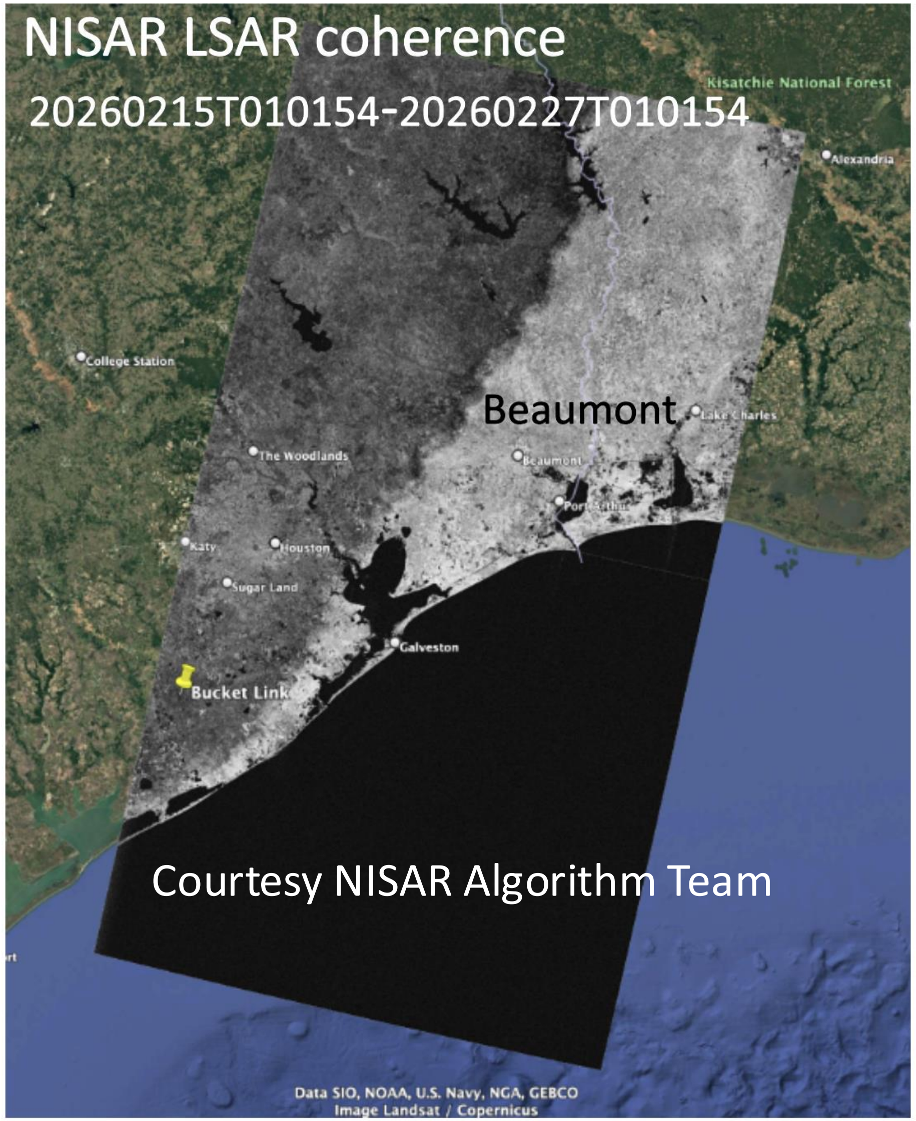


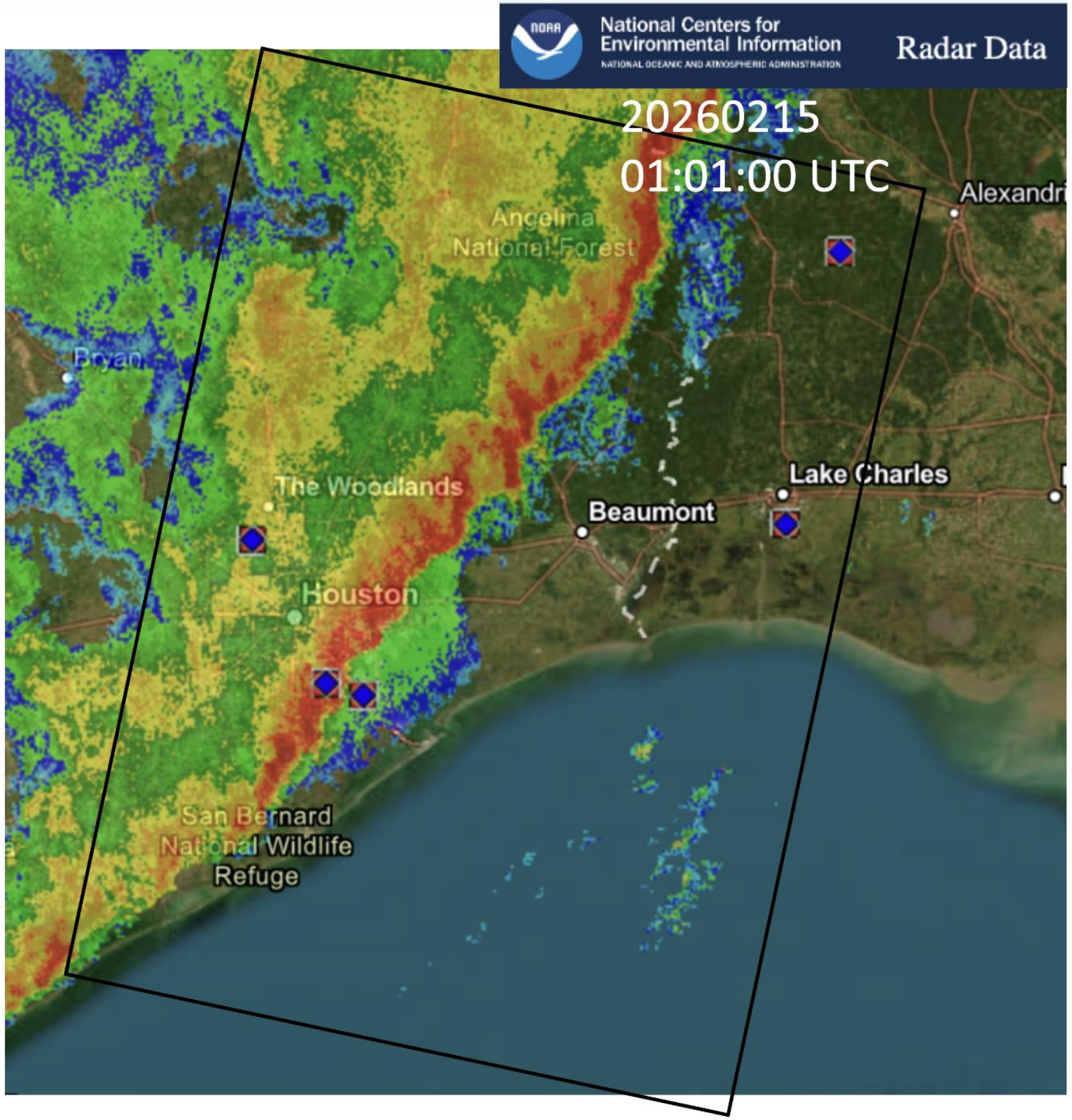


F. Rogez/NAV Team

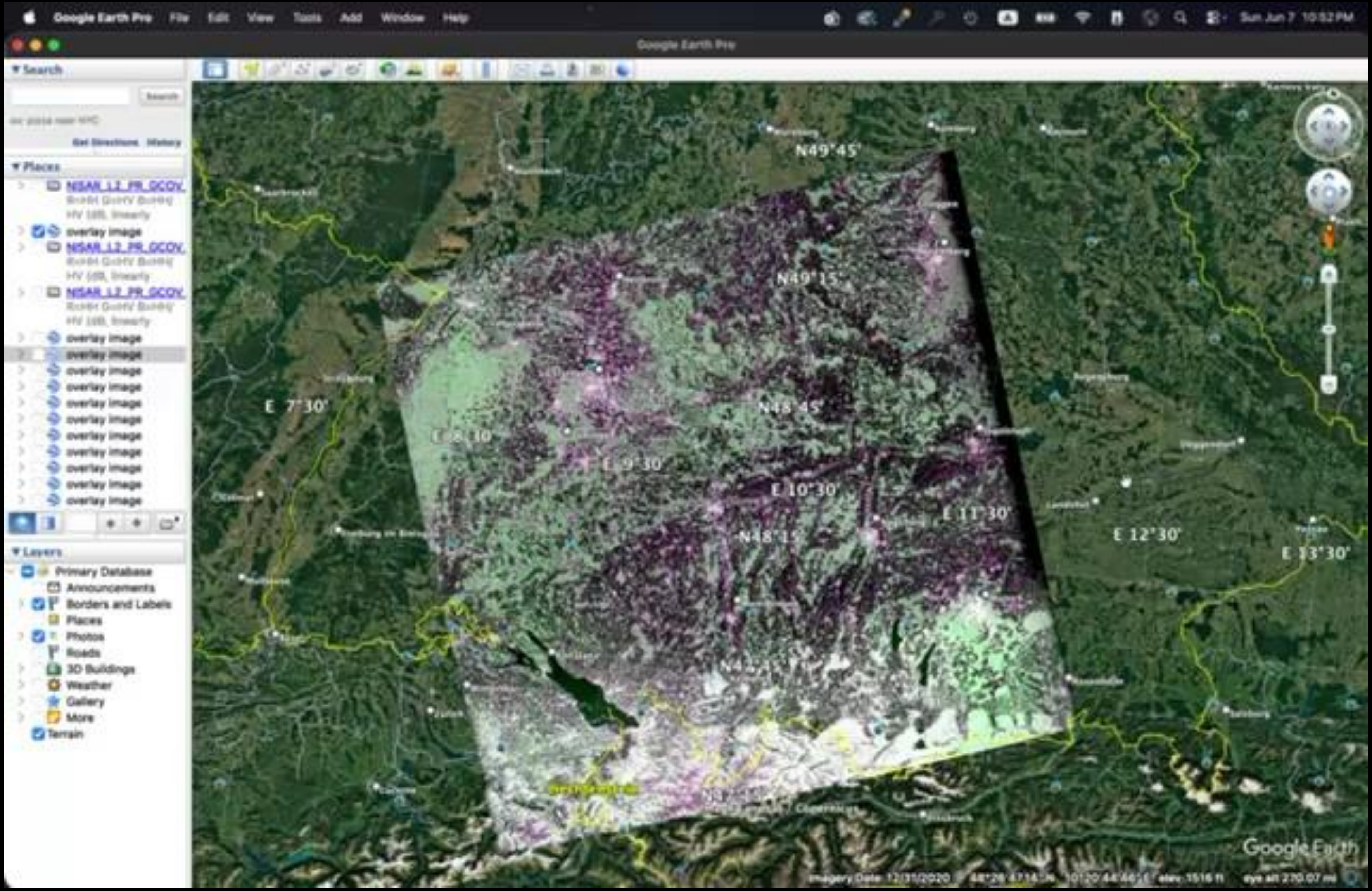
- The percentiles are used to show how diamond violations typically only affect a portion of each orbit.
- Visible violations:
  - End of January: Geomagnetic storm
  - Mid March: RMMs. No radar observations for several hours around the Time of Closest Approach.
  - Early April: Precautionary move away from a potentially active spacecraft

NISAR: InSAR Robust Coherence





InSAR over Krakow



Interferometric 12-day pairs

20251231 20260112

20260112 20260124

20260124 20260205

20260205 20260217

20260217 20260301

20260325 20260406

20260406 20260418

20260418 20260430

20260430 20260512

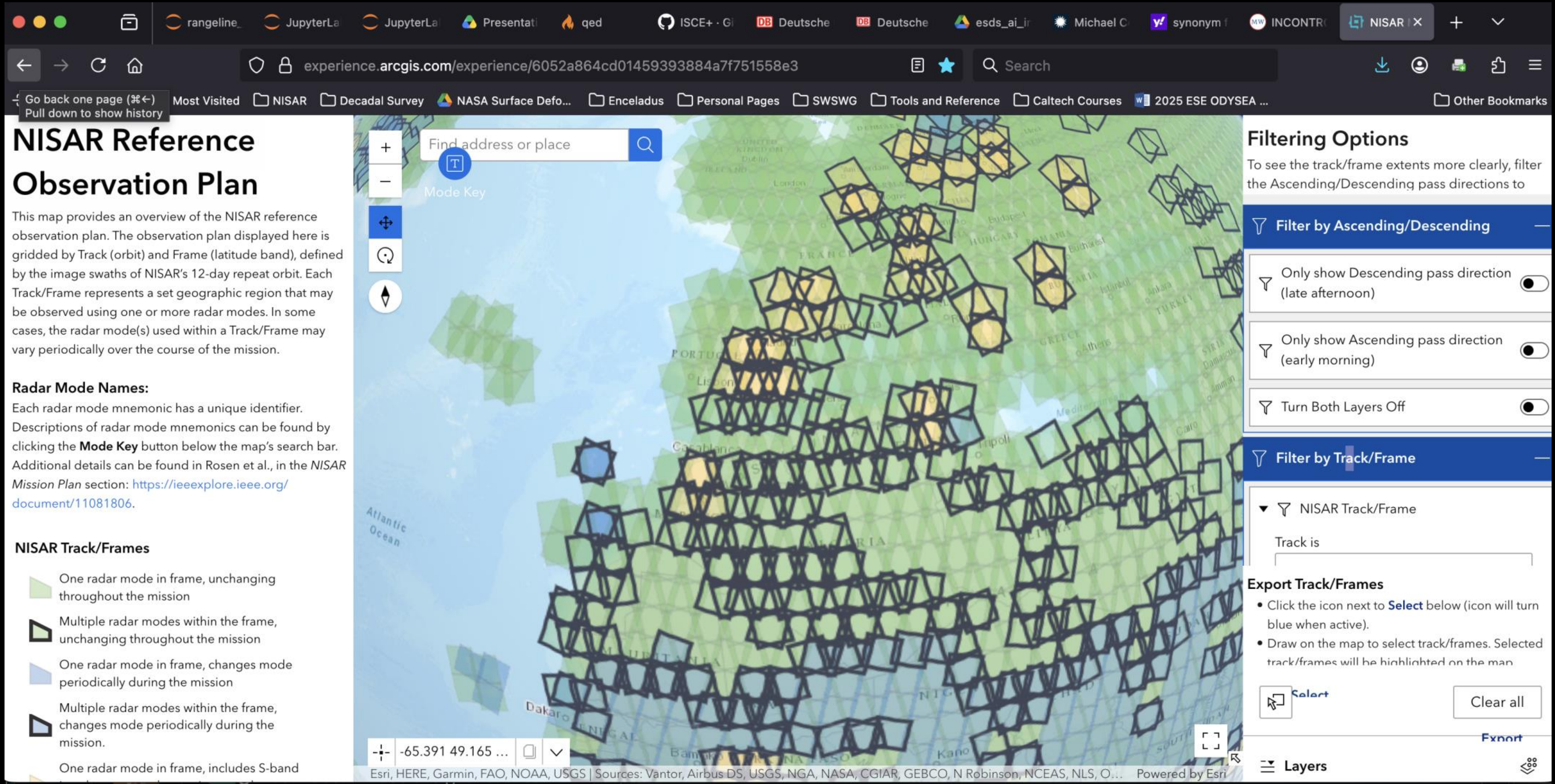
20260512 20260524

NISAR: InSAR Features

- 12-day or best pair geocoded unwrapped (80 m res) and wrapped (20 m res) interferograms for all frames ascending and descending globally
- Hi-resolution ionosphere model group delay correction to geocoded products (geocoded SLC, geocoded interferograms)
- ”Rubbersheeting” coregistration for polar interferogram products
- Polynomial coregistration for non-polar interferogram products
- Coherence layer for unwrapped and wrapped phase
- Split-spectrum ionosphere interferometric phase correction layer
- ECMWF-based tropospheric delay correction layer
- Rich meta-data and layers to describe all aspects of the products

Planned NISAR Acquisitions

Accessed via: *https://science.nasa.gov/mission/nisar/data/*



NISAR Free and Open Science Products

Products	*Product Level*	*Extent*	5 MHz (Single Pol)	20+5 MHz (Dual pol)	40 + 5 MHz (Dual Pol)	80 MHz Single-pol
RSLC (Range Doppler Single Look Complex)	*L1*	*Global*	1.5	14	25	10
GSLC (Geocoded SLC)	*L2*	*Global*	1.3	10.9	17.6	8.8 (half-swath)
GCOV (Geocoded Covariance)	*L2*	*Global*	0.3	1.8	6.6	0.6 (half-swath)
GUNW (Geocoded Unwrapped and wrapped Interferogram)	*L2*	*Global*		1.5	1.5	1.5
GOFF (Geocoded Pixel Offsets)	*L2*	*Cryosphere regions*		0.97	0.98	0.99
RIFG (Range-Doppler wrapped Interferogram)	*L1*	*Cryosphere regions*		0.9	1	0.7
RUNW (Range-Doppler Unwrapped Interferogram)	*L1*	*Cryosphere regions*		0.5	0.65	0.6
ROFF (Range-Doppler Pixel Offsets)	*L1*	*Cryosphere regions*		0.9	0.95	0.98
Soil Moisture	*L3*	*Near global*	0.35	0.29	0.31	0.20

All NISAR L-band products will be archived at NASA's Alaska Satellite Facility DAAC
Joint L-and S-band NISAR Products will be available from ISRO's Bhoonidhi Portal

NISAR: A New Unique Capability for Science and Applications

- Comprehensive, reliable coverage in space and time
  - All-weather, day/night
  - All land and ice, twice every 12 days
- 24 cm wavelength polarimetric radar for repeat-pass interferometric persistence in vegetation globally
- Regional 24/9.4 cm wavelength joint measurements for extended sensitivity to surface properties
- Free and open data policy
- Analysis ready, terrain-corrected, geocoded data products
- Timeline for release of full collection: July 2026

NISAR: Solid Earth Science Observations and Cal/Val

Mark Simons, Caltech
Gerald Bawden, NASA
Adrian Borsa, SIO, UCSD
Jingyi Chen, The University of Texas at Austin
Heresh Fattahi, JPL/Caltech
Eric Fielding, JPL/Caltech
Marin Govorcin, JPL/Caltech
Emre Havazli, JPL/Caltech
Andrew Johnson, University of Alaska Fairbanks
Cathleen Jones, JPL/Caltech
Jungkyo Jung, JPL/Caltech
Yuankun Liu, Caltech
Diego Lobos, Cornell University
Rowena Lohman, Cornell University
Franz Meyer, University of Alaska Fairbanks
Soyeon Park, Caltech
Matthew Pritchard, Cornell University
Paul Rosen, JPL/Caltech
Ekaterina Tymofyeyeva, JPL/Caltech
Howard Zebker, Stanford University
Molly Zebker, SIO, UCSD

Launched
July 30, 2025
☺

NISAR
NASA - ISRO SAR Mission

The Promise of NISAR

Global L-band (NASA) and regional S-band (ISRO)

High coherence and tracks large deformation

Designed to allow removal of ionospheric effects

"Clean" measurements

Left-looking satellite

Complements international constellation

Consistent 12-day acquisitions (ASC+DSC)

Data will be free, open and easily accessible

The era of time series

Identify, isolate and model complex processes

Wide area mapping

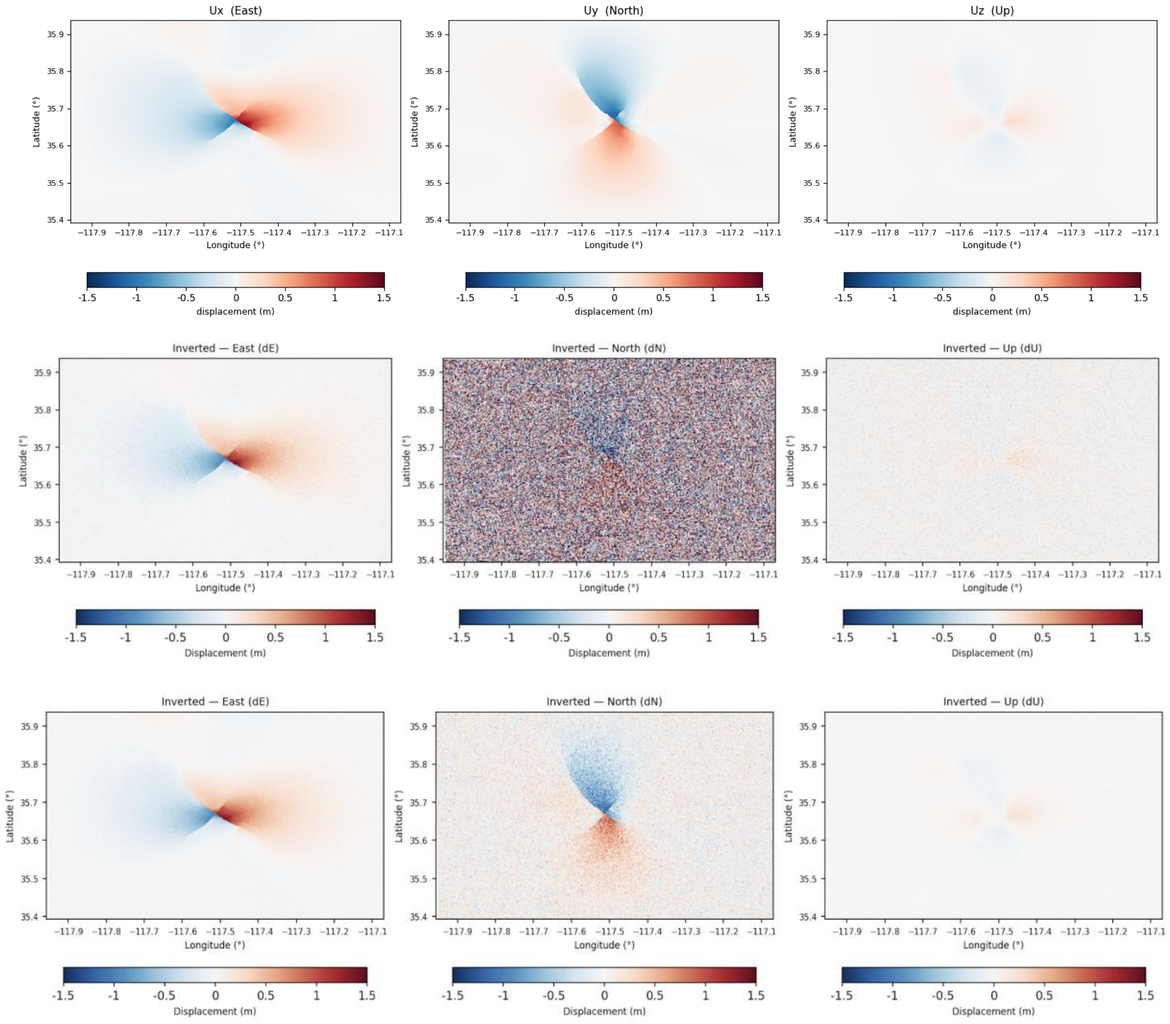
Synoptic high-resolution observations

NISAR
NASA - ISRO SAR Mission

NISAR Solid Earth

- Seismic cycle
- Hydrology
- Landslides
- Volcanic processes
- Ground subsidence
- Resource exploitation
- Permafrost
- And other stuff...

NISAR's Unique Contribution: Enhancing Vector Diversity



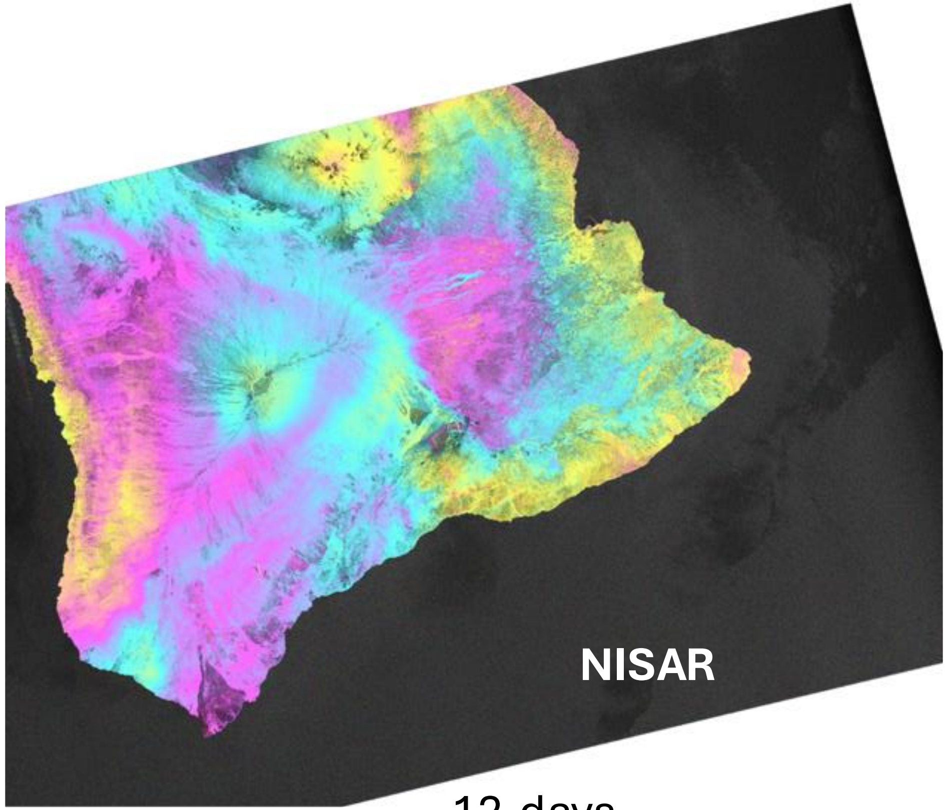
Modeled displacements from the 2019 Ridgecrest Earthquakes. Uphoff *et al.* [2022] and Nevitt *et al.* [2023]. (crustal-strikeslip-3d example)

Data were rotated from NEU to Sentinel-1, ALOS-2, and NISAR LOS. Random noise was added, σ = 5cm.

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.

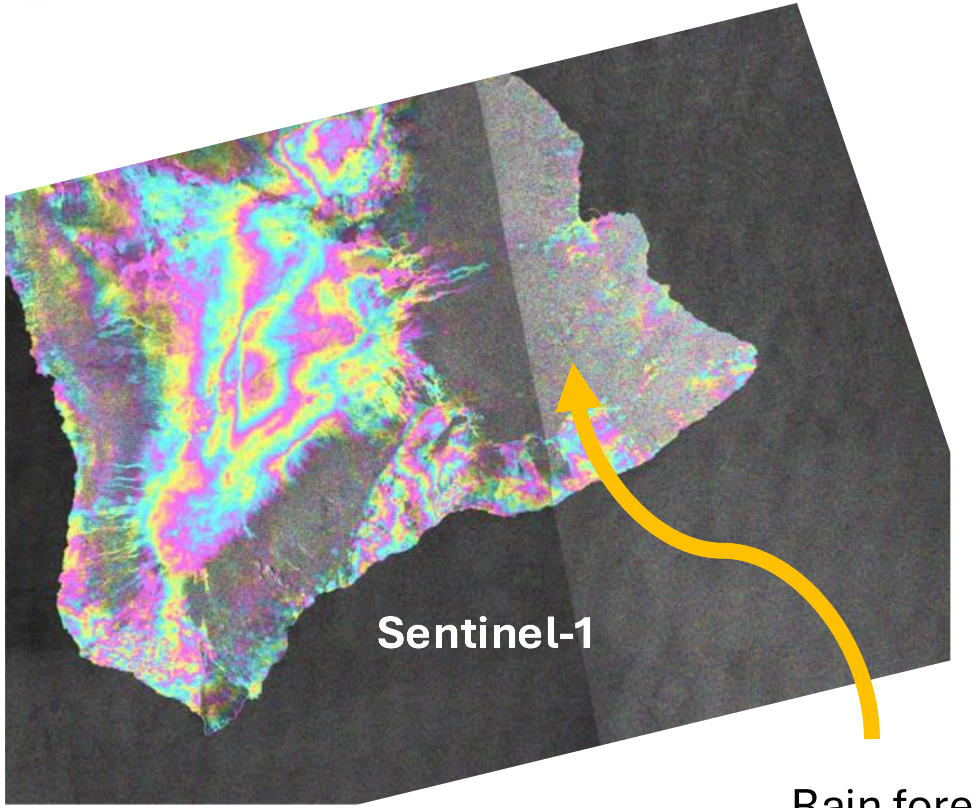
Adding **NISAR LOS** deformation, leads to a significant improvement in vector diversity, allowing for the resolution of the North deformation component.

Hawaii: NISAR (L-band) vs Sentinel (C-band)



12-days

6-days

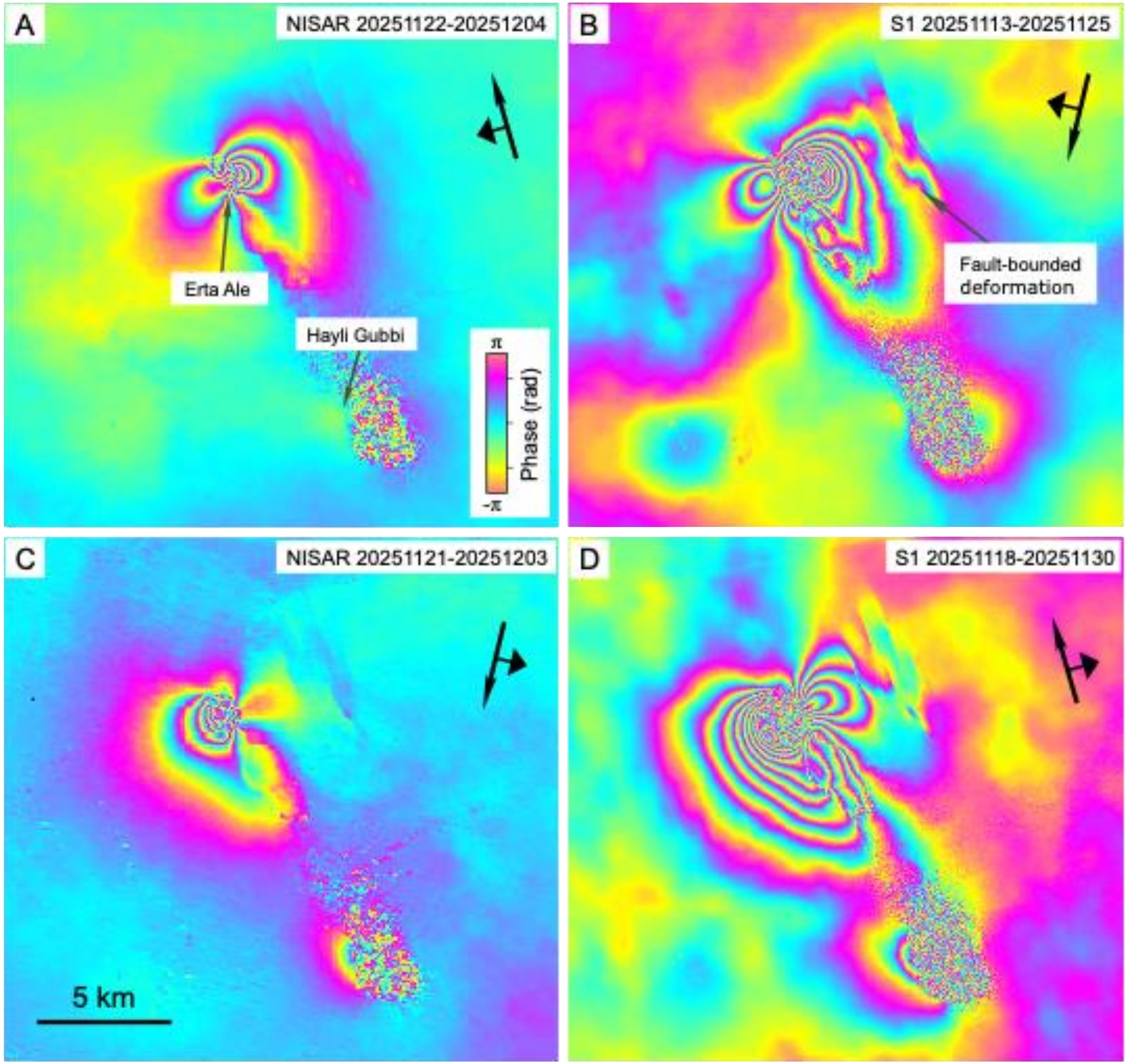


Rain forest

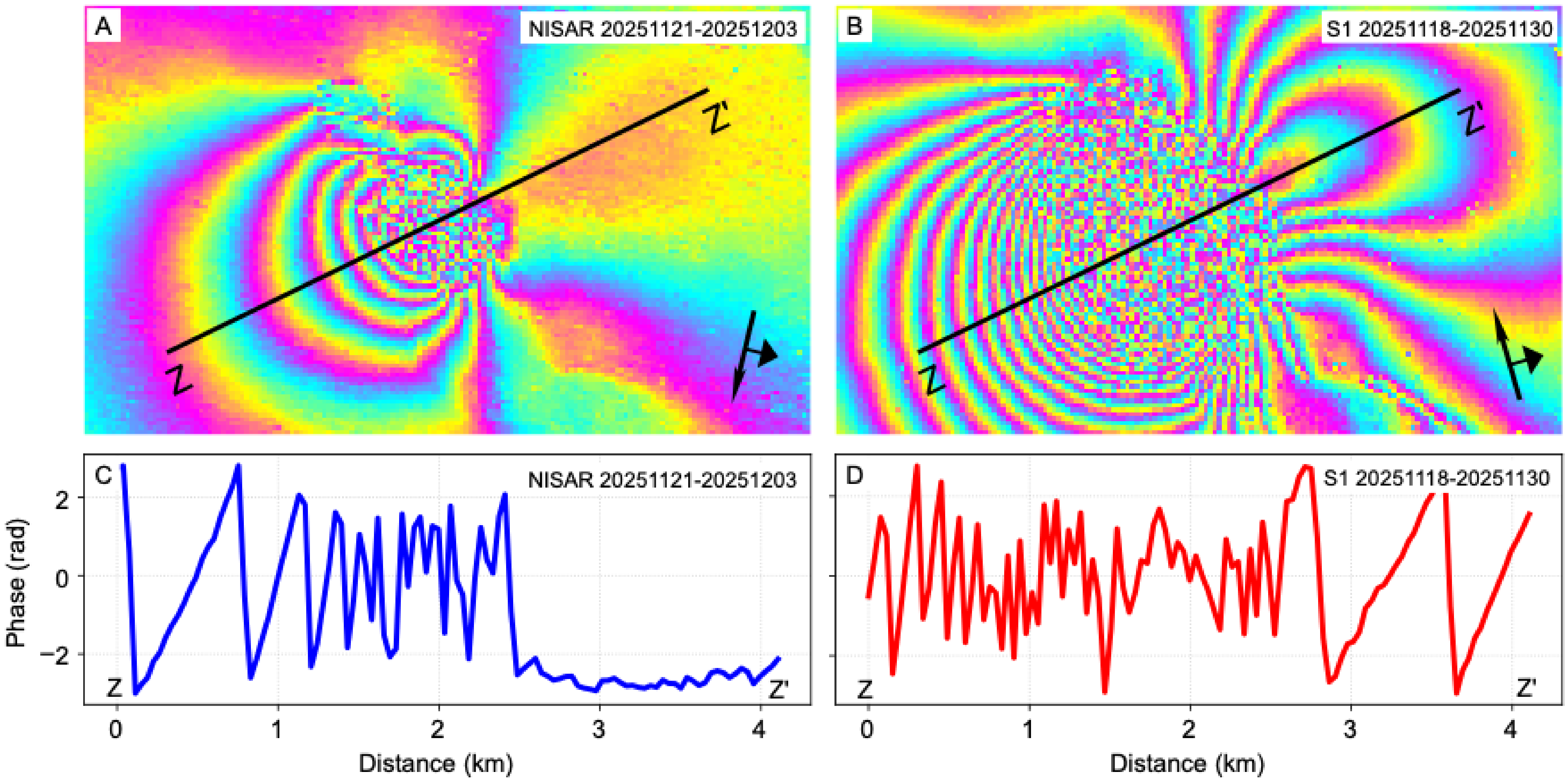
Image from: Howard Zebker, Stanford U.

Examples from the Erta Ale / Hayli Gubbi (Ethiopia) sequence

- NISAR standard products
- NISAR custom products
- Comparison with Sentinel 1

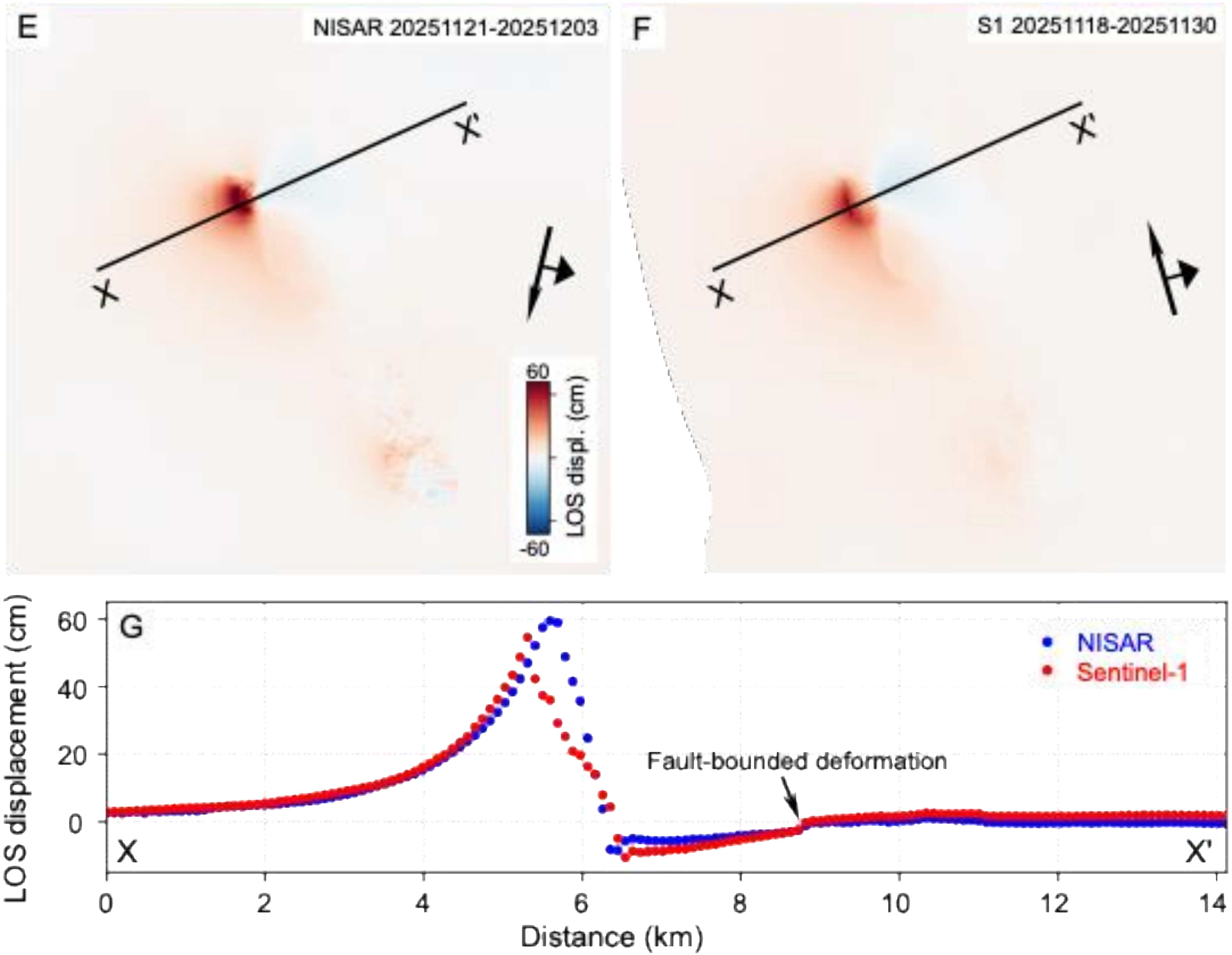


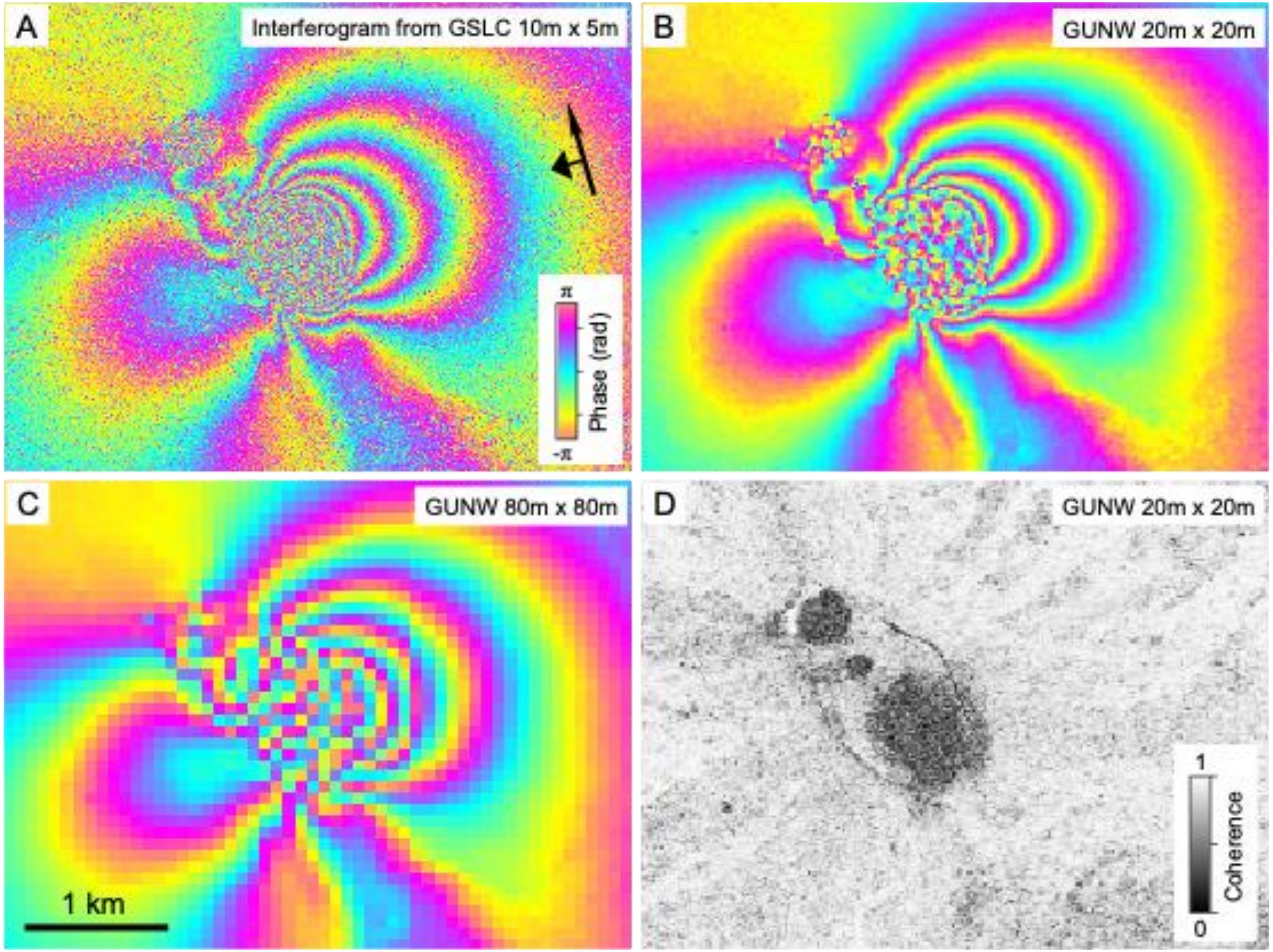
Note: NISAR is left-looking

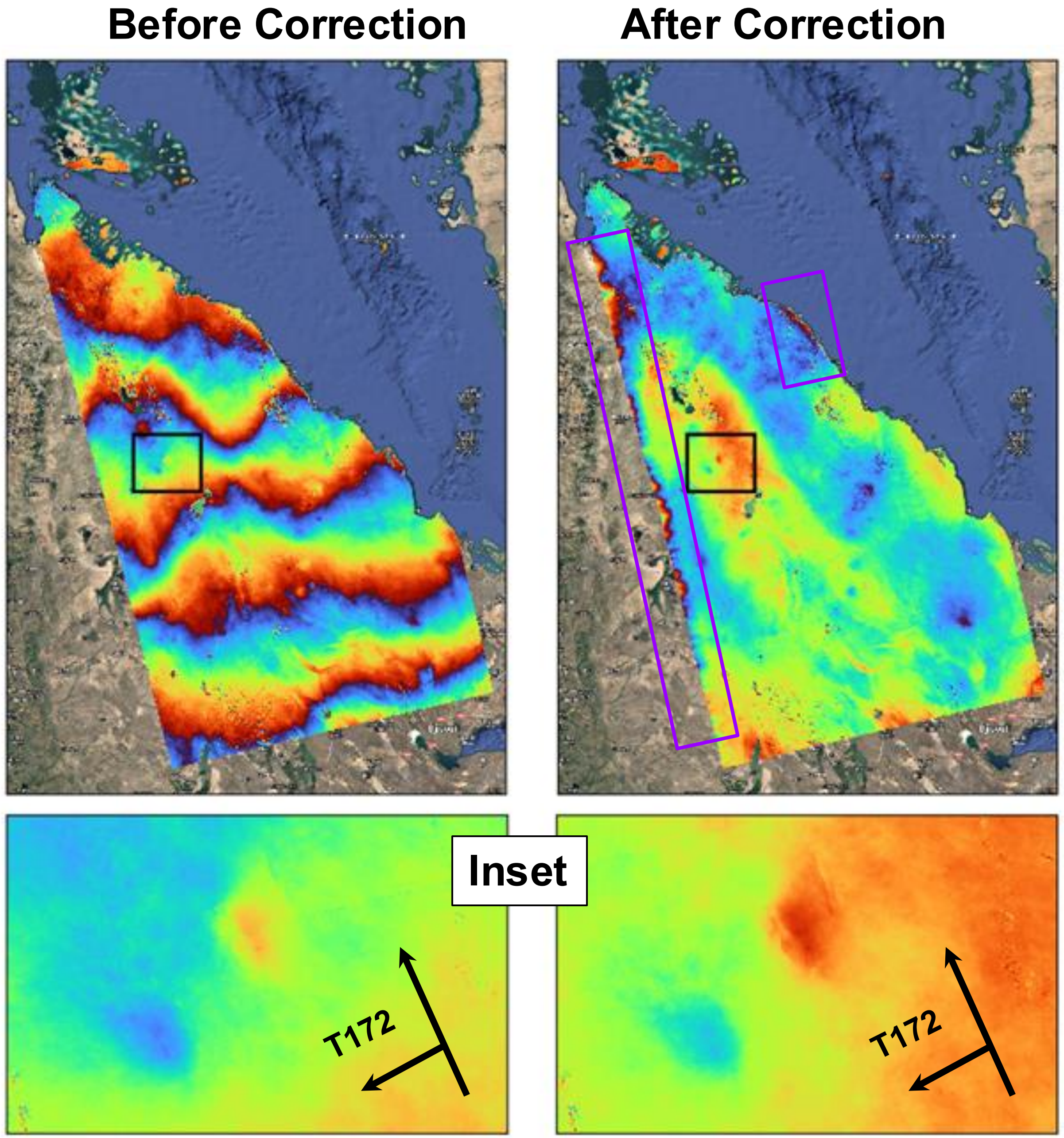


A
NISAR 20251121-20251203
Z
Z'
B
S1 20251118-20251130
Z
Z'
C
NISAR 20251121-20251203
Phase (rad)
2
0
−2
Z
Z'
0
1
2
3
4
Distance (km)
D
S1 20251118-20251130
Z
Z'
0
1
2
3
4
Distance (km)

Impact of decorrelation and aliasing of fringes in regions of high strains




A
Interferogram from GSLC 10m x 5m
π
Phase (rad)
-π
B
GUNW 20m x 20m
C
GUNW 80m x 80m
1 km
D
GUNW 20m x 20m
1
Coherence
0



Impact of ionosphere correction

Hayli Gubbi and Erta Ale volcanoes, Ethiopia
NISAR Track 172 – Ascending orbit

October 29, 2025 ➔ November 10, 2025

- The ionosphere phase screens are important! Especially if you are considering longer wavelength processes.
- An ionosphere phase screen is provided with each interferometric product, and it usually works well.
- Estimating the phase screen using a split-band approach requires filtering and unwrapping the subband images. So, make sure to look at these phase screens to ensure they are optimal for your use.

Created by Marin Govorcin, JPL/Caltech

ASC/DSC/LEFT/RIGHT

NISAR & S1 ➔ 3D [E, N, U] displacements

- **Validate against GNSS**
- **Allows eventual inclusion of the all orbiting sensors**

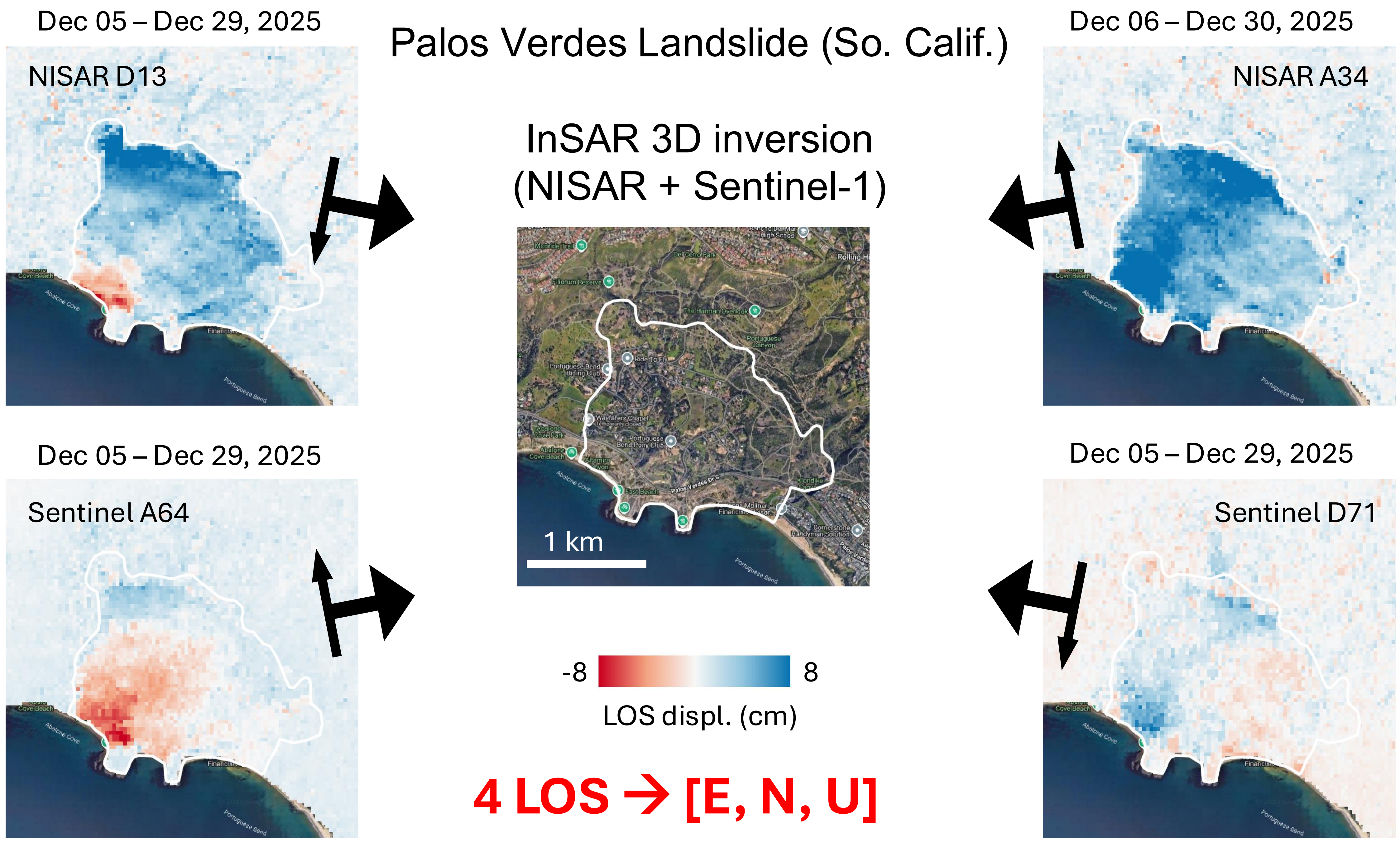
Example: Palos Verde (Portuguese Bend) Landslide

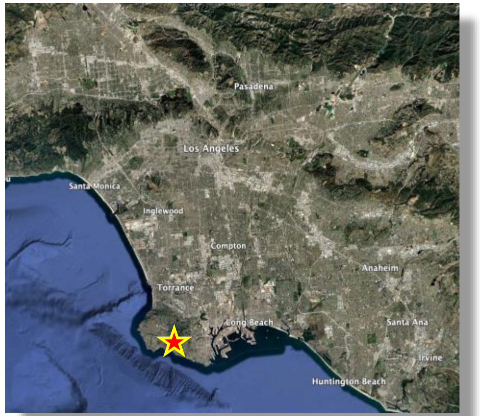
Figures from Yuankun Xu

Palos Verde: Portuguese Bend Landslide

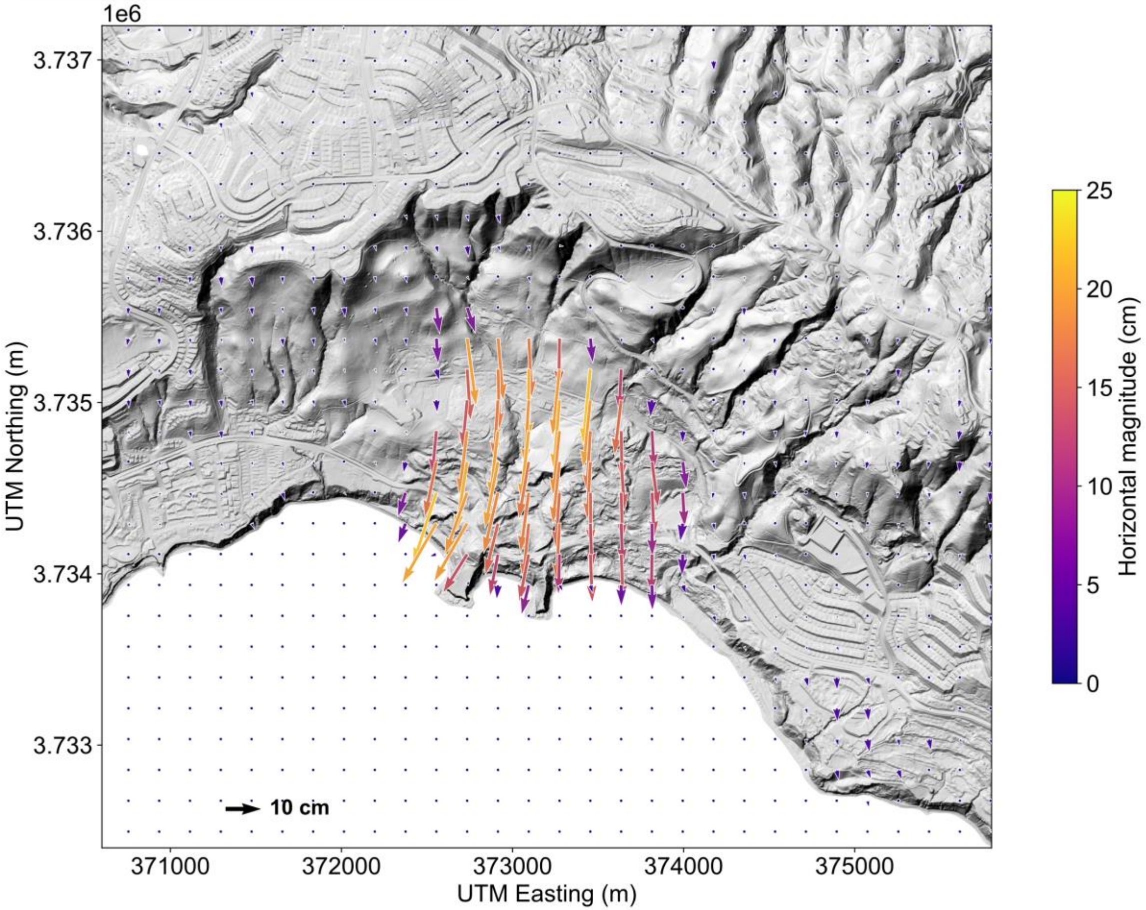
3D motion inversion from NISAR and S1

Yuankun Xu

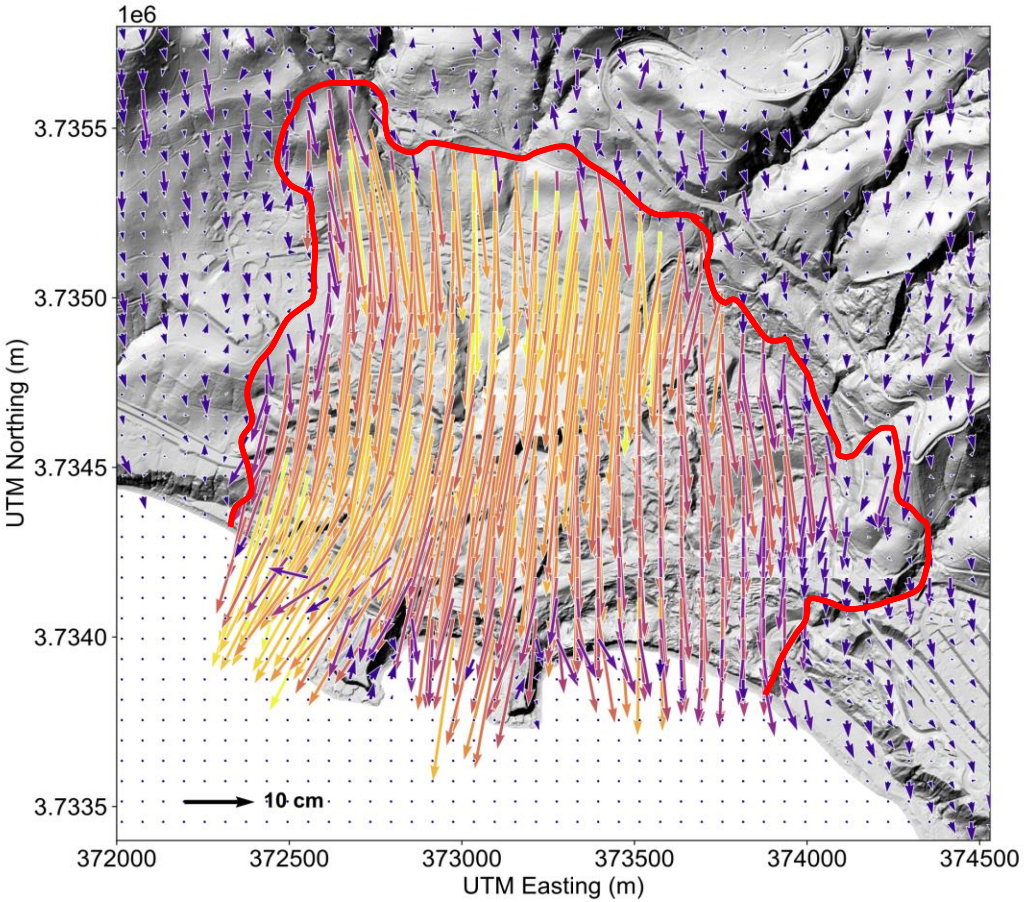

Palos Verdes Landslide (So. Calif.)
Dec 05 – Dec 29, 2025
NISAR D13
Dec 06 – Dec 30, 2025
NISAR A34
InSAR 3D inversion
(NISAR + Sentinel-1)
1 km
Dec 05 – Dec 29, 2025
Sentinel A64
Dec 05 – Dec 29, 2025
Sentinel D71
-8
8
LOS displ. (cm)
4 LOS → [E, N, U]



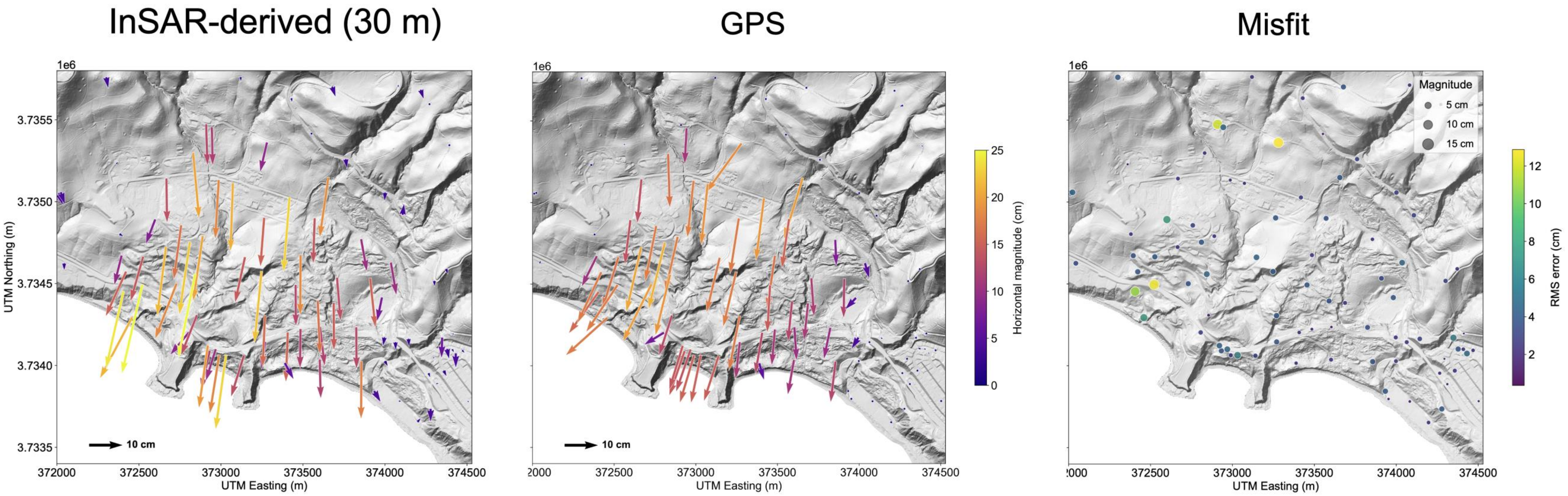
Landslide motion - InSAR 3D inversion (NISAR+Sentinel-1)



Zoom in to 60 m resolution



InSAR vs. GPS



Horizontal only

Misfit < 3 cm except for particular GPS stations

For simplicity, our requirements are in the form of secular, coseismic & transient deformation

L2 Requirement 658 - Secular Deformation Rates

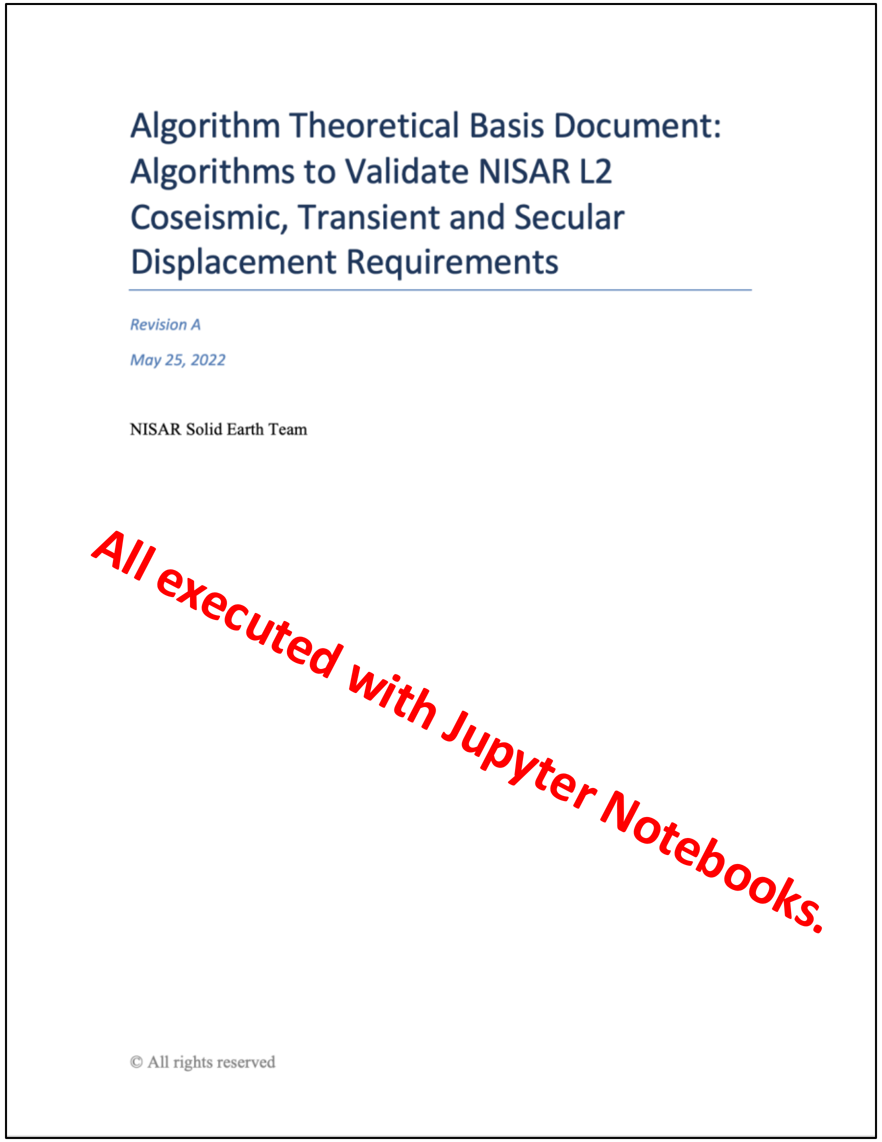
Over three years, the NISAR project shall measure at least two components of the spatially and temporally averaged relative vector velocities over active regions of Earth's land surface with accuracy of 2 mm/yr or better, over length scales 0.1 km $< L <$ 50 km, over 70% of these regions.

L2 Requirement 660 - Coseismic Displacements

Over three years, the NISAR project shall measure at least two components of the point-to-point vector co-seismic displacements of at least 80% of regions where earthquakes with sufficient magnitude to generate surface displacements of 100 mm or greater occur, with accuracy of $4(1 + L^{1/2})$ mm or better, over length scales 0.1 km $< L <$ 50 km, at 100 m spatial resolution over at least 70% of these regions.

L2 Requirement 663 - Deformation Transients

The NISAR project shall measure at least two components of the point-to-point vector displacements over at least 70% of targeted sites with accuracy of $3(1+ L^{1/2})$ mm or better, over length scales 0.1 km $< L <$ 50 km, at 100 m resolution, and over 12-day time scales.


Algorithm Theoretical Basis Document: Algorithms to Validate NISAR L2 Coseismic, Transient and Secular Displacement Requirements

Revision A

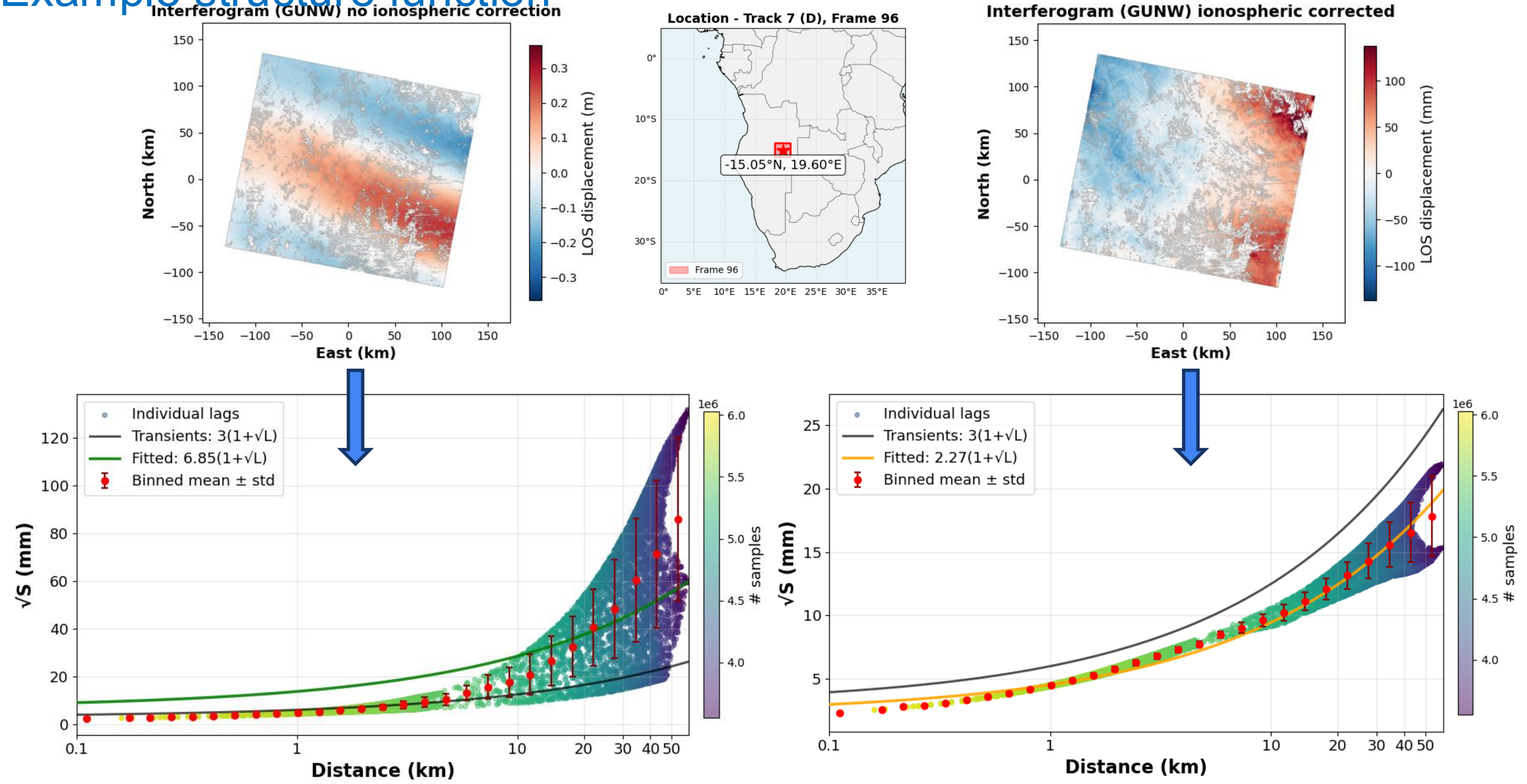
May 25, 2022

NISAR Solid Earth Team

All executed with Jupyter Notebooks.

For details, see https://science.nasa.gov/mission/nisar/

Example structure function

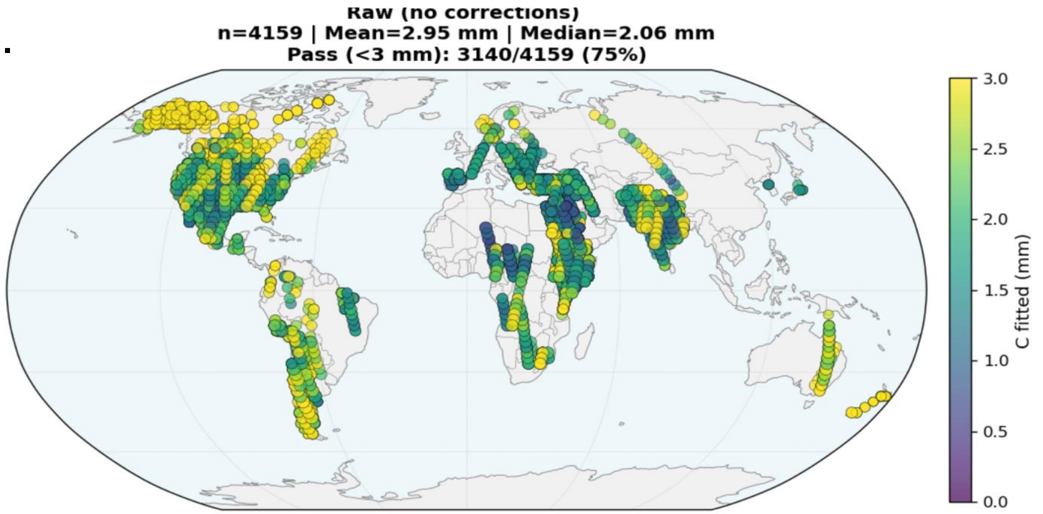


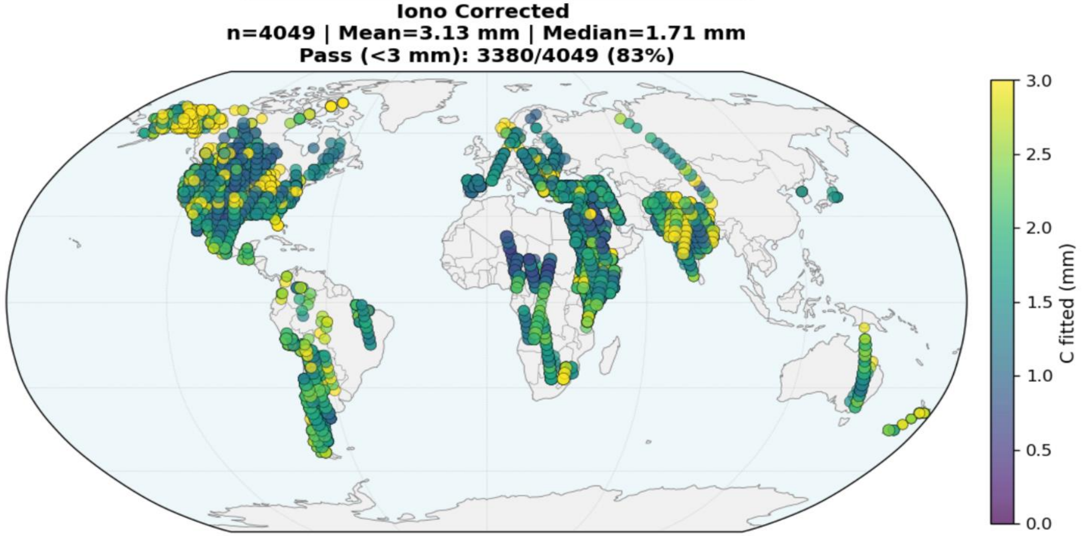
Diego Lobos-Lillo (Cornell University)

Example validation: Transient deformation with NISAR

Validation analysis using statistical analysis only (no GNSS or other ground truth measurements).
Right figure: Analysing all the data released in February 2026.
Bottom table: Results for NISAR Cal/Val sites.

	Pass	No pass (with iono)	Site
	5	1	Central Valley CA
	2	0	Los Angeles Basin
	15	1	Mojave Desert
	4	0	Long Valley Caldera
	2	2	Mejillones, Chile
	10	1	Western Oregon
	3	0	Tokyo Region, Japan
	16	3	Houston/Galveston
	0	0	Big Island, Hawaii
	10	0	North Island, New Zealand
	3	3	Oklahoma
	0	6	Eastern North Slope of AK & Toolik Lake
total	70	17	





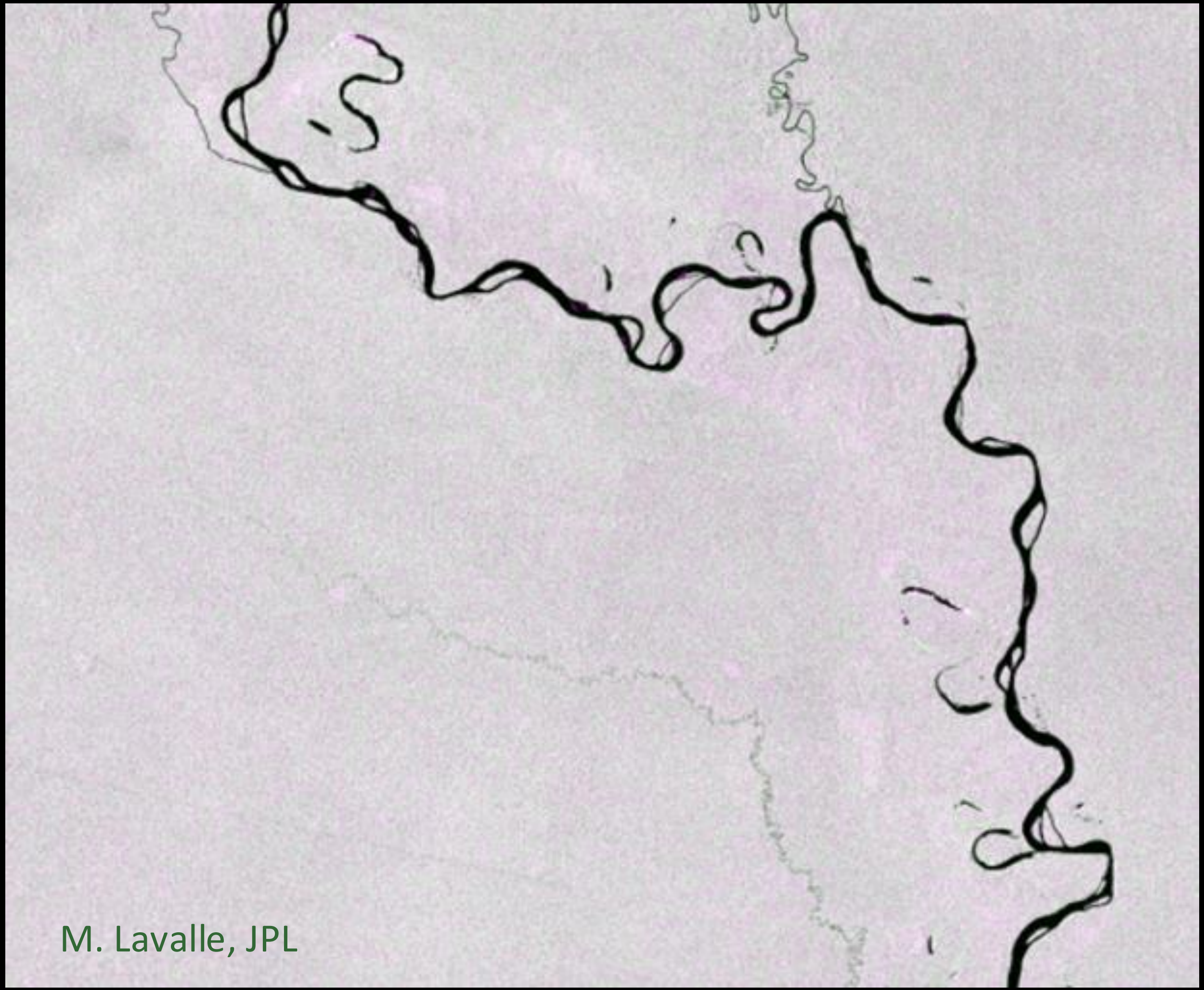
Results from **Matthew Pritchard and team**

Jet Propulsion Laboratory
California Institute of Technology

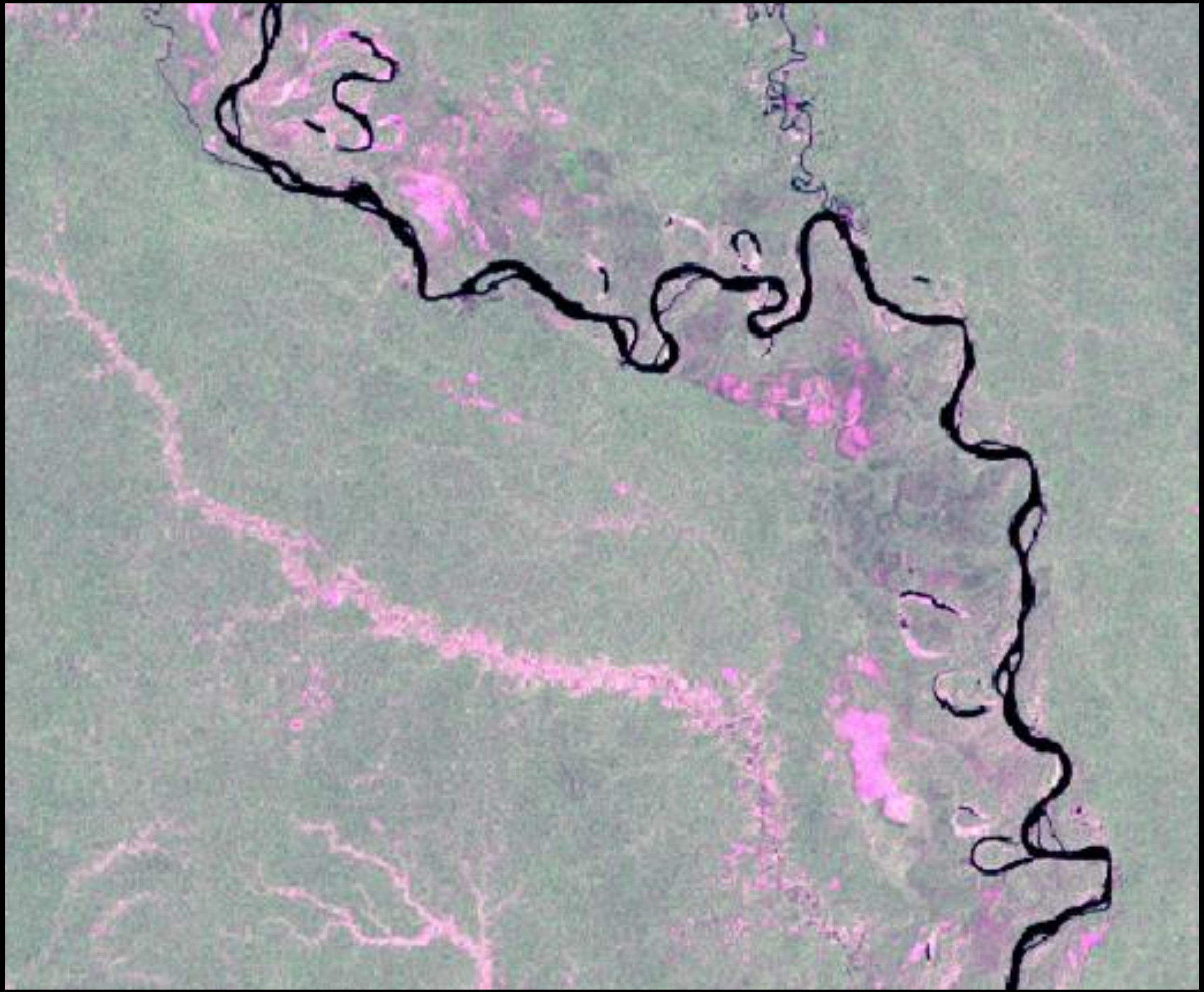
jpl.nasa.gov

NISAR vs Sentinel – Complementary at Different Wavelengths

OPERA RTC-S1 (Sentinel-1, C-band, 2 days apart)



NISAR GCOV (L-band)



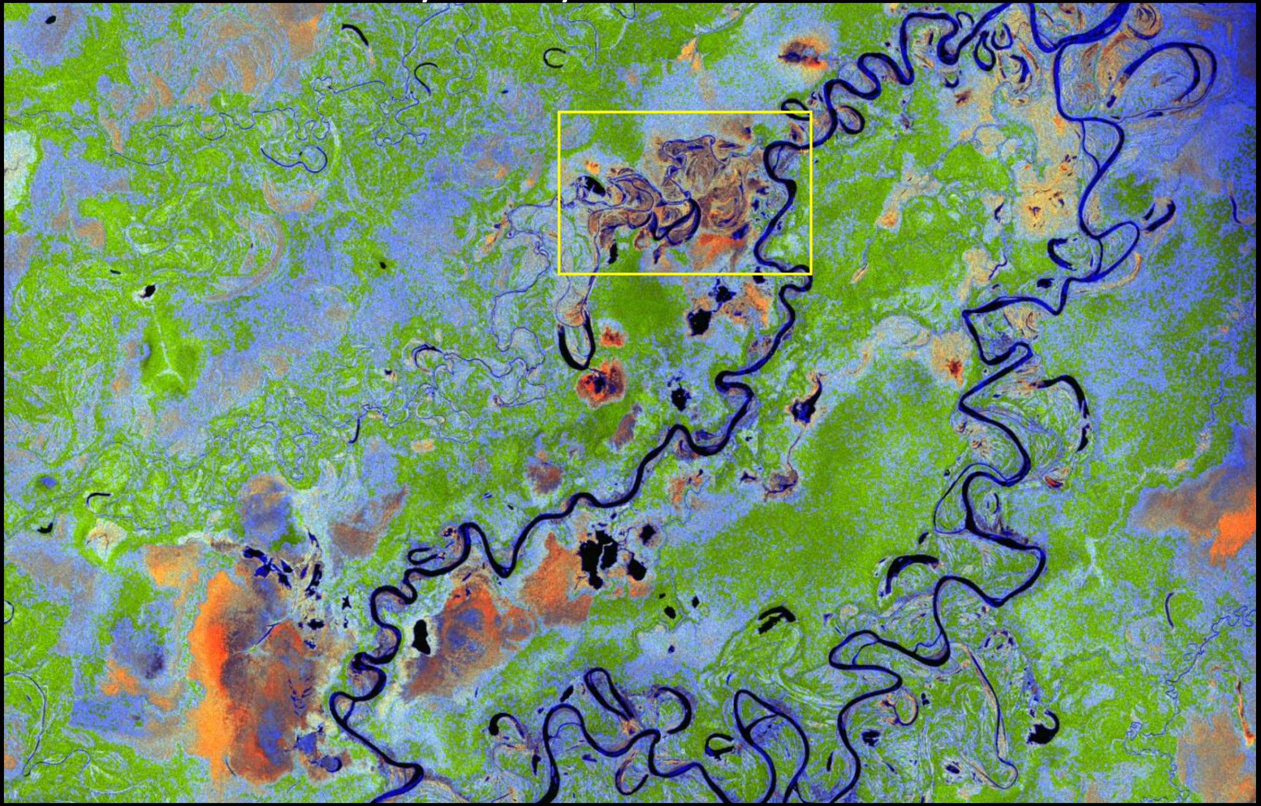
NISAR image of the Pacaya Samiria National Reserve

NISAR imagery like this collected twice every 12 days

December 26, 2025

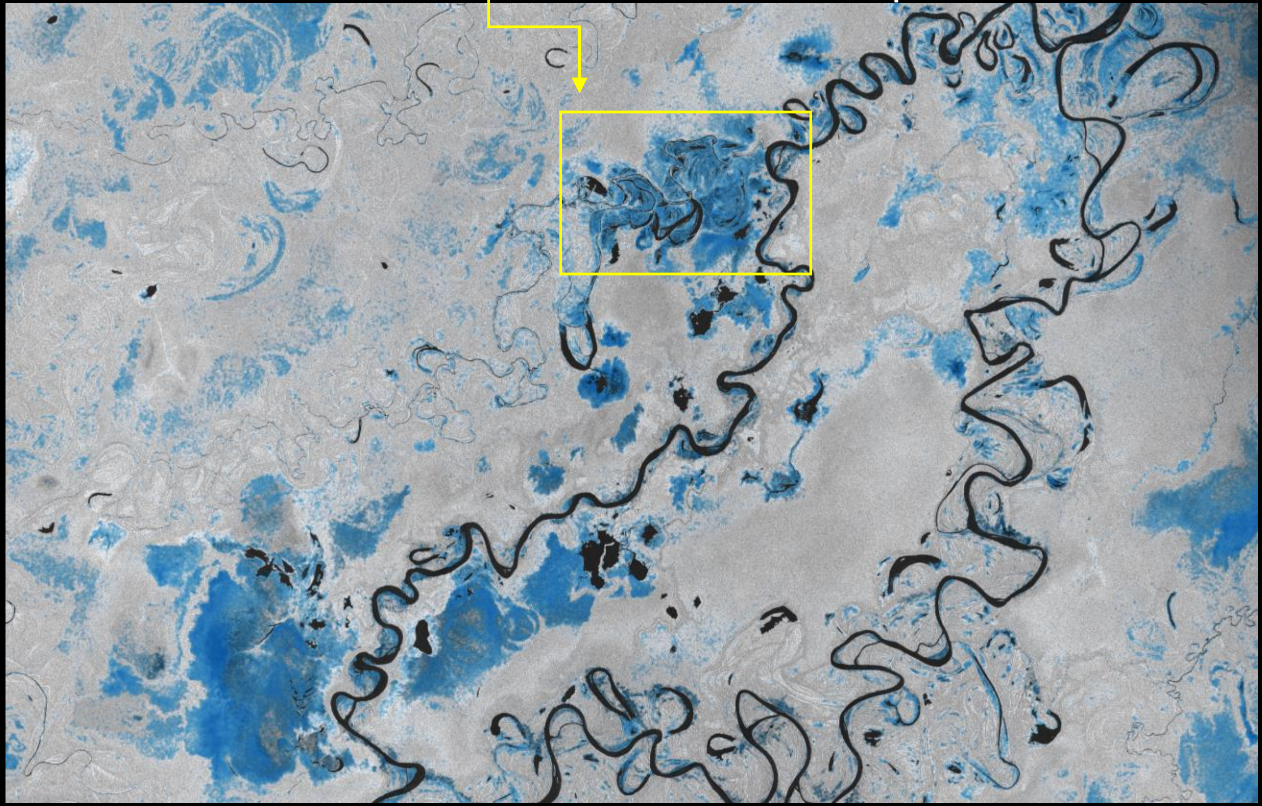
study site

A few months after the low flood time-period



False color NISAR image

Colors are indicating forests, meadows, and surface water

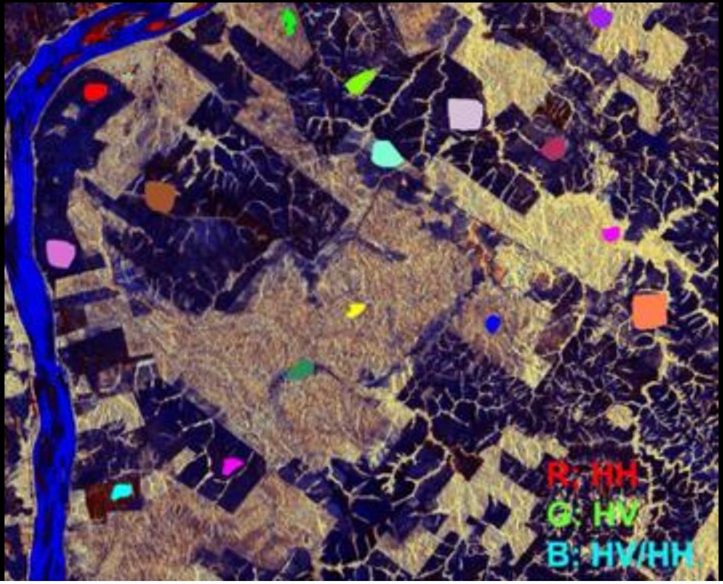


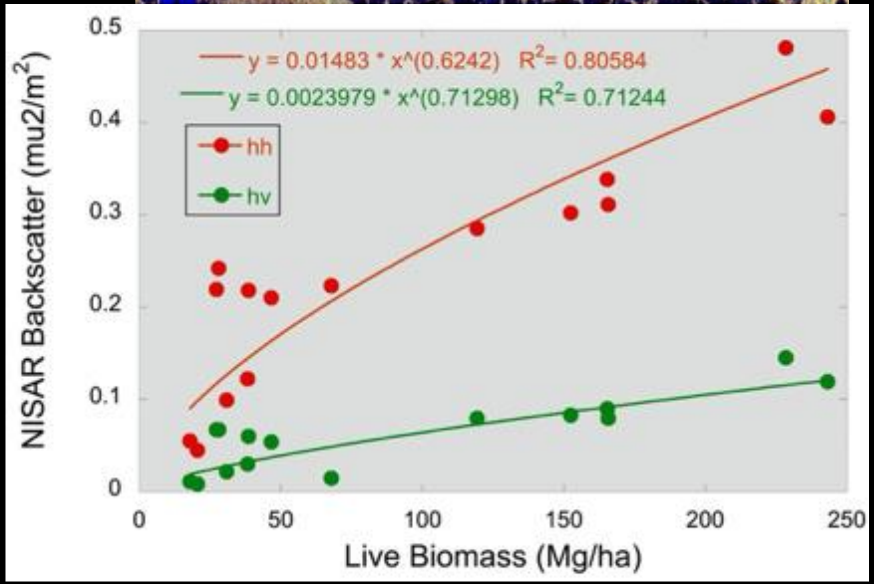
Surface Water Extent

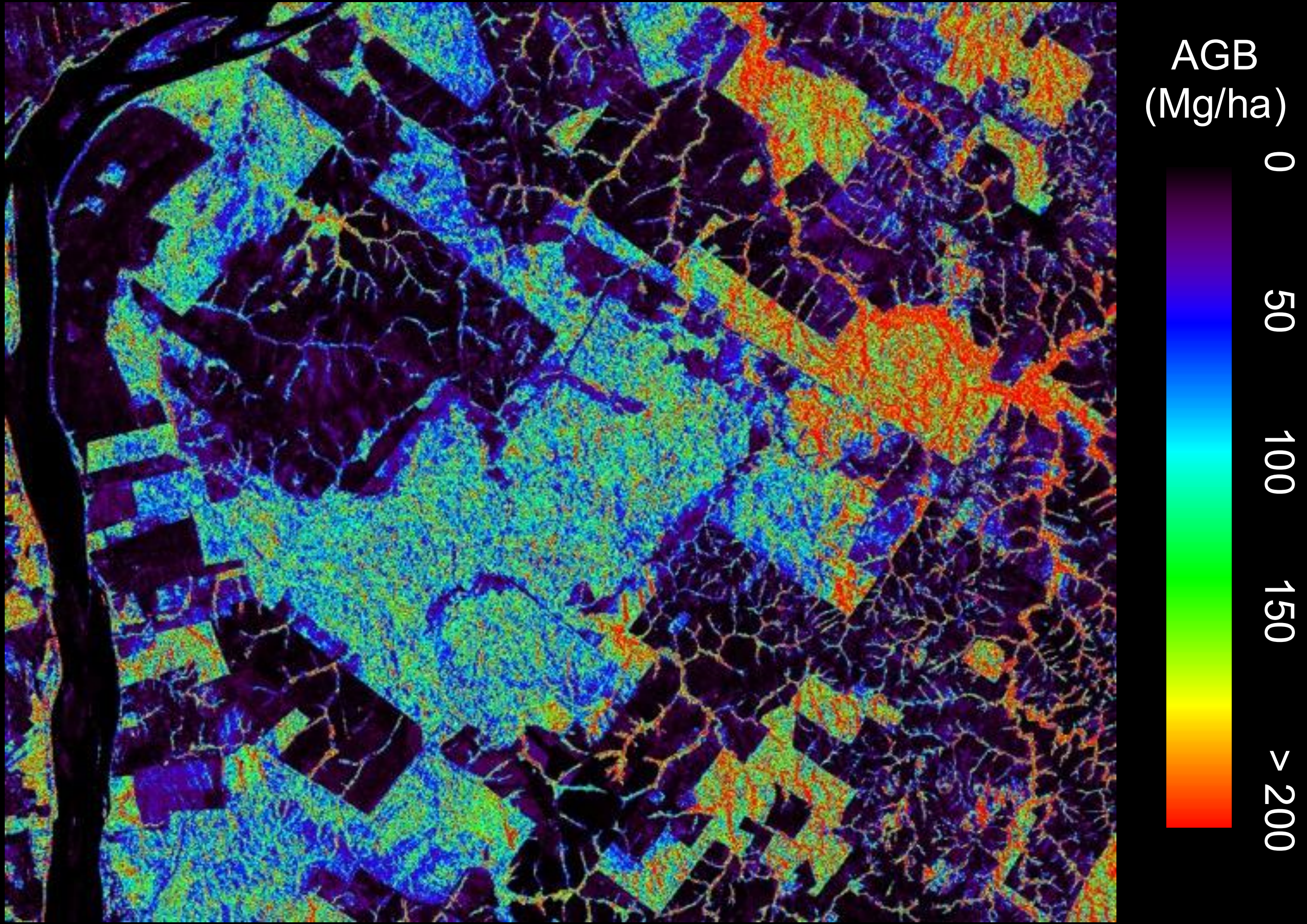
Blue: wetlands | Black: open water | Grey: no surface water

B. Chapman, JPL

Above-ground Biomass (AGB) in Tocantins, Brazil



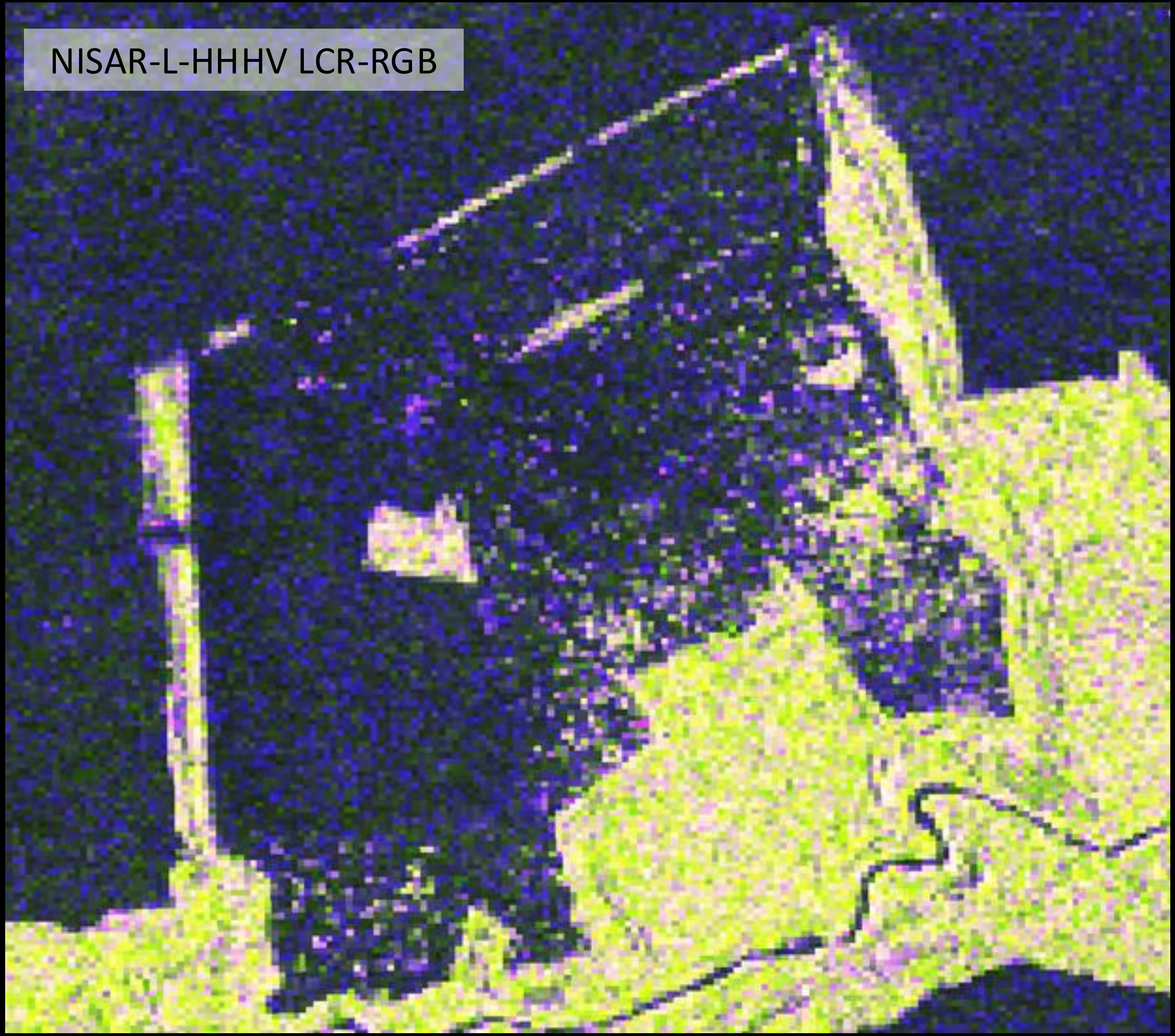




Point Pelee
National Park

Courtesy of S. Saatchi

NISAR For Disturbance at 10-20 m Resolution

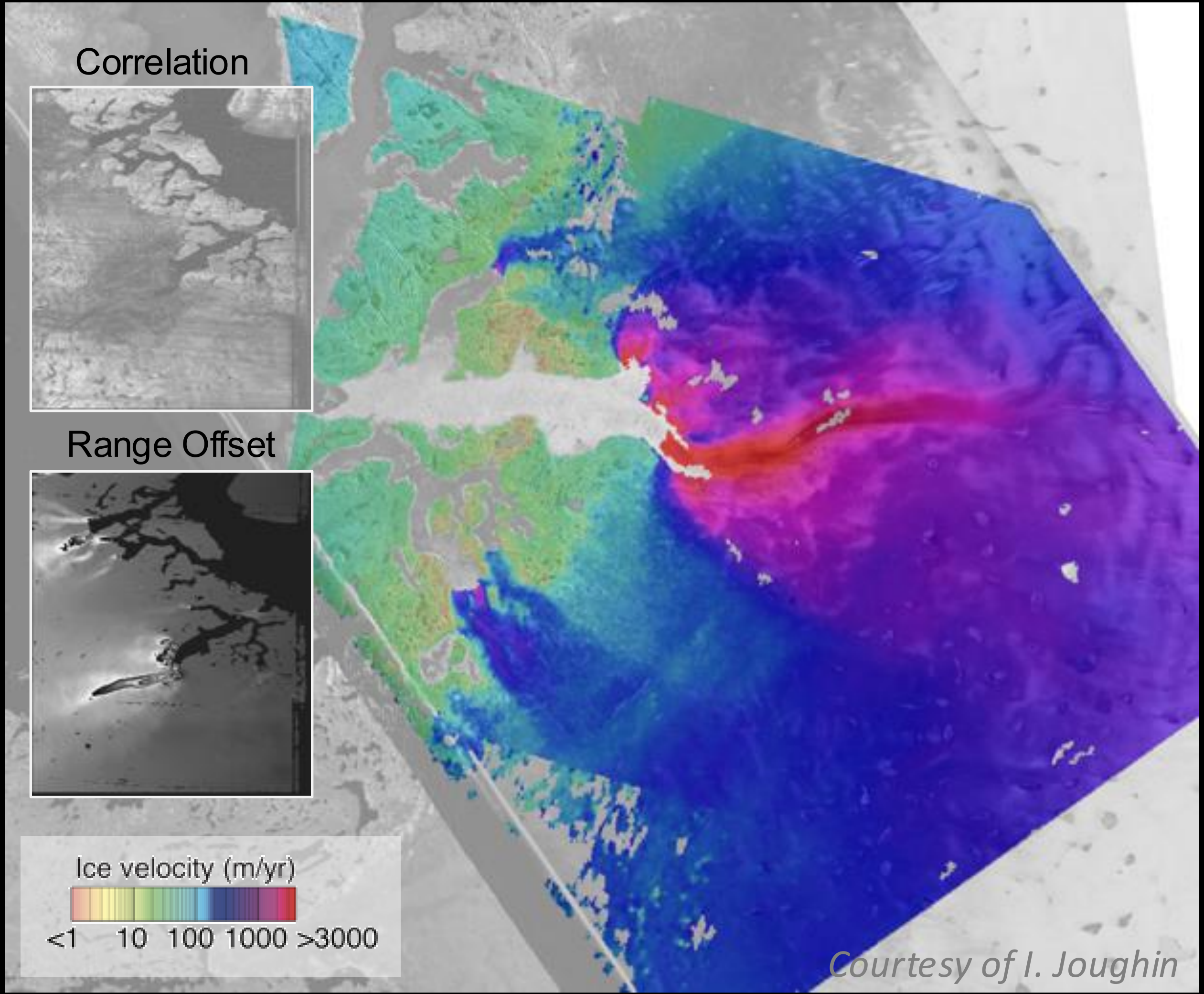


Courtesy of J. Kellndorfer

Ice Sheet Velocity with NISAR 80 MHz data

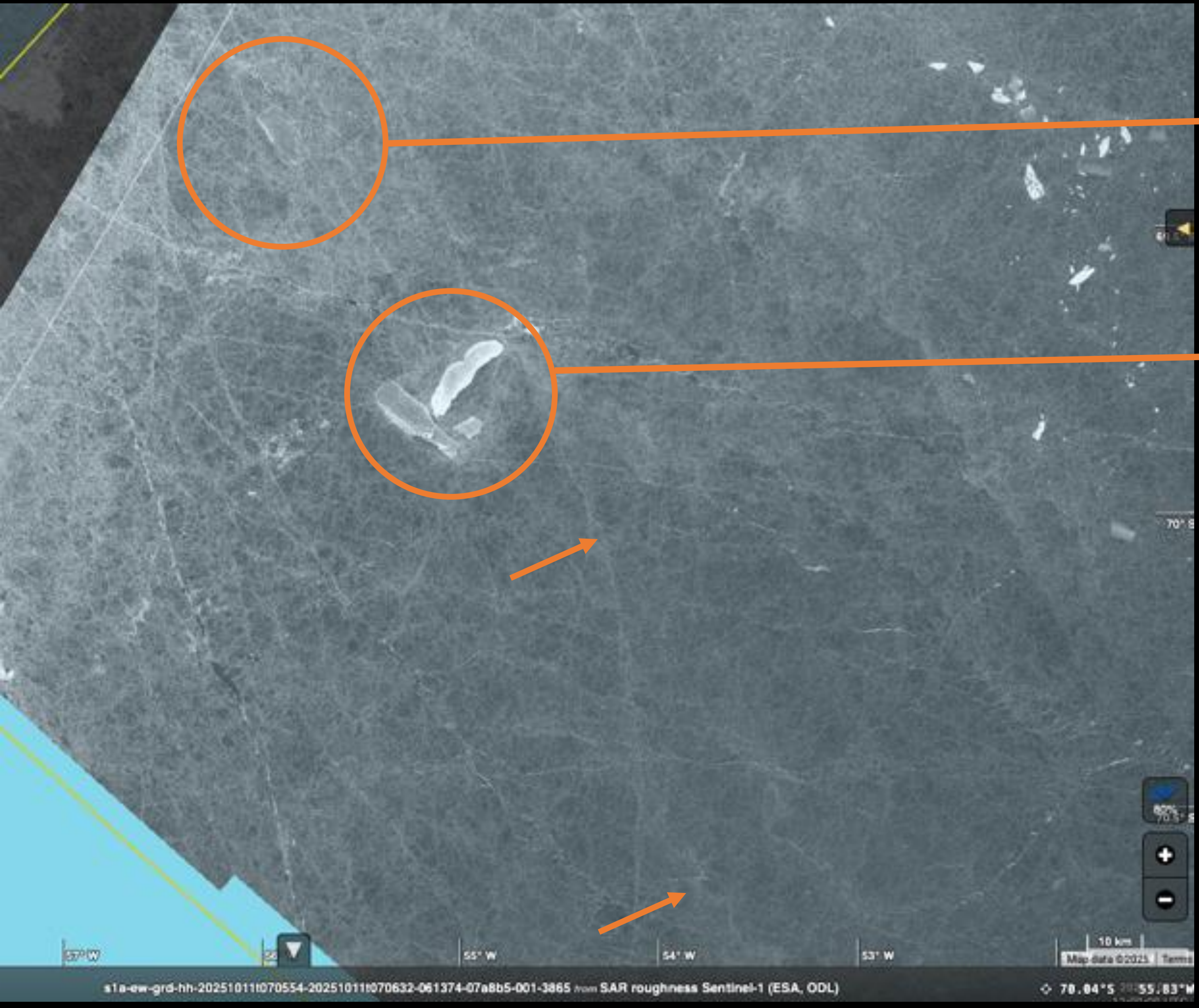
L-band Backscatter (γ^0) over Jakobshavn Glacier (Greenland)

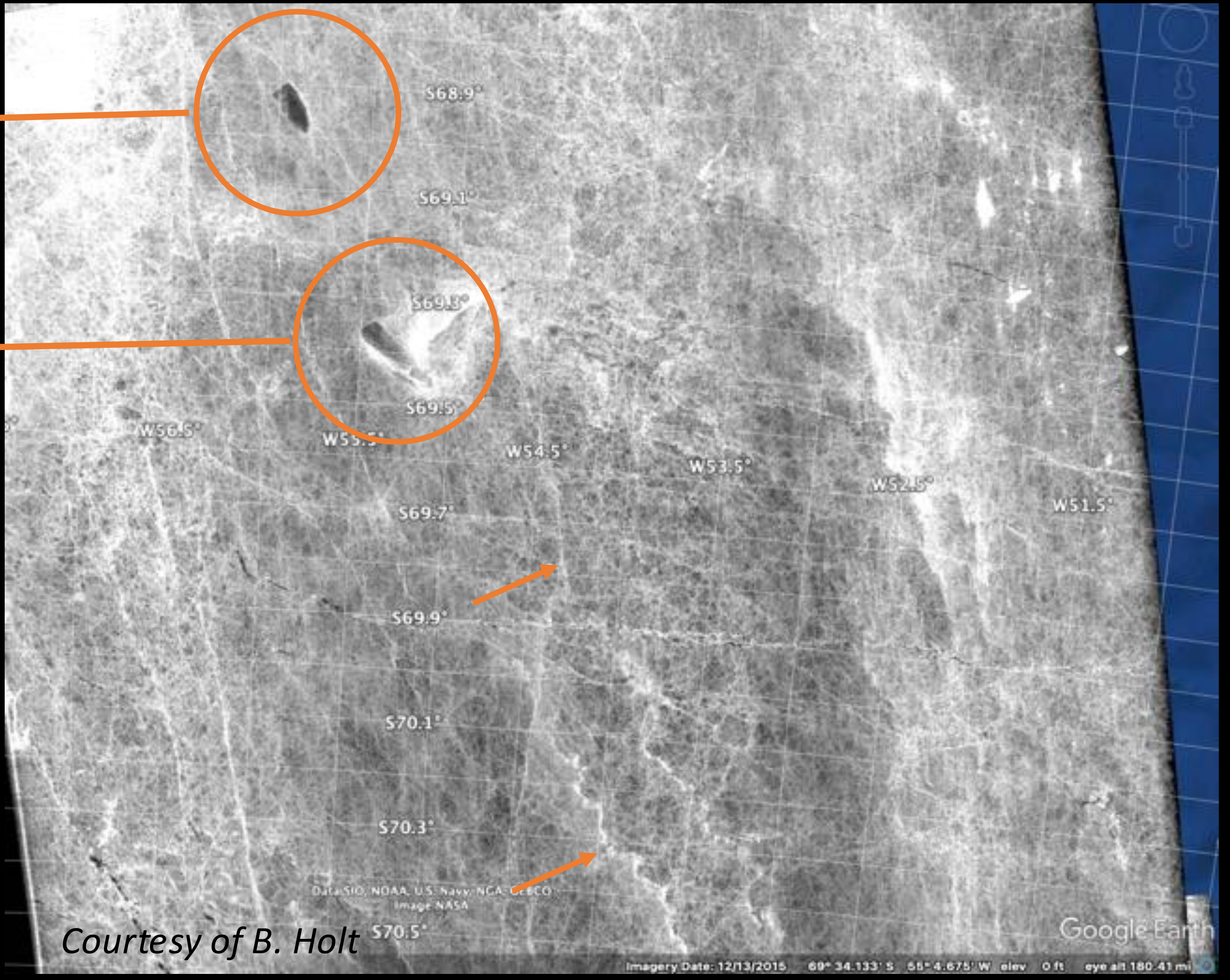
Ice velocity solution with NISAR and Sentinel-1 range offsets



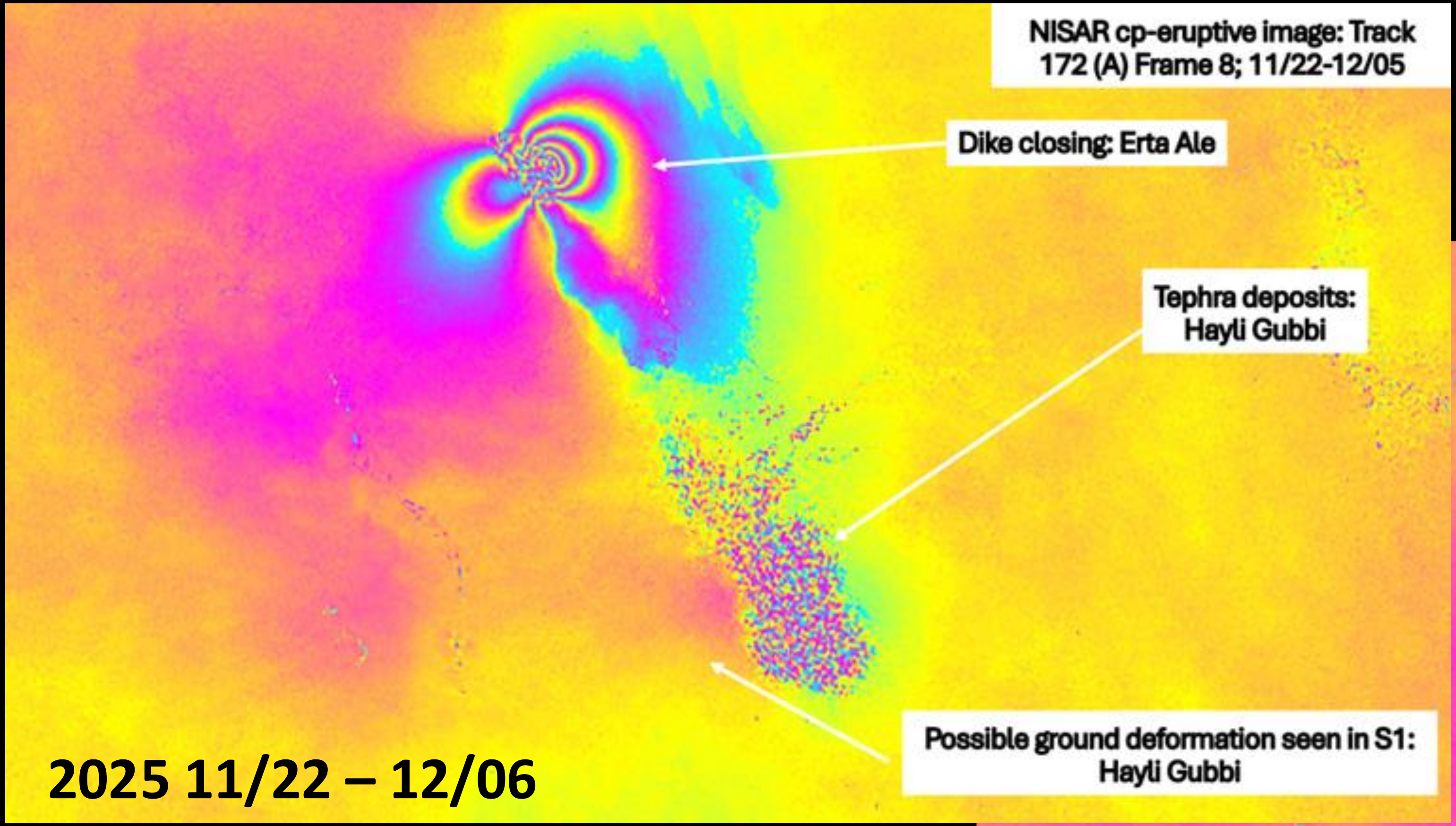
Sentinel-1 (C-band) on 11 Oct. 2025 (Weddell Sea)

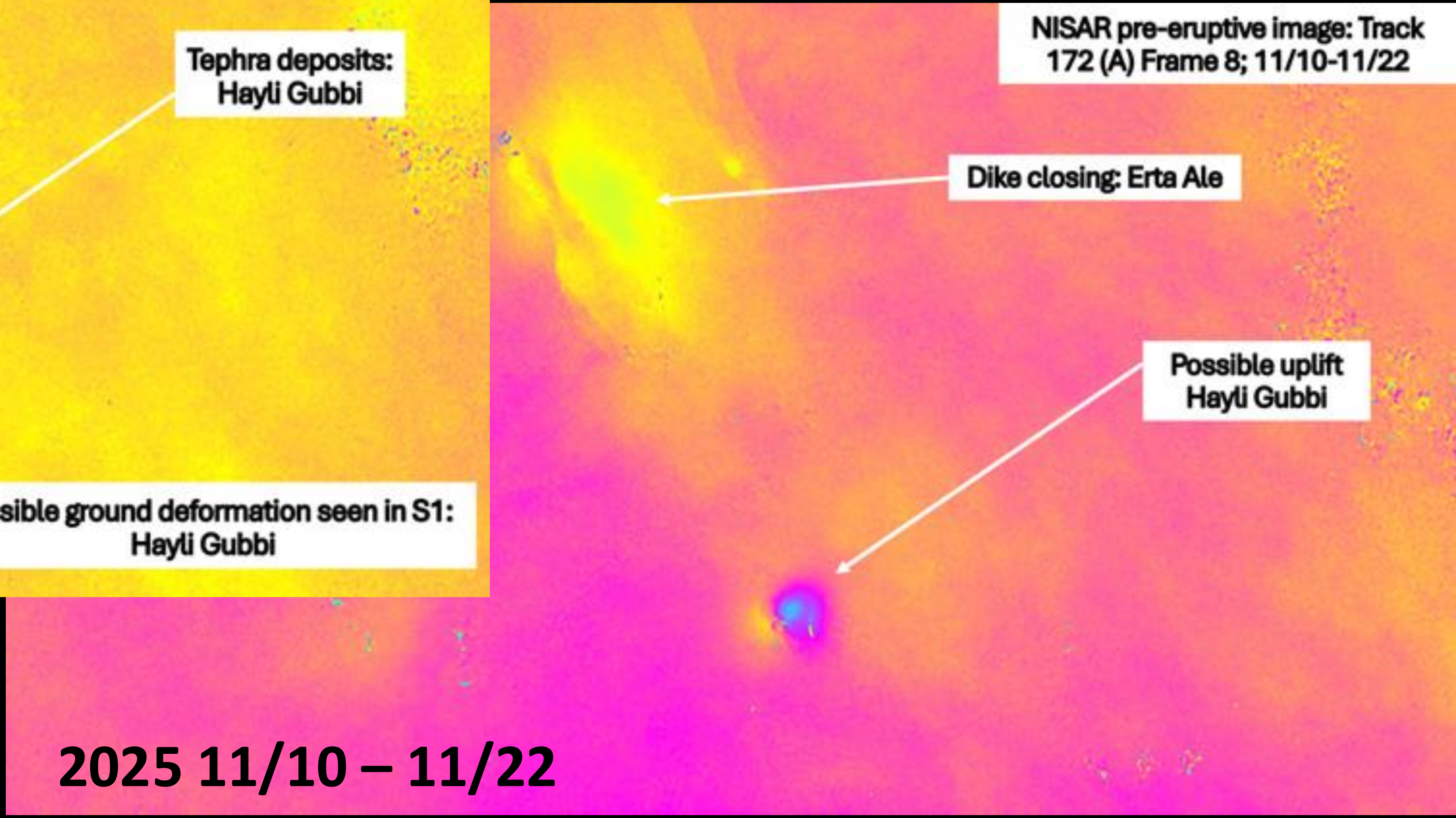
NISAR (L-band) on 13 Oct. 2025 (Weddell Sea)





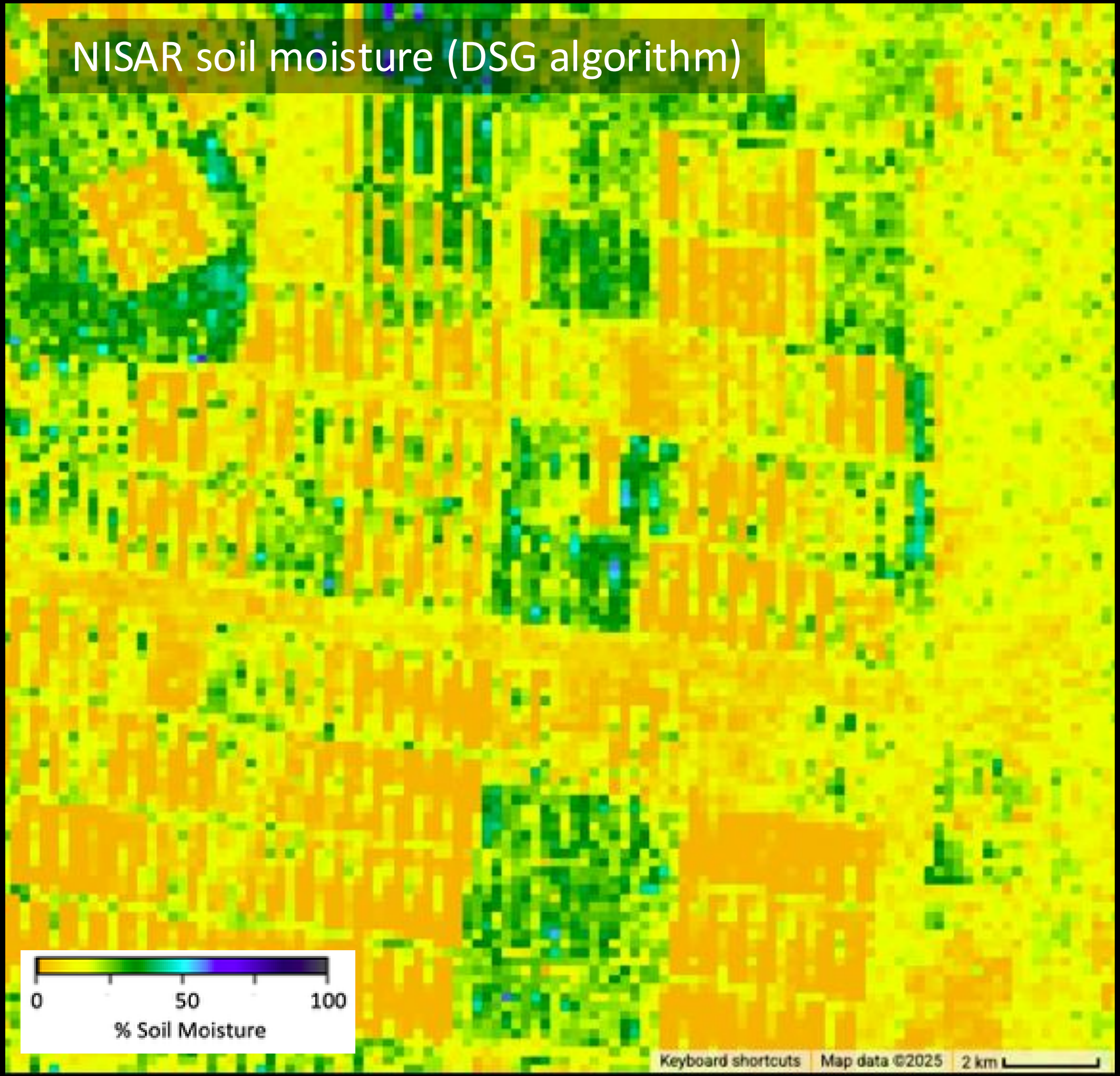
Courtesy of B. Holt





Matt Pritchard , Cornell Univ.

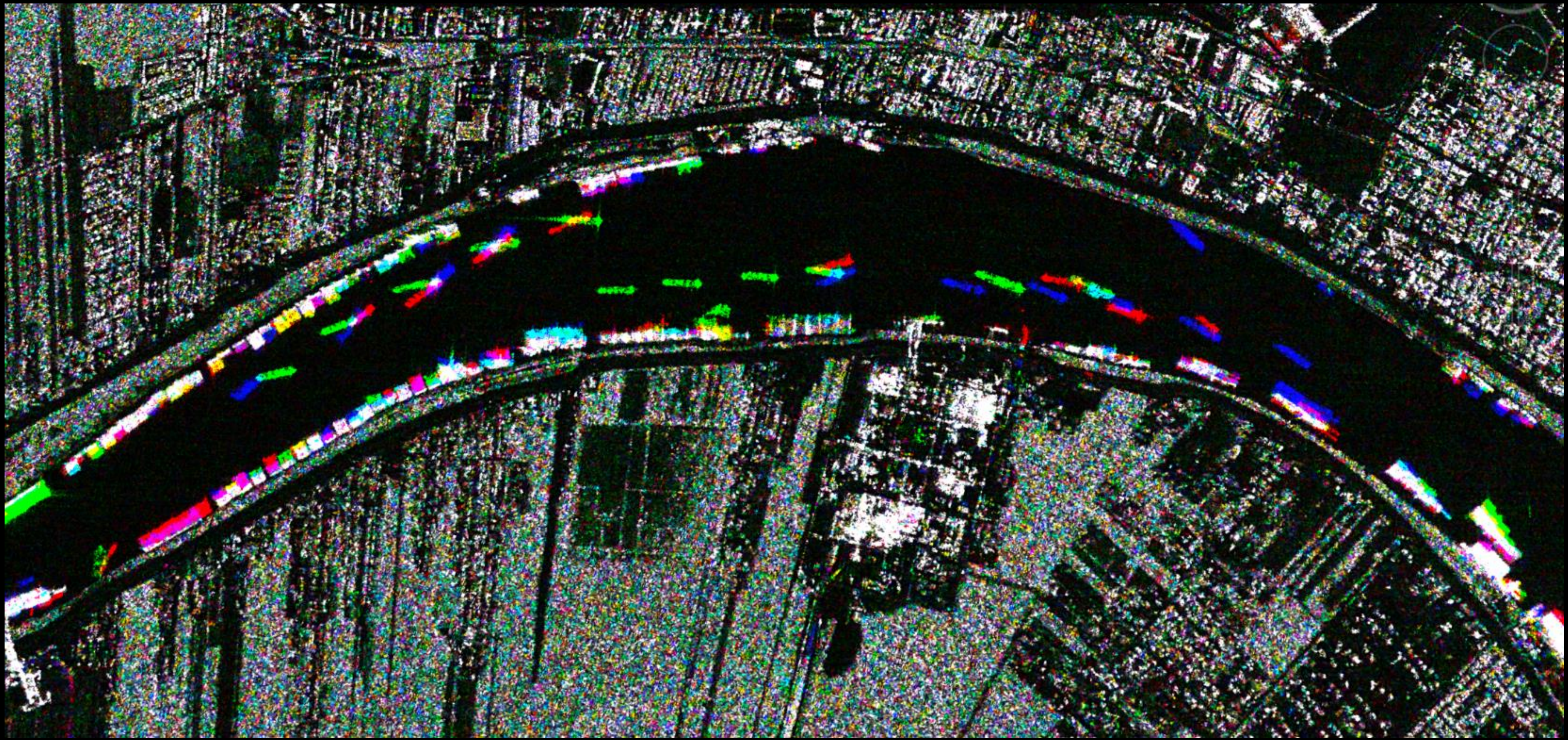
Soil Moisture



Courtesy of R. Lohman

Shipping Activity in New Orleans

Full resolution (5m x 5m) NISAR imagery over New Orleans on three consecutive orbits with red, green, blue assigned to the 1st, 2nd and 3rd images. Colors indicate objects (e.g., boats and barges moored along the riverbanks).



Red: 1st image
Green: 2nd image
Blue: 3rd image

White = 1st+2nd +3rd all
Magenta = 1st and 3rd
Cyan = 2nd and 3rd

M. Lavalle, JPL